Spring Integration Reference Manual

5.0.13.RELEASE

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Part I. Preface

Requirements

This section details the compatible Java and Spring Framework versions.

1 Compatible Java Versions

For *Spring Integration* **5.0.x**, the **minimum** compatible Java version is **Java SE 8**. Older versions of Java are not supported.

2 Compatible Versions of the Spring Framework

Spring Integration **5.0.x** requires *Spring Framework* **5.0** or later.

3 Code Conventions

The Spring Framework 2.0 introduced support for namespaces, which simplifies the XML configuration of the application context, and consequently Spring Integration provides broad namespace support. This reference guide applies the following conventions for all code examples that use namespace support:

The **int** namespace prefix will be used for Spring Integration's core namespace support. Each Spring Integration adapter type (module) will provide its own namespace, which is configured using the following convention:

int- followed by the name of the module, e.g. **int-twitter**, **int-stream**, …

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-twitter="http://www.springframework.org/schema/integration/twitter"
  xmlns:int-stream="http://www.springframework.org/schema/integration/stream"
  xsi:schemaLocation="
   http://www.springframework.org/schema/beans
   https://www.springframework.org/schema/beans/spring-beans.xsd
   http://www.springframework.org/schema/integration
   https://www.springframework.org/schema/integration/spring-integration.xsd
   http://www.springframework.org/schema/integration/twitter
   https://www.springframework.org/schema/integration/twitter/spring-integration-twitter.xsd
   http://www.springframework.org/schema/integration/stream
   https://www.springframework.org/schema/integration/stream/spring-integration-stream.xsd">
…
</beans>
```

For a detailed explanation regarding Spring Integration's namespace support see *the section called "CompletableFuture"*.

Note

Please note that the namespace prefix can be freely chosen. You may even choose not to use any namespace prefixes at all. Therefore, apply the convention that suits your application needs best. Be aware, though, that SpringSource Tool Suite™ (STS) uses the same namespace conventions for Spring Integration as used in this reference guide.

1. Conventions in this Book

In some cases, to aid formatting, when specifying long fully-qualified class names, we shorten the package `org.springframework` to `o.s` and `org.springframework.integration` to `o.s.i`, such as with `o.s.i.transaction.TransactionSynchronizationFactory`.

Part II. What’s new?

For those who are already familiar with Spring Integration, this chapter provides a brief overview of the new features of version 5.0. If you are interested in the changes and features, that were introduced in earlier versions, please see chapter: the section called “CompletableFuture”

2. What’s new in Spring Integration 5.0?

This chapter provides an overview of the new features and improvements that have been introduced with Spring Integration 5.0. If you are interested in more details, please see the Issue Tracker tickets that were resolved as part of the 5.0 development process.

2.1 New Components

Java DSL

The separate Spring Integration Java DSL project has now been merged into the core Spring Integration project. The `IntegrationComponentSpec` implementations for channel adapters and gateways are distributed to their specific modules. See the section called “CompletableFuture” for more information about Java DSL support. Also see the 4.3 to 5.0 Migration Guide for the required steps to move to Spring Integration 5.0.

Testing Support

A new Spring Integration Test Framework has been created to assist with testing Spring Integration applications. Now, with the `@SpringIntegrationTest` annotation on test class and `MockIntegration` factory you can make your JUnit tests for integration flows somewhat easier.

See the section called “CompletableFuture” for more information.

MongoDB Outbound Gateway

The new `MongoDbOutboundGateway` allows you to make queries to the database on demand by sending a message to its request channel.

See the section called “CompletableFuture” for more information.

WebFlux Gateways and Channel Adapters

The new WebFlux support module has been introduced for Spring WebFlux Framework gateways and channel adapters.

See the section called “CompletableFuture” for more information.

Content Type Conversion

Now that we use the new `InvocableHandlerMethod` -based infrastructure for service method invocations, we can perform `contentType` conversion from payload to target method argument.

See the section called “Content Type Conversion” for more information.

ErrorMessagePublisher and ErrorMessageStrategy

The `ErrorMessagePublisher` and the `ErrorMessageStrategy` are provided for creating `ErrorMessage` instances.

See the section called “CompletableFuture” for more information.

JDBC Metadata Store

A JDBC implementation of `MetadataStore` implementation is now provided. This is useful when it is necessary to ensure transactional boundaries for metadata.

See the section called "CompletableFuture" for more information.

2.2 General Changes

Spring Integration is now fully based on Spring Framework `5.0` and Project Reactor `3.1`. Previous Project Reactor versions are no longer supported.

Core Changes

The `@Poller` annotation now has the `errorChannel` attribute for easier configuration of the underlying `MessagePublishingErrorHandler`.

See the section called "CompletableFuture" for more information.

All the request-reply endpoints (based on `AbstractReplyProducingMessageHandler`) can now start transaction and, therefore, make the whole downstream flow transactional.

See the section called "CompletableFuture" for more information.

The `SmartLifecycleRoleController` now provides methods to obtain status of endpoints in roles.

See Section 8.2, "Endpoint Roles" for more information.

POJO methods are now invoked using an `InvocableHandlerMethod` by default, but can be configured to use SpEL as before.

See Section 3.9, "POJO Method invocation" for more information.

When targeting POJO methods as message handlers, one of the service methods can now be marked with the `@Default` annotation to provide a fallback mechanism for non-matched conditions.

See the section called "CompletableFuture" for more information.

A simple `PassThroughTransactionSynchronizationFactory` is provided to always store a polled message in the current transaction context. That message is used as a `failedMessage` property of the `MessagingException` which wraps a raw exception thrown during transaction completion.

See the section called "CompletableFuture" for more information.

The aggregator expression-based `ReleaseStrategy` now evaluates the expression against the `MessageGroup` instead of just the collection of `Message<?>`.

See the section called "Aggregators and Spring Expression Language (SpEL)" for more information.

The `ObjectToMapTransformer` can now be supplied with a customised `JsonObjectMapper`.

See the section called "Aggregators and Spring Expression Language (SpEL)" for more information.

The `@GlobalChannelInterceptor` annotation and `<int:channel-interceptor>` now support negative patterns (via `!` prepending) for component names matching.

See the section called “Global Channel Interceptor Configuration” for more information.

A new `OnFailedToAcquireMutexEvent` is emitted now via `DefaultLeaderEventPublisher` by the `LockRegistryLeaderInitiator`, when candidate is failed to acquire the lock.

See Section 8.3, “Leadership Event Handling” for more information.

Gateway Changes

The gateway now correctly sets the `errorChannel` header when the gateway method has a `void` return type and an error channel is provided. Previously, the header was not populated. This had the effect that synchronous downstream flows (running on the calling thread) would send the exception to the configured channel but an exception on an async downstream flow would be sent to the default `errorChannel` instead.

The `RequestReplyExchanger` interface now has a `throws MessagingException` clause to meet all the proposed messages exchange contract.

The request and reply timeouts can now be specified as SpEL expressions.

See Section 8.4, “Messaging Gateways” for more information.

Aggregator Performance Changes

Aggregators now use a `SimpleSequenceSizeReleaseStrategy` by default, which is more efficient, especially with large groups. Empty groups are now scheduled for removal after `empty-group-min-timeout`.

See Section 6.4, “Aggregator” for more information.

Splitter Changes

The Splitter component now can handle and split Java `Stream` and Reactive Streams `Publisher` objects. If the output channel is a `ReactiveStreamsSubscribableChannel`, the `AbstractMessageSplitter` builds a `Flux` for subsequent iteration instead of a regular `Iterator` independent of object being split. In addition, `AbstractMessageSplitter` provides `protected obtainSizeIfPossible()` methods to allow the determination of the size of the `Iterable` and `Iterator` objects if that is possible.

See Section 6.3, “Splitter” for more information.

JMS Changes

Previously, Spring Integration JMS XML configuration used a default bean name `connectionFactory` for the JMS Connection Factory, allowing the property to be omitted from component definitions. It has now been renamed to `jmsConnectionFactory`, which is the bean name used by Spring Boot to auto-configure the JMS Connection Factory bean.

If your application is relying on the previous behavior, rename your `connectionFactory` bean to `jmsConnectionFactory`, or specifically configure your components to use your bean using its current name.

See the section called “CompletableFuture” for more information.

Mail Changes

Some inconsistencies with rendering IMAP mail content have been resolved.

See the note in the Mail-Receiving Channel Adapter Section for more information.

Feed Changes

Instead of the `com.rometools.fetcher.FeedFetcher`, which is deprecated in ROME, a new `Resource` property has been introduced to the `FeedEntryMessageSource`.

See the section called “CompletableFuture” for more information.

File Changes

The new `FileHeaders.RELATIVE_PATH` Message header has been introduced to represent relative path in the `FileReadingMessageSource`.

The tail adapter now supports `idleEventInterval` to emit events when there is no data in the file during that period.

The flush predicates for the `FileWritingMessageHandler` now have an additional parameter.

The file outbound channel adapter and gateway (`FileWritingMessageHandler`) now support the `REPLACE_IF_MODIFIED` `FileExistsMode`.

They also now support setting file permissions on the newly written file.

A new `FileSystemMarkerFilePresentFileListFilter` is now available; see the section called “CompletableFuture” for more information.

The `FileSplitter` now provides a `firstLineAsHeader` option to carry the first line of content as a header in the messages emitted for the remaining lines.

See the section called “CompletableFuture” for more information.

(S)FTP Changes

The Inbound Channel Adapters now have a property `max-fetch-size` which is used to limit the number of files fetched during a poll when there are no files currently in the local directory. They also are configured with a `FileSystemPersistentAcceptOnceFileListFilter` in the `local-filter` by default.

You can also provide a custom `DirectoryScanner` implementation to Inbound Channel Adapters via the newly introduced `scanner` attribute.

The regex and pattern filters can now be configured to always pass directories. This can be useful when using recursion in the outbound gateways.

All the Inbound Channel Adapters (streaming and synchronization-based) now use an appropriate `AbstractPersistentAcceptOnceFileListFilter` implementation by default to prevent remote files duplicate downloads.

The FTP and SFTP outbound gateways now support the `REPLACE_IF_MODIFIED` `FileExistsMode` when fetching remote files.

The (S)FTP streaming inbound channel adapters now add remote file information in a message header.

The FTP and SFTP outbound channel adapters, as well as `PUT` command of the outbound gateways, now support `InputStream` as `payload`, too.

The inbound channel adapters now can build file tree locally using a newly introduced `RecursiveDirectoryScanner`. See `scanner` option for injection. Also these adapters can now be switched to the `WatchService` instead.

The `NLST` command has been added to the `AbstractRemoteFileOutboundGateway` to perform only list files names remote command.

The `FtpOutboundGateway` can now be supplied with `workingDirExpression` to change the FTP client working directory for the current request message.

The `RemoteFileTemplate` is supplied now with the `invoke(OperationsCallback<F, T> action)` to perform several `RemoteFileOperations` calls in the scope of the same, thread-bounded, `Session`.

New filters for detecting incomplete remote files are now provided.

The `FtpOutboundGateway` and `SftpOutboundGateway` now support an option to remove the remote file after a successful transfer using the `GET` or `MGET` commands.

A `RotatingServerAdvice` is now available to poll multiple servers and/or directories with the inbound channel adapters.

Also inbound adapter `localFilenameExpression` s can contain the variable `#remoteDirectory` which contains the remote directory being polled.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

Integration Properties

Since *version 4.3.2* a new `spring.integration.readOnly.headers` global property has been added to customize the list of headers which should not be copied to a newly created `Message` by the `MessageBuilder`.

See the section called “CompletableFuture” for more information.

Stream Changes

There is a new option on the `CharacterStreamReadingMessageSource` to allow it to be used to "pipe" stdin and publish an application event when the pipe is closed.

See the section called “CompletableFuture” for more information.

Barrier Changes

The `BarrierMessageHandler` now supports a discard channel to which late-arriving trigger messages are sent.

See Section 6.8, “Thread Barrier” for more information.

AMQP Changes

The AMQP outbound endpoints now support setting a delay expression for when using the RabbitMQ Delayed Message Exchange plugin.

The inbound endpoints now support the Spring AMQP `DirectMessageListenerContainer`.

Pollable AMQP-backed channels now block the poller thread for the poller’s configured `receiveTimeout` (default 1 second).

Headers, such as `contentType` that are added to message properties by the message converter are now used in the final message; previously, it depended on the converter type as to which headers/ message properties appeared in the final message. To override headers set by the converter, set the `headersMappedLast` property to `true`.

See the section called “CompletableFuture” for more information.

HTTP Changes

The `DefaultHttpHeaderMapper.userDefinedHeaderPrefix` property is now an empty string by default instead of `X-`.

See the section called “CompletableFuture” for more information.

MQTT Changes

Inbound messages are now mapped with headers `RECEIVED_TOPIC`, `RECEIVED_QOS` and `RECEIVED_RETAINED` to avoid inadvertent propagation to outbound messages when an application is relaying messages.

The outbound channel adapter now supports expressions for the topic, qos and retained properties; the defaults remain the same.

See the section called “CompletableFuture” for more information.

STOMP Changes

The STOMP module has been changed to use `ReactorNettyTcpStompClient`, based on the Project Reactor `3.1` and `reactor-netty` extension. The `Reactor2TcpStompSessionManager` has been renamed to the `ReactorNettyTcpStompSessionManager` according to the `ReactorNettyTcpStompClient` foundation.

See the section called “CompletableFuture” for more information.

Web Services Changes

- The `WebServiceOutboundGateway s` can now be supplied with an externally configured `WebServiceTemplate` instances.
- The `DefaultSoapHeaderMapper` can now map a `javax.xml.transform.Source` user-defined header to a SOAP header element.
- Simple WebService Inbound and Outbound gateways can now deal with the complete `WebServiceMessage` as a `payload`, allowing the manipulation of MTOM attachments.

See the section called “CompletableFuture” for more information.

Redis Changes

The `RedisStoreWritingMessageHandler` is supplied now with additional String-based setters for SpEL expressions - for convenience with Java configuration. The `zsetIncrementExpression` can now be configured on the `RedisStoreWritingMessageHandler`, as well. In addition this property has been changed from `true` to `false` since `INCR` option on `ZADD` Redis command is optional.

The `RedisInboundChannelAdapter` can now be supplied with an `Executor` for executing Redis listener invokers. In addition the received messages now contains a `RedisHeaders.MESSAGE_SOURCE` header to indicate the source of the message - topic or pattern.

See the section called “CompletableFuture” for more information.

TCP Changes

A new `ThreadAffinityClientConnectionFactory` is provided that binds TCP connections to threads.

You can now configure the TCP connection factories to support `PushbackInputStream` s, allowing deserializers to "unread" (push back) bytes after "reading ahead".

A `ByteArrayElasticRawDeserializer` has been added without `maxMessageSize` control and buffer incoming data as needed.

See the section called “CompletableFuture” for more information.

Gemfire Changes

The `GemfireMetadataStore` now implements `ListenableMetadataStore`, allowing users to listen to cache events by providing `MetadataStoreListener` instances to the store.

See the section called “CompletableFuture” for more information.

Jdbc Changes

The `JdbcMessageChannelStore` now provides setter for the `ChannelMessageStorePreparedStatementSetter` allowing users to customize a message insertion in the store.

The `ExpressionEvaluatingSqlParameterSourceFactory` now provides setter for the sqlParameterTypes allowing users to customize sql types of the parameters.

See the section called “CompletableFuture” for more information.

Metrics Changes

Micrometer application monitoring is now supported (since *version 5.0.2*). See the section called “CompletableFuture” for more information.

Important

Changes were made to the Micrometer `Meters` in *version 5.0.3* to make them more suitable for use in dimensional systems. Further changes were made in 5.0.4; if using Micrometer, a minimum of version 5.0.4 is recommended.

2.3 TCP Support

When using SSL, host verification can be configured, to prevent man-in-the-middle attacks with a trusted certificate. See the section called “CompletableFuture” for more information.

In addition the key and trust store types can now be configured on the `DefaultTcpSSLContextSupport`.

@EndpointId Annotations

Introduced in *version 5.0.4*, this annotation provides control over bean naming when using Java configuration. See the section called “Endpoint Bean Names” for more information.

Integration Flows: Generated bean names

Starting with *version 5.0.5*, generated bean names for the components in an `IntegrationFlow` include the flow bean name, followed by a dot, as a prefix.

See the section called “CompletableFuture” for more information.

Part III. Overview of Spring Integration Framework

Spring Integration provides an extension of the Spring programming model to support the well-known Enterprise Integration Patterns. It enables lightweight messaging *within* Spring-based applications and supports integration with external systems via declarative adapters. Those adapters provide a higher-level of abstraction over Spring’s support for remoting, messaging, and scheduling. Spring Integration’s primary goal is to provide a simple model for building enterprise integration solutions while maintaining the separation of concerns that is essential for producing maintainable, testable code.

3. Spring Integration Overview

3.1 Background

One of the key themes of the Spring Framework is *inversion of control*. In its broadest sense, this means that the framework handles responsibilities on behalf of the components that are managed within its context. The components themselves are simplified since they are relieved of those responsibilities. For example, *dependency injection* relieves the components of the responsibility of locating or creating their dependencies. Likewise, *aspect-oriented programming* relieves business components of generic cross-cutting concerns by modularizing them into reusable aspects. In each case, the end result is a system that is easier to test, understand, maintain, and extend.

Furthermore, the Spring framework and portfolio provide a comprehensive programming model for building enterprise applications. Developers benefit from the consistency of this model and especially the fact that it is based upon well-established best practices such as programming to interfaces and favoring composition over inheritance. Spring's simplified abstractions and powerful support libraries boost developer productivity while simultaneously increasing the level of testability and portability.

Spring Integration is motivated by these same goals and principles. It extends the Spring programming model into the messaging domain and builds upon Spring's existing enterprise integration support to provide an even higher level of abstraction. It supports message-driven architectures where inversion of control applies to runtime concerns, such as *when* certain business logic should execute and *where* the response should be sent. It supports routing and transformation of messages so that different transports and different data formats can be integrated without impacting testability. In other words, the messaging and integration concerns are handled by the framework, so business components are further isolated from the infrastructure and developers are relieved of complex integration responsibilities.

As an extension of the Spring programming model, Spring Integration provides a wide variety of configuration options including annotations, XML with namespace support, XML with generic "bean" elements, and of course direct usage of the underlying API. That API is based upon well-defined strategy interfaces and non-invasive, delegating adapters. Spring Integration's design is inspired by the recognition of a strong affinity between common patterns within Spring and the well-known Enterprise Integration Patterns as described in the book of the same name by Gregor Hohpe and Bobby Woolf (Addison Wesley, 2004). Developers who have read that book should be immediately comfortable with the Spring Integration concepts and terminology.

3.2 Goals and Principles

Spring Integration is motivated by the following goals:

- Provide a simple model for implementing complex enterprise integration solutions.
- Facilitate asynchronous, message-driven behavior within a Spring-based application.
- Promote intuitive, incremental adoption for existing Spring users.

Spring Integration is guided by the following principles:

- Components should be *loosely coupled* for modularity and testability.
- The framework should enforce *separation of concerns* between business logic and integration logic.

- Extension points should be abstract in nature but within well-defined boundaries to promote *reuse* and *portability*.

3.3 Main Components

From the *vertical* perspective, a layered architecture facilitates separation of concerns, and interface-based contracts between layers promote loose coupling. Spring-based applications are typically designed this way, and the Spring framework and portfolio provide a strong foundation for following this best practice for the full-stack of an enterprise application. Message-driven architectures add a *horizontal* perspective, yet these same goals are still relevant. Just as "layered architecture" is an extremely generic and abstract paradigm, messaging systems typically follow the similarly abstract "pipes-and-filters" model. The "filters" represent any component that is capable of producing and/or consuming messages, and the "pipes" transport the messages between filters so that the components themselves remain loosely-coupled. It is important to note that these two high-level paradigms are not mutually exclusive. The underlying messaging infrastructure that supports the "pipes" should still be encapsulated in a layer whose contracts are defined as interfaces. Likewise, the "filters" themselves would typically be managed within a layer that is logically above the application's service layer, interacting with those services through interfaces much in the same way that a web-tier would.

Message

In Spring Integration, a Message is a generic wrapper for any Java object combined with metadata used by the framework while handling that object. It consists of a payload and headers. The payload can be of any type and the headers hold commonly required information such as id, timestamp, correlation id, and return address. Headers are also used for passing values to and from connected transports. For example, when creating a Message from a received File, the file name may be stored in a header to be accessed by downstream components. Likewise, if a Message's content is ultimately going to be sent by an outbound Mail adapter, the various properties (to, from, cc, subject, etc.) may be configured as Message header values by an upstream component. Developers can also store any arbitrary key-value pairs in the headers.

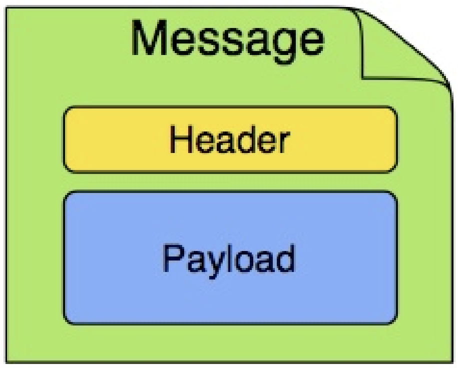


Figure 3.1. Message

Message Channel

A Message Channel represents the "pipe" of a pipes-and-filters architecture. Producers send Messages to a channel, and consumers receive Messages from a channel. The Message Channel therefore decouples the messaging components, and also provides a convenient point for interception and monitoring of Messages.

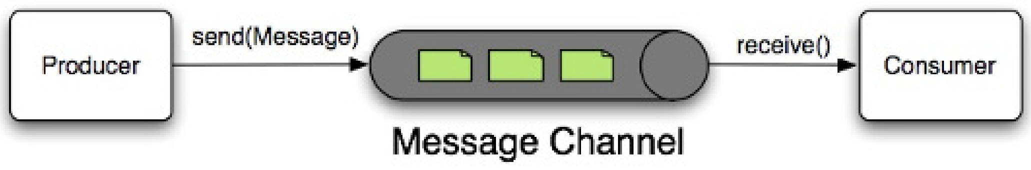


Figure 3.2. Message Channel

A Message Channel may follow either Point-to-Point or Publish/Subscribe semantics. With a Point-to-Point channel, at most one consumer can receive each Message sent to the channel. Publish/Subscribe channels, on the other hand, will attempt to broadcast each Message to all of its subscribers. Spring Integration supports both of these.

Whereas "Point-to-Point" and "Publish/Subscribe" define the two options for *how many* consumers will ultimately receive each Message, there is another important consideration: should the channel buffer messages? In Spring Integration, *Pollable Channels* are capable of buffering Messages within a queue. The advantage of buffering is that it allows for throttling the inbound Messages and thereby prevents overloading a consumer. However, as the name suggests, this also adds some complexity, since a consumer can only receive the Messages from such a channel if a *poller* is configured. On the other hand, a consumer connected to a *Subscribable Channel* is simply Message-driven. The variety of channel implementations available in Spring Integration will be discussed in detail in the section called “Message Channel Implementations”.

Message Endpoint

One of the primary goals of Spring Integration is to simplify the development of enterprise integration solutions through *inversion of control*. This means that you should not have to implement consumers and producers directly, and you should not even have to build Messages and invoke send or receive operations on a Message Channel. Instead, you should be able to focus on your specific domain model with an implementation based on plain Objects. Then, by providing declarative configuration, you can "connect" your domain-specific code to the messaging infrastructure provided by Spring Integration. The components responsible for these connections are Message Endpoints. This does not mean that you will necessarily connect your existing application code directly. Any real-world enterprise integration solution will require some amount of code focused upon integration concerns such as *routing* and *transformation*. The important thing is to achieve separation of concerns between such integration logic and business logic. In other words, as with the Model-View-Controller paradigm for web applications, the goal should be to provide a thin but dedicated layer that translates inbound requests into service layer invocations, and then translates service layer return values into outbound replies. The next section will provide an overview of the Message Endpoint types that handle these responsibilities, and in upcoming chapters, you will see how Spring Integration’s declarative configuration options provide a non-invasive way to use each of these.

3.4 Message Endpoints

A Message Endpoint represents the "filter" of a pipes-and-filters architecture. As mentioned above, the endpoint’s primary role is to connect application code to the messaging framework and to do so in a non-invasive manner. In other words, the application code should ideally have no awareness of the Message objects or the Message Channels. This is similar to the role of a Controller in the MVC paradigm. Just as a Controller handles HTTP requests, the Message Endpoint handles Messages. Just as Controllers are mapped to URL patterns, Message Endpoints are mapped to Message Channels. The goal is the same in both cases: isolate application code from the infrastructure. These concepts are discussed at length along with all of the patterns that follow in the Enterprise Integration Patterns book. Here, we provide only a high-level description of the main endpoint types supported by Spring Integration and their roles. The chapters that follow will elaborate and provide sample code as well as configuration examples.

Transformer

A Message Transformer is responsible for converting a Message’s content or structure and returning the modified Message. Probably the most common type of transformer is one that converts the payload of the Message from one format to another (e.g. from XML Document to java.lang.String). Similarly, a transformer may be used to add, remove, or modify the Message’s header values.

Filter

A Message Filter determines whether a Message should be passed to an output channel at all. This simply requires a boolean test method that may check for a particular payload content type, a property value, the presence of a header, etc. If the Message is accepted, it is sent to the output channel, but if not it will be dropped (or for a more severe implementation, an Exception could be thrown). Message Filters are often used in conjunction with a Publish Subscribe channel, where multiple consumers may receive the same Message and use the filter to narrow down the set of Messages to be processed based on some criteria.

> **Note**
>
> Be careful not to confuse the generic use of "filter" within the Pipes-and-Filters architectural pattern with this specific endpoint type that selectively narrows down the Messages flowing between two channels. The Pipes-and-Filters concept of "filter" matches more closely with Spring Integration’s Message Endpoint: any component that can be connected to Message Channel(s) in order to send and/or receive Messages.

Router

A Message Router is responsible for deciding what channel or channels should receive the Message next (if any). Typically the decision is based upon the Message’s content and/or metadata available in the Message Headers. A Message Router is often used as a dynamic alternative to a statically configured output channel on a Service Activator or other endpoint capable of sending reply Messages. Likewise, a Message Router provides a proactive alternative to the reactive Message Filters used by multiple subscribers as described above.

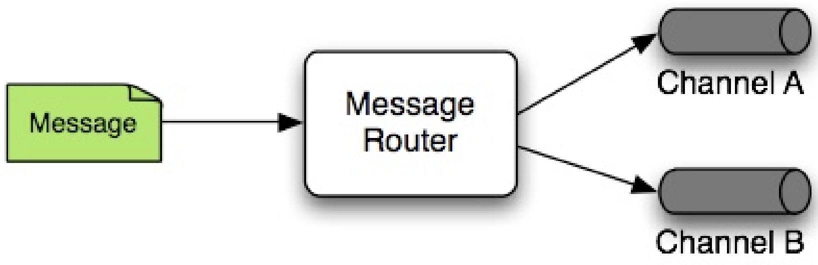


Figure 3.3. Router

Splitter

A Splitter is another type of Message Endpoint whose responsibility is to accept a Message from its input channel, split that Message into multiple Messages, and then send each of those to its output channel.

This is typically used for dividing a "composite" payload object into a group of Messages containing the sub-divided payloads.

Aggregator

Basically a mirror-image of the Splitter, the Aggregator is a type of Message Endpoint that receives multiple Messages and combines them into a single Message. In fact, Aggregators are often downstream consumers in a pipeline that includes a Splitter. Technically, the Aggregator is more complex than a Splitter, because it is required to maintain state (the Messages to-be-aggregated), to decide when the complete group of Messages is available, and to timeout if necessary. Furthermore, in case of a timeout, the Aggregator needs to know whether to send the partial results or to discard them to a separate channel. Spring Integration provides a `CorrelationStrategy`, a `ReleaseStrategy` and configurable settings for: timeout, whether to send partial results upon timeout, and a discard channel.

Service Activator

A Service Activator is a generic endpoint for connecting a service instance to the messaging system. The input Message Channel must be configured, and if the service method to be invoked is capable of returning a value, an output Message Channel may also be provided.

> **Note**
>
> The output channel is optional, since each Message may also provide its own *Return Address* header. This same rule applies for all consumer endpoints.

The Service Activator invokes an operation on some service object to process the request Message, extracting the request Message's payload and converting if necessary (if the method does not expect a Message-typed parameter). Whenever the service object's method returns a value, that return value will likewise be converted to a reply Message if necessary (if it's not already a Message). That reply Message is sent to the output channel. If no output channel has been configured, then the reply will be sent to the channel specified in the Message's "return address" if available.

A request-reply "Service Activator" endpoint connects a target object's method to input and output Message Channels.

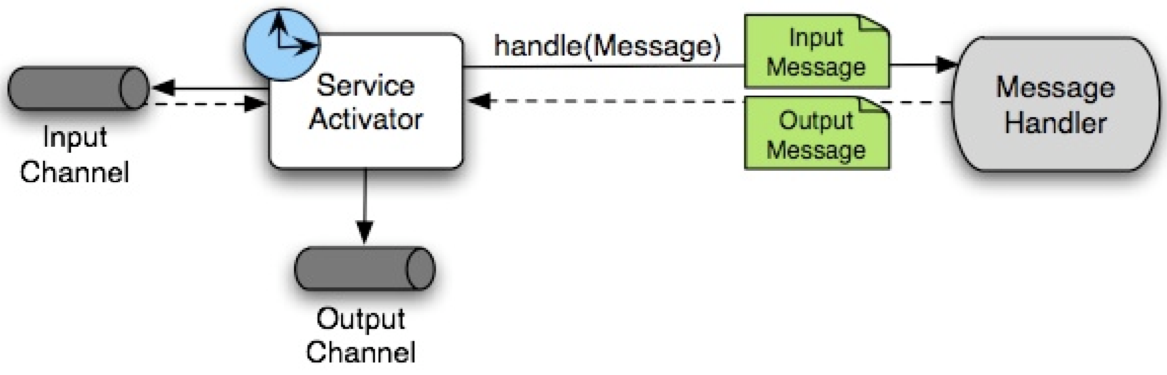


Figure 3.4. Service Activator

> **Note**
>
> As discussed in Message Channel above, channels can be *Pollable* or *Subscribable*; in this diagram, this is depicted by the "clock" symbol and the solid arrow (poll) and the dotted arrow (subscribe).

Channel Adapter

A Channel Adapter is an endpoint that connects a Message Channel to some other system or transport. Channel Adapters may be either inbound or outbound. Typically, the Channel Adapter will do some mapping between the Message and whatever object or resource is received-from or sent-to the other system (File, HTTP Request, JMS Message, etc). Depending on the transport, the Channel Adapter may also populate or extract Message header values. Spring Integration provides a number of Channel Adapters, and they will be described in upcoming chapters.

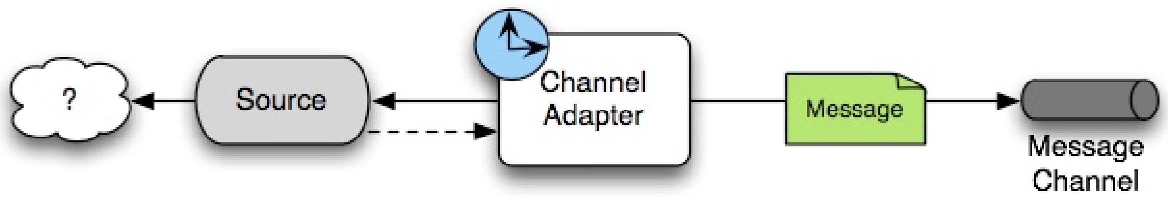


Figure 3.5. An inbound "Channel Adapter" endpoint connects a source system to a MessageChannel.

> **Note**
>
> Message sources can be *Pollable* (e.g. POP3) or *Message-Driven* (e.g. IMAP Idle); in this diagram, this is depicted by the "clock" symbol and the solid arrow (poll) and the dotted arrow (message-driven).

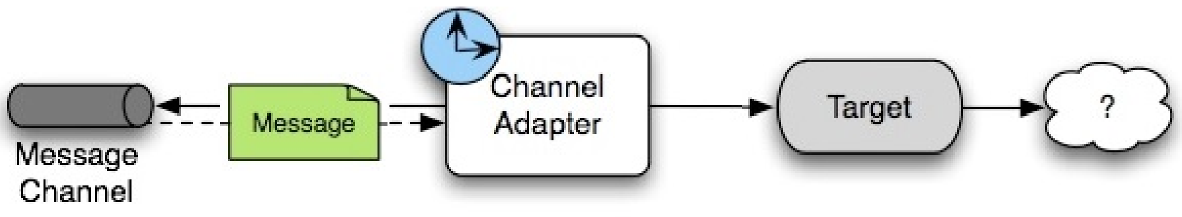


Figure 3.6. An outbound "Channel Adapter" endpoint connects a MessageChannel to a target system.

> **Note**
>
> As discussed in Message Channel above, channels can be *Pollable* or *Subscribable*; in this diagram, this is depicted by the "clock" symbol and the solid arrow (poll) and the dotted arrow (subscribe).

Endpoint Bean Names

Consuming endpoints (anything with an `inputChannel`) consist of two beans, the consumer and message handler. The consumer has a reference to the message handler and invokes it as messages arrive.

When configuring with XML:

```
<int:service-activator id = "someService" ... />
```

the bean names will be as follows:

- Consumer: `someService` (the `id`)

- Handler: `someService.handler`

When using EIP annotations, the names depend on several factors.

When Annotating POJO Methods

```
@Component
public class SomeComponent {

    @ServiceActivator(inputChannel = ...)
    public String someMethod(...) {
        ...
    }

}
```

the bean names will be as follows:

- Consumer: `someComponent.someMethod.serviceActivator`
- Handler: `someComponent.someMethod.serviceActivator.handler`

Starting with *version 5.0.4*, these names can be modified using the `@EndpointId` annotation:

```
@Component
public class SomeComponent {

    @EndpointId("someService")
    @ServiceActivator(inputChannel = ...)
    public String someMethod(...) {
        ...
    }

}
```

the bean names will be as follows:

- Consumer: `someService`
- Handler: `someService.handler`

i.e. `@EndpointId` creates names as created by the `id` attribute with XML configuration.

When Annotating @Beans

```
@Configuration
public class SomeConfiguration {

    @Bean
    @ServiceActivator(inputChannel = ...)
    public MessageHandler someHandler() {
        ...
    }

}
```

the bean names will be as follows:

- Consumer: `someConfiguration.someHandler.serviceActivator`
- Handler: `someHandler` (the `@Bean` name)

Starting with *version 5.0.4*, these names can be modified using the `@EndpointId` annotation:

```
@Configuratiom
public class SomeConfiguration {

    @Bean("someService.handler")
    @EndpointId("someService")
    @ServiceActivator(inputChannel = ...)
    public MessageHandler someHandler() {
        ...
    }

}
```

- Consumer: `someService`
- Handler: `someService.handler`

i.e. `@EndpointId` creates names as created by the `id` attribute with XML configuration, as long as you use the convention of appending `.handler` to the `@Bean` name.

There is one special case where a third bean is created; for architectural reasons, if a `MessageHandler` `@Bean` does not define an `AbstractReplyProducingMessageHandler`, the framework wraps the provided bean in a `ReplyProducingMessageHandlerWrapper`. This wrapper supports request handler advice handling as well as emitting the normal *produced no reply* debug log messages. Its bean name is the handler bean name plus `.wrapper` (when there is an `@EndpointId`, otherwise it's the normal generated handler name).

Message Sources

Similarly Pollable Message Sources create two beans, a `SourcePollingChannelAdapter` (SPCA) and a `MessageSource`.

When configuring with XML:

```
<int:inbound-channel-adapter id = "someAdapter" ... />
```

the bean names will be as follows:

- SPCA: `someAdapter` (the `id`)
- Handler: `someAdapter.source`

Using `@EndpointId` with Java configuration:

```
@EndpointId("someAdapter")
@InboundChannelAdapter(channel = "channel3", poller = @Poller(fixedDelay = "5000"))
public String pojoSource() {
    ...
}
```

the bean names will be as follows:

- SPCA: `someAdapter`
- Handler: `someAdapter.source`

```
@Bean("someAdapter.source")
@EndpointId("someAdapter")
@InboundChannelAdapter(channel = "channel3", poller = @Poller(fixedDelay = "5000"))
public MessageSource<?> source() {
    return () -> {
        ...
    };
}
```

the bean names will be as follows:

- SPCA: `someAdapter`
- Handler: `someAdapter.source` (as long as you use the convention of appending `.source` to the `@Bean` name)

3.5 Configuration and @EnableIntegration

Throughout this document you will see references to XML namespace support for declaring elements in a Spring Integration flow. This support is provided by a series of namespace parsers that generate appropriate bean definitions to implement a particular component. For example, many endpoints consist of a `MessageHandler` bean and a `ConsumerEndpointFactoryBean` into which the handler and an input channel name are injected.

The first time a Spring Integration namespace element is encountered, the framework automatically declares a number of beans that are used to support the runtime environment (task scheduler, implicit channel creator, etc).

Important

Starting with *version 4.0*, the `@EnableIntegration` annotation has been introduced, to allow the registration of Spring Integration infrastructure beans (see JavaDocs). This annotation is required when only Java & Annotation configuration is used, e.g. with Spring Boot and/or Spring Integration Messaging Annotation support and Spring Integration Java DSL with no XML integration configuration.

The `@EnableIntegration` annotation is also useful when you have a parent context with no Spring Integration components and 2 or more child contexts that use Spring Integration. It enables these common components to be declared once only, in the parent context.

The `@EnableIntegration` annotation registers many infrastructure components with the application context:

- Registers some built-in beans, e.g. `errorChannel` and its `LoggingHandler`, `taskScheduler` for pollers, `jsonPath` SpEL-function etc.;
- Adds several `BeanFactoryPostProcessor` s to enhance the `BeanFactory` for global and default integration environment;
- Adds several `BeanPostProcessor` s to enhance and/or convert and wrap particular beans for integration purposes;
- Adds annotations processors to parse Messaging Annotations and registers components for them with the application context.

The `@IntegrationComponentScan` annotation has also been introduced to permit classpath scanning. This annotation plays a similar role as the standard Spring Framework `@ComponentScan` annotation, but it is restricted just to Spring Integration specific components and annotations, which aren't reachable by the standard Spring Framework component scan mechanism. For example the section called "@MessagingGateway Annotation".

The `@EnablePublisher` annotation has been introduced to register a `PublisherAnnotationBeanPostProcessor` bean and configure the `default-publisher-channel` for those `@Publisher` annotations which are provided without a `channel` attribute. If more than one `@EnablePublisher` annotation is found, they must all have the same value for the default channel. See the section called "CompletableFuture" for more information.

The `@GlobalChannelInterceptor` annotation has been introduced to mark `ChannelInterceptor` beans for global channel interception. This annotation is an analogue of the `<int:channel-interceptor>` xml element (see the section called "Global Channel Interceptor Configuration"). `@GlobalChannelInterceptor` annotations can be placed at the class level (with a `@Component` stereotype annotation), or on `@Bean` methods within `@Configuration` classes. In either case, the bean **must** be a `ChannelInterceptor`.

The `@IntegrationConverter` annotation has been introduced to mark `Converter`, `GenericConverter` or `ConverterFactory` beans as candidate converters for `integrationConversionService`. This annotation is an analogue of the `<int:converter>` xml element (see the section called "Payload Type Conversion"). `@IntegrationConverter` annotations can be placed at the class level (with a `@Component` stereotype annotation), or on `@Bean` methods within `@Configuration` classes.

Also see the section called "CompletableFuture" for more information about Messaging Annotations.

3.6 Programming Considerations

It is generally recommended that you use plain old java objects (POJOs) whenever possible and only expose the framework in your code when absolutely necessary. See Section 3.9, "POJO Method invocation" for more information.

If you do expose the framework to your classes, there are some considerations that need to be taken into account, especially during application startup; some of these are listed here.

- If your component is `ApplicationContextAware`, you should generally not "use" the `ApplicationContext` in the `setApplicationContext()` method; just store a reference and defer such uses until later in the context lifecycle.

- If your component is an `InitializingBean` or uses `@PostConstruct` methods, do not send any messages from these initialization methods - the application context is not yet initialized when these methods are called, and sending such messages will likely fail. If you need to send a messages during startup, implement `ApplicationListener` and wait for the `ContextRefreshedEvent`. Alternatively, implement `SmartLifecycle`, put your bean in a late phase, and send the messages from the `start()` method.

3.7 Considerations When using Packaged (e.g. Shaded) Jars

Spring Integration bootstraps certain features using Spring Framework's `SpringFactories` mechanism to load several `IntegrationConfigurationInitializer` classes. This includes the

`-core` jar as well as certain others such as `-http`, `-jmx`, etc. The information for this process is stored in a file `META-INF/spring.factories` in each jar.

Some developers prefer to repackage their application and all dependencies into a single jar using well-known tools, such as the Apache Maven Shade Plugin.

By default, the shade plugin will not merge the `spring.factories` files when producing the shaded jar.

In addition to `spring.factories`, there are other `META-INF` files (`spring.handlers`, `spring.schemas`) used for XML configuration. These also need to be merged.

> **Important**
>
> Spring Boot's executable jar mechanism takes a different approach in that it nests the jars, thus retaining each `spring.factories` file on the class path. So, with a Spring Boot application, nothing more is needed, if you use its default executable jar format.

Even if you are not using Spring Boot, you can still use tooling provided by Boot to enhance the shade plugin by adding transformers for the above mentioned files.

The following is an example configuration for the plugin at the time of writing. You may wish to consult the current spring-boot-starter-parent pom to see the current settings that boot uses.

pom.xml.

```
...
    <plugins>
        <plugin>
            <groupId>org.apache.maven.plugins</groupId>
            <artifactId>maven-shade-plugin</artifactId>
            <configuration>
                <keepDependenciesWithProvidedScope>true</keepDependenciesWithProvidedScope>
                <createDependencyReducedPom>true</createDependencyReducedPom>
            </configuration>
            <dependencies>
                <dependency> ❶
                    <groupId>org.springframework.boot</groupId>
                    <artifactId>spring-boot-maven-plugin</artifactId>
                    <version>${spring.boot.version}</version>
                </dependency>
            </dependencies>
            <executions>
                <execution>
                    <phase>package</phase>
                    <goals>
                        <goal>shade</goal>
                    </goals>
                    <configuration>
                        <transformers> ❷
                            <transformer

  implementation="org.apache.maven.plugins.shade.resource.AppendingTransformer">
                                <resource>META-INF/spring.handlers</resource>
                            </transformer>
                            <transformer

  implementation="org.springframework.boot.maven.PropertiesMergingResourceTransformer">
                                <resource>META-INF/spring.factories</resource>
                            </transformer>
                            <transformer

  implementation="org.apache.maven.plugins.shade.resource.AppendingTransformer">
                                <resource>META-INF/spring.schemas</resource>
                            </transformer>
                            <transformer

  implementation="org.apache.maven.plugins.shade.resource.ServicesResourceTransformer" />
                        </transformers>
                    </configuration>
                </execution>
            </executions>
        </plugin>
    </plugins>
...
```

Specifically,

❶ add the `spring-boot-maven-plugin` as a dependency

❷ configure the transformers

Add a property for `${spring.boot.version}` or use a version explicitly there.

3.8 Programming Tips and Tricks

XML Schemas

When using XML configuration, to avoid getting false schema validation errors, you should use a "Spring-aware" IDE, such as the Spring Tool Suite (STS) (or eclipse with the Spring IDE plugins) or IntelliJ IDEA, for example. These IDEs know how to resolve the correct XML schema from the classpath (using the

`META-INF/spring.schemas` file in the jar(s)). When using STS, or eclipse with the plugin, be sure to enable `Spring Project Nature` on the project.

The schemas hosted on the internet for certain legacy modules (those that existed in version 1.0) are the 1.0 versions for compatibility reasons; if your IDE uses these schemas, you will likely see false errors.

Each of these online schemas has a warning similar to this:

> **Important**
>
> This schema is for the 1.0 version of Spring Integration Core. We cannot update it to the current schema because that will break any applications using 1.0.3 or lower. For subsequent versions, the unversioned schema is resolved from the classpath and obtained from the jar. Please refer to github:
>
> https://github.com/spring-projects/spring-integration/tree/master/spring-integration-core/src/main/resources/org/springframework/integration/config

The affected modules are

- core (`spring-integration.xsd`)
- file
- http
- jms
- mail
- rmi
- security
- stream
- ws
- xml

Finding Class Names for Java and DSL Configuration

With XML configuration and Spring Integration Namespace support, the XML Parsers hide how target beans are declared and wired together. For Java & Annotation Configuration, it is important to understand the Framework API for target end-user applications.

The first class citizens for EIP implementation are `Message`, `Channel` and `Endpoint` (see Section 3.3, “Main Components” above). Their implementations (contracts) are:

- `org.springframework.messaging.Message` - see Section 5.1, “Message”;
- `org.springframework.messaging.MessageChannel` - see Section 4.1, “Message Channels”;
- `org.springframework.integration.endpoint.AbstractEndpoint` - see Section 4.2, “Poller”.

The first two are simple enough to understand how to implement, configure and use, respectively; the last one deserves more review.

The `AbstractEndpoint` is widely used throughout the Framework for different component implementations; its main implementations are:

- `EventDrivenConsumer`, when we subscribe to a `SubscribableChannel` to *listen* for messages;
- `PollingConsumer`, when we *poll* for messages from a `PollableChannel`.

Using Messaging Annotations and/or Java DSL, you shouldn't worry about these components, because the Framework produces them automatically via appropriate annotations and `BeanPostProcessor` s. When building components manually, the `ConsumerEndpointFactoryBean` should be used to help to determine the target `AbstractEndpoint` consumer implementation to create, based on the provided `inputChannel` property.

On the other hand, the `ConsumerEndpointFactoryBean` delegates to an another first class citizen in the Framework - `org.springframework.messaging.MessageHandler`. The goal of the implementation of this interface is to *handle the message consumed by the endpoint from the channel*. All EIP components in Spring Integration are `MessageHandler` implementations, e.g. `AggregatingMessageHandler`, `MessageTransformingHandler`, `AbstractMessageSplitter` etc.; as well as the target protocol outbound adapters are implementations too, e.g. `FileWritingMessageHandler`, `HttpRequestExecutingMessageHandler`, `AbstractMqttMessageHandler` etc. When you develop Spring Integration applications with Java & Annotation Configuration, you should take a look into the Spring Integration module to find an appropriate `MessageHandler` implementation to be used for the `@ServiceActivator` configuration. For example to send an XMPP message (see the section called "CompletableFuture") we should configure something like this:

```
@Bean
@ServiceActivator(inputChannel = "input")
public MessageHandler sendChatMessageHandler(XMPPConnection xmppConnection) {
    ChatMessageSendingMessageHandler handler = new ChatMessageSendingMessageHandler(xmppConnection);

    DefaultXmppHeaderMapper xmppHeaderMapper = new DefaultXmppHeaderMapper();
    xmppHeaderMapper.setRequestHeaderNames("*");
    handler.setHeaderMapper(xmppHeaderMapper);

    return handler;
}
```

The `MessageHandler` implementations represent the *outbound* and *processing* part of the message flow.

The *inbound* message flow side has its own components, which are divided to *polling* and *listening* behaviors. The listening (message-driven) components are simple and typically require only one target class implementation to be ready to produce messages. Listening components can be one-way `MessageProducerSupport` implementations, e.g. `AbstractMqttMessageDrivenChannelAdapter` and `ImapIdleChannelAdapter`; and request-reply - `MessagingGatewaySupport` implementations, e.g. `AmqpInboundGateway` and `AbstractWebServiceInboundGateway`.

Polling inbound endpoints are for those protocols which don't provide a listener API or aren't intended for such a behavior. For example any File based protocol, as an FTP, any data bases (RDBMS or NoSQL) etc.

These inbound endpoints consist with two components: the poller configuration, to initiate the polling task periodically, and message source class to read data from the target protocol and produce a message for the downstream integration flow. The first class, for the poller configuration, is a `SourcePollingChannelAdapter`. It is one more `AbstractEndpoint` implementation, but especially for polling to initiate an integration flow. Typically, with the Messaging Annotations or Java DSL, you shouldn't worry about this class, the Framework produces a bean for it, based on the `@InboundChannelAdapter` configuration or a Java DSL Builder spec.

Message source components are more important for the target application development and they all implement the `MessageSource` interface, e.g. `MongoDbMessageSource` and `AbstractTwitterMessageSource`. With that in mind, our config for reading data from an RDBMS table with JDBC may look like:

```
@Bean
@InboundChannelAdapter(value = "fooChannel", poller = @Poller(fixedDelay="5000"))
public MessageSource<?> storedProc(DataSource dataSource) {
    return new JdbcPollingChannelAdapter(dataSource, "SELECT * FROM foo where status = 0");
}
```

All the required *inbound* and *outbound* classes for the target protocols you can find in the particular Spring Integration module, in most cases in the respective package. For example `spring-integration-websocket` adapters are:

- `o.s.i.websocket.inbound.WebSocketInboundChannelAdapter` - implements `MessageProducerSupport` implementation to listen frames on the socket and produce message to the channel;
- `o.s.i.websocket.outbound.WebSocketOutboundMessageHandler` - the one-way `AbstractMessageHandler` implementation to convert incoming messages to the appropriate frame and send over websocket.

If you are familiar with Spring Integration XML configuration, starting with *version 4.3*, we provide information in the XSD element definitions about which target classes are used to declare beans for the adapter or gateway, for example:

```
<xsd:element name="outbound-async-gateway">
    <xsd:annotation>
  <xsd:documentation>
Configures a Consumer Endpoint for the 'o.s.i.amqp.outbound.AsyncAmqpOutboundGateway'
that will publish an AMQP Message to the provided Exchange and expect a reply Message.
The sending thread returns immediately; the reply is sent asynchronously; uses
 'AsyncRabbitTemplate.sendAndReceive()'.
       </xsd:documentation>
 </xsd:annotation>
```

3.9 POJO Method invocation

As discussed in Section 3.6, “Programming Considerations”, it is generally recommended to use a POJO programming style. For example,

```
@ServiceActivator
public String myService(String payload) { ... }
```

In this case, the framework will extract a String payload, invoke your method, and wrap the result in a message to send to the next component in the flow (the original headers will be copied to the new message). In fact, if you are using XML configuration, you don't even need the `@ServiceActivator` annotation:

```
<int:service-activator ... ref="myPojo" method="myService" />
```

```
public String myService(String payload) { ... }
```

You can omit the `method` attribute as long as there is no ambiguity in the public methods on the class.

Some further observations:

You can obtain header information in your POJO methods:

```
@ServiceActivator
public String myService(@Payload String payload, @Header("foo") String fooHeader) { ... }
```

You can dereference properties on the message:

```
@ServiceActivator
public String myService(@Payload("payload.foo") String foo, @Header("bar.baz") String barbaz) { ... }
```

Because many any varied POJO method invocations are available, versions prior to *5.0* used SpEL to invoke the POJO methods. SpEL (even interpreted) is usually "fast enough" for these operations, when compared to the actual work usually done in the methods. However, starting with *version 5.0*, the `org.springframework.messaging.handler.invocation.InvocableHandlerMethod` is used by default, when possible. This technique is usually faster to execute than interpreted SpEL and is consistent with other Spring messaging projects. The `InvocableHandlerMethod` is similar to the technique used to invoke controller methods in Spring MVC. There are certain methods that are still always invoked using SpEL; examples include annotated parameters with dereferenced properties as discussed above. This is because SpEL has the capability to navigate a property path.

There may be some other corner cases that we haven't considered that also won't work with `InvocableHandlerMethod` s. For this reason, we automatically fall-back to using SpEL in those cases.

If you wish, you can also set up your POJO method such that it always uses SpEL, with the `UseSpelInvoker` annotation:

```
@UseSpelInvoker(compilerMode = "IMMEDIATE")
public void bar(String bar) { ... }
```

If the `compilerMode` property is omitted, the `spring.expression.compiler.mode` system property will determine the compiler mode - see SpEL compilation for more information about compiled SpEL.

Part IV. Core Messaging

This section covers all aspects of the core messaging API in Spring Integration. Here you will learn about Messages, Message Channels, and Message Endpoints. Many of the Enterprise Integration Patterns are covered here as well, such as Filters, Routers, Transformers, Service-Activators, Splitters, and Aggregators. The section also contains material about System Management, including the Control Bus and Message History support.

4. Messaging Channels

4.1 Message Channels

While the `Message` plays the crucial role of encapsulating data, it is the `MessageChannel` that decouples message producers from message consumers.

The MessageChannel Interface

Spring Integration's top-level `MessageChannel` interface is defined as follows.

```
public interface MessageChannel {

    boolean send(Message message);

    boolean send(Message message, long timeout);
}
```

When sending a message, the return value will be *true* if the message is sent successfully. If the send call times out or is interrupted, then it will return *false*.

PollableChannel

Since Message Channels may or may not buffer Messages (as discussed in the overview), there are two sub-interfaces defining the buffering (pollable) and non-buffering (subscribable) channel behavior. Here is the definition of `PollableChannel`.

```
public interface PollableChannel extends MessageChannel {

    Message<?> receive();

    Message<?> receive(long timeout);

}
```

Similar to the send methods, when receiving a message, the return value will be *null* in the case of a timeout or interrupt.

SubscribableChannel

The `SubscribableChannel` base interface is implemented by channels that send Messages directly to their subscribed `MessageHandler` s. Therefore, they do not provide receive methods for polling, but instead define methods for managing those subscribers:

```
public interface SubscribableChannel extends MessageChannel {

    boolean subscribe(MessageHandler handler);

    boolean unsubscribe(MessageHandler handler);

}
```

Message Channel Implementations

Spring Integration provides several different Message Channel implementations. Each is briefly described in the sections below.

PublishSubscribeChannel

The `PublishSubscribeChannel` implementation broadcasts any Message sent to it to all of its subscribed handlers. This is most often used for sending *Event Messages* whose primary role is notification as opposed to *Document Messages* which are generally intended to be processed by a single handler. Note that the `PublishSubscribeChannel` is intended for sending only. Since it broadcasts to its subscribers directly when its `send(Message)` method is invoked, consumers cannot poll for Messages (it does not implement `PollableChannel` and therefore has no `receive()` method). Instead, any subscriber must be a `MessageHandler` itself, and the subscriber's `handleMessage(Message)` method will be invoked in turn.

Prior to version 3.0, invoking the send method on a `PublishSubscribeChannel` that had no subscribers returned `false`. When used in conjunction with a `MessagingTemplate`, a `MessageDeliveryException` was thrown. Starting with version 3.0, the behavior has changed such that a send is always considered successful if at least the minimum subscribers are present (and successfully handle the message). This behavior can be modified by setting the `minSubscribers` property, which defaults to `0`.

Note

If a `TaskExecutor` is used, only the presence of the correct number of subscribers is used for this determination, because the actual handling of the message is performed asynchronously.

QueueChannel

The `QueueChannel` implementation wraps a queue. Unlike the `PublishSubscribeChannel`, the `QueueChannel` has point-to-point semantics. In other words, even if the channel has multiple consumers, only one of them should receive any Message sent to that channel. It provides a default no-argument constructor (providing an essentially unbounded capacity of `Integer.MAX_VALUE`) as well as a constructor that accepts the queue capacity:

```
public QueueChannel(int capacity)
```

A channel that has not reached its capacity limit will store messages in its internal queue, and the `send()` method will return immediately even if no receiver is ready to handle the message. If the queue has reached capacity, then the sender will block until room is available. Or, if using the send call that accepts a timeout, it will block until either room is available or the timeout period elapses, whichever occurs first. Likewise, a receive call will return immediately if a message is available on the queue, but if the queue is empty, then a receive call may block until either a message is available or the timeout elapses. In either case, it is possible to force an immediate return regardless of the queue's state by passing a timeout value of 0. Note however, that calls to the no-arg versions of `send()` and `receive()` will block indefinitely.

PriorityChannel

Whereas the `QueueChannel` enforces first-in/first-out (FIFO) ordering, the `PriorityChannel` is an alternative implementation that allows for messages to be ordered within the channel based upon a priority. By default the priority is determined by the *`priority`* header within each message. However, for custom priority determination logic, a comparator of type `Comparator<Message<?>>` can be provided to the `PriorityChannel`'s constructor.

RendezvousChannel

The `RendezvousChannel` enables a "direct-handoff" scenario where a sender will block until another party invokes the channel's `receive()` method or vice-versa. Internally, this implementation is quite similar to the `QueueChannel` except that it uses a `SynchronousQueue` (a zero-capacity implementation of `BlockingQueue`). This works well in situations where the sender and receiver are operating in different threads but simply dropping the message in a queue asynchronously is not appropriate. In other words, with a `RendezvousChannel` at least the sender knows that some receiver has accepted the message, whereas with a `QueueChannel`, the message would have been stored to the internal queue and potentially never received.

> **Tip**
>
> Keep in mind that all of these queue-based channels are storing messages in-memory only by default. When persistence is required, you can either provide a *message-store* attribute within the *queue* element to reference a persistent MessageStore implementation, or you can replace the local channel with one that is backed by a persistent broker, such as a JMS-backed channel or Channel Adapter. The latter option allows you to take advantage of any JMS provider's implementation for message persistence, and it will be discussed in the section called "CompletableFuture". However, when buffering in a queue is not necessary, the simplest approach is to rely upon the `DirectChannel` discussed next.

The `RendezvousChannel` is also useful for implementing request-reply operations. The sender can create a temporary, anonymous instance of `RendezvousChannel` which it then sets as the *replyChannel* header when building a Message. After sending that Message, the sender can immediately call receive (optionally providing a timeout value) in order to block while waiting for a reply Message. This is very similar to the implementation used internally by many of Spring Integration's request-reply components.

DirectChannel

The `DirectChannel` has point-to-point semantics but otherwise is more similar to the `PublishSubscribeChannel` than any of the queue-based channel implementations described above. It implements the `SubscribableChannel` interface instead of the `PollableChannel` interface, so it dispatches Messages directly to a subscriber. As a point-to-point channel, however, it differs from the `PublishSubscribeChannel` in that it will only send each Message to a *single* subscribed `MessageHandler`.

In addition to being the simplest point-to-point channel option, one of its most important features is that it enables a single thread to perform the operations on "both sides" of the channel. For example, if a handler is subscribed to a `DirectChannel`, then sending a Message to that channel will trigger invocation of that handler's `handleMessage(Message)` method *directly in the sender's thread*, before the send() method invocation can return.

The key motivation for providing a channel implementation with this behavior is to support transactions that must span across the channel while still benefiting from the abstraction and loose coupling that the channel provides. If the send call is invoked within the scope of a transaction, then the outcome of the handler's invocation (e.g. updating a database record) will play a role in determining the ultimate result of that transaction (commit or rollback).

Note

Since the `DirectChannel` is the simplest option and does not add any additional overhead that would be required for scheduling and managing the threads of a poller, it is the default channel type within Spring Integration. The general idea is to define the channels for an application and then to consider which of those need to provide buffering or to throttle input, and then modify those to be queue-based `PollableChannels`. Likewise, if a channel needs to broadcast messages, it should not be a `DirectChannel` but rather a `PublishSubscribeChannel`. Below you will see how each of these can be configured.

The `DirectChannel` internally delegates to a Message Dispatcher to invoke its subscribed Message Handlers, and that dispatcher can have a load-balancing strategy exposed via *load-balancer* or *load-balancer-ref* attributes (mutually exclusive). The load balancing strategy is used by the Message Dispatcher to help determine how Messages are distributed amongst Message Handlers in the case that there are multiple Message Handlers subscribed to the same channel. As a convenience the *load-balancer* attribute exposes enumeration of values pointing to pre-existing implementations of `LoadBalancingStrategy`. The "round-robin" (load-balances across the handlers in rotation) and "none" (for the cases where one wants to explicitely disable load balancing) are the only available values. Other strategy implementations may be added in future versions. However, since version 3.0 you can provide your own implementation of the `LoadBalancingStrategy` and inject it using *load-balancer-ref* attribute which should point to a bean that implements `LoadBalancingStrategy`.

```
<int:channel id="lbRefChannel">
  <int:dispatcher load-balancer-ref="lb"/>
</int:channel>

<bean id="lb" class="foo.bar.SampleLoadBalancingStrategy"/>
```

Note that *load-balancer* or *load-balancer-ref* attributes are mutually exclusive.

The load-balancing also works in combination with a boolean *failover* property. If the "failover" value is true (the default), then the dispatcher will fall back to any subsequent handlers as necessary when preceding handlers throw Exceptions. The order is determined by an optional order value defined on the handlers themselves or, if no such value exists, the order in which the handlers are subscribed.

If a certain situation requires that the dispatcher always try to invoke the first handler, then fallback in the same fixed order sequence every time an error occurs, no load-balancing strategy should be provided. In other words, the dispatcher still supports the failover boolean property even when no load-balancing is enabled. Without load-balancing, however, the invocation of handlers will always begin with the first according to their order. For example, this approach works well when there is a clear definition of primary, secondary, tertiary, and so on. When using the namespace support, the "order" attribute on any endpoint will determine that order.

Note

Keep in mind that load-balancing and failover only apply when a channel has more than one subscribed Message Handler. When using the namespace support, this means that more than one endpoint shares the same channel reference in the "input-channel" attribute.

ExecutorChannel

The `ExecutorChannel` is a point-to-point channel that supports the same dispatcher configuration as `DirectChannel` (load-balancing strategy and the failover boolean property). The key difference between these two dispatching channel types is that the `ExecutorChannel` delegates to an instance of `TaskExecutor` to perform the dispatch. This means that the send method typically will not block, but it also means that the handler invocation may not occur in the sender's thread. It therefore *does not support transactions spanning the sender and receiving handler*.

> **Tip**
>
> Note that there are occasions where the sender may block. For example, when using a TaskExecutor with a rejection-policy that throttles back on the client (such as the `ThreadPoolExecutor.CallerRunsPolicy`), the sender's thread will execute the method directly anytime the thread pool is at its maximum capacity and the executor's work queue is full. Since that situation would only occur in a non-predictable way, that obviously cannot be relied upon for transactions.

Scoped Channel

Spring Integration 1.0 provided a `ThreadLocalChannel` implementation, but that has been removed as of 2.0. Now, there is a more general way for handling the same requirement by simply adding a "scope" attribute to a channel. The value of the attribute can be any name of a Scope that is available within the context. For example, in a web environment, certain Scopes are available, and any custom Scope implementations can be registered with the context. Here's an example of a ThreadLocal-based scope being applied to a channel, including the registration of the Scope itself.

```xml
<int:channel id="threadScopedChannel" scope="thread">
     <int:queue />
</int:channel>

<bean class="org.springframework.beans.factory.config.CustomScopeConfigurer">
    <property name="scopes">
        <map>
            <entry key="thread" value="org.springframework.context.support.SimpleThreadScope" />
        </map>
    </property>
</bean>
```

The channel above also delegates to a queue internally, but the channel is bound to the current thread, so the contents of the queue are as well. That way the thread that sends to the channel will later be able to receive those same Messages, but no other thread would be able to access them. While thread-scoped channels are rarely needed, they can be useful in situations where `DirectChannels` are being used to enforce a single thread of operation but any reply Messages should be sent to a "terminal" channel. If that terminal channel is thread-scoped, the original sending thread can collect its replies from it.

Now, since any channel can be scoped, you can define your own scopes in addition to Thread Local.

Channel Interceptors

One of the advantages of a messaging architecture is the ability to provide common behavior and capture meaningful information about the messages passing through the system in a non-invasive way. Since the `Message` s are being sent to and received from `MessageChannels`, those channels provide an opportunity for intercepting the send and receive operations. The `ChannelInterceptor` strategy interface provides methods for each of those operations:

```
public interface ChannelInterceptor {

    Message<?> preSend(Message<?> message, MessageChannel channel);

    void postSend(Message<?> message, MessageChannel channel, boolean sent);

    void afterSendCompletion(Message<?> message, MessageChannel channel, boolean sent, Exception ex);

    boolean preReceive(MessageChannel channel);

    Message<?> postReceive(Message<?> message, MessageChannel channel);

    void afterReceiveCompletion(Message<?> message, MessageChannel channel, Exception ex);
}
```

After implementing the interface, registering the interceptor with a channel is just a matter of calling:

```
channel.addInterceptor(someChannelInterceptor);
```

The methods that return a Message instance can be used for transforming the Message or can return *null* to prevent further processing (of course, any of the methods can throw a RuntimeException). Also, the `preReceive` method can return *`false`* to prevent the receive operation from proceeding.

Note

Keep in mind that `receive()` calls are only relevant for `PollableChannels`. In fact the `SubscribableChannel` interface does not even define a `receive()` method. The reason for this is that when a Message is sent to a `SubscribableChannel` it will be sent directly to one or more subscribers depending on the type of channel (e.g. a PublishSubscribeChannel sends to all of its subscribers). Therefore, the `preReceive(..)`, `postReceive(..)` and `afterReceiveCompletion(..)` interceptor methods are only invoked when the interceptor is applied to a `PollableChannel`.

Spring Integration also provides an implementation of the Wire Tap pattern. It is a simple interceptor that sends the Message to another channel without otherwise altering the existing flow. It can be very useful for debugging and monitoring. An example is shown in the section called “Wire Tap”.

Because it is rarely necessary to implement all of the interceptor methods, a `ChannelInterceptorAdapter` class is also available for sub-classing. It provides no-op methods (the `void` method is empty, the `Message` returning methods return the Message as-is, and the `boolean` method returns `true`). Therefore, it is often easiest to extend that class and just implement the method(s) that you need as in the following example.

```
public class CountingChannelInterceptor extends ChannelInterceptorAdapter {

    private final AtomicInteger sendCount = new AtomicInteger();

    @Override
    public Message<?> preSend(Message<?> message, MessageChannel channel) {
        sendCount.incrementAndGet();
        return message;
    }
}
```

Tip

The order of invocation for the interceptor methods depends on the type of channel. As described above, the queue-based channels are the only ones where the receive method is intercepted in the first place. Additionally, the relationship between send and receive interception depends on the timing of separate sender and receiver threads. For example, if a receiver is already blocked while waiting for a message the order could be: preSend, preReceive, postReceive, postSend. However, if a receiver polls after the sender has placed a message on the channel and already returned, the order would be: preSend, postSend, (some-time-elapses) preReceive, postReceive. The time that elapses in such a case depends on a number of factors and is therefore generally unpredictable (in fact, the receive may never happen!). Obviously, the type of queue also plays a role (e.g. rendezvous vs. priority). The bottom line is that you cannot rely on the order beyond the fact that preSend will precede postSend and preReceive will precede postReceive.

Starting with *Spring Framework 4.1* and Spring Integration 4.1, the `ChannelInterceptor` provides new methods - `afterSendCompletion()` and `afterReceiveCompletion()`. They are invoked after `send()/receive()` calls, regardless of any exception that is raised, thus allowing for resource cleanup. Note, the Channel invokes these methods on the ChannelInterceptor List in the reverse order of the initial `preSend()/preReceive()` calls.

MessagingTemplate

As you will see when the endpoints and their various configuration options are introduced, Spring Integration provides a foundation for messaging components that enables non-invasive invocation of your application code *from the messaging system*. However, sometimes it is necessary to invoke the messaging system *from your application code*. For convenience when implementing such use-cases, Spring Integration provides a `MessagingTemplate` that supports a variety of operations across the Message Channels, including request/reply scenarios. For example, it is possible to send a request and wait for a reply.

```
MessagingTemplate template = new MessagingTemplate();

Message reply = template.sendAndReceive(someChannel, new GenericMessage("test"));
```

In that example, a temporary anonymous channel would be created internally by the template. The *sendTimeout* and *receiveTimeout* properties may also be set on the template, and other exchange types are also supported.

```
public boolean send(final MessageChannel channel, final Message<?> message) { ...
}

public Message<?> sendAndReceive(final MessageChannel channel, final Message<?> request) { ..
}

public Message<?> receive(final PollableChannel<?> channel) { ...
}
```

Note

A less invasive approach that allows you to invoke simple interfaces with payload and/or header values instead of Message instances is described in the section called “Enter the GatewayProxyFactoryBean”.

Configuring Message Channels

To create a Message Channel instance, you can use the <channel/> element:

```
<int:channel id="exampleChannel"/>
```

The default channel type is *Point to Point*. To create a *Publish Subscribe* channel, use the `<publish-subscribe-channel/>` element:

```
<int:publish-subscribe-channel id="exampleChannel"/>
```

When using the `<channel/>` element without any sub-elements, it will create a `DirectChannel` instance (a `SubscribableChannel`).

However, you can alternatively provide a variety of `<queue/>` sub-elements to create any of the pollable channel types (as described in the section called “Message Channel Implementations”). Examples of each are shown below.

DirectChannel Configuration

As mentioned above, `DirectChannel` is the default type.

```
<int:channel id="directChannel"/>
```

A default channel will have a *round-robin* load-balancer and will also have failover enabled (See the discussion in the section called “DirectChannel” for more detail). To disable one or both of these, add a `<dispatcher/>` sub-element and configure the attributes:

```
<int:channel id="failFastChannel">
    <int:dispatcher failover="false"/>
</channel>

<int:channel id="channelWithFixedOrderSequenceFailover">
    <int:dispatcher load-balancer="none"/>
</int:channel>
```

Datatype Channel Configuration

There are times when a consumer can only process a particular type of payload and you need to therefore ensure the payload type of input Messages. Of course the first thing that comes to mind is Message Filter. However all that Message Filter will do is filter out Messages that are not compliant with the requirements of the consumer. Another way would be to use a Content Based Router and route Messages with non-compliant data-types to specific Transformers to enforce transformation/conversion to the required data-type. This of course would work, but a simpler way of accomplishing the same thing is to apply the Datatype Channel pattern. You can use separate Datatype Channels for each specific payload data-type.

To create a Datatype Channel that only accepts messages containing a certain payload type, provide the fully-qualified class name in the channel element’s `datatype` attribute:

```
<int:channel id="numberChannel" datatype="java.lang.Number"/>
```

Note that the type check passes for any type that is *assignable* to the channel’s datatype. In other words, the "numberChannel" above would accept messages whose payload is `java.lang.Integer` or `java.lang.Double`. Multiple types can be provided as a comma-delimited list:

```
<int:channel id="stringOrNumberChannel" datatype="java.lang.String,java.lang.Number"/>
```

So the *numberChannel* above will only accept Messages with a data-type of `java.lang.Number`. But what happens if the payload of the Message is not of the required type? It depends on whether you have defined a bean named `integrationConversionService` that is an instance of Spring’s Conversion Service. If not, then an Exception would be thrown immediately, but if you do have an "integrationConversionService" bean defined, it will be used in an attempt to convert the Message's payload to the acceptable type.

You can even register custom converters. For example, let's say you are sending a Message with a String payload to the *numberChannel* we configured above.

```
MessageChannel inChannel = context.getBean("numberChannel", MessageChannel.class);
inChannel.send(new GenericMessage<String>("5"));
```

Typically this would be a perfectly legal operation, however since we are using Datatype Channel the result of such operation would generate an exception:

```
Exception in thread "main" org.springframework.integration.MessageDeliveryException:
Channel 'numberChannel'
expected one of the following datataypes [class java.lang.Number],
but received [class java.lang.String]
…
```

And rightfully so since we are requiring the payload type to be a Number while sending a String. So we need something to convert String to a Number. All we need to do is implement a Converter.

```
public static class StringToIntegerConverter implements Converter<String, Integer> {
    public Integer convert(String source) {
        return Integer.parseInt(source);
    }
}
```

Then, register it as a Converter with the Integration Conversion Service:

```
<int:converter ref="strToInt"/>

<bean id="strToInt" class="org.springframework.integration.util.Demo.StringToIntegerConverter"/>
```

When the *converter* element is parsed, it will create the "integrationConversionService" bean on-demand if one is not already defined. With that Converter in place, the send operation would now be successful since the Datatype Channel will use that Converter to convert the String payload to an Integer.

Note

For more information regarding Payload Type Conversion, please read the section called "Payload Type Conversion".

Beginning with *version 4.0*, the `integrationConversionService` is invoked by the `DefaultDatatypeChannelMessageConverter`, which looks up the conversion service in the application context. To use a different conversion technique, you can specify the `message-converter` attribute on the channel. This must be a reference to a `MessageConverter` implementation. Only the `fromMessage` method is used, which provides the converter with access to the message headers (for example if the conversion might need information from the headers, such as `content-type`). The method can return just the converted payload, or a full `Message` object. If the latter, the converter must be careful to copy all the headers from the inbound message.

Alternatively, declare a `<bean/>` of type `MessageConverter` with an id `"datatypeChannelMessageConverter"` and that converter will be used by all channels with a `datatype`.

QueueChannel Configuration

To create a `QueueChannel`, use the `<queue/>` sub-element. You may specify the channel's capacity:

```
<int:channel id="queueChannel">
    <queue capacity="25"/>
</int:channel>
```

Note

If you do not provide a value for the *capacity* attribute on this `<queue/>` sub-element, the resulting queue will be unbounded. To avoid issues such as OutOfMemoryErrors, it is highly recommended to set an explicit value for a bounded queue.

Persistent QueueChannel Configuration

Since a `QueueChannel` provides the capability to buffer Messages, but does so in-memory only by default, it also introduces a possibility that Messages could be lost in the event of a system failure. To mitigate this risk, a `QueueChannel` may be backed by a persistent implementation of the `MessageGroupStore` strategy interface. For more details on `MessageGroupStore` and `MessageStore` see the section called “CompletableFuture”.

Important

The `capacity` attribute is not allowed when the `message-store` attribute is used.

When a `QueueChannel` receives a Message, it will add it to the Message Store, and when a Message is polled from a `QueueChannel`, it is removed from the Message Store.

By default, a `QueueChannel` stores its Messages in an in-memory Queue and can therefore lead to the lost message scenario mentioned above. However Spring Integration provides persistent stores, such as the `JdbcChannelMessageStore`.

You can configure a Message Store for any `QueueChannel` by adding the `message-store` attribute as shown in the next example.

```
<int:channel id="dbBackedChannel">
    <int:queue message-store="channelStore"/>
</int:channel>

<bean id="channelStore" class="o.s.i.jdbc.store.JdbcChannelMessageStore">
    <property name="dataSource" ref="dataSource"/>
    <property name="channelMessageStoreQueryProvider" ref="queryProvider"/>
</bean>
```

The Spring Integration JDBC module also provides schema DDL for a number of popular databases. These schemas are located in the *org.springframework.integration.jdbc.store.channel* package of that module (spring-integration-jdbc).

Important

One important feature is that with any transactional persistent store (e.g., `JdbcChannelMessageStore`), as long as the poller has a transaction configured, a Message removed from the store will only be permanently removed if the transaction completes successfully, otherwise the transaction will roll back and the Message will not be lost.

Many other implementations of the Message Store will be available as the growing number of Spring projects related to "NoSQL" data stores provide the underlying support. Of course, you can always provide your own implementation of the MessageGroupStore interface if you cannot find one that meets your particular needs.

Since *version 4.0*, it is recommended that `QueueChannel` s are configured to use a `ChannelMessageStore` if possible. These are generally optimized for this use, when compared with a general message store. If the `ChannelMessageStore` is a `ChannelPriorityMessageStore` the messages will be received in FIFO within priority order. The notion of priority is determined by the message store implementation. For example the Java Configuration for the the section called “CompletableFuture”:

```
@Bean
public BasicMessageGroupStore mongoDbChannelMessageStore(MongoDbFactory mongoDbFactory) {
    MongoDbChannelMessageStore store = new MongoDbChannelMessageStore(mongoDbFactory);
    store.setPriorityEnabled(true);
    return store;
}

@Bean
public PollableChannel priorityQueue(BasicMessageGroupStore mongoDbChannelMessageStore) {
    return new PriorityChannel(new MessageGroupQueue(mongoDbChannelMessageStore, "priorityQueue"));
}
```

Note

Pay attention to the `MessageGroupQueue` class. That is a `BlockingQueue` implementation to utilize the `MessageGroupStore` operations.

The same with Java DSL may look like:

```
@Bean
public IntegrationFlow priorityFlow(PriorityCapableChannelMessageStore mongoDbChannelMessageStore) {
    return IntegrationFlows.from((Channels c) ->
            c.priority("priorityChannel", mongoDbChannelMessageStore, "priorityGroup"))
            ....
            .get();
}
```

Another option to customize the `QueueChannel` environment is provided by the `ref` attribute of the `<int:queue>` sub-element or particular constructor. This attribute implies the reference to any `java.util.Queue` implementation. For example Hazelcast distributed `IQueue`:

```
@Bean
public HazelcastInstance hazelcastInstance() {
    return Hazelcast.newHazelcastInstance(new Config()
                                           .setProperty("hazelcast.logging.type", "log4j"));
}

@Bean
public PollableChannel distributedQueue() {
    return new QueueChannel(hazelcastInstance()
                              .getQueue("springIntegrationQueue"));
}
```

PublishSubscribeChannel Configuration

To create a `PublishSubscribeChannel`, use the <publish-subscribe-channel/> element. When using this element, you can also specify the `task-executor` used for publishing Messages (if none is specified it simply publishes in the sender’s thread):

```
<int:publish-subscribe-channel id="pubsubChannel" task-executor="someExecutor"/>
```

Alongside with the `Executor`, an `ErrorHandler` can be configured as well. By default the `PublishSubscribeChannel` uses a `MessagePublishingErrorHandler` implementation to send error to the `MessageChannel` from the `errorChannel` header or a global `errorChannel` instance. If an `Executor` is not configured, the `ErrorHandler` is ignored and exceptions are thrown directly to the caller’s Thread.

If you are providing a *Resequencer* or *Aggregator* downstream from a `PublishSubscribeChannel`, then you can set the *apply-sequence* property on the channel to `true`. That will indicate that the channel should set the sequence-size and sequence-number Message headers as well as the correlation id prior to passing the Messages along. For example, if there are 5 subscribers, the sequence-size would be set to 5, and the Messages would have sequence-number header values ranging from 1 to 5.

```
<int:publish-subscribe-channel id="pubsubChannel" apply-sequence="true"/>
```

Note

The `apply-sequence` value is `false` by default so that a Publish Subscribe Channel can send the exact same Message instances to multiple outbound channels. Since Spring Integration enforces immutability of the payload and header references, the channel creates new Message instances with the same payload reference but different header values when the flag is set to `true`.

ExecutorChannel

To create an `ExecutorChannel`, add the <dispatcher> sub-element along with a `task-executor` attribute. Its value can reference any `TaskExecutor` within the context. For example, this enables configuration of a thread-pool for dispatching messages to subscribed handlers. As mentioned above, this does break the "single-threaded" execution context between sender and receiver so that any active transaction context will not be shared by the invocation of the handler (i.e. the handler may throw an Exception, but the send invocation has already returned successfully).

```
<int:channel id="executorChannel">
    <int:dispatcher task-executor="someExecutor"/>
</int:channel>
```

Note

The `load-balancer` and `failover` options are also both available on the <dispatcher/> sub-element as described above in the section called “DirectChannel Configuration”. The same defaults apply as well. So, the channel will have a round-robin load-balancing strategy with failover enabled unless explicit configuration is provided for one or both of those attributes.

```
<int:channel id="executorChannelWithoutFailover">
    <int:dispatcher task-executor="someExecutor" failover="false"/>
</int:channel>
```

PriorityChannel Configuration

To create a `PriorityChannel`, use the `<priority-queue/>` sub-element:

```
<int:channel id="priorityChannel">
    <int:priority-queue capacity="20"/>
</int:channel>
```

By default, the channel will consult the `priority` header of the message. However, a custom `Comparator` reference may be provided instead. Also, note that the `PriorityChannel` (like the other types) does support the `datatype` attribute. As with the QueueChannel, it also supports a `capacity` attribute. The following example demonstrates all of these:

```
<int:channel id="priorityChannel" datatype="example.Widget">
    <int:priority-queue comparator="widgetComparator"
                    capacity="10"/>
</int:channel>
```

Since *version 4.0*, the `priority-channel` child element supports the `message-store` option (`comparator` and `capacity` are not allowed in that case). The message store must be a `PriorityCapableChannelMessageStore` and, in this case. Implementations of the `PriorityCapableChannelMessageStore` are currently provided for `Redis`, `JDBC` and `MongoDB`. See the section called “QueueChannel Configuration” and the section called “CompletableFuture” for more information. You can find sample configuration in the section called “CompletableFuture”.

RendezvousChannel Configuration

A `RendezvousChannel` is created when the queue sub-element is a `<rendezvous-queue>`. It does not provide any additional configuration options to those described above, and its queue does not accept any capacity value since it is a 0-capacity direct handoff queue.

```
<int:channel id="rendezvousChannel"/>
    <int:rendezvous-queue/>
</int:channel>
```

Scoped Channel Configuration

Any channel can be configured with a "scope" attribute.

```
<int:channel id="threadLocalChannel" scope="thread"/>
```

Channel Interceptor Configuration

Message channels may also have interceptors as described in the section called “Channel Interceptors”. The `<interceptors/>` sub-element can be added within a `<channel/>` (or the more specific element types). Provide the `ref` attribute to reference any Spring-managed object that implements the `ChannelInterceptor` interface:

```
<int:channel id="exampleChannel">
    <int:interceptors>
        <ref bean="trafficMonitoringInterceptor"/>
    </int:interceptors>
</int:channel>
```

In general, it is a good idea to define the interceptor implementations in a separate location since they usually provide common behavior that can be reused across multiple channels.

Global Channel Interceptor Configuration

Channel Interceptors provide a clean and concise way of applying cross-cutting behavior per individual channel. If the same behavior should be applied on multiple channels, configuring the same set of interceptors for each channel *would not be* the most efficient way. To avoid repeated configuration while also enabling interceptors to apply to multiple channels, Spring Integration provides *Global Interceptors*. Look at the example below:

```
<int:channel-interceptor pattern="input*, bar*, foo, !baz*" order="3">
    <bean class="foo.barSampleInterceptor"/>
</int:channel-interceptor>
```

or

```
<int:channel-interceptor ref="myInterceptor" pattern="input*, bar*, foo, !baz*" order="3"/>

<bean id="myInterceptor" class="foo.barSampleInterceptor"/>
```

Each `<channel-interceptor/>` element allows you to define a global interceptor which will be applied on all channels that match any patterns defined via the `pattern` attribute. In the above case the global interceptor will be applied on the *foo* channel and all other channels that begin with *bar* or *input* and not to channel starting with *baz* (starting with *version 5.0*).

Warning

The addition of this syntax to the pattern causes one possible (although perhaps unlikely) problem. If you have a bean `"!foo"`**and** you included a pattern `"!foo"` in your channel-interceptor's `pattern` patterns; it will no long match; the pattern will now match all beans **not** named `foo`. In this case, you can escape the `!` in the pattern with `\`. The pattern `"\!foo"` means match a bean named `"!foo"`.

The *order* attribute allows you to manage where this interceptor will be injected if there are multiple interceptors on a given channel. For example, channel *inputChannel* could have individual interceptors configured locally (see below):

```
<int:channel id="inputChannel">
  <int:interceptors>
    <int:wire-tap channel="logger"/>
  </int:interceptors>
</int:channel>
```

A reasonable question is how will a global interceptor be injected in relation to other interceptors configured locally or through other global interceptor definitions? The current implementation provides a very simple mechanism for defining the order of interceptor execution. A positive number in the `order` attribute will ensure interceptor injection after any existing interceptors and a negative number will ensure that the interceptor is injected before existing interceptors. This means that in the above example, the global interceptor will be injected *AFTER* (since its order is greater than 0) the *wire-tap* interceptor configured locally. If there were another global interceptor with a matching `pattern`, its order would be determined by comparing the values of the `order` attribute. To inject a global interceptor *BEFORE* the existing interceptors, use a negative value for the `order` attribute.

Note

Note that both the `order` and `pattern` attributes are optional. The default value for `order` will be 0 and for `pattern`, the default is * (to match all channels).

Starting with *version 4.3.15*, you can configure a property `spring.integration.postProcessDynamicBeans = true` to apply any global interceptors to dynamically created `MessageChannel` beans. See the section called "CompletableFuture" for more information.

Wire Tap

As mentioned above, Spring Integration provides a simple *Wire Tap* interceptor out of the box. You can configure a *Wire Tap* on any channel within an `<interceptors/>` element. This is especially useful for debugging, and can be used in conjunction with Spring Integration's logging Channel Adapter as follows:

```
<int:channel id="in">
    <int:interceptors>
        <int:wire-tap channel="logger"/>
    </int:interceptors>
</int:channel>

<int:logging-channel-adapter id="logger" level="DEBUG"/>
```

Tip

The *logging-channel-adapter* also accepts an *expression* attribute so that you can evaluate a SpEL expression against *payload* and/or *headers* variables. Alternatively, to simply log the full Message toString() result, provide a value of "true" for the *log-full-message* attribute. That is `false` by default so that only the payload is logged. Setting that to `true` enables logging of all headers in addition to the payload. The *expression* option does provide the most flexibility, however (e.g. expression="payload.user.name").

A little more on Wire Tap

One of the common misconceptions about the wire tap and other similar components (the section called "CompletableFuture") is that they are automatically asynchronous in nature. Wire-tap as a component is not invoked asynchronously be default. Instead, Spring Integration focuses on a single unified approach to configuring asynchronous behavior: the Message Channel. What makes certain parts of the message flow *sync* or *async* is the type of *Message Channel* that has been configured within that flow. That is one of the primary benefits of the Message Channel abstraction. From the inception of the framework, we have always emphasized the need and the value of the *Message Channel* as a first-class citizen of the framework. It is not just an internal, implicit realization of the EIP pattern, it is fully exposed as a configurable component to the end user. So, the Wire-tap component is ONLY responsible for performing the following 3 tasks:

- intercept a message flow by tapping into a channel (e.g., channelA)
- grab each message
- send the message to another channel (e.g., channelB)

It is essentially a variation of the Bridge, but it is encapsulated within a channel definition (and hence easier to enable and disable without disrupting a flow). Also, unlike the bridge, it basically forks another message flow. Is that flow *synchronous* or *asynchronous*? The answer simply depends on the type of *Message Channel* that *channelB* is. And, now you know that we have: *Direct Channel*, *Pollable Channel*, and *Executor Channel* as options. The last two do break the thread boundary making communication via such channels *asynchronous* simply because the dispatching of the message from that channel to its subscribed handlers happens on a different thread than the one used to send the message to that channel. That is what is going to make your wire-tap flow *sync* or *async*. It is consistent with other components within the framework (e.g., Message Publisher) and actually brings a level of consistency and simplicity by sparing you from worrying in advance (other than writing thread safe code) whether a particular piece of code should be implemented as *sync* or *async*. The actual wiring of two pieces of code (component A and component B) via *Message Channel* is what makes their collaboration *sync* or *async*. You may even want to change from *sync* to *async* in the future and *Message Channel* is what’s going to allow you to do it swiftly without ever touching the code.

One final point regarding the Wire Tap is that, despite the rationale provided above for not being async by default, one should keep in mind it is usually desirable to hand off the Message as soon as possible. Therefore, it would be quite common to use an asynchronous channel option as the wire-tap’s outbound channel. Nonetheless, another reason that we do not enforce asynchronous behavior by default is that you might not want to break a transactional boundary. Perhaps you are using the Wire Tap for auditing purposes, and you DO want the audit Messages to be sent within the original transaction. As an example, you might connect the wire-tap to a JMS outbound-channel-adapter. That way, you get the best of both worlds: 1) the sending of a JMS Message can occur within the transaction while 2) it is still a "fire-and-forget" action thereby preventing any noticeable delay in the main message flow.

Important

Starting with *version 4.0*, it is important to avoid circular references when an interceptor (such as `WireTap`) references a channel itself. You need to exclude such channels from those being intercepted by the current interceptor. This can be done with appropriate `patterns` or programmatically. If you have a custom `ChannelInterceptor` that references a `channel`, consider implementing `VetoCapableInterceptor`. That way, the framework will ask the interceptor if it’s OK to intercept each channel that is a candidate based on the pattern. You can also add runtime protection in the interceptor methods that ensures that the channel is not one that is referenced by the interceptor. The `WireTap` uses both of these techniques.

Starting with *version 4.3*, the `WireTap` has additional constructors that take a `channelName` instead of a `MessageChannel` instance. This can be convenient for Java Configuration and when channel auto-creation logic is being used. The target `MessageChannel` bean is resolved from the provided `channelName` later, on the first interaction with the interceptor.

Important

Channel resolution requires a `BeanFactory` so the wire tap instance must be a Spring-managed bean.

This *late-binding* approach also allows simplification of typical wire-tapping patterns with Java DSL configuration:

```
@Bean
public PollableChannel myChannel() {
    return MessageChannels.queue()
            .wireTap("loggingFlow.input")
            .get();
}

@Bean
public IntegrationFlow loggingFlow() {
    return f -> f.log();
}
```

Conditional Wire Taps

Wire taps can be made conditional, using the `selector` or `selector-expression` attributes. The `selector` references a `MessageSelector` bean, which can determine at runtime whether the message should go to the tap channel. Similarly, the` selector-expression` is a boolean SpEL expression that performs the same purpose - if the expression evaluates to true, the message will be sent to the tap channel.

Global Wire Tap Configuration

It is possible to configure a global wire tap as a special case of the the section called "Global Channel Interceptor Configuration". Simply configure a top level `wire-tap` element. Now, in addition to the normal `wire-tap` namespace support, the `pattern` and `order` attributes are supported and work in exactly the same way as with the `channel-interceptor`

```
<int:wire-tap pattern="input*, bar*, foo" order="3" channel="wiretapChannel"/>
```

Tip

A global wire tap provides a convenient way to configure a single channel wire tap externally without modifying the existing channel configuration. Simply set the `pattern` attribute to the target channel name. For example, This technique may be used to configure a test case to verify messages on a channel.

Special Channels

If namespace support is enabled, there are two special channels defined within the application context by default: `errorChannel` and `nullChannel`. The *nullChannel* acts like `/dev/null`, simply logging any Message sent to it at DEBUG level and returning immediately. Any time you face channel resolution errors for a reply that you don't care about, you can set the affected component's `output-channel` attribute to *nullChannel* (the name *nullChannel* is reserved within the application context). The *errorChannel* is used internally for sending error messages and may be overridden with a custom configuration. This is discussed in greater detail in the section called "CompletableFuture".

See also the section called "CompletableFuture" in Java DSL chapter for more information about message channel and interceptors.

4.2 Poller

Polling Consumer

When Message Endpoints (Channel Adapters) are connected to channels and instantiated, they produce one of the following 2 instances:

- PollingConsumer
- EventDrivenConsumer

The actual implementation depends on which type of channel these Endpoints are connected to. A channel adapter connected to a channel that implements the org.springframework.messaging.SubscribableChannel interface will produce an instance of `EventDrivenConsumer`. On the other hand, a channel adapter connected to a channel that implements the org.springframework.messaging.PollableChannel interface (e.g. a QueueChannel) will produce an instance of `PollingConsumer`.

Polling Consumers allow Spring Integration components to actively poll for Messages, rather than to process Messages in an event-driven manner.

They represent a critical cross cutting concern in many messaging scenarios. In Spring Integration, Polling Consumers are based on the pattern with the same name, which is described in the book "Enterprise Integration Patterns" by Gregor Hohpe and Bobby Woolf. You can find a description of the pattern on the book's website at:

https://www.enterpriseintegrationpatterns.com/PollingConsumer.html

Pollable Message Source

Furthermore, in Spring Integration a second variation of the Polling Consumer pattern exists. When Inbound Channel Adapters are being used, these adapters are often wrapped by a `SourcePollingChannelAdapter`. For example, when retrieving messages from a remote FTP Server location, the adapter described in the section called "CompletableFuture" is configured with a *poller* to retrieve messages periodically. So, when components are configured with Pollers, the resulting instances are of one of the following types:

- PollingConsumer
- SourcePollingChannelAdapter

This means, Pollers are used in both inbound and outbound messaging scenarios. Here are some use-cases that illustrate the scenarios in which Pollers are used:

- Polling certain external systems such as FTP Servers, Databases, Web Services
- Polling internal (pollable) Message Channels
- Polling internal services (E.g. repeatedly execute methods on a Java class)

> **Note**
>
> AOP Advice classes can be applied to pollers, in an `advice-chain`. An example being a transaction advice to start a transaction. Starting with *version 4.1* a `PollSkipAdvice` is provided. Pollers use triggers to determine the time of the next poll. The `PollSkipAdvice` can be used to suppress (skip) a poll, perhaps because there is some downstream condition that would prevent the message to be processed properly. To use this advice, you have to provide it with an implementation of a `PollSkipStrategy`. Starting with *version 4.2.5*, a `SimplePollSkipStrategy` is provided. Add an instance as a bean to the application context, inject it into a `PollSkipAdvice` and add that to the poller's advice chain. To skip polling, call `skipPolls()`, to resume polling, call `reset()`. *Version 4.2* added more flexibility in this area - see the section called "Conditional Pollers for Message Sources".

This chapter is meant to only give a high-level overview regarding Polling Consumers and how they fit into the concept of message channels - Section 4.1, "Message Channels" and channel adapters - Section 4.3, "Channel Adapter". For more in-depth information regarding Messaging Endpoints in general and Polling Consumers in particular, please see Section 8.1, "Message Endpoints".

Deferred Acknowledgment Pollable Message Source

Starting with *version 5.0.1*, certain modules provide `MessageSource` implementations that support deferring acknowledgment until the downstream flow completes (or hands off the message to another thread). This is currently limited to the `AmqpMessageSource` and the `KafkaMessageSource` provided by the spring-kafka-integration extension project, version 3.0.1 or higher.

With these message sources, the IntegrationMessageHeaderAccessor.ACKNOWLEDGMENT_CALLBACK header (see the section called “MessageHeaderAccessor API”) is added to the message. The value of the header is an instance of AcknowledgmentCallback:

```
@FunctionalInterface
public interface AcknowledgmentCallback {

    void acknlowledge(Status status);

    boolean isAcknowledged();

    void noAutoAck();

    default boolean isAutoAck();

    enum Status {

        /**
         * Mark the message as accepted.
         */
        ACCEPT,

        /**
         * Mark the message as rejected.
         */
        REJECT,

        /**
         * Reject the message and requeue so that it will be redelivered.
         */
        REQUEUE

    }

}
```

Not all message sources (e.g. Kafka) support the REJECT status; it is treated the same as ACCEPT.

Applications can acknowledge a message at any time:

```
Message<?> received = source.receive();

...

StaticMessageHeaderAccessor.getAcknowledgmentCallback(received)
        .acknowledge(Status.ACCEPT);
```

If the MessageSource is wired into a SourcePollingChannelAdapter, when the poller thread returns to the adapter after the downstream flow completes, the adapter will check if the acknowledgment has already been acknowledged and, if not, ACCEPT it (or REJECT it if the flow throws an exception).

To perform ad-hoc polling of a MessageSource a MessageSourcePollingTemplate is provided; this, too will take care of ACCEPT ing or REJECT ing the AcknowledgmentCallback when the MessageHandler callback returns (or throws an exception).

```
MessageSourcePollingTemplate template =
    new MessageSourcePollingTemplate(this.source);
template.poll(h -> {
    ...
});
```

In both cases (`SourcePollingChannelAdapter` and `MessageSourcePollingTemplate`), you can disable auto ack/nack by calling `noAutoAck()` on the callback. You might do this if you hand off the message to another thread and wish to acknowledge later. Not all implementations support this (for example Apache Kafka because the offset commit has to be performed on the same thread).

Conditional Pollers for Message Sources

Background

`Advice` objects, in an `advice-chain` on a poller, advise the whole polling task (message retrieval and processing). These "around advice" methods do not have access to any context for the poll, just the poll itself. This is fine for requirements such as making a task transactional, or skipping a poll due to some external condition as discussed above. What if we wish to take some action depending on the result of the `receive` part of the poll, or if we want to adjust the poller depending on conditions?

"Smart" Polling

Version 4.2 introduced the `AbstractMessageSourceAdvice`. Any `Advice` objects in the `advice-chain` that subclass this class, are applied to just the receive operation. Such classes implement the following methods:

```
beforeReceive(MessageSource<?> source)
```

This method is called before the `MessageSource.receive()` method. It enables you to examine and or reconfigure the source at this time. Returning `false` cancels this poll (similar to the `PollSkipAdvice` mentioned above).

```
Message<?> afterReceive(Message<?> result, MessageSource<?> source)
```

This method is called after the `receive()` method; again, you can reconfigure the source, or take any action perhaps depending on the result (which can be `null` if there was no message created by the source). You can even return a different message

Thread safety

You should not configure the poller with a `TaskExecutor` if an advice mutates the `MessageSource`. If an advice mutates the source, such mutations are not thread safe and could cause unexpected results, especially with high frequency pollers. Consider using a downstream `ExecutorChannel` instead of adding an executor to the poller if you need to process poll results concurrently.

Advice Chain Ordering

It is important to understand how the advice chain is processed during initialization. `Advice` objects that do not extend `AbstractMessageSourceAdvice` are applied to the whole poll process and are all invoked first, in order, before any `AbstractMessageSourceAdvice`; then `AbstractMessageSourceAdvice` objects are invoked in order around the `MessageSource` `receive()` method. If you have, say `Advice` objects `a, b, c, d`, where `b` and `d` are `AbstractMessageSourceAdvice`, they will be applied in the order `a, c, b, d`. Also, if a `MessageSource` is already a `Proxy`, the `AbstractMessageSourceAdvice` will be invoked after any existing `Advice` objects. If you wish to change the order, you should wire up the proxy yourself.

SimpleActiveIdleMessageSourceAdvice

This advice is a simple implementation of `AbstractMessageSourceAdvice`, when used in conjunction with a `DynamicPeriodicTrigger`, it adjusts the polling frequency depending on whether or not the previous poll resulted in a message or not. The poller must also have a reference to the same `DynamicPeriodicTrigger`.

> **Important: Async Handoff**
>
> This advice modifies the trigger based on the `receive()` result. This will only work if the advice is called on the poller thread. It will **not** work if the poller has a `task-executor`. To use this advice where you wish to use async operations after the result of a poll, do the async handoff later, perhaps by using an `ExecutorChannel`.

CompoundTriggerAdvice

This advice allows the selection of one of two triggers based on whether a poll returns a message or not. Consider a poller that uses a `CronTrigger`; `CronTrigger` s are immutable so cannot be altered once constructed. Consider a use case where we want to use a cron expression to trigger a poll once each hour but, if no message is received, poll once per minute and, when a message is retrieved, revert to using the cron expression.

The advice (and poller) use a `CompoundTrigger` for this purpose. The trigger's `primary` trigger can be a `CronTrigger`. When the advice detects that no message is received, it adds the secondary trigger to the `CompoundTrigger`. When the `CompoundTrigger` 's `nextExecutionTime` method is invoked, it will delegate to the secondary trigger, if present; otherwise the primary trigger.

The poller must also have a reference to the same `CompoundTrigger`.

The following shows the configuration for the hourly cron expression with fall-back to every minute…

```
<int:inbound-channel-adapter channel="nullChannel" auto-startup="false">
    <bean class="org.springframework.integration.endpoint.PollerAdviceTests.Source" />
    <int:poller trigger="compoundTrigger">
        <int:advice-chain>
            <bean class="org.springframework.integration.aop.CompoundTriggerAdvice">
                <constructor-arg ref="compoundTrigger"/>
                <constructor-arg ref="secondary"/>
            </bean>
        </int:advice-chain>
    </int:poller>
</int:inbound-channel-adapter>

<bean id="compoundTrigger" class="org.springframework.integration.util.CompoundTrigger">
    <constructor-arg ref="primary" />
</bean>

<bean id="primary" class="org.springframework.scheduling.support.CronTrigger">
    <constructor-arg value="0 0 * * * *" /> <!-- top of every hour -->
</bean>

<bean id="secondary" class="org.springframework.scheduling.support.PeriodicTrigger">
    <constructor-arg value="60000" />
</bean>
```

> **Important: Async Handoff**
>
> This advice modifies the trigger based on the `receive()` result. This will only work if the advice is called on the poller thread. It will **not** work if the poller has a `task-executor`. To use this

advice where you wish to use async operations after the result of a poll, do the async handoff later, perhaps by using an `ExecutorChannel`.

4.3 Channel Adapter

A Channel Adapter is a Message Endpoint that enables connecting a single sender or receiver to a Message Channel. Spring Integration provides a number of adapters out of the box to support various transports, such as JMS, File, HTTP, Web Services, Mail, and more. Those will be discussed in upcoming chapters of this reference guide. However, this chapter focuses on the simple but flexible Method-invoking Channel Adapter support. There are both inbound and outbound adapters, and each may be configured with XML elements provided in the core namespace. These provide an easy way to extend Spring Integration as long as you have a method that can be invoked as either a source or destination.

Configuring An Inbound Channel Adapter

An "inbound-channel-adapter" element can invoke any method on a Spring-managed Object and send a non-null return value to a `MessageChannel` after converting it to a `Message`. When the adapter's subscription is activated, a poller will attempt to receive messages from the source. The poller will be scheduled with the `TaskScheduler` according to the provided configuration. To configure the polling interval or cron expression for an individual channel-adapter, provide a *poller* element with one of the scheduling attributes, such as *fixed-rate* or *cron*.

```
<int:inbound-channel-adapter ref="source1" method="method1" channel="channel1">
    <int:poller fixed-rate="5000"/>
</int:inbound-channel-adapter>

<int:inbound-channel-adapter ref="source2" method="method2" channel="channel2">
    <int:poller cron="30 * 9-17 * * MON-FRI"/>
</int:channel-adapter>
```

Also see the section called “Channel Adapter Expressions and Scripts”.

Note

If no poller is provided, then a single default poller must be registered within the context. See the section called “Endpoint Namespace Support” for more detail.

Important: Poller Configuration

Some `inbound-channel-adapter` types are backed by a `SourcePollingChannelAdapter` which means they contain Poller configuration which will poll the `MessageSource` (invoke a custom method which produces the value that becomes a `Message` payload) based on the configuration specified in the Poller.

For example:

```
<int:poller max-messages-per-poll="1" fixed-rate="1000"/>

<int:poller max-messages-per-poll="10" fixed-rate="1000"/>
```

In the the first configuration the polling task will be invoked once per poll and during such task (poll) the method (which results in the production of the Message) will be invoked once based on the `max-messages-per-poll` attribute value. In the second configuration the polling task will be invoked 10 times per poll or until it returns *null* thus possibly producing 10 Messages per poll while each poll happens at 1 second intervals. However what if the configuration looks like this:

```
<int:poller fixed-rate="1000"/>
```

Note there is no `max-messages-per-poll` specified. As you'll learn later the identical poller configuration in the `PollingConsumer` (e.g., service-activator, filter, router etc.) would have a default value of -1 for `max-messages-per-poll` which means "execute poling task non-stop unless polling method returns null (e.g., no more Messages in the QueueChannel)" and then sleep for 1 second.

However in the SourcePollingChannelAdapter it is a bit different. The default value for `max-messages-per-poll` will be set to 1 by default unless you explicitly set it to a negative value (e.g., -1). It is done so to make sure that poller can react to a LifeCycle events (e.g., start/stop) and prevent it from potentially spinning in the infinite loop if the implementation of the custom method of the `MessageSource` has a potential to never return null and happened to be non-interruptible.

However if you are sure that your method can return null and you need the behavior where you want to poll for as many sources as available per each poll, then you should explicitly set `max-messages-per-poll` to a negative value.

```
<int:poller max-messages-per-poll="-1" fixed-rate="1000"/>
```

Configuring An Outbound Channel Adapter

An "outbound-channel-adapter" element can also connect a `MessageChannel` to any POJO consumer method that should be invoked with the payload of Messages sent to that channel.

```
<int:outbound-channel-adapter channel="channel1" ref="target" method="handle"/>

<beans:bean id="target" class="org.Foo"/>
```

If the channel being adapted is a `PollableChannel`, provide a poller sub-element:

```
<int:outbound-channel-adapter channel="channel2" ref="target" method="handle">
    <int:poller fixed-rate="3000" />
</int:outbound-channel-adapter>

<beans:bean id="target" class="org.Foo"/>
```

Using a "ref" attribute is generally recommended if the POJO consumer implementation can be reused in other `<outbound-channel-adapter>` definitions. However if the consumer implementation is only referenced by a single definition of the `<outbound-channel-adapter>`, you can define it as inner bean:

```
<int:outbound-channel-adapter channel="channel" method="handle">
    <beans:bean class="org.Foo"/>
</int:outbound-channel-adapter>
```

Note

Using both the "ref" attribute and an inner handler definition in the same `<outbound-channel-adapter>` configuration is not allowed as it creates an ambiguous condition. Such a configuration will result in an Exception being thrown.

Any Channel Adapter can be created without a "channel" reference in which case it will implicitly create an instance of `DirectChannel`. The created channel's name will match the "id" attribute of the `<inbound-channel-adapter>` or `<outbound-channel-adapter>` element. Therefore, if the "channel" is not provided, the "id" is required.

Channel Adapter Expressions and Scripts

Like many other Spring Integration components, the `<inbound-channel-adapter>` and `<outbound-channel-adapter>` also provide support for SpEL expression evaluation. To use SpEL, provide the expression string via the *expression* attribute instead of providing the *ref* and *method* attributes that are used for method-invocation on a bean. When an Expression is evaluated, it follows the same contract as method-invocation where: the *expression* for an `<inbound-channel-adapter>` will generate a message anytime the evaluation result is a *non-null* value, while the *expression* for an `<outbound-channel-adapter>` must be the equivalent of a *void* returning method invocation.

Starting with Spring Integration 3.0, an `<int:inbound-channel-adapter/>` can also be configured with a SpEL `<expression/>` (or even with `<script/>`) sub-element, for when more sophistication is required than can be achieved with the simple *expression* attribute. If you provide a script as a `Resource` using the `location` attribute, you can also set the *refresh-check-delay* allowing the resource to be refreshed periodically. If you want the script to be checked on each poll, you would need to coordinate this setting with the poller's trigger:

```
<int:inbound-channel-adapter ref="source1" method="method1" channel="channel1">
    <int:poller max-messages-per-poll="1" fixed-delay="5000"/>
    <script:script lang="ruby" location="Foo.rb" refresh-check-delay="5000"/>
</int:inbound-channel-adapter>
```

Also see the `cacheSeconds` property on the `ReloadableResourceBundleExpressionSource` when using the `<expression/>` sub-element. For more information regarding expressions see the section called “CompletableFuture”, and for scripts - the section called “CompletableFuture” and the section called “CompletableFuture”.

Important

The `<int:inbound-channel-adapter/>` is an endpoint that starts a message flow via periodic triggering to poll some underlying `MessageSource`. Since, at the time of polling, there is not yet a message object, expressions and scripts don't have access to a root `Message`, so there are no *payload* or *headers* properties that are available in most other messaging SpEL expressions. Of course, the script **can** generate and return a complete `Message` object with headers and payload, or just a payload, which will be added to a message with basic headers.

4.4 Messaging Bridge

Introduction

A Messaging Bridge is a relatively trivial endpoint that simply connects two Message Channels or Channel Adapters. For example, you may want to connect a `PollableChannel` to a `SubscribableChannel` so that the subscribing endpoints do not have to worry about any polling configuration. Instead, the Messaging Bridge provides the polling configuration.

By providing an intermediary poller between two channels, a Messaging Bridge can be used to throttle inbound Messages. The poller's trigger will determine the rate at which messages arrive on the second channel, and the poller's "maxMessagesPerPoll" property will enforce a limit on the throughput.

Another valid use for a Messaging Bridge is to connect two different systems. In such a scenario, Spring Integration’s role would be limited to making the connection between these systems and managing a poller if necessary. It is probably more common to have at least a *Transformer* between the two systems to translate between their formats, and in that case, the channels would be provided as the *input-channel* and *output-channel* of a Transformer endpoint. If data format translation is not required, the Messaging Bridge may indeed be sufficient.

Configuring a Bridge with XML

The <bridge> element is used to create a Messaging Bridge between two Message Channels or Channel Adapters. Simply provide the "input-channel" and "output-channel" attributes:

```
<int:bridge input-channel="input" output-channel="output"/>
```

As mentioned above, a common use case for the Messaging Bridge is to connect a `PollableChannel` to a `SubscribableChannel`, and when performing this role, the Messaging Bridge may also serve as a throttler:

```
<int:bridge input-channel="pollable" output-channel="subscribable">
     <int:poller max-messages-per-poll="10" fixed-rate="5000"/>
 </int:bridge>
```

Connecting Channel Adapters is just as easy. Here is a simple echo example between the "stdin" and "stdout" adapters from Spring Integration’s "stream" namespace.

```
<int-stream:stdin-channel-adapter id="stdin"/>

 <int-stream:stdout-channel-adapter id="stdout"/>

 <int:bridge id="echo" input-channel="stdin" output-channel="stdout"/>
```

Of course, the configuration would be similar for other (potentially more useful) Channel Adapter bridges, such as File to JMS, or Mail to File. The various Channel Adapters will be discussed in upcoming chapters.

Note

If no *output-channel* is defined on a bridge, the reply channel provided by the inbound Message will be used, if available. If neither output or reply channel is available, an Exception will be thrown.

Configuring a Bridge with Java Configuration

```
@Bean
public PollableChannel polled() {
    return new QueueChannel();
}

@Bean
@BridgeFrom(value = "polled", poller = @Poller(fixedDelay = "5000", maxMessagesPerPoll = "10"))
public SubscribableChannel direct() {
    return new DirectChannel();
}
```

or

```
@Bean
@BridgeTo(value = "direct", poller = @Poller(fixedDelay = "5000", maxMessagesPerPoll = "10"))
public PollableChannel polled() {
    return new QueueChannel();
}

@Bean
public SubscribableChannel direct() {
    return new DirectChannel();
}
```

Or, using a `BridgeHandler`:

```
@Bean
@ServiceActivator(inputChannel = "polled",
        poller = @Poller(fixedRate = "5000", maxMessagesPerPoll = "10"))
public BridgeHandler bridge() {
    BridgeHandler bridge = new BridgeHandler();
    bridge.setOutputChannelName("direct");
    return bridge;
}
```

Configuring a Bridge with the Java DSL

```
@Bean
public IntegrationFlow bridgeFlow() {
    return IntegrationFlows.from("polled")
            .bridge(e -> e.poller(Pollers.fixedDelay(5000).maxMessagesPerPoll(10)))
            .channel("direct")
            .get();
}
```

5. Message Construction

5.1 Message

The Spring Integration `Message` is a generic container for data. Any object can be provided as the payload, and each `Message` also includes headers containing user-extensible properties as key-value pairs.

The Message Interface

Here is the definition of the `Message` interface:

```
public interface Message<T> {

    T getPayload();

    MessageHeaders getHeaders();

}
```

The `Message` is obviously a very important part of the API. By encapsulating the data in a generic wrapper, the messaging system can pass it around without any knowledge of the data’s type. As an application evolves to support new types, or when the types themselves are modified and/or extended, the messaging system will not be affected by such changes. On the other hand, when some component in the messaging system *does* require access to information about the `Message`, such metadata can typically be stored to and retrieved from the metadata in the Message Headers.

Message Headers

Just as Spring Integration allows any Object to be used as the payload of a Message, it also supports any Object types as header values. In fact, the `MessageHeaders` class implements the *java.util.Map* interface:

```
public final class MessageHeaders implements Map<String, Object>, Serializable {
  ...
}
```

Note

Even though the MessageHeaders implements Map, it is effectively a read-only implementation. Any attempt to *put* a value in the Map will result in an `UnsupportedOperationException`. The same applies for *remove* and *clear*. Since Messages may be passed to multiple consumers, the structure of the Map cannot be modified. Likewise, the Message’s payload Object can not be *set* after the initial creation. However, the mutability of the header values themselves (or the payload Object) is intentionally left as a decision for the framework user.

As an implementation of Map, the headers can obviously be retrieved by calling `get(..)` with the name of the header. Alternatively, you can provide the expected *Class* as an additional parameter. Even better, when retrieving one of the pre-defined values, convenient getters are available. Here is an example of each of these three options:

```
Object someValue = message.getHeaders().get("someKey");

CustomerId customerId = message.getHeaders().get("customerId", CustomerId.class);

Long timestamp = message.getHeaders().getTimestamp();
```

The following Message headers are pre-defined:

Table 5.1. Pre-defined Message Headers

Header Name	Header Type	Usage
`MessageHeaders.ID`	`java.util.UUID`	An identifier for this message instance. Changes each time a message is mutated.
`MessageHeaders.TIMESTAMP`	`java.lang.Long`	The time the message was created. Changes each time a message is mutated.
`MessageHeaders.REPLY_CHANNEL`	`java.lang.Object (String or MessageChannel)`	A channel to which a reply (if any) will be sent when no explicit output channel is configured and there is no `ROUTING_SLIP` or the `ROUTING_SLIP` is exhausted. If the value is a `String` it must represent a bean name, or have been generated by a `ChannelRegistry.`
`MessageHeaders.ERROR_CHANNEL`	`java.lang.Object (String or MessageChannel)`	A channel to which errors will be sent. If the value is a `String` it must represent a bean name, or have been generated by a `ChannelRegistry.`

Many inbound and outbound adapter implementations will also provide and/or expect certain headers, and additional user-defined headers can also be configured. Constants for these headers can be found in those modules where such headers exist, for example `AmqpHeaders`, `JmsHeaders` etc.

MessageHeaderAccessor API

Starting with Spring Framework 4.0 and Spring Integration 4.0, the core Messaging abstraction has been moved to the *spring-messaging* module and the new `MessageHeaderAccessor` API has been introduced to provide additional abstraction over Messaging implementations. All (core) Spring Integration specific Message Headers constants are now declared in the `IntegrationMessageHeaderAccessor` class:

Table 5.2. Pre-defined Message Headers

Header Name	Header Type	Usage
`IntegrationMessageHeaderAccessor.CORRELATION_ID`	`java.lang.Object`	Used to correlate two or more messages.
`IntegrationMessageHeaderAccessor.SEQUENCE_NUMBER`	`java.lang.Integer`	Usually a sequence number with a group of messages with a `SEQUENCE_SIZE` but can also be used in a `<resequencer/>` to resequence an unbounded group of messages.
`IntegrationMessageHeaderAccessor.SEQUENCE_SIZE`	`java.lang.Integer`	The number of messages within a group of correlated messages.

Header Name	Header Type	Usage
`IntegrationMessageHeaderAccessor. EXPIRATION_DATE`	`java.lang.Long`	Indicates when a message is expired. Not used by the framework directly but can be set with a header enricher and used in a `<filter/>` configured with an `UnexpiredMessageSelector`.
`IntegrationMessageHeaderAccessor. PRIORITY`	`java.lang.Integer`	Message priority; for example within a `PriorityChannel`
`IntegrationMessageHeaderAccessor. DUPLICATE_MESSAGE`	`java.lang.Boolean`	True if a message was detected as a duplicate by an idempotent receiver interceptor. See the section called “CompletableFuture”.
`IntegrationMessageHeaderAccessor. CLOSEABLE_RESOURCE`	`java.io.Closeable`	This header is present if the message is associated with a `Closeable` which should be closed when message processing is complete. An example is the `Session` associated with a streamed file transfer using FTP, SFTP, etc.
`IntegrationMessageHeaderAccessor. DELIVERY_ATTEMPT`	`java.lang. AtomicInteger`	If a message-driven channel adapter supports the configuration of a `RetryTemplate` this header contains the current delivery attempt.
`IntegrationMessageHeaderAccessor. ACKNOWLEDGMENT_CALLBACK`	`o.s.i.support. Acknowledgment Callback`	If a message source supports it, a call back to accept, reject, or requeue a message - see the section called “Deferred Acknowledgment Pollable Message Source”.

Convenient typed getters for some of these headers are provided on the `IntegrationMessageHeaderAccessor` class:

```
IntegrationMessageHeaderAccessor accessor = new IntegrationMessageHeaderAccessor(message);
int sequenceNumber = accessor.getSequenceNumber();
Object correlationId = accessor.getCorrelationId();
...
```

The following headers also appear in the `IntegrationMessageHeaderAccessor` but are generally not used by user code; their inclusion here is for completeness:

Table 5.3. Pre-defined Message Headers

Header Name	Header Type	Usage
`IntegrationMessageHeaderAccessor. SEQUENCE_DETAILS`	`java.util.List< List<Object>>`	A stack of correlation data used when nested correlation is needed (e.g. `splitter->...-`

Header Name	Header Type	Usage
		>splitter->...->aggregator->...->aggregator).
`IntegrationMessageHeaderAccessor.ROUTING_SLIP`	`java.util.Map<List<Object>, Integer>`	See the section called “Routing Slip”.

Message ID Generation

When a message transitions through an application, each time it is mutated (e.g. by a transformer) a new message id is assigned. The message id is a `UUID`. Beginning with *Spring Integration 3.0*, the default strategy used for id generation is more efficient than the previous `java.util.UUID.randomUUID()` implementation. It uses simple random numbers based on a secure random seed, instead of creating a secure random number each time.

A different UUID generation strategy can be selected by declaring a bean that implements `org.springframework.util.IdGenerator` in the application context.

Important

Only one UUID generation strategy can be used in a classloader. This means that if two or more application contexts are running in the same classloader, they will share the same strategy. If one of the contexts changes the strategy, it will be used by all contexts. If two or more contexts in the same classloader declare a bean of type `org.springframework.util.IdGenerator`, they must all be an instance of the same class, otherwise the context attempting to replace a custom strategy will fail to initialize. If the strategy is the same, but parameterized, the strategy in the first context to initialize will be used.

In addition to the default strategy, two additional `IdGenerators` are provided; `org.springframework.util.JdkIdGenerator` uses the previous `UUID.randomUUID()` mechanism; `o.s.i.support.IdGenerators.SimpleIncrementingIdGenerator` can be used in cases where a UUID is not really needed and a simple incrementing value is sufficient.

Read-only Headers

The `MessageHeaders.ID` and `MessageHeaders.TIMESTAMP` are read-only headers and they cannot be overridden.

Since *version 4.3.2*, the `MessageBuilder` provides the `readOnlyHeaders(String... readOnlyHeaders)` API to customize a list of headers which should not be copied from an upstream `Message`. Just the `MessageHeaders.ID` and `MessageHeaders.TIMESTAMP` are read only by default. The global `spring.integration.readOnly.headers` property (see the section called “CompletableFuture”) is provided to customize `DefaultMessageBuilderFactory` for Framework components. This can be useful when you would like do not populate some out-of-the-box headers, like `contentType` by the `ObjectToJsonTransformer` (see the section called “JSON Transformers”).

When you try to build a new message using `MessageBuilder`, this kind of headers are ignored and particular `INFO` message is emitted to logs.

Starting with *version 5.0*, Messaging Gateway, Header Enricher, Content Enricher and Header Filter don’t allow to configure `MessageHeaders.ID` and `MessageHeaders.TIMESTAMP` header names when `DefaultMessageBuilderFactory` is used and they throw `BeanInitializationException`.

Header Propagation

When messages are processed (and modified) by message-producing endpoints (such as a service activator), in general, inbound headers are propagated to the outbound message. One exception to this is a transformer, when a complete message is returned to the framework; in that case, the user code is responsible for the entire outbound message. When a transformer just returns the payload; the inbound headers **are** propagated. Also, a header is only propagated if it does not already exist in the outbound message, allowing user code to change header values as needed.

Starting with *version 4.3.10*, you can configure message handlers (that modify messages and produce output) to suppress the propagation of specific headers. Call the `setNotPropagatedHeaders()` or `addNotPropagatedHeaders()` methods on the `MessageProducingMessageHandler` abstract class, to configure the header(s) you don't want to be copied.

You can also globally suppress propagation of specific message headers by setting the `readOnlyHeaders` property in `META-INF/spring.integration.properties` to a comma-delimited list of headers.

Starting with *version 5.0*, the `setNotPropagatedHeaders()` implementation on the `AbstractMessageProducingHandler` applies the simple patterns (`xxx*`, `*xxx`, `*xxx*` or `xxx*yyy`) to allow filtering headers with a common suffix or prefix. See `PatternMatchUtils` JavaDocs for more information. When one of the patterns is `*` (asterisk), no headers are propagated; all other patterns are ignored. In this case the Service Activator behaves the same way as Transformer and any required headers must be supplied in the `Message` returned from the service method. The option `notPropagatedHeaders()` is available in the `ConsumerEndpointSpec` for Java DSL, as well as for XML configuration of the `<service-activator>` component as a `not-propagated-headers` attribute.

> **Important**
>
> Header propagation suppression does not apply to those endpoints that don't modify the message, e.g. bridges and routers.

Message Implementations

The base implementation of the `Message` interface is `GenericMessage<T>`, and it provides two constructors:

```
new GenericMessage<T>(T payload);

new GenericMessage<T>(T payload, Map<String, Object> headers)
```

When a Message is created, a random unique id will be generated. The constructor that accepts a Map of headers will copy the provided headers to the newly created Message.

There is also a convenient implementation of `Message` designed to communicate error conditions. This implementation takes `Throwable` object as its payload:

```
ErrorMessage message = new ErrorMessage(someThrowable);

Throwable t = message.getPayload();
```

Notice that this implementation takes advantage of the fact that the `GenericMessage` base class is parameterized. Therefore, as shown in both examples, no casting is necessary when retrieving the Message payload Object.

The MessageBuilder Helper Class

You may notice that the Message interface defines retrieval methods for its payload and headers but no setters. The reason for this is that a Message cannot be modified after its initial creation. Therefore, when a Message instance is sent to multiple consumers (e.g. through a Publish Subscribe Channel), if one of those consumers needs to send a reply with a different payload type, it will need to create a new Message. As a result, the other consumers are not affected by those changes. Keep in mind, that multiple consumers may access the same payload instance or header value, and whether such an instance is itself immutable is a decision left to the developer. In other words, the contract for Messages is similar to that of an *unmodifiable Collection*, and the MessageHeaders' map further exemplifies that; even though the MessageHeaders class implements `java.util.Map`, any attempt to invoke a *put* operation (or *remove* or *clear*) on the MessageHeaders will result in an `UnsupportedOperationException`.

Rather than requiring the creation and population of a Map to pass into the GenericMessage constructor, Spring Integration does provide a far more convenient way to construct Messages: `MessageBuilder`. The MessageBuilder provides two factory methods for creating Messages from either an existing Message or with a payload Object. When building from an existing Message, the headers *and payload* of that Message will be copied to the new Message:

```
Message<String> message1 = MessageBuilder.withPayload("test")
        .setHeader("foo", "bar")
        .build();

Message<String> message2 = MessageBuilder.fromMessage(message1).build();

assertEquals("test", message2.getPayload());
assertEquals("bar", message2.getHeaders().get("foo"));
```

If you need to create a Message with a new payload but still want to copy the headers from an existing Message, you can use one of the *copy* methods.

```
Message<String> message3 = MessageBuilder.withPayload("test3")
        .copyHeaders(message1.getHeaders())
        .build();

Message<String> message4 = MessageBuilder.withPayload("test4")
        .setHeader("foo", 123)
        .copyHeadersIfAbsent(message1.getHeaders())
        .build();

assertEquals("bar", message3.getHeaders().get("foo"));
assertEquals(123, message4.getHeaders().get("foo"));
```

Notice that the `copyHeadersIfAbsent` does not overwrite existing values. Also, in the second example above, you can see how to set any user-defined header with `setHeader`. Finally, there are set methods available for the predefined headers as well as a non-destructive method for setting any header (MessageHeaders also defines constants for the pre-defined header names).

```
Message<Integer> importantMessage = MessageBuilder.withPayload(99)
        .setPriority(5)
        .build();

assertEquals(5, importantMessage.getHeaders().getPriority());

Message<Integer> lessImportantMessage = MessageBuilder.fromMessage(importantMessage)
        .setHeaderIfAbsent(IntegrationMessageHeaderAccessor.PRIORITY, 2)
        .build();

assertEquals(2, lessImportantMessage.getHeaders().getPriority());
```

The `priority` header is only considered when using a `PriorityChannel` (as described in the next chapter). It is defined as *java.lang.Integer*.

6. Message Routing

6.1 Routers

Overview

Routers are a crucial element in many messaging architectures. They consume Messages from a Message Channel and forward each consumed message to one or more different Message Channel depending on a set of conditions.

Spring Integration provides the following routers out-of-the-box:

- *Payload Type Router*
- *Header Value Router*
- *Recipient List Router*
- *XPath Router (Part of the XML Module)*
- *Error Message Exception Type Router*
- *(Generic) Router*

Router implementations share many configuration parameters. Yet, certain differences exist between routers. Furthermore, the availability of configuration parameters depends on whether Routers are used inside or outside of a chain. In order to provide a quick overview, all available attributes are listed in the 2 tables below.

Table 6.1. Routers Outside of a Chain

Attribute	router	header value router	xpath router	payload type router	recipient list router	exception type router
apply-sequence	✓	✓	✓	✓	✓	✓
default-output-channel	✓	✓	✓	✓	✓	✓
resolution-required	✓	✓	✓	✓	✓	✓
ignore-send-failures	✓	✓	✓	✓	✓	✓
timeout	✓	✓	✓	✓	✓	✓
id	✓	✓	✓	✓	✓	✓
auto-startup	✓	✓	✓	✓	✓	✓
input-channel	✓	✓	✓	✓	✓	✓
order	✓	✓	✓	✓	✓	✓

Attribute	router	header value router	xpath router	payload type router	recipient list router	exception type router
method	✓					
ref	✓					
expression	✓					
header-name		✓				
evaluate-as-string			✓			
xpath-expression-ref			✓			
converter			✓			

Table 6.2. Routers Inside of a Chain

Attribute	router	header value router	xpath router	payload type router	recipient list router	exception type router
apply-sequence	✓	✓	✓	✓	✓	✓
default-output-channel	✓	✓	✓	✓	✓	✓
resolution-required	✓	✓	✓	✓	✓	✓
ignore-send-failures	✓	✓	✓	✓	✓	✓
timeout	✓	✓	✓	✓	✓	✓
id						
auto-startup						
input-channel						
order						
method	✓					
ref	✓					
expression	✓					
header-name		✓				
evaluate-as-string			✓			

Attribute	router	header value router	xpath router	payload type router	recipient list router	exception type router
xpath-expression-ref			✓			
converter			✓			

Important

Router parameters have been more standardized across all router implementations with Spring Integration 2.1. Consequently, there are a few minor changes that leave the possibility of breaking older Spring Integration based applications.

Since Spring Integration 2.1 the `ignore-channel-name-resolution-failures` attribute is removed in favor of consolidating its behavior with the `resolution-required` attribute. Also, the `resolution-required` attribute now defaults to `true`.

Prior to these changes, the `resolution-required` attribute defaulted to `false` causing messages to be silently dropped when no channel was resolved and no `default-output-channel` was set. The new behavior will require at least one resolved channel and by default will throw an `MessageDeliveryException` if no channel was determined (or an attempt to send was not successful).

If you do desire to drop messages silently simply set `default-output-channel="nullChannel"`.

Common Router Parameters

Inside and Outside of a Chain

The following parameters are valid for all routers inside and outside of chains.

apply-sequence
: This attribute specifies whether sequence number and size headers should be added to each Message. This *optional* attribute defaults to *false*.

default-output-channel
: If set, this attribute provides a reference to the channel, where Messages should be sent, if channel resolution fails to return any channels. If no default output channel is provided, the router will throw an Exception. If you would like to silently drop those messages instead, add the `nullChannel` as the default output channel attribute value.

Note

A Message will only be sent to the `default-output-channel` if `resolution-required` is false and the channel is not resolved.

resolution-required
: If *true* this attribute specifies that channel names must always be successfully resolved to channel instances that exist. If set to *true*, a `MessagingException` will be raised, in case the channel

cannot be resolved. Setting this attribute to *false*, will cause any unresovable channels to be ignored. This *optional* attribute will, if not explicitly set, default to *true*.

> **Note**
>
> A Message will only be sent to the `default-output-channel`, if specified, when `resolution-required` is false and the channel is not resolved.

ignore-send-failures
: If set to *true*, failures to send to a message channel will be ignored. If set to *false*, a `MessageDeliveryException` will be thrown instead, and if the router resolves more than one channel, any subsequent channels will not receive the message.

The exact behavior of this attribute depends on the type of the `Channel` messages are sent to. For example, when using direct channels (single threaded), send-failures can be caused by exceptions thrown by components much further down-stream. However, when sending messages to a simple queue channel (asynchronous) the likelihood of an exception to be thrown is rather remote.

> **Note**
>
> While most routers will route to a single channel, they are allowed to return more than one channel name. The `recipient-list-router`, for instance, does exactly that. If you set this attribute to *true* on a router that only routes to a single channel, any caused exception is simply swallowed, which usually makes little sense to do. In that case it would be better to catch the exception in an error flow at the flow entry point. Therefore, setting the `ignore-send-failures` attribute to *true* usually makes more sense when the router implementation returns more than one channel name, because the other channel(s) following the one that fails would still receive the Message.

This attribute defaults to *false*.

timeout
: The `timeout` attribute specifies the maximum amount of time in milliseconds to wait, when sending Messages to the target Message Channels. By default the send operation will block indefinitely.

Top-Level (Outside of a Chain)

The following parameters are valid only across all top-level routers that are ourside of chains.

id
: Identifies the underlying Spring bean definition which in case of Routers is an instance of EventDrivenConsumer or PollingConsumer depending on whether the Router's *input-channel* is a *SubscribableChannel* or *PollableChannel*, respectively. This is an *optional* attribute.

auto-startup
: This `Lifecycle` attribute signaled if this component should be started during startup of the Application Context. This *optional* attribute defaults to *true*.

input-channel
: The receiving Message channel of this endpoint.

order
: This attribute defines the order for invocation when this endpoint is connected as a subscriber to a channel. This is particularly relevant when that channel is using a *failover* dispatching strategy. It has no effect when this endpoint itself is a Polling Consumer for a channel with a queue.

Router Implementations

Since content-based routing often requires some domain-specific logic, most use-cases will require Spring Integration’s options for delegating to POJOs using the XML namespace support and/or Annotations. Both of these are discussed below, but first we present a couple implementations that are available out-of-the-box since they fulfill common requirements.

PayloadTypeRouter

A `PayloadTypeRouter` will send Messages to the channel as defined by payload-type mappings.

```
<bean id="payloadTypeRouter"
      class="org.springframework.integration.router.PayloadTypeRouter">
    <property name="channelMapping">
        <map>
            <entry key="java.lang.String" value-ref="stringChannel"/>
            <entry key="java.lang.Integer" value-ref="integerChannel"/>
        </map>
    </property>
</bean>
```

Configuration of the `PayloadTypeRouter` is also supported via the namespace provided by Spring Integration (see the section called “CompletableFuture”), which essentially simplifies configuration by combining the `<router/>` configuration and its corresponding implementation defined using a `<bean/>` element into a single and more concise configuration element. The example below demonstrates a `PayloadTypeRouter` configuration which is equivalent to the one above using the namespace support:

```
<int:payload-type-router input-channel="routingChannel">
    <int:mapping type="java.lang.String" channel="stringChannel" />
    <int:mapping type="java.lang.Integer" channel="integerChannel" />
</int:payload-type-router>
```

The equivalent router, using Java configuration:

```
@ServiceActivator(inputChannel = "routingChannel")
@Bean
public PayloadTypeRouter router() {
    PayloadTypeRouter router = new PayloadTypeRouter();
    router.setChannelMapping(String.class.getName(), "stringChannel");
    router.setChannelMapping(Integer.class.getName(), "integerChannel");
    return router;
}
```

When using the Java DSL, there are two options; 1) define the router object as above…

```
@Bean
public IntegrationFlow routerFlow1() {
    return IntegrationFlows.from("routingChannel")
            .route(router())
            .get();
}

public PayloadTypeRouter router() {
    PayloadTypeRouter router = new PayloadTypeRouter();
    router.setChannelMapping(String.class.getName(), "stringChannel");
    router.setChannelMapping(Integer.class.getName(), "integerChannel");
    return router;
}
```

Note that the router can be, but doesn’t have to be, a `@Bean` - the flow will register it if it is not.

2) define the routing function within the DSL flow itself…

```
@Bean
public IntegrationFlow routerFlow2() {
    return IntegrationFlows.from("routingChannel")
            .<Object, Class<?>>route(Object::getClass, m -> m
                    .channelMapping(String.class, "stringChannel")
                    .channelMapping(Integer.class, "integerChannel"))
            .get();
}
```

HeaderValueRouter

A `HeaderValueRouter` will send Messages to the channel based on the individual header value mappings. When a `HeaderValueRouter` is created it is initialized with the *name* of the header to be evaluated. The *value* of the header could be one of two things:

1. Arbitrary value

2. Channel name

If arbitrary then additional mappings for these header values to channel names is required, otherwise no additional configuration is needed.

Spring Integration provides a simple namespace-based XML configuration to configure a `HeaderValueRouter`. The example below demonstrates two types of namespace-based configuration for the `HeaderValueRouter`.

1. Configuration where mapping of header values to channels is required

```
<int:header-value-router input-channel="routingChannel" header-name="testHeader">
    <int:mapping value="someHeaderValue" channel="channelA" />
    <int:mapping value="someOtherHeaderValue" channel="channelB" />
</int:header-value-router>
```

During the resolution process this router may encounter channel resolution failures, causing an exception. If you want to suppress such exceptions and send unresolved messages to the default output channel (identified with the `default-output-channel` attribute) set `resolution-required` to `false`.

Normally, messages for which the header value is not explicitly mapped to a channel will be sent to the `default-output-channel`. However, in cases where the header value is mapped to a channel name but the channel cannot be resolved, setting the `resolution-required` attribute to `false` will result in routing such messages to the `default-output-channel`.

Important

With Spring Integration 2.1 the attribute was changed from `ignore-channel-name-resolution-failures` to `resolution-required`. Attribute `resolution-required` will default to `true`.

The equivalent router, using Java configuration:

```
@ServiceActivator(inputChannel = "routingChannel")
@Bean
public HeaderValueRouter router() {
    HeaderValueRouter router = new HeaderValueRouter("testHeader");
    router.setChannelMapping("someHeaderValue", "channelA");
    router.setChannelMapping("someOtherHeaderValue", "channelB");
    return router;
}
```

When using the Java DSL, there are two options; 1) define the router object as above…

```
@Bean
public IntegrationFlow routerFlow1() {
    return IntegrationFlows.from("routingChannel")
            .route(router())
            .get();
}

public HeaderValueRouter router() {
    HeaderValueRouter router = new HeaderValueRouter("testHeader");
    router.setChannelMapping("someHeaderValue", "channelA");
    router.setChannelMapping("someOtherHeaderValue", "channelB");
    return router;
}
```

Note that the router can be, but doesn't have to be, a `@Bean` - the flow will register it if it is not.

2) define the routing function within the DSL flow itself…

```
@Bean
public IntegrationFlow routerFlow2() {
    return IntegrationFlows.from("routingChannel")
            .<Message<?>, String>route(m -> m.getHeaders().get("testHeader", String.class), m -> m
                    .channelMapping("someHeaderValue", "channelA")
                    .channelMapping("someOtherHeaderValue", "channelB"),
                e -> e.id("headerValueRouter"))
            .get();
}
```

2. Configuration where mapping of header values to channel names is not required since header values themselves represent channel names

```
<int:header-value-router input-channel="routingChannel" header-name="testHeader"/>
```

Note

Since Spring Integration 2.1 the behavior of resolving channels is more explicit. For example, if you ommit the `default-output-channel` attribute and the Router was unable to resolve at least one valid channel, and any channel name resolution failures were ignored by setting `resolution-required` to `false`, then a `MessageDeliveryException` is thrown.

Basically, by default the Router must be able to route messages successfully to at least one channel. If you really want to drop messages, you must also have `default-output-channel` set to `nullChannel`.

RecipientListRouter

A `RecipientListRouter` will send each received Message to a statically defined list of Message Channels:

```
<bean id="recipientListRouter"
      class="org.springframework.integration.router.RecipientListRouter">
    <property name="channels">
        <list>
            <ref bean="channel1"/>
            <ref bean="channel2"/>
            <ref bean="channel3"/>
        </list>
    </property>
</bean>
```

Spring Integration also provides namespace support for the `RecipientListRouter` configuration (see the section called “CompletableFuture”) as the example below demonstrates.

```
<int:recipient-list-router id="customRouter" input-channel="routingChannel"
        timeout="1234"
        ignore-send-failures="true"
        apply-sequence="true">
  <int:recipient channel="channel1"/>
  <int:recipient channel="channel2"/>
</int:recipient-list-router>
```

The equivalent router, using Java configuration:

```
@ServiceActivator(inputChannel = "routingChannel")
@Bean
public RecipientListRouter router() {
    RecipientListRouter router = new RecipientListRouter();
    router.setSendTimeout(1_234L);
    router.setIgnoreSendFailures(true);
    router.setApplySequence(true);
    router.addRecipient("channel1");
    router.addRecipient("channel2");
    router.addRecipient("channel3");
    return router;
}
```

The equivalent router, using the Java DSL:

```
@Bean
public IntegrationFlow routerFlow() {
    return IntegrationFlows.from("routingChannel")
            .routeToRecipients(r -> r
                    .applySequence(true)
                    .ignoreSendFailures(true)
                    .recipient("channel1")
                    .recipient("channel2")
                    .recipient("channel3")
                    .sendTimeout(1_234L))
            .get();
}
```

Note

The *apply-sequence* flag here has the same effect as it does for a publish-subscribe-channel, and like a publish-subscribe-channel, it is disabled by default on the recipient-list-router. Refer to the section called “PublishSubscribeChannel Configuration” for more information.

Another convenient option when configuring a `RecipientListRouter` is to use Spring Expression Language (SpEL) support as selectors for individual recipient channels. This is similar to using a Filter at the beginning of *chain* to act as a "Selective Consumer". However, in this case, it’s all combined rather concisely into the router’s configuration.

```
<int:recipient-list-router id="customRouter" input-channel="routingChannel">
    <int:recipient channel="channel1" selector-expression="payload.equals('foo')"/>
    <int:recipient channel="channel2" selector-expression="headers.containsKey('bar')"/>
</int:recipient-list-router>
```

In the above configuration a SpEL expression identified by the `selector-expression` attribute will be evaluated to determine if this recipient should be included in the recipient list for a given input Message. The evaluation result of the expression must be a boolean. If this attribute is not defined, the channel will always be among the list of recipients.

RecipientListRouterManagement

Starting with *version 4.1*, the `RecipientListRouter` provides several operation to manipulate with *recipients* dynamically at runtime. These management operations are presented by `RecipientListRouterManagement` `@ManagedResource`. They are available using the section called "CompletableFuture" as well as via JMX:

```
<control-bus input-channel="controlBus"/>

<recipient-list-router id="simpleRouter" input-channel="routingChannelA">
   <recipient channel="channel1"/>
</recipient-list-router>

<channel id="channel2"/>
```

```
messagingTemplate.convertAndSend(controlBus, "@'simpleRouter.handler'.addRecipient('channel2')");
```

From the application start up the `simpleRouter` will have only one `channel1` recipient. But after the `addRecipient` command above the new `channel2` recipient will be added. It is a "registering an interest in something that is part of the Message" use case, when we may be interested in messages from the *router* at some time period, so we are *subscribing* to the the `recipient-list-router` and in some point decide to *unsubscribe* our interest.

Having the runtime management operation for the `<recipient-list-router>`, it can be configured without any `<recipient>` from the start. In this case the behaviour of `RecipientListRouter` is the same, when there is no one matching recipient for the message: if `defaultOutputChannel` is configured, the message will be sent there, otherwise the `MessageDeliveryException` is thrown.

XPath Router

The XPath Router is part of the XML Module. See *the section called "CompletableFuture"*.

Routing and Error handling

Spring Integration also provides a special type-based router called `ErrorMessageExceptionTypeRouter` for routing Error Messages (Messages whose `payload` is a `Throwable` instance). `ErrorMessageExceptionTypeRouter` is very similar to the `PayloadTypeRouter`. In fact they are almost identical. The only difference is that while `PayloadTypeRouter` navigates the instance hierarchy of a payload instance (e.g., `payload.getClass().getSuperclass()`) to find the most specific type/channel mappings, the `ErrorMessageExceptionTypeRouter` navigates the hierarchy of *exception causes* (e.g., `payload.getCause()`) to find the most specific `Throwable` type/channel mappings and uses `mappingClass.isInstance(cause)` to match the `cause` to the class or any super class.

> **Note**
>
> Since *version 4.3* the `ErrorMessageExceptionTypeRouter` loads all mapping classes during the initialization phase to fail-fast for a `ClassNotFoundException`.

Below is a sample configuration for `ErrorMessageExceptionTypeRouter`.

```
<int:exception-type-router input-channel="inputChannel"
                           default-output-channel="defaultChannel">
    <int:mapping exception-type="java.lang.IllegalArgumentException"
                 channel="illegalChannel"/>
    <int:mapping exception-type="java.lang.NullPointerException"
                 channel="npeChannel"/>
</int:exception-type-router>

<int:channel id="illegalChannel" />
<int:channel id="npeChannel" />
```

Configuring a Generic Router

Configuring a Content Based Router with XML

The "router" element provides a simple way to connect a router to an input channel and also accepts the optional `default-output-channel` attribute. The `ref` attribute references the bean name of a custom Router implementation (extending `AbstractMessageRouter`):

```
<int:router ref="payloadTypeRouter" input-channel="input1"
            default-output-channel="defaultOutput1"/>

<int:router ref="recipientListRouter" input-channel="input2"
            default-output-channel="defaultOutput2"/>

<int:router ref="customRouter" input-channel="input3"
            default-output-channel="defaultOutput3"/>

<beans:bean id="customRouterBean" class="org.foo.MyCustomRouter"/>
```

Alternatively, `ref` may point to a simple POJO that contains the @Router annotation (see below), or the `ref` may be combined with an explicit `method` name. Specifying a `method` applies the same behavior described in the @Router annotation section below.

```
<int:router input-channel="input" ref="somePojo" method="someMethod"/>
```

Using a `ref` attribute is generally recommended if the custom router implementation is referenced in other `<router>` definitions. However if the custom router implementation should be scoped to a single definition of the `<router>`, you may provide an inner bean definition:

```
<int:router method="someMethod" input-channel="input3"
            default-output-channel="defaultOutput3">
    <beans:bean class="org.foo.MyCustomRouter"/>
</int:router>
```

Note

Using both the `ref` attribute and an inner handler definition in the same `<router>` configuration is not allowed, as it creates an ambiguous condition, and an Exception will be thrown.

Important

If the "ref" attribute references a bean that extends `AbstractMessageProducingHandler` (such as routers provided by the framework itself), the configuration is optimized referencing the router directly. In this case, each "ref" must be to a separate bean instance (or a `prototype`-scoped bean), or use the inner `<bean/>` configuration type. However, this optimization only applies if you don't provide any router-specific attributes in the router XML definition. If you inadvertently reference the same message handler from multiple beans, you will get a configuration exception.

The equivalent router, using Java Configuration:

```
@Bean
@Router(inputChannel = "routingChannel")
public AbstractMessageRouter myCustomRouter() {
    return new AbstractMessageRouter() {

        @Override
        protected Collection<MessageChannel> determineTargetChannels(Message<?> message) {
            return // determine channel(s) for message
        }

    };
}
```

The equivalent router, using the Java DSL:

```
@Bean
public IntegrationFlow routerFlow() {
    return IntegrationFlows.from("routingChannel")
            .route(myCustomRouter())
            .get();
}

public AbstractMessageRouter myCustomRouter() {
    return new AbstractMessageRouter() {

        @Override
        protected Collection<MessageChannel> determineTargetChannels(Message<?> message) {
            return // determine channel(s) for message
        }

    };
}
```

or, if you can route on just some message payload data:

```
@Bean
public IntegrationFlow routerFlow() {
    return IntegrationFlows.from("routingChannel")
            .route(String.class, p -> p.contains("foo") ? "fooChannel" : "barChannel")
            .get();
}
```

Routers and the Spring Expression Language (SpEL)

Sometimes the routing logic may be simple and writing a separate class for it and configuring it as a bean may seem like overkill. As of Spring Integration 2.0 we offer an alternative where you can now use SpEL to implement simple computations that previously required a custom POJO router.

> **Note**
>
> For more information about the Spring Expression Language, please refer to the respective chapter in the Spring Framework Reference Documentation at:

Generally a SpEL expression is evaluated and the result is mapped to a channel:

```
<int:router input-channel="inChannel" expression="payload.paymentType">
    <int:mapping value="CASH" channel="cashPaymentChannel"/>
    <int:mapping value="CREDIT" channel="authorizePaymentChannel"/>
    <int:mapping value="DEBIT" channel="authorizePaymentChannel"/>
</int:router>
```

The equivalent router, using Java Configuration:

```
@Router(inputChannel = "routingChannel")
@Bean
public ExpressionEvaluatingRouter router() {
    ExpressionEvaluatingRouter router = new ExpressionEvaluatingRouter("payload.paymentType");
    router.setChannelMapping("CASH", "cashPaymentChannel");
    router.setChannelMapping("CREDIT", "authorizePaymentChannel");
    router.setChannelMapping("DEBIT", "authorizePaymentChannel");
    return router;
}
```

The equivalent router, using the Java DSL:

```
@Bean
public IntegrationFlow routerFlow() {
    return IntegrationFlows.from("routingChannel")
        .route("payload.paymentType", r -> r
            .channelMapping("CASH", "cashPaymentChannel")
            .channelMapping("CREDIT", "authorizePaymentChannel")
            .channelMapping("DEBIT", "authorizePaymentChannel"))
        .get();
}
```

To simplify things even more, the SpEL expression may evaluate to a channel name:

```
<int:router input-channel="inChannel" expression="payload + 'Channel'"/>
```

In the above configuration the result channel will be computed by the SpEL expression which simply concatenates the value of the `payload` with the literal String *Channel*.

Another value of SpEL for configuring routers is that an expression can actually return a `Collection`, effectively making every `<router>` a *Recipient List Router*. Whenever the expression returns multiple channel values the Message will be forwarded to each channel.

```
<int:router input-channel="inChannel" expression="headers.channels"/>
```

In the above configuration, if the Message includes a header with the name *channels* the value of which is a `List` of channel names then the Message will be sent to each channel in the list. You may also find *Collection Projection* and *Collection Selection* expressions useful to select multiple channels. For further information, please see:

- Collection Projection
- Collection Selection

Configuring a Router with Annotations

When using `@Router` to annotate a method, the method may return either a `MessageChannel` or `String` type. In the latter case, the endpoint will resolve the channel name as it does for the default output channel. Additionally, the method may return either a single value or a collection. If a collection is returned, the reply message will be sent to multiple channels. To summarize, the following method signatures are all valid.

```
@Router
public MessageChannel route(Message message) {...}

@Router
public List<MessageChannel> route(Message message) {...}

@Router
public String route(Foo payload) {...}

@Router
public List<String> route(Foo payload) {...}
```

In addition to payload-based routing, a Message may be routed based on metadata available within the message header as either a property or attribute. In this case, a method annotated with `@Router` may include a parameter annotated with `@Header` which is mapped to a header value as illustrated below and documented in the section called “CompletableFuture”.

```
@Router
public List<String> route(@Header("orderStatus") OrderStatus status)
```

Note

For routing of XML-based Messages, including XPath support, see the section called “CompletableFuture”.

Also see the section called “CompletableFuture” in Java DSL chapter for more information about routers configuration.

Dynamic Routers

So as you can see, Spring Integration provides quite a few different router configurations for common *content-based routing* use cases as well as the option of implementing custom routers as POJOs. For example `PayloadTypeRouter` provides a simple way to configure a router which computes `channels` based on the `payload type` of the incoming Message while `HeaderValueRouter` provides the same convenience in configuring a router which computes `channels` by evaluating the value of a particular Message Header. There are also *expression-based* (SpEL) routers where the `channel` is determined based on evaluating an expression. Thus, these type of routers exhibit some dynamic characteristics.

However these routers all require *static configuration*. Even in the case of expression-based routers, the expression itself is defined as part of the router configuration which means that_the same expression operating on the same value will always result in the computation of the same channel_. This is acceptable in most cases since such routes are well defined and therefore predictable. But there are times when we need to change router configurations dynamically so message flows may be routed to a different channel.

Example:

You might want to bring down some part of your system for maintenance and temporarily re-reroute messages to a different message flow. Or you may want to introduce more granularity to your message flow by adding another route to handle a more concrete type of `java.lang.Number` (in the case of `PayloadTypeRouter`).

Unfortunately with static router configuration to accomplish this, you would have to bring down your entire application, change the configuration of the router (change routes) and bring it back up. This is obviously not the solution.

The Dynamic Router pattern describes the mechanisms by which one can change/configure routers dynamically without bringing down the system or individual routers.

Before we get into the specifics of how this is accomplished in Spring Integration, let's quickly summarize the typical flow of the router, which consists of 3 simple steps:

- *Step 1* - Compute `channel identifier` which is a value calculated by the router once it receives the Message. Typically it is a `String` or and instance of the actual `MessageChannel`.
- *Step 2* - Resolve `channel identifier` to `channel name`. We'll describe specifics of this process in a moment.
- *Step 3* - Resolve `channel name` to the actual `MessageChannel`

There is not much that can be done with regard to dynamic routing if Step 1 results in the actual instance of the `MessageChannel`, simply because the `MessageChannel` is the *final product* of any router's job. However, if Step 1 results in a `channel identifier` that is not an instance of `MessageChannel`, then there are quite a few possibilities to influence the process of deriving the `Message Channel`. Lets look at couple of the examples in the context of the 3 steps mentioned above:

Payload Type Router

```
<int:payload-type-router input-channel="routingChannel">
    <int:mapping type="java.lang.String"  channel="channel1" />
    <int:mapping type="java.lang.Integer" channel="channel2" />
</int:payload-type-router>
```

Within the context of the Payload Type Router the 3 steps mentioned above would be realized as:

- *Step 1* - Compute `channel identifier` which is the fully qualified name of the payload type (e.g., java.lang.String).
- *Step 2* - Resolve `channel identifier` to `channel name` where the result of the previous step is used to select the appropriate value from the *payload type mapping* defined via `mapping` element.
- *Step 3* - Resolve `channel name` to the actual instance of the `MessageChannel` as a reference to a bean within the Application Context (which is hopefully a `MessageChannel`) identified by the result of the previous step.

In other words, each step feeds the next step until the process completes.

Header Value Router

```
<int:header-value-router input-channel="inputChannel" header-name="testHeader">
    <int:mapping value="foo" channel="fooChannel" />
    <int:mapping value="bar" channel="barChannel" />
</int:header-value-router>
```

Similar to the PayloadTypeRouter:

- *Step 1* - Compute `channel identifier` which is the value of the header identified by the `header-name` attribute.
- *Step 2* - Resolve `channel identifier` to `channel name` where the result of the previous step is used to select the appropriate value from the *general mapping* defined via `mapping` element.

- *Step 3* - Resolve `channel name` to the actual instance of the `MessageChannel` as a reference to a bean within the Application Context (which is hopefully a `MessageChannel`) identified by the result of the previous step.

The above two configurations of two different router types look almost identical. However if we look at the alternate configuration of the `HeaderValueRouter` we clearly see that there is no `mapping` sub element:

```
<int:header-value-router input-channel="inputChannel" header-name="testHeader">
```

But the configuration is still perfectly valid. So the natural question is what about the mapping in the Step 2?

What this means is that Step 2 is now an optional step. If `mapping` is not defined then the `channel identifier` value computed in Step 1 will automatically be treated as the `channel name`, which will now be resolved to the actual `MessageChannel` as in Step 3. What it also means is that Step 2 is one of the key steps to provide dynamic characteristics to the routers, since it introduces a process which *allows you to change the way* channel identifier *resolves to 'channel name'*, thus influencing the process of determining the final instance of the `MessageChannel` from the initial `channel identifier`.

For Example:

In the above configuration let’s assume that the `testHeader` value is *kermit* which is now a `channel identifier` (Step 1). Since there is no mapping in this router, resolving this `channel identifier` to a `channel name` (Step 2) is impossible and this `channel identifier` is now treated as `channel name`. However what if there was a mapping but for a different value? The end result would still be the same and that is: *if a new value cannot be determined through the process of resolving the* channel identifier *to a* channel name*, such* channel identifier *becomes* channel name*.*

So all that is left is for Step 3 to resolve the `channel name` (*kermit*) to an actual instance of the `MessageChannel` identified by this name. That basically involves a bean lookup for the name provided. So now all messages which contain the header/value pair as `testHeader=kermit` are going to be routed to a `MessageChannel` whose bean name (id) is *kermit*.

But what if you want to route these messages to the *simpson* channel? Obviously changing a static configuration will work, but will also require bringing your system down. However if you had access to the `channel identifier` map, then you could just introduce a new mapping where the header/value pair is now `kermit=simpson`, thus allowing Step 2 to treat *kermit* as a `channel identifier` while resolving it to *simpson* as the `channel name` .

The same obviously applies for `PayloadTypeRouter`, where you can now remap or remove a particular *payload type mapping*. In fact, it applies to every other router, including *expression-based* routers, since their computed values will now have a chance to go through Step 2 to be additionally resolved to the actual `channel name`.

Any router that is a subclass of the `AbstractMappingMessageRouter` (which includes most framework defined routers) is a Dynamic Router simply because the `channelMapping` is defined at the `AbstractMappingMessageRouter` level. That map’s setter method is exposed as a public method along with *setChannelMapping* and *removeChannelMapping* methods. These allow you to change/add/remove router mappings at runtime as long as you have a reference to the router itself. It also means that you could expose these same configuration options via JMX (see the section called “CompletableFuture”) or the Spring Integration ControlBus (see the section called “CompletableFuture”) functionality.

Manage Router Mappings using the Control Bus

One way to manage the router mappings is through the Control Bus pattern which exposes a Control Channel where you can send control messages to manage and monitor Spring Integration components, including routers.

> **Note**
>
> For more information about the Control Bus, please see chapter *the section called "CompletableFuture"*.

Typically you would send a control message asking to invoke a particular operation on a particular managed component (e.g. router). Two managed operations (methods) that are specific to changing the router resolution process are:

- `public void setChannelMapping(String key, String channelName)` - will allow you to add a new or modify an existing mapping between `channel identifier` and `channel name`
- `public void removeChannelMapping(String key)` - will allow you to remove a particular channel mapping, thus disconnecting the relationship between `channel identifier` and `channel name`

Note that these methods can be used for simple changes (updating a single route or adding/removing a route). However, if you want to remove one route and add another, the updates are not atomic. This means the routing table may be in an indeterminate state between the updates. Starting with *version 4.0*, you can now use the control bus to update the entire routing table atomically.

- `public Map<String, String>getChannelMappings()` returns the current mappings.
- `public void replaceChannelMappings(Properties channelMappings)` updates the mappings. Notice that the parameter is a properties object; this allows the use of the inbuilt `StringToPropertiesConverter` by a control bus command, for example:

```
"@'router.handler'.replaceChannelMappings('foo=qux \n baz=bar')"
```

- note that each mapping is separated by a newline character (`\n`). For programmatic changes to the map, it is recommended that the `setChannelMappings` method is used instead, for type-safety. Any non-String keys or values passed into `replaceChannelMappings` are ignored.

Manage Router Mappings using JMX

You can also expose a router instance with Spring's JMX support, and then use your favorite JMX client (e.g., JConsole) to manage those operations (methods) for changing the router's configuration.

> **Note**
>
> For more information about Spring Integration's JMX support, please see chapter *the section called "CompletableFuture"*.

Routing Slip

Starting with *version 4.1*, Spring Integration provides an implementation of the Routing Slip Enterprise Integration Pattern. It is implemented as a `routingSlip` message header which is used to determine the next channel in `AbstractMessageProducingHandler` s, when an `outputChannel` isn't specified for the endpoint. This pattern is useful in complex, dynamic, cases when it can become difficult to configure multiple routers to determine message flow. When a message arrives at an endpoint that has no `output-channel`, the `routingSlip` is consulted to determine the next channel to which the message will be sent. When the routing slip is exhausted, normal `replyChannel` processing resumes.

Configuration for the *Routing Slip* is presented as a `HeaderEnricher` option - a *semicolon-separated* Routing Slip `path` entries:

```
<util:properties id="properties">
    <beans:prop key="myRoutePath1">channel1</beans:prop>
    <beans:prop key="myRoutePath2">request.headers[myRoutingSlipChannel]</beans:prop>
</util:properties>

<context:property-placeholder properties-ref="properties"/>

<header-enricher input-channel="input" output-channel="process">
    <routing-slip
        value="${myRoutePath1}; @routingSlipRoutingPojo.get(request, reply);
               routingSlipRoutingStrategy; ${myRoutePath2}; finishChannel"/>
</header-enricher>
```

In this sample we have:

- A `<context:property-placeholder>` configuration to demonstrate that the entries in the Routing Slip `path` can be specified as resolvable keys.
- The `<header-enricher>` `<routing-slip>` sub-element is used to populate the `RoutingSlipHeaderValueMessageProcessor` to the `HeaderEnricher` handler.
- The `RoutingSlipHeaderValueMessageProcessor` accepts a String array of resolved Routing Slip `path` entries and returns (from `processMessage()`) a `singletonMap` with the `path` as `key` and `0` as initial `routingSlipIndex`.

Routing Slip `path` entries can contain `MessageChannel` bean names, `RoutingSlipRouteStrategy` bean names and also Spring expressions (SpEL). The `RoutingSlipHeaderValueMessageProcessor` checks each Routing Slip `path` entry against the `BeanFactory` on the first `processMessage` invocation. It converts entries, which aren't bean names in the application context, to `ExpressionEvaluatingRoutingSlipRouteStrategy` instances. `RoutingSlipRouteStrategy` entries are invoked multiple times, until they return null, or an empty String.

Since the *Routing Slip* is involved in the `getOutputChannel` process we have a *request-reply* context. The `RoutingSlipRouteStrategy` has been introduced to determine the next `outputChannel` using the `requestMessage`, as well as the `reply` object. An implementation of this strategy should be registered as a bean in the application context and its bean name is used in the Routing Slip `path`. The `ExpressionEvaluatingRoutingSlipRouteStrategy` implementation is provided. It accepts a SpEL expression, and an internal `ExpressionEvaluatingRoutingSlipRouteStrategy.RequestAndReply` object is used as the *root object* of the evaluation context. This is to avoid the overhead of `EvaluationContext` creation for each `ExpressionEvaluatingRoutingSlipRouteStrategy.getNextPath()` invocation. It is a simple Java Bean with two properties - `Message<?> request` and `Object reply`. With this expression implementation, we can specify Routing Slip `path` entries using SpEL (`@routingSlipRoutingPojo.get(request, reply)`, `request.headers[myRoutingSlipChannel]`) avoiding a bean definition for the `RoutingSlipRouteStrategy`.

Note

The `requestMessage` argument is always a `Message<?>`; depending on context, the reply object may be a `Message<?>`, an `AbstractIntegrationMessageBuilder` or an arbitrary application domain object (if, for example, it is returned by a POJO method invoked by a service activator). In the first two cases, the usual "message" properties are available (`payload` and `headers`) when using SpEL (or a Java implementation). When an arbitrary domain object, these properties are, obviously, not available. Care should be taken when using routing slips in conjunction with POJO methods if the result is used to determine the next path.

Important

If a *Routing Slip* is involved in a distributed environment - cross-JVM application, `request-reply` through a Message Broker (e.g. the section called “CompletableFuture”, the section called “CompletableFuture”), or persistence `MessageStore` (the section called “CompletableFuture”) is used in the integration flow, etc., - it is recommended to **not** use *inline* expressions for the Routing Slip `path`. The framework (`RoutingSlipHeaderValueMessageProcessor`) converts them to `ExpressionEvaluatingRoutingSlipRouteStrategy` objects and they are used in the `routingSlip` message header. Since this class isn't `Serializable` (and it can't be, because it depends on the `BeanFactory`) the entire Message becomes non-serializable and in any distributed operation we end up with `NotSerializableException`. To overcome this limitation, register an `ExpressionEvaluatingRoutingSlipRouteStrategy` bean with the desired SpEL and use its bean name in the Routing Slip `path` configuration.

For Java configuration, simply add a `RoutingSlipHeaderValueMessageProcessor` instance to the `HeaderEnricher` bean definition:

```
@Bean
@Transformer(inputChannel = "routingSlipHeaderChannel")
public HeaderEnricher headerEnricher() {
    return new HeaderEnricher(Collections.singletonMap(IntegrationMessageHeaderAccessor.ROUTING_SLIP,
            new RoutingSlipHeaderValueMessageProcessor("myRoutePath1",
                                                      "@routingSlipRoutingPojo.get(request, reply)",
                                                      "routingSlipRoutingStrategy",
                                                      "request.headers[myRoutingSlipChannel]",
                                                      "finishChannel")));
}
```

The *Routing Slip* algorithm works as follows when an endpoint produces a reply and there is no `outputChannel` defined:

- The `routingSlipIndex` is used to get a value from the Routing Slip `path` list.
- If the value by `routingSlipIndex` is `String`, it is used to get a bean from `BeanFactory`.
- If a returned bean is an instance of `MessageChannel`, it is used as the next `outputChannel` and the `routingSlipIndex` is incremented in the reply message header (the Routing Slip `path` entries remain unchanged).
- If a returned bean is an instance of `RoutingSlipRouteStrategy` and its `getNextPath` doesn't return an empty String, that result is used a bean name for the next `outputChannel`. The `routingSlipIndex` remains unchanged.
- If `RoutingSlipRouteStrategy.getNextPath` returns an empty String, the `routingSlipIndex` is incremented and the `getOutputChannelFromRoutingSlip` is invoked recursively for the next Routing Slip `path` item;

- If the next Routing Slip `path` entry isn't a String it must be an instance of `RoutingSlipRouteStrategy`;
- When the `routingSlipIndex` exceeds the size of the Routing Slip `path` list, the algorithm moves to the default behavior for the standard `replyChannel` header.

Process Manager Enterprise Integration Pattern

The EIP also defines the Process Manager pattern. This pattern can now easily be implemented using custom *Process Manager* logic encapsulated in a `RoutingSlipRouteStrategy` within the routing slip. In addition to a bean name, the `RoutingSlipRouteStrategy` can return any `MessageChannel` object; and there is no requirement that this `MessageChannel` instance is a bean in the application context. This way, we can provide powerful dynamic routing logic, when there is no prediction which channel should be used; a `MessageChannel` can be created within the `RoutingSlipRouteStrategy` and returned. A `FixedSubscriberChannel` with an associated `MessageHandler` implementation is good combination for such cases. For example we can route to a Reactor Stream:

```
@Bean
public PollableChannel resultsChannel() {
    return new QueueChannel();
}
@Bean
public RoutingSlipRouteStrategy routeStrategy() {
    return (requestMessage, reply) -> requestMessage.getPayload() instanceof String
            ? new FixedSubscriberChannel(m ->
            Mono.just((String) m.getPayload())
                    .map(String::toUpperCase)
                    .subscribe(v -> messagingTemplate().convertAndSend(resultsChannel(), v)))
            : new FixedSubscriberChannel(m ->
            Mono.just((Integer) m.getPayload())
                    .map(v -> v * 2)
                    .subscribe(v -> messagingTemplate().convertAndSend(resultsChannel(), v)));
}
```

6.2 Filter

Introduction

Message Filters are used to decide whether a Message should be passed along or dropped based on some criteria such as a Message Header value or Message content itself. Therefore, a Message Filter is similar to a router, except that for each Message received from the filter's input channel, that same Message may or may not be sent to the filter's output channel. Unlike the router, it makes no decision regarding *which* Message Channel to send the Message to but only decides *whether* to send.

Note

As you will see momentarily, the Filter also supports a discard channel, so in certain cases it *can* play the role of a very simple router (or "switch") based on a boolean condition.

In Spring Integration, a Message Filter may be configured as a Message Endpoint that delegates to an implementation of the `MessageSelector` interface. That interface is itself quite simple:

```
public interface MessageSelector {

    boolean accept(Message<?> message);

}
```

The `MessageFilter` constructor accepts a selector instance:

```
MessageFilter filter = new MessageFilter(someSelector);
```

In combination with the namespace and SpEL, very powerful filters can be configured with very little java code.

Configuring Filter

Configuring a Filter with XML

The <filter> element is used to create a Message-selecting endpoint. In addition to `input-channel` and `output-channel` attributes, it requires a `ref`. The `ref` may point to a `MessageSelector` implementation:

```
<int:filter input-channel="input" ref="selector" output-channel="output"/>

<bean id="selector" class="example.MessageSelectorImpl"/>
```

Alternatively, the `method` attribute can be added at which point the `ref` may refer to any object. The referenced method may expect either the `Message` type or the payload type of inbound Messages. The method must return a boolean value. If the method returns *true*, the Message *will* be sent to the output-channel.

```
<int:filter input-channel="input" output-channel="output"
    ref="exampleObject" method="someBooleanReturningMethod"/>

<bean id="exampleObject" class="example.SomeObject"/>
```

If the selector or adapted POJO method returns `false`, there are a few settings that control the handling of the rejected Message. By default (if configured like the example above), rejected Messages will be silently dropped. If rejection should instead result in an error condition, then set the `throw-exception-on-rejection` attribute to `true`:

```
<int:filter input-channel="input" ref="selector"
    output-channel="output" throw-exception-on-rejection="true"/>
```

If you want rejected messages to be routed to a specific channel, provide that reference as the `discard-channel`:

```
<int:filter input-channel="input" ref="selector"
    output-channel="output" discard-channel="rejectedMessages"/>
```

Also see the section called “CompletableFuture”.

> **Note**
>
> Message Filters are commonly used in conjunction with a Publish Subscribe Channel. Many filter endpoints may be subscribed to the same channel, and they decide whether or not to pass the Message to the next endpoint which could be any of the supported types (e.g. Service Activator). This provides a *reactive* alternative to the more *proactive* approach of using a Message Router with a single Point-to-Point input channel and multiple output channels.

Using a `ref` attribute is generally recommended if the custom filter implementation is referenced in other `<filter>` definitions. However if the custom filter implementation is scoped to a single `<filter>` element, provide an inner bean definition:

```
<int:filter method="someMethod" input-channel="inChannel" output-channel="outChannel">
  <beans:bean class="org.foo.MyCustomFilter"/>
</filter>
```

Note

Using both the `ref` attribute and an inner handler definition in the same `<filter>` configuration is not allowed, as it creates an ambiguous condition, and an Exception will be thrown.

Important

If the "ref" attribute references a bean that extends `MessageFilter` (such as filters provided by the framework itself), the configuration is optimized by injecting the output channel into the filter bean directly. In this case, each "ref" must be to a separate bean instance (or a `prototype`-scoped bean), or use the inner `<bean/>` configuration type. However, this optimization only applies if you don't provide any filter-specific attributes in the filter XML definition. If you inadvertently reference the same message handler from multiple beans, you will get a configuration exception.

With the introduction of SpEL support, Spring Integration added the `expression` attribute to the filter element. It can be used to avoid Java entirely for simple filters.

```
<int:filter input-channel="input" expression="payload.equals('nonsense')"/>
```

The string passed as the expression attribute will be evaluated as a SpEL expression with the Message available in the evaluation context. If it is necessary to include the result of an expression in the scope of the application context you can use the #{} notation as defined in the SpEL reference documentation.

```
<int:filter input-channel="input"
            expression="payload.matches(#{filterPatterns.nonsensePattern})"/>
```

If the Expression itself needs to be dynamic, then an *expression* sub-element may be used. That provides a level of indirection for resolving the Expression by its key from an ExpressionSource. That is a strategy interface that you can implement directly, or you can rely upon a version available in Spring Integration that loads Expressions from a "resource bundle" and can check for modifications after a given number of seconds. All of this is demonstrated in the following configuration sample where the Expression could be reloaded within one minute if the underlying file had been modified. If the ExpressionSource bean is named "expressionSource", then it is not necessary to provide the` source` attribute on the <expression> element, but in this case it's shown for completeness.

```
<int:filter input-channel="input" output-channel="output">
    <int:expression key="filterPatterns.example" source="myExpressions"/>
</int:filter>

<beans:bean id="myExpressions" id="myExpressions"
    class="o.s.i.expression.ReloadableResourceBundleExpressionSource">
    <beans:property name="basename" value="config/integration/expressions"/>
    <beans:property name="cacheSeconds" value="60"/>
</beans:bean>
```

Then, the *config/integration/expressions.properties* file (or any more specific version with a locale extension to be resolved in the typical way that resource-bundles are loaded) would contain a key/value pair:

```
filterPatterns.example=payload > 100
```

> **Note**
>
> All of these examples that use `expression` as an attribute or sub-element can also be applied within transformer, router, splitter, service-activator, and header-enricher elements. Of course, the semantics/role of the given component type would affect the interpretation of the evaluation result in the same way that the return value of a method-invocation would be interpreted. For example, an expression can return Strings that are to be treated as Message Channel names by a router component. However, the underlying functionality of evaluating the expression against the Message as the root object, and resolving bean names if prefixed with @ is consistent across all of the core EIP components within Spring Integration.

Configuring a Filter with Annotations

A filter configured using annotations would look like this.

```
public class PetFilter {
    ...
    @Filter  ❶
    public boolean dogsOnly(String input) {
        ...
    }
}
```

❶ An annotation indicating that this method shall be used as a filter. Must be specified if this class will be used as a filter.

All of the configuration options provided by the xml element are also available for the `@Filter` annotation.

The filter can be either referenced explicitly from XML or, if the `@MessageEndpoint` annotation is defined on the class, detected automatically through classpath scanning.

Also see the section called “CompletableFuture”.

6.3 Splitter

Introduction

The Splitter is a component whose role is to partition a message in several parts, and send the resulting messages to be processed independently. Very often, they are upstream producers in a pipeline that includes an Aggregator.

Programming model

The API for performing splitting consists of one base class, `AbstractMessageSplitter`, which is a `MessageHandler` implementation, encapsulating features which are common to splitters, such as filling in the appropriate message headers `CORRELATION_ID`, `SEQUENCE_SIZE`, and `SEQUENCE_NUMBER` on the messages that are produced. This enables tracking down the messages and the results of their processing (in a typical scenario, these headers would be copied over to the messages that are produced by the various transforming endpoints), and use them, for example, in a Composed Message Processor scenario.

An excerpt from `AbstractMessageSplitter` can be seen below:

```
public abstract class AbstractMessageSplitter
    extends AbstractReplyProducingMessageConsumer {
    ...
    protected abstract Object splitMessage(Message<?> message);

}
```

To implement a specific Splitter in an application, extend `AbstractMessageSplitter` and implement the `splitMessage` method, which contains logic for splitting the messages. The return value may be one of the following:

- A `Collection` or an array of Messages, or an `Iterable` (or `Iterator`) that iterates over Messages - in this case the messages will be sent as such (after the `CORRELATION_ID`, `SEQUENCE_SIZE` and `SEQUENCE_NUMBER` are populated). Using this approach gives more control to the developer, for example for populating custom message headers as part of the splitting process.

- A `Collection` or an array of non-Message objects, or an `Iterable` (or `Iterator`) that iterates over non-Message objects - works like the prior case, except that each collection element will be used as a Message payload. Using this approach allows developers to focus on the domain objects without having to consider the Messaging system and produces code that is easier to test.

- a `Message` or non-Message object (but not a Collection or an Array) - it works like the previous cases, except a single message will be sent out.

In Spring Integration, any POJO can implement the splitting algorithm, provided that it defines a method that accepts a single argument and has a return value. In this case, the return value of the method will be interpreted as described above. The input argument might either be a `Message` or a simple POJO. In the latter case, the splitter will receive the payload of the incoming message. Since this decouples the code from the Spring Integration API and will typically be easier to test, it is the recommended approach.

Iterators

Starting with version 4.1, the `AbstractMessageSplitter` supports the `Iterator` type for the `value` to split. Note, in the case of an `Iterator` (or `Iterable`), we don't have access to the number of underlying items and the `SEQUENCE_SIZE` header is set to `0`. This means that the default `SequenceSizeReleaseStrategy` of an `<aggregator>` won't work and the group for the `CORRELATION_ID` from the `splitter` won't be released; it will remain as `incomplete`. In this case you should use an appropriate custom `ReleaseStrategy` or rely on `send-partial-result-on-expiry` together with `group-timeout` or a `MessageGroupStoreReaper`.

Starting with version 5.0, the `AbstractMessageSplitter` provides `protected obtainSizeIfPossible()` methods to allow the determination of the size of the `Iterable` and `Iterator` objects if that is possible. For example `XPathMessageSplitter` can determine the size of the underlying `NodeList` object. And starting with version 5.0.9, this method also properly returns a size of the `com.fasterxml.jackson.core.TreeNode`.

An `Iterator` object is useful to avoid the need for building an entire collection in the memory before splitting. For example, when underlying items are populated from some external system (e.g. DataBase or FTP `MGET`) using iterations or streams.

Stream and Flux

Starting with *version 5.0*, the `AbstractMessageSplitter` supports the Java `Stream` and Reactive Streams `Publisher` types for the `value` to split. In this case the target `Iterator` is built on their iteration functionality.

In addition, if Splitter's output channel is an instance of a `ReactiveStreamsSubscribableChannel`, the `AbstractMessageSplitter` produces a `Flux` result instead of an `Iterator` and the output channel is *subscribed* to this `Flux` for back-pressure based splitting on downstream flow demand.

Configuring Splitter

Configuring a Splitter using XML

A splitter can be configured through XML as follows:

```
<int:channel id="inputChannel"/>

<int:splitter id="splitter"  ❶
  ref="splitterBean"  ❷
  method="split"  ❸
  input-channel="inputChannel"  ❹
  output-channel="outputChannel" /> ❺

<int:channel id="outputChannel"/>

<beans:bean id="splitterBean" class="sample.PojoSplitter"/>
```

❶ The id of the splitter is *optional*.

❷ A reference to a bean defined in the application context. The bean must implement the splitting logic as described in the section above .*Optional*. If reference to a bean is not provided, then it is assumed that the *payload* of the Message that arrived on the `input-channel` is an implementation of `java.util.Collection` and the default splitting logic will be applied to the Collection, incorporating each individual element into a Message and sending it to the `output-channel`.

❸ The method (defined on the bean specified above) that implements the splitting logic.*Optional*.

❹ The input channel of the splitter. *Required*.

❺ The channel to which the splitter will send the results of splitting the incoming message. *Optional (because incoming messages can specify a reply channel themselves)*.

Using a `ref` attribute is generally recommended if the custom splitter implementation may be referenced in other `<splitter>` definitions. However if the custom splitter handler implementation should be scoped to a single definition of the `<splitter>`, configure an inner bean definition:

```
<int:splitter id="testSplitter" input-channel="inChannel" method="split"
                output-channel="outChannel">
  <beans:bean class="org.foo.TestSplitter"/>
</int:splitter>
```

Note

Using both a `ref` attribute and an inner handler definition in the same `<int:splitter>` configuration is not allowed, as it creates an ambiguous condition and will result in an Exception being thrown.

Important

If the "ref" attribute references a bean that extends `AbstractMessageProducingHandler` (such as splitters provided by the framework itself), the configuration is optimized by injecting the output channel into the handler directly. In this case, each "ref" must be to a separate bean instance (or a `prototype`-scoped bean), or use the inner `<bean/>` configuration type. However, this optimization only applies if you don't provide any splitter-specific attributes in the splitter XML definition. If you inadvertently reference the same message handler from multiple beans, you will get a configuration exception.

Configuring a Splitter with Annotations

The `@Splitter` annotation is applicable to methods that expect either the `Message` type or the message payload type, and the return values of the method should be a `Collection` of any type. If the returned values are not actual `Message` objects, then each item will be wrapped in a Message as its payload. Each message will be sent to the designated output channel for the endpoint on which the `@Splitter` is defined.

```
@Splitter
List<LineItem> extractItems(Order order) {
    return order.getItems()
}
```

Also see the section called “CompletableFuture”.

Also see the section called “CompletableFuture” in Java DSL chapter.

6.4 Aggregator

Introduction

Basically a mirror-image of the Splitter, the Aggregator is a type of Message Handler that receives multiple Messages and combines them into a single Message. In fact, an Aggregator is often a downstream consumer in a pipeline that includes a Splitter.

Technically, the Aggregator is more complex than a Splitter, because it is stateful as it must hold the Messages to be aggregated and determine when the complete group of Messages is ready to be aggregated. In order to do this it requires a `MessageStore`.

Functionality

The Aggregator combines a group of related messages, by correlating and storing them, until the group is deemed complete. At that point, the Aggregator will create a single message by processing the whole group, and will send the aggregated message as output.

Implementing an Aggregator requires providing the logic to perform the aggregation (i.e., the creation of a single message from many). Two related concepts are correlation and release.

Correlation determines how messages are grouped for aggregation. In Spring Integration correlation is done by default based on the `IntegrationMessageHeaderAccessor.CORRELATION_ID` message header. Messages with the same `IntegrationMessageHeaderAccessor.CORRELATION_ID` will be grouped together. However, the correlation strategy may be customized to allow other ways of specifying how the messages should be grouped together by implementing a `CorrelationStrategy` (see below).

To determine the point at which a group of messages is ready to be processed, a `ReleaseStrategy` is consulted. The default release strategy for the Aggregator will release a group when all messages included in a sequence are present, based on the `IntegrationMessageHeaderAccessor.SEQUENCE_SIZE` header. This default strategy may be overridden by providing a reference to a custom `ReleaseStrategy` implementation.

Programming model

The Aggregation API consists of a number of classes:

- The interface `MessageGroupProcessor`, and its subclasses: `MethodInvokingAggregatingMessageGroupProcessor` and `ExpressionEvaluatingMessageGroupProcessor`
- The `ReleaseStrategy` interface and its default implementation `SimpleSequenceSizeReleaseStrategy`
- The `CorrelationStrategy` interface and its default implementation `HeaderAttributeCorrelationStrategy`

AggregatingMessageHandler

The `AggregatingMessageHandler` (subclass of `AbstractCorrelatingMessageHandler`) is a `MessageHandler` implementation, encapsulating the common functionalities of an Aggregator (and other correlating use cases), which are:

- correlating messages into a group to be aggregated
- maintaining those messages in a `MessageStore` until the group can be released
- deciding when the group can be released
- aggregating the released group into a single message
- recognizing and responding to an expired group

The responsibility of deciding how the messages should be grouped together is delegated to a `CorrelationStrategy` instance. The responsibility of deciding whether the message group can be released is delegated to a `ReleaseStrategy` instance.

Here is a brief highlight of the base `AbstractAggregatingMessageGroupProcessor` (the responsibility of implementing the `aggregatePayloads` method is left to the developer):

```
public abstract class AbstractAggregatingMessageGroupProcessor
              implements MessageGroupProcessor {

    protected Map<String, Object> aggregateHeaders(MessageGroup group) {
        // default implementation exists
    }

    protected abstract Object aggregatePayloads(MessageGroup group, Map<String, Object> defaultHeaders);

}
```

The `CorrelationStrategy` is owned by the `AbstractCorrelatingMessageHandler` and it has a default value based on the `IntegrationMessageHeaderAccessor.CORRELATION_ID` message header:

```
public AbstractCorrelatingMessageHandler(MessageGroupProcessor processor, MessageGroupStore store,
        CorrelationStrategy correlationStrategy, ReleaseStrategy releaseStrategy) {
    ...
    this.correlationStrategy = correlationStrategy == null ?
        new HeaderAttributeCorrelationStrategy(IntegrationMessageHeaderAccessor.CORRELATION_ID) :
 correlationStrategy;
    this.releaseStrategy = releaseStrategy == null ? new SimpleSequenceSizeReleaseStrategy() :
 releaseStrategy;
    ...
}
```

As for actual processing of the message group, the default implementation is the `DefaultAggregatingMessageGroupProcessor`. It creates a single Message whose payload is a List of the payloads received for a given group. This works well for simple Scatter Gather implementations with either a Splitter, Publish Subscribe Channel, or Recipient List Router upstream.

Note

When using a Publish Subscribe Channel or Recipient List Router in this type of scenario, be sure to enable the flag to `apply-sequence`. That will add the necessary headers (`CORRELATION_ID`, `SEQUENCE_NUMBER` and `SEQUENCE_SIZE`). That behavior is enabled by default for Splitters in Spring Integration, but it is not enabled for the Publish Subscribe Channel or Recipient List Router because those components may be used in a variety of contexts in which these headers are not necessary.

When implementing a specific aggregator strategy for an application, a developer can extend `AbstractAggregatingMessageGroupProcessor` and implement the `aggregatePayloads` method. However, there are better solutions, less coupled to the API, for implementing the aggregation logic which can be configured easily either through XML or through annotations.

In general, any POJO can implement the aggregation algorithm if it provides a method that accepts a single `java.util.List` as an argument (parameterized lists are supported as well). This method will be invoked for aggregating messages as follows:

- if the argument is a `java.util.Collection<T>`, and the parameter type T is assignable to `Message`, then the whole list of messages accumulated for aggregation will be sent to the aggregator
- if the argument is a non-parameterized `java.util.Collection` or the parameter type is not assignable to `Message`, then the method will receive the payloads of the accumulated messages
- if the return type is not assignable to `Message`, then it will be treated as the payload for a Message that will be created automatically by the framework.

Note

In the interest of code simplicity, and promoting best practices such as low coupling, testability, etc., the preferred way of implementing the aggregation logic is through a POJO, and using the XML or annotation support for configuring it in the application.

Important

The `SimpleMessageGroup.getMessages()` method returns an `unmodifiableCollection`, therefore, if your aggregating POJO method has a `Collection<Message>` parameter, the argument passed in will be exactly that

> `Collection` instance and, when a `SimpleMessageStore` is used for the Aggregator, that original `Collection<Message>` will be cleared after releasing the group. Hence the `Collection<Message>` variable in the POJO will be cleared too, if passed out of the aggregator. If you wish to simply release that collection as-is for further processing, it is required that you build a new `Collection` (e.g. `new ArrayList<Message>(messages)`) Starting with _version 4.3, the Framework no longer copies the messages to a new collection, to avoid undesired extra object creation.

If the `MessageGroupProcessor` 's `processMessageGroup` method returns a collection, it must be a collection of `Message<?>` s. In this case, the messages are released individually. Prior to *version 4.2*, it was not possible to provide a `MessageGroupProcessor` using XML configuration, only POJO methods could be used for aggregation. Now, if the framework detects that the referenced (or inner) bean implements `MessageProcessor`, it is used as the aggregator's output processor.

If you wish to release a collection of objects from a custom `MessageGroupProcessor` as the payload of a message, your class should extend `AbstractAggregatingMessageGroupProcessor` and implement `aggregatePayloads()`.

Also, since *version 4.2*, a `SimpleMessageGroupProcessor` is provided; which simply returns the collection of messages from the group, which, as indicated above, causes the released messages to be sent individually.

This allows the aggregator to work as a message barrier where arriving messages are held until the release strategy fires, and the group is released, as a sequence of individual messages.

ReleaseStrategy

The `ReleaseStrategy` interface is defined as follows:

```
public interface ReleaseStrategy {

  boolean canRelease(MessageGroup group);

}
```

In general, any POJO can implement the completion decision logic if it provides a method that accepts a single `java.util.List` as an argument (parameterized lists are supported as well), and returns a boolean value. This method will be invoked after the arrival of each new message, to decide whether the group is complete or not, as follows:

- if the argument is a `java.util.List<T>`, and the parameter type T is assignable to `Message`, then the whole list of messages accumulated in the group will be sent to the method
- if the argument is a non-parametrized `java.util.List` or the parameter type is not assignable to `Message`, then the method will receive the payloads of the accumulated messages
- the method must return true if the message group is ready for aggregation, and false otherwise.

For example:

```
public class MyReleaseStrategy {

    @ReleaseStrategy
    public boolean canMessagesBeReleased(List<Message<?>>) {...}
}
```

```
public class MyReleaseStrategy {

    @ReleaseStrategy
    public boolean canMessagesBeReleased(List<String>) {...}
}
```

As you can see based on the above signatures, the POJO-based Release Strategy will be passed a `Collection` of not-yet-released Messages (if you need access to the whole `Message`) or a `Collection` of payload objects (if the type parameter is anything other than `Message`). Typically this would satisfy the majority of use cases. However if, for some reason, you need to access the full `MessageGroup` then you should simply provide an implementation of the `ReleaseStrategy` interface.

> **Warning**
>
> When handling potentially large groups, it is important to understand how these methods are invoked because the release strategy may be invoked multiple times before the group is released. The most efficient is an implementation of `ReleaseStrategy` because the aggregator can invoke it directly. The second most efficient is a POJO method with a `Collection<Message<?>>` parameter type. The least efficient is a POJO method with a `Collection<Foo>` type - the framework has to copy the payloads from the messages in the group into a new collection (and possibly attempt conversion on the payloads to `Foo`) every time the release strategy is called. `Collection<?>` avoids the conversion but still requires creating the new `Collection`.
>
> **For these reasons, for large groups, it is recommended that you implement `ReleaseStrategy`.**

When the group is released for aggregation, all its not-yet-released messages are processed and removed from the group. If the group is also complete (i.e. if all messages from a sequence have arrived or if there is no sequence defined), then the group is marked as complete. Any new messages for this group will be sent to the discard channel (if defined). Setting `expire-groups-upon-completion` to `true` (default is `false`) removes the entire group and any new messages, with the same correlation id as the removed group, will form a new group. Partial sequences can be released by using a `MessageGroupStoreReaper` together with `send-partial-result-on-expiry` being set to `true`.

> **Important**
>
> To facilitate discarding of late-arriving messages, the aggregator must maintain state about the group after it has been released. This can eventually cause out of memory conditions. To avoid such situations, you should consider configuring a `MessageGroupStoreReaper` to remove the group metadata; the expiry parameters should be set to expire groups after it is not expected that late messages will arrive. For information about configuring a reaper, see the section called “Managing State in an Aggregator: MessageGroupStore”.

Spring Integration provides an out-of-the box implementation for `ReleaseStrategy`, the `SimpleSequenceSizeReleaseStrategy`. This implementation consults the `SEQUENCE_NUMBER` and `SEQUENCE_SIZE` headers of each arriving message to decide when a message group is complete and ready to be aggregated. As shown above, it is also the default strategy.

> **Note**
>
> Before *version 5.0*, the default release strategy was `SequenceSizeReleaseStrategy` which does not perform well with large groups. With that strategy, duplicate sequence numbers are detected and rejected; this operation can be expensive.

If you are aggregating large groups, you don't need to release partial groups, and you don't need to detect/reject duplicate sequences, consider using the `SimpleSequenceSizeReleaseStrategy` instead - it is much more efficient for these use cases, and is the default since *version 5.0* when partial group release is not specified.

Aggregating Large Groups

The 4.3 release changed the default `Collection` for messages in a `SimpleMessageGroup` to `HashSet` (it was previously a `BlockingQueue`). This was expensive when removing individual messages from large groups (an O(n) linear scan was required). Although the hash set is generally much faster for removing, it can be expensive for large messages because the hash has to be calculated (on both inserts and removes). If you have messages that are expensive to hash, consider using some other collection type. As discussed in the section called "CompletableFuture", a `SimpleMessageGroupFactory` is provided so you can select the `Collection` that best suits your needs. You can also provide your own factory implementation to create some other `Collection<Message<?>>`.

Here is an example of how to configure an aggregator with the previous implementation and a `SimpleSequenceSizeReleaseStrategy`.

```
<int:aggregator input-channel="aggregate"
    output-channel="out" message-store="store" release-strategy="releaser" />

<bean id="store" class="org.springframework.integration.store.SimpleMessageStore">
    <property name="messageGroupFactory">
        <bean class="org.springframework.integration.store.SimpleMessageGroupFactory">
            <constructor-arg value="BLOCKING_QUEUE"/>
        </bean>
    </property>
</bean>

<bean id="releaser" class="SimpleSequenceSizeReleaseStrategy" />
```

CorrelationStrategy

The `CorrelationStrategy` interface is defined as follows:

```
public interface CorrelationStrategy {

  Object getCorrelationKey(Message<?> message);

}
```

The method returns an Object which represents the correlation key used for associating the message with a message group. The key must satisfy the criteria used for a key in a Map with respect to the implementation of `equals()` and `hashCode()`.

In general, any POJO can implement the correlation logic, and the rules for mapping a message to a method's argument (or arguments) are the same as for a `ServiceActivator` (including support for @Header annotations). The method must return a value, and the value must not be `null`.

Spring Integration provides an out-of-the box implementation for `CorrelationStrategy`, the `HeaderAttributeCorrelationStrategy`. This implementation returns the value of one of the message headers (whose name is specified by a constructor argument) as the correlation key. By default, the correlation strategy is a `HeaderAttributeCorrelationStrategy` returning the value of the `CORRELATION_ID` header attribute. If you have a custom header name you would like to use for correlation, then simply configure that on an instance of `HeaderAttributeCorrelationStrategy` and provide that as a reference for the Aggregator's correlation-strategy.

LockRegistry

Changes to groups are thread safe; a `LockRegistry` is used to obtain a lock for the resolved correlation id. A `DefaultLockRegistry` is used by default (in-memory). For synchronizing updates across servers, where a shared `MessageGroupStore` is being used, a shared lock registry must be configured. See the section called “Configuring an Aggregator” below for more information.

Configuring an Aggregator

See the section called “CompletableFuture” for configuring an Aggregator in Java DSL.

Configuring an Aggregator with XML

Spring Integration supports the configuration of an aggregator via XML through the `<aggregator/>` element. Below you can see an example of an aggregator.

```
<channel id="inputChannel"/>

<int:aggregator id="myAggregator"  ❶
        auto-startup="true"  ❷
        input-channel="inputChannel"  ❸
        output-channel="outputChannel"  ❹
        discard-channel="throwAwayChannel"  ❺
        message-store="persistentMessageStore"  ❻
        order="1"  ❼
        send-partial-result-on-expiry="false"  ❽
        send-timeout="1000"  ❾

        correlation-strategy="correlationStrategyBean"  ❿
        correlation-strategy-method="correlate"  11
        correlation-strategy-expression="headers['foo']"  12

        ref="aggregatorBean"  13
        method="aggregate"  14

        release-strategy="releaseStrategyBean"  15
        release-strategy-method="release"  16
        release-strategy-expression="size() == 5"  17

        expire-groups-upon-completion="false"  18
        empty-group-min-timeout="60000"  19

        lock-registry="lockRegistry"  20

        group-timeout="60000"  21
        group-timeout-expression="size() ge 2 ? 100 : -1"  22
        expire-groups-upon-timeout="true"  23

        scheduler="taskScheduler" >  24
            <expire-transactional/>  25
            <expire-advice-chain/>  26
</aggregator>

<int:channel id="outputChannel"/>

<int:channel id="throwAwayChannel"/>

<bean id="persistentMessageStore" class="org.springframework.integration.jdbc.store.JdbcMessageStore">
    <constructor-arg ref="dataSource"/>
</bean>

<bean id="aggregatorBean" class="sample.PojoAggregator"/>

<bean id="releaseStrategyBean" class="sample.PojoReleaseStrategy"/>

<bean id="correlationStrategyBean" class="sample.PojoCorrelationStrategy"/>
```

❶ The id of the aggregator is *Optional*.

❷ Lifecycle attribute signaling if aggregator should be started during Application Context startup. *Optional (default is* true*)*.

❸ The channel from which where aggregator will receive messages. *Required*.

❹ The channel to which the aggregator will send the aggregation results. *Optional (because incoming messages can specify a reply channel themselves via* replyChannel *Message Header)*.

❺ The channel to which the aggregator will send the messages that timed out (if `send-partial-result-on-expiry` is *false*). *Optional*.

❻ A reference to a `MessageGroupStore` used to store groups of messages under their correlation key until they are complete. *Optional*, by default a volatile in-memory store.

❼ Order of this aggregator when more than one handle is subscribed to the same DirectChannel (use for load balancing purposes). *Optional*.

8 Indicates that expired messages should be aggregated and sent to the *output-channel* or *replyChannel* once their containing `MessageGroup` is expired (see `MessageGroupStore.expireMessageGroups(long)`). One way of expiring `MessageGroup` s is by configuring a `MessageGroupStoreReaper`. However `MessageGroup` s can alternatively be expired by simply calling `MessageGroupStore.expireMessageGroups(timeout)`. That could be accomplished via a Control Bus operation or by simply invoking that method if you have a reference to the `MessageGroupStore` instance. Otherwise by itself this attribute has no behavior. It only serves as an indicator of what to do (discard or send to the output/reply channel) with Messages that are still in the `MessageGroup` that is about to be expired. *Optional*. *Default - false*. **NOTE:** This attribute is more properly `send-partial-result-on-timeout` because the group may not actually expire if `expire-groups-upon-timeout` is set to `false`.

9 The timeout interval to wait when sending a reply `Message` to the `output-channel` or `discard-channel`. Defaults to `-1` - blocking indefinitely. It is applied only if the output channel has some *sending* limitations, e.g. `QueueChannel` with a fixed *capacity*. In this case a `MessageDeliveryException` is thrown. The `send-timeout` is ignored in case of `AbstractSubscribableChannel` implementations. In case of `group-timeout(-expression)` the `MessageDeliveryException` from the scheduled expire task leads this task to be rescheduled. *Optional*.

10 A reference to a bean that implements the message correlation (grouping) algorithm. The bean can be an implementation of the `CorrelationStrategy` interface or a POJO. In the latter case the correlation-strategy-method attribute must be defined as well. *Optional (by default, the aggregator will use the `IntegrationMessageHeaderAccessor.CORRELATION_ID` header)*.

11 A method defined on the bean referenced by `correlation-strategy`, that implements the correlation decision algorithm. *Optional, with restrictions (requires `correlation-strategy` to be present).*

12 A SpEL expression representing the correlation strategy. Example: `"headers['foo']"`. Only one of `correlation-strategy` or `correlation-strategy-expression` is allowed.

13 A reference to a bean defined in the application context. The bean must implement the aggregation logic as described above. *Optional (by default the list of aggregated Messages will become a payload of the output message).*

14 A method defined on the bean referenced by `ref`, that implements the message aggregation algorithm. *Optional, depends on `ref` attribute being defined.*

15 A reference to a bean that implements the release strategy. The bean can be an implementation of the `ReleaseStrategy` interface or a POJO. In the latter case the release-strategy-method attribute must be defined as well. *Optional (by default, the aggregator will use the `IntegrationMessageHeaderAccessor.SEQUENCE_SIZE` header attribute)*.

16 A method defined on the bean referenced by `release-strategy`, that implements the completion decision algorithm. *Optional, with restrictions (requires `release-strategy` to be present).*

17 A SpEL expression representing the release strategy; the root object for the expression is a `MessageGroup`. Example: `"size() == 5"`. Only one of `release-strategy` or `release-strategy-expression` is allowed.

18 When set to true (default false), completed groups are removed from the message store, allowing subsequent messages with the same correlation to form a new group. The default behavior is to send messages with the same correlation as a completed group to the *discard-channel*.

19 Only applies if a `MessageGroupStoreReaper` is configured for the `<aggregator>`'s `MessageStore`. By default, when a `MessageGroupStoreReaper` is configured to expire partial groups, empty groups are also removed. Empty groups exist after a group is released normally. This is to enable the detection and discarding of late-arriving messages. If you wish to expire empty groups on a longer schedule than expiring partial groups, set this property. Empty groups will then

not be removed from the `MessageStore` until they have not been modified for at least this number of milliseconds. Note that the actual time to expire an empty group will also be affected by the reaper's *timeout* property and it could be as much as this value plus the timeout.

20 A reference to a `org.springframework.integration.util.LockRegistry` bean; used to obtain a `Lock` based on the `groupId` for concurrent operations on the `MessageGroup`. By default, an internal `DefaultLockRegistry` is used. Use of a distributed `LockRegistry`, such as the `ZookeeperLockRegistry`, ensures only one instance of the aggregator will operate on a group concurrently. See the section called "CompletableFuture", the section called "CompletableFuture", the section called "CompletableFuture" for more information.

21 A timeout in milliseconds to force the `MessageGroup` complete, when the `ReleaseStrategy` doesn't *release* the group when the current Message arrives. This attribute provides a built-in *Time-base Release Strategy* for the aggregator, when there is a need to emit a partial result (or discard the group), if a new Message does not arrive for the `MessageGroup` within the timeout. When a new Message arrives at the aggregator, any existing `ScheduledFuture<?>` for its `MessageGroup` is canceled. If the `ReleaseStrategy` returns `false` (don't release) and the `groupTimeout > 0` a new task will be scheduled to expire the group. Setting this attribute to zero is not advised because it will effectively disable the aggregator because every message group will be immediately completed. It is possible, however to conditionally set it to zero using an expression; see `group-timeout-expression` for information. The action taken during the completion depends on the `ReleaseStrategy` and the `send-partial-group-on-expiry` attribute. See the section called "Aggregator and Group Timeout" for more information. Mutually exclusive with *group-timeout-expression* attribute.

22 The SpEL expression that evaluates to a `groupTimeout` with the `MessageGroup` as the `#root` evaluation context object. Used for scheduling the `MessageGroup` to be forced complete. If the expression evaluates to null or `< 0`, the completion is not scheduled. If it evaluates to zero, the group is completed immediately on the current thread. In effect, this provides a dynamic `group-timeout` property. See `group-timeout` for more information. Mutually exclusive with *group-timeout* attribute.

23 When a group is completed due to a timeout (or by a `MessageGroupStoreReaper`), the group is expired (completely removed) by default. Late arriving messages will start a new group. Set this to `false` to complete the group but have its metadata remain so that late arriving messages will be discarded. Empty groups can be expired later using a `MessageGroupStoreReaper` together with the `empty-group-min-timeout` attribute. Default: *true*.

24 A `TaskScheduler` bean reference to schedule the `MessageGroup` to be forced complete if no new message arrives for the `MessageGroup` within the `groupTimeout`. If not provided, the default scheduler `taskScheduler`, registered in the `ApplicationContext` (`ThreadPoolTaskScheduler`) will be used. This attribute does not apply if `group-timeout` or `group-timeout-expression` is not specified.

25 Since *version 4.1*. Allows a transaction to be started for the `forceComplete` operation. It is initiated from a `group-timeout(-expression)` or by a `MessageGroupStoreReaper` and is not applied to the normal `add/release/discard` operations. Only this sub-element or `<expire-advice-chain/>` is allowed.

26 Since *version 4.1*. Allows the configuration of any `Advice` for the `forceComplete` operation. It is initiated from a `group-timeout(-expression)` or by a `MessageGroupStoreReaper` and is not applied to the normal `add/release/discard` operations. Only this sub-element or `<expire-transactional/>` is allowed. A transaction `Advice` can also be configured here using the Spring `tx` namespace.

Expiring Groups

There are two attributes related to expiring (completely removing) groups. When a group is expired, there is no record of it and if a new message arrives with the same correlation, a new group is started. When a group is completed (without expiry), the empty group remains and late arriving messages are discarded. Empty groups can be removed later using a `MessageGroupStoreReaper` in combination with the `empty-group-min-timeout` attribute.

`expire-groups-upon-completion` relates to "normal" completion - when the `ReleaseStrategy` releases the group. This defaults to `false`.

If a group is not completed normally, but is released or discarded because of a timeout, the group is normally expired. Since *version 4.1*, you can now control this behavior using `expire-groups-upon-timeout`; this defaults to `true` for backwards compatibility.

Note

When a group is timed out, the `ReleaseStrategy` is given one more opportunity to release the group; if it does so, and `expire-groups-upon-timeout` is false, then expiration is controlled by `expire-groups-upon-completion`. If the group is not released by the release strategy during timeout, then the expiration is controlled by the `expire-groups-upon-timeout`. Timed-out groups are either discarded, or a partial release occurs (based on `send-partial-result-on-expiry`).

Starting with *version 5.0* empty groups are also scheduled for removal after `empty-group-min-timeout`. If `expireGroupsUponCompletion == false` and `minimumTimeoutForEmptyGroups > 0`, the task to remove the group is scheduled, when normal or partial sequences release happens.

Using a `ref` attribute is generally recommended if a custom aggregator handler implementation may be referenced in other `<aggregator>` definitions. However if a custom aggregator implementation is only being used by a single definition of the `<aggregator>`, you can use an inner bean definition (starting with version 1.0.3) to configure the aggregation POJO within the `<aggregator>` element:

```
<aggregator input-channel="input" method="sum" output-channel="output">
    <beans:bean class="org.foo.PojoAggregator"/>
</aggregator>
```

Note

Using both a `ref` attribute and an inner bean definition in the same `<aggregator>` configuration is not allowed, as it creates an ambiguous condition. In such cases, an Exception will be thrown.

An example implementation of the aggregator bean looks as follows:

```
public class PojoAggregator {

  public Long add(List<Long> results) {
    long total = 0l;
    for (long partialResult: results) {
      total += partialResult;
    }
    return total;
  }
}
```

An implementation of the completion strategy bean for the example above may be as follows:

```
public class PojoReleaseStrategy {
...
  public boolean canRelease(List<Long> numbers) {
    int sum = 0;
    for (long number: numbers) {
      sum += number;
    }
    return sum >= maxValue;
  }
}
```

> **Note**
>
> Wherever it makes sense, the release strategy method and the aggregator method can be combined in a single bean.

An implementation of the correlation strategy bean for the example above may be as follows:

```
public class PojoCorrelationStrategy {
...
  public Long groupNumbersByLastDigit(Long number) {
    return number % 10;
  }
}
```

For example, this aggregator would group numbers by some criterion (in our case the remainder after dividing by 10) and will hold the group until the sum of the numbers provided by the payloads exceeds a certain value.

> **Note**
>
> Wherever it makes sense, the release strategy method, correlation strategy method and the aggregator method can be combined in a single bean (all of them or any two).

Aggregators and Spring Expression Language (SpEL)

Since Spring Integration 2.0, the various strategies (correlation, release, and aggregation) may be handled with SpEL which is recommended if the logic behind such *release strategy* is relatively simple. Let’s say you have a legacy component that was designed to receive an array of objects. We know that the default release strategy will assemble all aggregated messages in the List. So now we have two problems. First we need to extract individual messages from the list, and then we need to extract the payload of each message and assemble the array of objects (see code below).

```
public String[] processRelease(List<Message<String>> messages){
    List<String> stringList = new ArrayList<String>();
    for (Message<String> message : messages) {
        stringList.add(message.getPayload());
    }
    return stringList.toArray(new String[]{});
}
```

However, with SpEL such a requirement could actually be handled relatively easily with a one-line expression, thus sparing you from writing a custom class and configuring it as a bean.

```
<int:aggregator input-channel="aggChannel"
    output-channel="replyChannel"
    expression="#this.![payload].toArray()"/>
```

In the above configuration we are using a Collection Projection expression to assemble a new collection from the payloads of all messages in the list and then transforming it to an Array, thus achieving the same result as the java code above.

The same expression-based approach can be applied when dealing with custom *Release* and *Correlation* strategies.

Instead of defining a bean for a custom `CorrelationStrategy` via the `correlation-strategy` attribute, you can implement your simple correlation logic via a SpEL expression and configure it via the `correlation-strategy-expression` attribute.

For example:

```
correlation-strategy-expression="payload.person.id"
```

In the above example it is assumed that the payload has an attribute `person` with an `id` which is going to be used to correlate messages.

Likewise, for the `ReleaseStrategy` you can implement your release logic as a SpEL expression and configure it via the `release-strategy-expression` attribute. The root object for evaluation context is the `MessageGroup` itself. The List of messages can be referenced using the `message` property of the group within the expression.

Note

In releases prior to *version 5.0*, the root object was the collection of `Message<?>`.

For example:

```
release-strategy-expression="!messages.?[payload==5].empty"
```

In this example the root object of the SpEL Evaluation Context is the `MessageGroup` itself, and you are simply stating that as soon as there are a message with payload as 5 in this group, it should be released.

Aggregator and Group Timeout

Starting with *version 4.0*, two new mutually exclusive attributes have been introduced: `group-timeout` and `group-timeout-expression` (see the description above). There are some cases where it is needed to emit the aggregator result (or discard the group) after a timeout if the `ReleaseStrategy` doesn't *release* when the current Message arrives. For this purpose the `groupTimeout` option allows scheduling the `MessageGroup` to be forced complete:

```
<aggregator input-channel="input" output-channel="output"
        send-partial-result-on-expiry="true"
        group-timeout-expression="size() ge 2 ? 10000 : -1"
        release-strategy-expression="messages[0].headers.sequenceNumber ==
 messages[0].headers.sequenceSize"/>
```

With this example, the normal *release* will be possible if the aggregator receives the last message in sequence as defined by the `release-strategy-expression`. If that specific message does not arrive, the `groupTimeout` will force the group complete after 10 seconds as long as the group contains at least 2 Messages.

The results of forcing the group complete depends on the `ReleaseStrategy` and the `send-partial-result-on-expiry`. First, the release strategy is again consulted to see if a *normal* release is to be made - while the group won't have changed, the `ReleaseStrategy` can decide to release the group at this time. If the release strategy still does not release the group, it will be expired. If `send-partial-result-on-expiry` is `true`, existing messages in the (partial) `MessageGroup` will be released as a normal aggregator reply Message to the `output-channel`, otherwise it will be discarded.

There is a difference between `groupTimeout` behavior and `MessageGroupStoreReaper` (see the section called "Configuring an Aggregator"). The reaper initiates forced completion for all `MessageGroup` s in the `MessageGroupStore` periodically. The `groupTimeout` does it for each `MessageGroup` individually, if a new Message doesn't arrive during the `groupTimeout`. Also, the reaper can be used to remove empty groups (empty groups are retained in order to discard late messages, if `expire-groups-upon-completion` is false).

Configuring an Aggregator with Annotations

An aggregator configured using annotations would look like this.

```
public class Waiter {
  ...

  @Aggregator  ❶
  public Delivery aggregatingMethod(List<OrderItem> items) {
    ...
  }

  @ReleaseStrategy  ❷
  public boolean releaseChecker(List<Message<?>> messages) {
    ...
  }

  @CorrelationStrategy  ❸
  public String correlateBy(OrderItem item) {
    ...
  }
}
```

❶ An annotation indicating that this method shall be used as an aggregator. Must be specified if this class will be used as an aggregator.

❷ An annotation indicating that this method shall be used as the release strategy of an aggregator. If not present on any method, the aggregator will use the `SimpleSequenceSizeReleaseStrategy`.

❸ An annotation indicating that this method shall be used as the correlation strategy of an aggregator. If no correlation strategy is indicated, the aggregator will use the `HeaderAttributeCorrelationStrategy` based on `CORRELATION_ID`.

All of the configuration options provided by the xml element are also available for the `@Aggregator` annotation.

The aggregator can be either referenced explicitly from XML or, if the `@MessageEndpoint` is defined on the class, detected automatically through classpath scanning.

Annotation configuration (`@Aggregator` and others) for the Aggregator component covers only simple use cases, where most default options are sufficient. If you need more control over those options using Annotation configuration, consider using a `@Bean` definition for the `AggregatingMessageHandler` and mark its `@Bean` method with `@ServiceActivator`:

```
@ServiceActivator(inputChannel = "aggregatorChannel")
@Bean
public MessageHandler aggregator(MessageGroupStore jdbcMessageGroupStore) {
     AggregatingMessageHandler aggregator =
                      new AggregatingMessageHandler(new DefaultAggregatingMessageGroupProcessor(),
                                                  jdbcMessageGroupStore);
     aggregator.setOutputChannel(resultsChannel());
     aggregator.setGroupTimeoutExpression(new ValueExpression<>(500L));
     aggregator.setTaskScheduler(this.taskScheduler);
     return aggregator;
}
```

See the section called “Programming model” and the section called “CompletableFuture” for more information.

Note

Starting with the *version 4.2* the `AggregatorFactoryBean` is available, to simplify Java configuration for the `AggregatingMessageHandler`.

Managing State in an Aggregator: MessageGroupStore

Aggregator (and some other patterns in Spring Integration) is a stateful pattern that requires decisions to be made based on a group of messages that have arrived over a period of time, all with the same correlation key. The design of the interfaces in the stateful patterns (e.g. `ReleaseStrategy`) is driven by the principle that the components (whether defined by the framework or a user) should be able to remain stateless. All state is carried by the `MessageGroup` and its management is delegated to the `MessageGroupStore`.

```
public interface MessageGroupStore {

    int getMessageCountForAllMessageGroups();

    int getMarkedMessageCountForAllMessageGroups();

    int getMessageGroupCount();

    MessageGroup getMessageGroup(Object groupId);

    MessageGroup addMessageToGroup(Object groupId, Message<?> message);

    MessageGroup markMessageGroup(MessageGroup group);

    MessageGroup removeMessageFromGroup(Object key, Message<?> messageToRemove);

    MessageGroup markMessageFromGroup(Object key, Message<?> messageToMark);

    void removeMessageGroup(Object groupId);

    void registerMessageGroupExpiryCallback(MessageGroupCallback callback);

    int expireMessageGroups(long timeout);
}
```

For more information please refer to the JavaDoc.

The `MessageGroupStore` accumulates state information in `MessageGroups` while waiting for a release strategy to be triggered, and that event might not ever happen. So to prevent stale messages from lingering, and for volatile stores to provide a hook for cleaning up when the application shuts down, the `MessageGroupStore` allows the user to register callbacks to apply to its `MessageGroups` when they expire. The interface is very straightforward:

```
public interface MessageGroupCallback {

    void execute(MessageGroupStore messageGroupStore, MessageGroup group);

}
```

The callback has direct access to the store and the message group so it can manage the persistent state (e.g. by removing the group from the store entirely).

The `MessageGroupStore` maintains a list of these callbacks which it applies, on demand, to all messages whose timestamp is earlier than a time supplied as a parameter (see the `registerMessageGroupExpiryCallback(..)` and `expireMessageGroups(..)` methods above).

> **Important**
>
> It is important not to use the same `MessageGroupStore` instance in different aggregator components, when you intend to rely on the `expireMessageGroups` functionality. Every `AbstractCorrelatingMessageHandler` registers its own `MessageGroupCallback` based on the `forceComplete()` callback. This way each group for expiration may be completed or discarded by the wrong aggregator. Starting with version 5.0.10, a `UniqueExpiryCallback` is used from the `AbstractCorrelatingMessageHandler` for the registration callback in the `MessageGroupStore`. The `MessageGroupStore`, in turn, checks for presence an instance of this class and logs an error with an appropriate message if one is already present in the callbacks set. This way the Framework disallows usage of the `MessageGroupStore` instance in different aggregators/resequencers to avoid the mentioned side effect of expiration the groups not created by the particular correlation handler.

You can call the `expireMessageGroups` method with a timeout value. Any message older than the current time minus this value is expired and has the callbacks applied. Thus, it is the user of the store that defines what is meant by message group "`expiry`".

As a convenience for users, Spring Integration provides a wrapper for the message expiry in the form of a `MessageGroupStoreReaper`:

```
<bean id="reaper" class="org...MessageGroupStoreReaper">
    <property name="messageGroupStore" ref="messageStore"/>
    <property name="timeout" value="30000"/>
</bean>

<task:scheduled-tasks scheduler="scheduler">
    <task:scheduled ref="reaper" method="run" fixed-rate="10000"/>
</task:scheduled-tasks>
```

The reaper is a `Runnable`, and all that is happening in the example above is that the message group store’s expire method is being called once every 10 seconds. The timeout itself is 30 seconds.

> **Note**
>
> It is important to understand that the *timeout* property of the `MessageGroupStoreReaper` is an approximate value and is impacted by the the rate of the task scheduler since this property will only be checked on the next scheduled execution of the `MessageGroupStoreReaper` task. For example if the timeout is set for 10 min, but the `MessageGroupStoreReaper` task is scheduled to run every 60 min and the last execution of the `MessageGroupStoreReaper` task

happened 1 min before the timeout, the `MessageGroup` will not expire for the next 59 min. So it is recommended to set the rate at least equal to the value of the timeout or shorter.

In addition to the reaper, the expiry callbacks are invoked when the application shuts down via a lifecycle callback in the `AbstractCorrelatingMessageHandler`.

The `AbstractCorrelatingMessageHandler` registers its own expiry callback, and this is the link with the boolean flag `send-partial-result-on-expiry` in the XML configuration of the aggregator. If the flag is set to true, then when the expiry callback is invoked, any unmarked messages in groups that are not yet released can be sent on to the output channel.

Important

When a shared `MessageStore` is used for different correlation endpoints, it is necessary to configure a proper `CorrelationStrategy` to ensure uniqueness for group ids. Otherwise unexpected behavior may happen when one correlation endpoint may release or expire messages from others - messages with the same correlation key are stored in the same message group.

Some `MessageStore` implementations allow using the same physical resources, by partitioning the data; for example, the `JdbcMessageStore` has a `region` property; the `MongoDbMessageStore` has a `collectionName` property.

For more information about `MessageStore` interface and its implementations, please read the section called “CompletableFuture”.

6.5 Resequencer

Introduction

Related to the Aggregator, albeit different from a functional standpoint, is the Resequencer.

Functionality

The Resequencer works in a similar way to the Aggregator, in the sense that it uses the `CORRELATION_ID` to store messages in groups, the difference being that the Resequencer does not process the messages in any way. It simply releases them in the order of their `SEQUENCE_NUMBER` header values.

With respect to that, the user might opt to release all messages at once (after the whole sequence, according to the `SEQUENCE_SIZE`, has been released), or as soon as a valid sequence is available.

Important

The resequencer is intended to resequence relatively short sequences of messages with small gaps. If you have a large number of disjoint sequences with many gaps, you may experience performance issues.

Configuring a Resequencer

See the section called “CompletableFuture” for configuring a Resequencer in Java DSL.

Configuring a resequencer requires only including the appropriate element in XML.

A sample resequencer configuration is shown below.

```
<int:channel id="inputChannel"/>

<int:channel id="outputChannel"/>

<int:resequencer id="completelyDefinedResequencer"  ❶
  input-channel="inputChannel"  ❷
  output-channel="outputChannel"  ❸
  discard-channel="discardChannel"  ❹
  release-partial-sequences="true"  ❺
  message-store="messageStore"  ❻
  send-partial-result-on-expiry="true"  ❼
  send-timeout="86420000"  ❽
  correlation-strategy="correlationStrategyBean"  ❾
  correlation-strategy-method="correlate"  ❿
  correlation-strategy-expression="headers['foo']"  11
  release-strategy="releaseStrategyBean"  12
  release-strategy-method="release"  13
  release-strategy-expression="size() == 10"  14
  empty-group-min-timeout="60000"  15

  lock-registry="lockRegistry"  16

  group-timeout="60000"  17
  group-timeout-expression="size() ge 2 ? 100 : -1"  18
  scheduler="taskScheduler" />  19
  expire-group-upon-timeout="false" />  20
```

❶ The id of the resequencer is *optional*.

❷ The input channel of the resequencer. *Required*.

❸ The channel to which the resequencer will send the reordered messages. *Optional*.

❹ The channel to which the resequencer will send the messages that timed out (if `send-partial-result-on-timeout` is *false)*. *Optional*.

❺ Whether to send out ordered sequences as soon as they are available, or only after the whole message group arrives. *Optional (false by default)*.

❻ A reference to a `MessageGroupStore` that can be used to store groups of messages under their correlation key until they are complete. *Optional* with default a volatile in-memory store.

❼ Whether, upon the expiration of the group, the ordered group should be sent out (even if some of the messages are missing). *Optional (false by default)*. See the section called “Managing State in an Aggregator: MessageGroupStore”.

❽ The timeout interval to wait when sending a reply `Message` to the `output-channel` or `discard-channel`. Defaults to `-1` - blocking indefinitely. It is applied only if the output channel has some *sending* limitations, e.g. `QueueChannel` with a fixed *capacity*. In this case a `MessageDeliveryException` is thrown. The `send-timeout` is ignored in case of `AbstractSubscribableChannel` implementations. In case of `group-timeout(-expression)` the `MessageDeliveryException` from the scheduled expire task leads this task to be rescheduled. *Optional*.

❾ A reference to a bean that implements the message correlation (grouping) algorithm. The bean can be an implementation of the `CorrelationStrategy` interface or a POJO. In the latter case the correlation-strategy-method attribute must be defined as well. *Optional (by default, the aggregator will use the `IntegrationMessageHeaderAccessor.CORRELATION_ID` header)*.

❿ A method defined on the bean referenced by `correlation-strategy`, that implements the correlation decision algorithm. *Optional, with restrictions (requires `correlation-strategy` to be present).*

11 A SpEL expression representing the correlation strategy. Example: `"headers['foo']"`. Only one of `correlation-strategy` or `correlation-strategy-expression` is allowed.

12 A reference to a bean that implements the release strategy. The bean can be an implementation of the `ReleaseStrategy` interface or a POJO. In the latter case the release-strategy-method attribute must be defined as well. *Optional (by default, the aggregator will use the `IntegrationMessageHeaderAccessor.SEQUENCE_SIZE` header attribute)*.

13 A method defined on the bean referenced by `release-strategy`, that implements the completion decision algorithm. *Optional, with restrictions (requires `release-strategy` to be present).*

14 A SpEL expression representing the release strategy; the root object for the expression is a `MessageGroup`. Example: `"size() == 5"`. Only one of `release-strategy` or `release-strategy-expression` is allowed.

15 Only applies if a `MessageGroupStoreReaper` is configured for the `<resequencer>` `MessageStore`. By default, when a `MessageGroupStoreReaper` is configured to expire partial groups, empty groups are also removed. Empty groups exist after a group is released normally. This is to enable the detection and discarding of late-arriving messages. If you wish to expire empty groups on a longer schedule than expiring partial groups, set this property. Empty groups will then not be removed from the `MessageStore` until they have not been modified for at least this number of milliseconds. Note that the actual time to expire an empty group will also be affected by the reaper's *timeout* property and it could be as much as this value plus the timeout.

16 See the section called “Configuring an Aggregator with XML”.

17 See the section called “Configuring an Aggregator with XML”.

18 See the section called “Configuring an Aggregator with XML”.

19 See the section called “Configuring an Aggregator with XML”.

20 When a group is completed due to a timeout (or by a `MessageGroupStoreReaper`), the empty group's metadata is retained by default. Late arriving messages will be immediately discarded. Set this to `true` to remove the group completely; then, late arriving messages will start a new group and won't be discarded until the group again times out. The new group will never be released normally because of the "hole" in the sequence range that caused the timeout. Empty groups can be expired (completely removed) later using a `MessageGroupStoreReaper` together with the `empty-group-min-timeout` attribute. Starting with *version 5.0* empty groups are also scheduled for removal after `empty-group-min-timeout`. Default: *false*.

Note

Since there is no custom behavior to be implemented in Java classes for resequencers, there is no annotation support for it.

6.6 Message Handler Chain

Introduction

The `MessageHandlerChain` is an implementation of `MessageHandler` that can be configured as a single Message Endpoint while actually delegating to a chain of other handlers, such as Filters, Transformers, Splitters, and so on. This can lead to a much simpler configuration when several handlers need to be connected in a fixed, linear progression. For example, it is fairly common to provide a Transformer before other components. Similarly, when providing a *Filter* before some other component in a chain, you are essentially creating a Selective Consumer. In either case, the chain only requires a single `input-channel` and a single `output-channel` eliminating the need to define channels for each individual component.

> **Tip**
>
> Spring Integration's `Filter` provides a boolean property `throwExceptionOnRejection`. When providing multiple Selective Consumers on the same point-to-point channel with different acceptance criteria, this value should be set to *true* (the default is false) so that the dispatcher will know that the Message was rejected and as a result will attempt to pass the Message on to other subscribers. If the Exception were not thrown, then it would appear to the dispatcher as if the Message had been passed on successfully even though the Filter had *dropped* the Message to prevent further processing. If you do indeed want to "drop" the Messages, then the Filter's *discard-channel* might be useful since it does give you a chance to perform some operation with the dropped message (e.g. send to a JMS queue or simply write to a log).

The handler chain simplifies configuration while internally maintaining the same degree of loose coupling between components, and it is trivial to modify the configuration if at some point a non-linear arrangement is required.

Internally, the chain will be expanded into a linear setup of the listed endpoints, separated by anonymous channels. The reply channel header will not be taken into account within the chain: only after the last handler is invoked will the resulting message be forwarded on to the reply channel or the chain's output channel. Because of this setup all handlers except the last required to implement the MessageProducer interface (which provides a *setOutputChannel()* method). The last handler only needs an output channel if the outputChannel on the MessageHandlerChain is set.

> **Note**
>
> As with other endpoints, the `output-channel` is optional. If there is a reply Message at the end of the chain, the output-channel takes precedence, but if not available, the chain handler will check for a reply channel header on the inbound Message as a fallback.

In most cases there is no need to implement MessageHandlers yourself. The next section will focus on namespace support for the chain element. Most Spring Integration endpoints, like Service Activators and Transformers, are suitable for use within a `MessageHandlerChain`.

Configuring a Chain

The <chain> element provides an `input-channel` attribute, and if the last element in the chain is capable of producing reply messages (optional), it also supports an `output-channel` attribute. The sub-elements are then filters, transformers, splitters, and service-activators. The last element may also be a router or an outbound-channel-adapter.

```
<int:chain input-channel="input" output-channel="output">
    <int:filter ref="someSelector" throw-exception-on-rejection="true"/>
    <int:header-enricher>
        <int:header name="foo" value="bar"/>
    </int:header-enricher>
    <int:service-activator ref="someService" method="someMethod"/>
</int:chain>
```

The <header-enricher> element used in the above example will set a message header named "foo" with a value of "bar" on the message. A header enricher is a specialization of `Transformer` that touches only header values. You could obtain the same result by implementing a MessageHandler that did the header modifications and wiring that as a bean, but the header-enricher is obviously a simpler option.

The <chain> can be configured as the last *black-box* consumer of the message flow. For this solution it is enough to put at the end of the <chain> some <outbound-channel-adapter>:

```
<int:chain input-channel="input">
    <int-xml:marshalling-transformer marshaller="marshaller" result-type="StringResult" />
    <int:service-activator ref="someService" method="someMethod"/>
    <int:header-enricher>
        <int:header name="foo" value="bar"/>
    </int:header-enricher>
    <int:logging-channel-adapter level="INFO" log-full-message="true"/>
</int:chain>
```

Disallowed Attributes and Elements

It is important to note that certain attributes, such as **order** and **input-channel** are not allowed to be specified on components used within a *chain*. The same is true for the **poller** sub-element.

Important

For the *Spring Integration* core components, the XML Schema itself will enforce some of these constraints. However, for non-core components or your own custom components, these constraints are enforced by the XML namespace parser, not by the XML Schema.

These XML namespace parser constraints were added with *Spring Integration 2.2*. The XML namespace parser will throw an `BeanDefinitionParsingException` if you try to use disallowed attributes and elements.

'id' Attribute

Beginning with Spring Integration 3.0, if a chain element is given an *id*, the bean name for the element is a combination of the chain's *id* and the *id* of the element itself. Elements without an *id* are not registered as beans, but they are given `componentName` s that include the chain id. For example:

```
<int:chain id="fooChain" input-channel="input">
    <int:service-activator id="fooService" ref="someService" method="someMethod"/>
    <int:object-to-json-transformer/>
</int:chain>
```

- The `<chain>` root element has an *id fooChain*. So, the `AbstractEndpoint` implementation (`PollingConsumer` or `EventDrivenConsumer`, depending on the *input-channel* type) bean takes this value as it's bean name.
- The `MessageHandlerChain` bean acquires a bean alias *fooChain.handler*, which allows direct access to this bean from the `BeanFactory`.
- The `<service-activator>` is not a fully-fledged Messaging Endpoint (`PollingConsumer` or `EventDrivenConsumer`) - it is simply a `MessageHandler` within the `<chain>`. In this case, the bean name registered with the `BeanFactory` is *fooChain$child.fooService.handler*.
- The *componentName* of this `ServiceActivatingHandler` takes the same value, but without the *.handler* suffix - *fooChain$child.fooService*.
- The last `<chain>` sub-component, `<object-to-json-transformer>`, doesn't have an *id* attribute. Its *componentName* is based on its position in the `<chain>`. In this case, it is *fooChain $child#1*. (The final element of the name is the order within the chain, beginning with *#0*). Note, this transformer isn't registered as a bean within the application context, so, it doesn't get a *beanName*, however its *componentName* has a value which is useful for logging etc.

The *id* attribute for `<chain>` elements allows them to be eligible for JMX export and they are trackable via Message History. They can also be accessed from the `BeanFactory` using the appropriate bean name as discussed above.

> **Tip**
>
> It is useful to provide an explicit *id* attribute on `<chain>` s to simplify the identification of sub-components in logs, and to provide access to them from the `BeanFactory` etc.

Calling a Chain from within a Chain

Sometimes you need to make a nested call to another chain from within a chain and then come back and continue execution within the original chain. To accomplish this you can utilize a Messaging Gateway by including a <gateway> element. For example:

```
<int:chain id="main-chain" input-channel="in" output-channel="out">
    <int:header-enricher>
      <int:header name="name" value="Many" />
    </int:header-enricher>
    <int:service-activator>
      <bean class="org.foo.SampleService" />
    </int:service-activator>
    <int:gateway request-channel="inputA"/>
</int:chain>

<int:chain id="nested-chain-a" input-channel="inputA">
    <int:header-enricher>
        <int:header name="name" value="Moe" />
    </int:header-enricher>
    <int:gateway request-channel="inputB"/>
    <int:service-activator>
        <bean class="org.foo.SampleService" />
    </int:service-activator>
</int:chain>

<int:chain id="nested-chain-b" input-channel="inputB">
    <int:header-enricher>
        <int:header name="name" value="Jack" />
    </int:header-enricher>
    <int:service-activator>
        <bean class="org.foo.SampleService" />
    </int:service-activator>
</int:chain>
```

In the above example the *nested-chain-a* will be called at the end of *main-chain* processing by the *gateway* element configured there. While in *nested-chain-a* a call to a *nested-chain-b* will be made after header enrichment and then it will come back to finish execution in *nested-chain-b*. Finally the flow returns to the *main-chain*. When the nested version of a <gateway> element is defined in the chain, it does not require the `service-interface` attribute. Instead, it simple takes the message in its current state and places it on the channel defined via the `request-channel` attribute. When the downstream flow initiated by that gateway completes, a `Message` will be returned to the gateway and continue its journey within the current chain.

6.7 Scatter-Gather

Introduction

Starting with *version 4.1*, Spring Integration provides an implementation of the Scatter-Gather Enterprise Integration Pattern. It is a compound endpoint, where the goal is to send a message to the recipients and aggregate the results. Quoting the EIP Book, it is a component for scenarios like *best quote*, when we need to request information from several suppliers and decide which one provides us with the best term for the requested item.

Previously, the pattern could be configured using discrete components, this enhancement brings more convenient configuration.

The `ScatterGatherHandler` is a *request-reply* endpoint that combines a `PublishSubscribeChannel` (or `RecipientListRouter`) and an `AggregatingMessageHandler`. The request message is sent to the `scatter` channel and the `ScatterGatherHandler` waits for the reply from the aggregator to sends to the `outputChannel`.

Functionality

The `Scatter-Gather` pattern suggests two scenarios - *Auction* and *Distribution*. In both cases, the `aggregation` function is the same and provides all options available for the `AggregatingMessageHandler`. Actually the `ScatterGatherHandler` just requires an `AggregatingMessageHandler` as a constructor argument. See Section 6.4, “Aggregator” for more information.

Auction

The *Auction* `Scatter-Gather` variant uses `publish-subscribe` logic for the request message, where the `scatter` channel is a `PublishSubscribeChannel` with `apply-sequence="true"`. However, this channel can be any `MessageChannel` implementation as is the case with the `request-channel` in the `ContentEnricher` (see Section 7.2, “Content Enricher”) but, in this case, the end-user should support his own custom `correlationStrategy` for the `aggregation` function.

Distribution

The *Distribution* `Scatter-Gather` variant is based on the `RecipientListRouter` (see the section called “RecipientListRouter”) with all available options for the `RecipientListRouter`. This is the second `ScatterGatherHandler` constructor argument. If you want to rely just on the default `correlationStrategy` for the `recipient-list-router` and the `aggregator`, you should specify `apply-sequence="true"`. Otherwise, a custom `correlationStrategy` should be supplied for the `aggregator`. Unlike the `PublishSubscribeChannel` (*Auction*) variant, having a `recipient-list-router selector` option, we can *filter* target suppliers based on the message. With `apply-sequence="true"` the default `sequenceSize` will be supplied and the `aggregator` will be able to release the group correctly. The *Distribution* option is mutually exclusive with the *Auction* option.

In both cases, the request (*scatter*) message is enriched with the `gatherResultChannel QueueChannel` header, to wait for a reply message from the `aggregator`.

By default, all suppliers should send their result to the `replyChannel` header (usually by omitting the `output-channel` from the ultimate endpoint). However, the `gatherChannel` option is also provided, allowing suppliers to send their reply to that channel for the aggregation.

Configuring a Scatter-Gather Endpoint

For Java and Annotation configuration, the bean definition for the `Scatter-Gather` is:

```
@Bean
public MessageHandler distributor() {
    RecipientListRouter router = new RecipientListRouter();
    router.setApplySequence(true);
    router.setChannels(Arrays.asList(distributionChannel1(), distributionChannel2(),
            distributionChannel3()));
    return router;
}

@Bean
public MessageHandler gatherer() {
 return new AggregatingMessageHandler(
   new ExpressionEvaluatingMessageGroupProcessor("^[payload gt 5] ?: -1D"),
   new SimpleMessageStore(),
   new HeaderAttributeCorrelationStrategy(
          IntegrationMessageHeaderAccessor.CORRELATION_ID),
   new ExpressionEvaluatingReleaseStrategy("size() == 2"));
}

@Bean
@ServiceActivator(inputChannel = "distributionChannel")
public MessageHandler scatterGatherDistribution() {
 ScatterGatherHandler handler = new ScatterGatherHandler(distributor(), gatherer());
 handler.setOutputChannel(output());
 return handler;
}
```

Here, we configure the `RecipientListRouter` `distributor` bean, with `applySequence="true"` and the list of recipient channels. The next bean is for an `AggregatingMessageHandler`. Finally, we inject both those beans into the `ScatterGatherHandler` bean definition and mark it as a `@ServiceActivator` to wire the Scatter-Gather component into the integration flow.

Configuring the `<scatter-gather>` endpoint using the XML namespace:

```
<scatter-gather
  id=""  ❶
  auto-startup=""  ❷
  input-channel=""  ❸
  output-channel=""  ❹
  scatter-channel=""  ❺
  gather-channel=""  ❻
  order=""  ❼
  phase=""  ❽
  send-timeout=""  ❾
  gather-timeout=""  ❿
  requires-reply="" > 11
   <scatterer/>  12
   <gatherer/>  13
</scatter-gather>
```

❶ The id of the Endpoint. The `ScatterGatherHandler` bean is registered with `id + '.handler'` alias. The `RecipientListRouter` - with `id + '.scatterer'`. And the `AggregatingMessageHandler` with `id + '.gatherer'`. *Optional* (a default id is generated value by `BeanFactory`).

❷ Lifecycle attribute signaling if the Endpoint should be started during Application Context initialization. In addition, the `ScatterGatherHandler` also implements `Lifecycle` and starts/stops the `gatherEndpoint`, which is created internally if a `gather-channel` is provided. *Optional* (default is `true`).

❸ The channel to receive request messages to handle them in the `ScatterGatherHandler`. *Required*.

4 The channel to which the Scatter-Gather will send the aggregation results. *Optional (because incoming messages can specify a reply channel themselves via `replyChannel` Message Header)*.

5 The channel to send the scatter message for the *Auction* scenario. *Optional*. Mutually exclusive with `<scatterer>` sub-element.

6 The channel to receive replies from each supplier for the aggregation. is used as the `replyChannel` header in the scatter message. *Optional*. By default the `FixedSubscriberChannel` is created.

7 Order of this component when more than one handler is subscribed to the same DirectChannel (use for load balancing purposes). *Optional*.

8 Specify the phase in which the endpoint should be started and stopped. The startup order proceeds from lowest to highest, and the shutdown order is the reverse of that. By default this value is Integer.MAX_VALUE meaning that this container starts as late as possible and stops as soon as possible. *Optional*.

9 The timeout interval to wait when sending a reply `Message` to the `output-channel`. By default the send will block for one second. It applies only if the output channel has some *sending* limitations, e.g. a `QueueChannel` with a fixed *capacity* and is full. In this case, a `MessageDeliveryException` is thrown. The `send-timeout` is ignored in case of `AbstractSubscribableChannel` implementations. In case of `group-timeout(-expression)` the `MessageDeliveryException` from the scheduled expire task leads this task to be rescheduled. *Optional*.

10 Allows you to specify how long the Scatter-Gather will wait for the reply message before returning. By default it will wait indefinitely. *null* is returned if the reply times out. *Optional*. Defaults to `-1` - indefinitely.

11 Specify whether the Scatter-Gather must return a non-null value. This value is `true` by default, hence a `ReplyRequiredException` will be thrown when the underlying aggregator returns a null value after `gather-timeout`. Note, if `null` is a possibility, the `gather-timeout` should be specified to avoid an indefinite wait.

12 The `<recipient-list-router>` options. *Optional*. Mutually exclusive with `scatter-channel` attribute.

13 The `<aggregator>` options. *Required*.

6.8 Thread Barrier

Sometimes, we need to suspend a message flow thread until some other asynchronous event occurs. For example, consider an HTTP request that publishes a message to RabbitMQ. We might wish to not reply to the user until the RabbitMQ broker has issued an acknowledgment that the message was received.

Spring Integration *version 4.2* introduced the `<barrier/>` component for this purpose. The underlying `MessageHandler` is the `BarrierMessageHandler`; this class also implements `MessageTriggerAction` where a message passed to the `trigger()` method releases a corresponding thread in the `handleRequestMessage()` method (if present).

The suspended thread and trigger thread are correlated by invoking a `CorrelationStrategy` on the messages. When a message is sent to the `input-channel`, the thread is suspended for up to `timeout` milliseconds, waiting for a corresponding trigger message. The default correlation strategy uses the `IntegrationMessageHeaderAccessor.CORRELATION_ID` header. When a trigger message arrives with the same correlation, the thread is released. The message sent to the `output-channel` after release is constructed using a `MessageGroupProcessor`. By default, the message is a `Collection<?>` of the two payloads and the headers are merged, using a `DefaultAggregatingMessageGroupProcessor`.

> **Caution**
>
> If the `trigger()` method is invoked first (or after the main thread times out), it will be suspended for up to `timeout` waiting for the suspending message to arrive. If you do not want to suspend the trigger thread, consider handing off to a `TaskExecutor` instead so its thread will be suspended instead.

The `requires-reply` property determines the action if the suspended thread times out before the trigger message arrives. By default, it is `false` which means the endpoint simply returns `null`, the flow ends and the thread returns to the caller. When `true`, a `ReplyRequiredException` is thrown.

You can call the `trigger()` method programmatically (obtain the bean reference using the name `barrier.handler` - where *barrier* is the bean name of the barrier endpoint) or you can configure an `<outbound-channel-adapter/>` to trigger the release.

> **Important**
>
> Only one thread can be suspended with the same correlation; the same correlation can be used multiple times but only once concurrently. An exception is thrown if a second thread arrives with the same correlation.

```
<int:barrier id="barrier1" input-channel="in" output-channel="out"
        correlation-strategy-expression="headers['myHeader']"
        output-processor="myOutputProcessor"
        discard-channel="lateTriggerChannel"
        timeout="10000">
</int:barrier>

<int:outbound-channel-adapter channel="release" ref="barrier1.handler" method="trigger" />
```

In this example, a custom header is used for correlation. Either the thread sending a message to `in` or the one sending a message to `release` will wait for up to 10 seconds until the other arrives. When the message is released, the `out` channel will be sent a message combining the result of invoking the custom `MessageGroupProcessor` bean `myOutputProcessor`. If the main thread times out and a trigger arrives later, you can configure a discard channel to which the late trigger will be sent. Java configuration is shown below.

```
@Configuration
@EnableIntegration
public class Config {

    @ServiceActivator(inputChannel="in")
    @Bean
    public BarrierMessageHandler barrier() {
        BarrierMessageHandler barrier = new BarrierMessageHandler(10000);
        barrier.setOutputChannel(out());
        barrier.setDiscardChannel(lateTriggers());
        return barrier;
    }

    @ServiceActivator (inputChannel="release")
    @Bean
    public MessageHandler releaser() {
        return new MessageHandler() {

            @Override
            public void handleMessage(Message<?> message) throws MessagingException {
                barrier().trigger(message);
            }

        };
    }

}
```

See the barrier sample application for an example of this component.

7. Message Transformation

7.1 Transformer

Introduction

Message Transformers play a very important role in enabling the loose-coupling of Message Producers and Message Consumers. Rather than requiring every Message-producing component to know what type is expected by the next consumer, Transformers can be added between those components. Generic transformers, such as one that converts a String to an XML Document, are also highly reusable.

For some systems, it may be best to provide a Canonical Data Model, but Spring Integration's general philosophy is not to require any particular format. Rather, for maximum flexibility, Spring Integration aims to provide the simplest possible model for extension. As with the other endpoint types, the use of declarative configuration in XML and/or Annotations enables simple POJOs to be adapted for the role of Message Transformers. These configuration options will be described below.

Note

For the same reason of maximizing flexibility, Spring does not require XML-based Message payloads. Nevertheless, the framework does provide some convenient Transformers for dealing with XML-based payloads if that is indeed the right choice for your application. For more information on those transformers, see the section called “CompletableFuture”.

Configuring Transformer

Configuring Transformer with XML

The <transformer> element is used to create a Message-transforming endpoint. In addition to "input-channel" and "output-channel" attributes, it requires a "ref". The "ref" may either point to an Object that contains the @Transformer annotation on a single method (see below) or it may be combined with an explicit method name value provided via the "method" attribute.

```
<int:transformer id="testTransformer" ref="testTransformerBean" input-channel="inChannel"
             method="transform" output-channel="outChannel"/>
<beans:bean id="testTransformerBean" class="org.foo.TestTransformer" />
```

Using a `ref` attribute is generally recommended if the custom transformer handler implementation can be reused in other `<transformer>` definitions. However if the custom transformer handler implementation should be scoped to a single definition of the `<transformer>`, you can define an inner bean definition:

```
<int:transformer id="testTransformer" input-channel="inChannel" method="transform"
                output-channel="outChannel">
  <beans:bean class="org.foo.TestTransformer"/>
</transformer>
```

Note

Using both the "ref" attribute and an inner handler definition in the same `<transformer>` configuration is not allowed, as it creates an ambiguous condition and will result in an Exception being thrown.

Important

If the "ref" attribute references a bean that extends `AbstractMessageProducingHandler` (such as transformers provided by the framework itself), the configuration is optimized by injecting the output channel into the handler directly. In this case, each "ref" must be to a separate bean instance (or a `prototype`-scoped bean), or use the inner `<bean/>` configuration type. If you inadvertently reference the same message handler from multiple beans, you will get a configuration exception.

When using a POJO, the method that is used for transformation may expect either the `Message` type or the payload type of inbound Messages. It may also accept Message header values either individually or as a full map by using the `@Header` and `@Headers` parameter annotations respectively. The return value of the method can be any type. If the return value is itself a `Message`, that will be passed along to the transformer's output channel.

As of Spring Integration 2.0, a Message Transformer's transformation method can no longer return `null`. Returning `null` will result in an exception since a Message Transformer should always be expected to transform each source Message into a valid target Message. In other words, a Message Transformer should not be used as a Message Filter since there is a dedicated `<filter>` option for that. However, if you do need this type of behavior (where a component might return NULL and that should not be considered an error), a *service-activator* could be used. Its `requires-reply` value is FALSE by default, but that can be set to TRUE in order to have Exceptions thrown for NULL return values as with the transformer.

Transformers and Spring Expression Language (SpEL)

Just like Routers, Aggregators and other components, as of Spring Integration 2.0 Transformers can also benefit from SpEL support (https://docs.spring.io/spring/docs/current/spring-framework-reference/html/expressions.html) whenever transformation logic is relatively simple.

```
<int:transformer input-channel="inChannel"
 output-channel="outChannel"
 expression="payload.toUpperCase() + '- [' + T(java.lang.System).currentTimeMillis() + ']'"/>
```

In the above configuration we are achieving a simple transformation of the *payload* with a simple SpEL expression and without writing a custom transformer. Our *payload* (assuming String) will be upper-cased and concatenated with the current timestamp with some simple formatting.

Common Transformers

There are also a few Transformer implementations available out of the box.

Object-to-String Transformer

Because, it is fairly common to use the `toString()` representation of an Object, Spring Integration provides an `ObjectToStringTransformer` whose output is a `Message` with a String `payload`. That String is the result of invoking the `toString()` operation on the inbound Message's payload.

```
<int:object-to-string-transformer input-channel="in" output-channel="out"/>
```

A potential example for this would be sending some arbitrary object to the *outbound-channel-adapter* in the *file* namespace. Whereas that Channel Adapter only supports String, byte-array, or `java.io.File` payloads by default, adding this transformer immediately before the adapter will handle the necessary conversion. Of course, that works fine as long as the result of the `toString()` call is what you want to be written to the File. Otherwise, you can just provide a custom POJO-based Transformer via the generic *transformer* element shown previously.

> **Tip**
>
> When debugging, this transformer is not typically necessary since the *logging-channel-adapter* is capable of logging the Message payload. Refer to the section called “Wire Tap” for more detail.

> **Note**
>
> The *object-to-string-transformer* is very simple; it invokes `toString()` on the inbound payload. There are two exceptions to this (since 3.0): if the payload is a `char[]`, it invokes `new String(payload)`; if the payload is a `byte[]`, it invokes `new String(payload, charset)`, where `charset` is "UTF-8" by default. The `charset` can be modified by supplying the *charset* attribute on the transformer.
>
> For more sophistication (such as selection of the charset dynamically, at runtime), you can use a SpEL expression-based transformer instead; for example:
>
> ```
> <int:transformer input-channel="in" output-channel="out"
>        expression="new java.lang.String(payload, headers['myCharset']" />
> ```

If you need to serialize an Object to a byte array or deserialize a byte array back into an Object, Spring Integration provides symmetrical serialization transformers. These will use standard Java serialization by default, but you can provide an implementation of Spring 3.0's Serializer or Deserializer strategies via the *serializer* and *deserializer* attributes, respectively.

```
<int:payload-serializing-transformer input-channel="objectsIn" output-channel="bytesOut"/>

<int:payload-deserializing-transformer input-channel="bytesIn" output-channel="objectsOut"
    white-list="com.mycom.*,com.yourcom.*"/>
```

> **Important**
>
> When deserializing data from untrusted sources, you should consider adding a `white-list` of package/class patterns. By default, all classes will be deserialized.

Object-to-Map and Map-to-Object Transformers

Spring Integration also provides *Object-to-Map* and *Map-to-Object* transformers which utilize the JSON to serialize and de-serialize the object graphs. The object hierarchy is introspected to the most primitive types (String, int, etc.). The path to this type is described via SpEL, which becomes the *key* in the transformed Map. The primitive type becomes the value.

For example:

```
public class Parent{
    private Child child;
    private String name;
    // setters and getters are omitted
}

public class Child{
    private String name;
    private List<String> nickNames;
    // setters and getters are omitted
}
```

...will be transformed to a Map which looks like this: `{person.name=George, person.child.name=Jenna, person.child.nickNames[0]=Bimbo ... etc}`

The JSON-based Map allows you to describe the object structure without sharing the actual types allowing you to restore/rebuild the object graph into a differently typed Object graph as long as you maintain the structure.

For example: The above structure could be easily restored back to the following Object graph via the Map-to-Object transformer:

```
public class Father {
    private Kid child;
    private String name;
    // setters and getters are omitted
}

public class Kid {
    private String name;
    private List<String> nickNames;
    // setters and getters are omitted
}
```

If you need to create a "structured" map, you can provide the *flatten* attribute. The default value for this attribute is *true* meaning the default behavior; if you provide a *false* value, then the structure will be a map of maps.

For example:

```
public class Parent {
 private Child child;
 private String name;
 // setters and getters are omitted
}

public class Child {
 private String name;
 private List<String> nickNames;
 // setters and getters are omitted
}
```

...will be transformed to a Map which looks like this: `{name=George,  child={name=Jenna, nickNames=[Bimbo, ...]}}`

To configure these transformers, Spring Integration provides namespace support Object-to-Map:

```
<int:object-to-map-transformer input-channel="directInput" output-channel="output"/>
```

or

```
<int:object-to-map-transformer input-channel="directInput" output-channel="output" flatten="false"/>
```

Map-to-Object

```
<int:map-to-object-transformer input-channel="input"
                         output-channel="output"
                          type="org.foo.Person"/>
```

or

```
<int:map-to-object-transformer input-channel="inputA"
                                output-channel="outputA"
                                ref="person"/>
<bean id="person" class="org.foo.Person" scope="prototype"/>
```

Note

NOTE: *ref* and *type* attributes are mutually exclusive. You can only use one. Also, if using the *ref* attribute, you must point to a *prototype* scoped bean, otherwise a `BeanCreationException` will be thrown.

Starting with *version 5.0*, the `ObjectToMapTransformer` can be supplied with the customized `JsonObjectMapper`, for example in use-cases when we need special formats for dates or nulls for empty collections. See the section called “JSON Transformers” for more information about `JsonObjectMapper` implementations.

Stream Transformer

The `StreamTransformer` transforms `InputStream` payloads to a `byte[]` or a `String` if a `charset` is provided.

```
<int:stream-transformer input-channel="directInput" output-channel="output"/> <!-- byte[] -->

<int:stream-transformer id="withCharset" charset="UTF-8"
    input-channel="charsetChannel" output-channel="output"/> <!-- String -->
```

```
@Bean
@Transformer(inputChannel = "stream", outputChannel = "data")
public StreamTransformer streamToBytes() {
    return new StreamTransformer(); // transforms to byte[]
}

@Bean
@Transformer(inputChannel = "stream", outputChannel = "data")
public StreamTransformer streamToString() {
    return new StreamTransformer("UTF-8"); // transforms to String
}
```

JSON Transformers

Object to JSON and *JSON to Object* transformers are provided.

```
<int:object-to-json-transformer input-channel="objectMapperInput"/>
```

```
<int:json-to-object-transformer input-channel="objectMapperInput"
    type="foo.MyDomainObject"/>
```

These use a vanilla `JsonObjectMapper` by default based on implementation from classpath. You can provide your own custom `JsonObjectMapper` implementation with appropriate options or based on required library (e.g. GSON).

```
<int:json-to-object-transformer input-channel="objectMapperInput"
    type="foo.MyDomainObject" object-mapper="customObjectMapper"/>
```

Note

Beginning with version 3.0, the `object-mapper` attribute references an instance of a new strategy interface `JsonObjectMapper`. This abstraction allows multiple implementations of json mappers to be used. Implementations that wraphttps://github.com/RichardHightower/boon[Boon] and Jackson 2 are provided, with the version being detected on the classpath. These classes are `BoonJsonObjectMapper` and `Jackson2JsonObjectMapper`.

Note, `BoonJsonObjectMapper` is provided since *version 4.1*.

Important

If there are requirements to use both Jackson libraries and/or Boon in the same application, keep in mind that before version 3.0, the JSON transformers used only Jackson 1.x. From *4.1* on, the framework will select Jackson 2 by default ahead of the Boon implementation if both are on the classpath. Jackson 1.x is no longer supported by the framework internally but, of course, you can still use it within your code. To avoid unexpected issues with JSON mapping features, when using annotations, there may be a need to apply annotations from both Jacksons and/or Boon on domain classes:

```
@org.codehaus.jackson.annotate.JsonIgnoreProperties(ignoreUnknown=true)
@com.fasterxml.jackson.annotation.JsonIgnoreProperties(ignoreUnknown=true)
@org.boon.json.annotations.JsonIgnoreProperties("foo")
public class Foo {

        @org.codehaus.jackson.annotate.JsonProperty("fooBar")
        @com.fasterxml.jackson.annotation.JsonProperty("fooBar")
        @org.boon.json.annotations.JsonProperty("fooBar")
        public Object bar;

}
```

You may wish to consider using a `FactoryBean` or simple factory method to create the `JsonObjectMapper` with the required characteristics.

```
public class ObjectMapperFactory {

    public static Jackson2JsonObjectMapper getMapper() {
        ObjectMapper mapper = new ObjectMapper();
        mapper.configure(JsonParser.Feature.ALLOW_COMMENTS, true);
        return new Jackson2JsonObjectMapper(mapper);
    }
}
```

```
<bean id="customObjectMapper" class="foo.ObjectMapperFactory"
            factory-method="getMapper"/>
```

Important

Beginning with *version 2.2*, the `object-to-json-transformer` sets the *content-type* header to `application/json`, by default, if the input message does not already have that header present.

It you wish to set the *content type* header to some other value, or explicitly overwrite any existing header with some value (including `application/json`), use the `content-type` attribute. If you wish to suppress the setting of the header, set the `content-type` attribute to an empty string (`""`). This will result in a message with no `content-type` header, unless such a header was present on the input message.

Beginning with *version 3.0*, the `ObjectToJsonTransformer` adds headers, reflecting the source type, to the message. Similarly, the `JsonToObjectTransformer` can use those type headers when converting the JSON to an object. These headers are mapped in the AMQP adapters so that they are entirely compatible with the Spring-AMQP JsonMessageConverter.

This enables the following flows to work without any special configuration…

`...->amqp-outbound-adapter---->`

`---->amqp-inbound-adapter->json-to-object-transformer->...`

Where the outbound adapter is configured with a `JsonMessageConverter` and the inbound adapter uses the default `SimpleMessageConverter`.

`...->object-to-json-transformer->amqp-outbound-adapter---->`

`---->amqp-inbound-adapter->...`

Where the outbound adapter is configured with a `SimpleMessageConverter` and the inbound adapter uses the default `JsonMessageConverter`.

`...->object-to-json-transformer->amqp-outbound-adapter---->`

`---->amqp-inbound-adapter->json-to-object-transformer->`

Where both adapters are configured with a `SimpleMessageConverter`.

> **Note**
>
> When using the headers to determine the type, you should **not** provide a `class` attribute, because it takes precedence over the headers.

In addition to JSON Transformers, Spring Integration provides a built-in *#jsonPath* SpEL function for use in expressions. For more information see the section called “CompletableFuture”.

#xpath SpEL Function

Since version *3.0*, Spring Integration also provides a built-in *#xpath* SpEL function for use in expressions. For more information see the section called “CompletableFuture”.

Beginning with *version 4.0*, the `ObjectToJsonTransformer` supports the `resultType` property, to specify the *node* JSON representation. The result node tree representation depends on the implementation of the provided `JsonObjectMapper`. By default, the `ObjectToJsonTransformer` uses a `Jackson2JsonObjectMapper` and delegates the conversion of the object to the node tree to the `ObjectMapper#valueToTree` method. The node JSON representation provides efficiency for using the `JsonPropertyAccessor`, when the downstream message flow uses SpEL expressions with access to the properties of the JSON data. See the section called “CompletableFuture”. When using Boon, the `NODE` representation is a `Map<String, Object>`

Configuring a Transformer with Annotations

The `@Transformer` annotation can also be added to methods that expect either the `Message` type or the message payload type. The return value will be handled in the exact same way as described above in the section describing the <transformer> element.

```
@Transformer
Order generateOrder(String productId) {
    return new Order(productId);
}
```

Transformer methods may also accept the @Header and @Headers annotations that is documented in the section called “CompletableFuture”

```
@Transformer
Order generateOrder(String productId, @Header("customerName") String customer) {
    return new Order(productId, customer);
}
```

Also see the section called “CompletableFuture”.

Header Filter

Some times your transformation use case might be as simple as removing a few headers. For such a use case, Spring Integration provides a *Header Filter* which allows you to specify certain header names that should be removed from the output Message (e.g. for security reasons or a value that was only needed temporarily). Basically, the *Header Filter* is the opposite of the *Header Enricher*. The latter is discussed in the section called “Header Enricher”.

```
<int:header-filter input-channel="inputChannel"
  output-channel="outputChannel" header-names="lastName, state"/>
```

As you can see, configuration of a *Header Filter* is quite simple. It is a typical endpoint with input/output channels and a `header-names` attribute. That attribute accepts the names of the header(s) (delimited by commas if there are multiple) that need to be removed. So, in the above example the headers named *lastName* and *state* will not be present on the outbound Message.

Codec-Based Transformers

See Section 7.4, “Codec”.

7.2 Content Enricher

Introduction

At times you may have a requirement to enhance a request with more information than was provided by the target system. The Content Enricher pattern describes various scenarios as well as the component (Enricher), which allows you to address such requirements.

The Spring Integration `Core` module includes 2 enrichers:

- Header Enricher
- Payload Enricher

Furthermore, several *Adapter specific Header Enrichers* are included as well:

- XPath Header Enricher (XML Module)
- Mail Header Enricher (Mail Module)
- XMPP Header Enricher (XMPP Module)

Please go to the adapter specific sections of this reference manual to learn more about those adapters.

For more information regarding expressions support, please see the section called “CompletableFuture”.

Header Enricher

If you only need to add headers to a Message, and they are not dynamically determined by the Message content, then referencing a custom implementation of a Transformer may be overkill. For that reason, Spring Integration provides support for the *Header Enricher* pattern. It is exposed via the `<header-enricher>` element.

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:header name="foo" value="123"/>
    <int:header name="bar" ref="someBean"/>
</int:header-enricher>
```

The *Header Enricher* also provides helpful sub-elements to set well-known header names.

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:error-channel ref="applicationErrorChannel"/>
    <int:reply-channel ref="quoteReplyChannel"/>
    <int:correlation-id value="123"/>
    <int:priority value="HIGHEST"/>
    <routing-slip value="channel1; routingSlipRoutingStrategy; request.headers[myRoutingSlipChannel]"/>
    <int:header name="bar" ref="someBean"/>
</int:header-enricher>
```

In the above configuration you can clearly see that for well-known headers such as `errorChannel`, `correlationId`, `priority`, `replyChannel`, `routing-slip` etc., instead of using generic *<header>* sub-elements where you would have to provide both header *name* and *value*, you can use convenient sub-elements to set those values directly.

Starting with *version 4.1* the *Header Enricher* provides `routing-slip` sub-element. See the section called “Routing Slip” for more information.

POJO Support

Often a header value cannot be defined statically and has to be determined dynamically based on some content in the Message. That is why *Header Enricher* allows you to also specify a bean reference using the `ref` and `method` attribute. The specified method will calculate the header value. Let’s look at the following configuration:

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:header name="foo" method="computeValue" ref="myBean"/>
</int:header-enricher>

<bean id="myBean" class="foo.bar.MyBean"/>
```

```
public class MyBean {

    public String computeValue(String payload){
        return payload.toUpperCase() + "_US";
    }
}
```

You can also configure your POJO as inner bean:

```
<int:header-enricher  input-channel="inputChannel" output-channel="outputChannel">
    <int:header name="some_header">
        <bean class="org.MyEnricher"/>
    </int:header>
</int:header-enricher>
```

as well as point to a Groovy script:

```
<int:header-enricher  input-channel="inputChannel" output-channel="outputChannel">
    <int:header name="some_header">
        <int-groovy:script location="org/SampleGroovyHeaderEnricher.groovy"/>
    </int:header>
</int:header-enricher>
```

SpEL Support

In Spring Integration 2.0 we have introduced the convenience of the Spring Expression Language (SpEL) to help configure many different components. The *Header Enricher* is one of them. Looking again at the POJO example above, you can see that the computation logic to determine the header value is actually pretty simple. A natural question would be: "is there a simpler way to accomplish this?". That is where SpEL shows its true power.

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:header name="foo" expression="payload.toUpperCase() + '_US'"/>
</int:header-enricher>
```

As you can see, by using SpEL for such simple cases, we no longer have to provide a separate class and configure it in the application context. All we need is the *expression* attribute configured with a valid SpEL expression. The *payload* and *headers* variables are bound to the SpEL Evaluation Context, giving you full access to the incoming Message.

Configuring a Header Enricher with Java Configuration

The following are some examples of Java Configuration for header enrichers:

```
@Bean
@Transformer(inputChannel = "enrichHeadersChannel", outputChannel = "emailChannel")
public HeaderEnricher enrichHeaders() {
    Map<String, ? extends HeaderValueMessageProcessor<?>> headersToAdd =
            Collections.singletonMap("emailUrl",
                      new StaticHeaderValueMessageProcessor<>(this.imapUrl));
    HeaderEnricher enricher = new HeaderEnricher(headersToAdd);
    return enricher;
}

@Bean
@Transformer(inputChannel="enrichHeadersChannel", outputChannel="emailChannel")
public HeaderEnricher enrichHeaders() {
    Map<String, HeaderValueMessageProcessor<?>> headersToAdd = new HashMap<>();
    headersToAdd.put("emailUrl", new StaticHeaderValueMessageProcessor<String>(this.imapUrl));
    Expression expression = new SpelExpressionParser().parseExpression("payload.from[0].toString()");
    headersToAdd.put("from",
               new ExpressionEvaluatingHeaderValueMessageProcessor<>(expression, String.class));
    HeaderEnricher enricher = new HeaderEnricher(headersToAdd);
    return enricher;
}
```

The first adds a single literal header. The second adds two headers - a literal header and one based on a SpEL expression.

Configuring a Header Enricher with the Java DSL

The following is an example of Java DSL Configuration for a header enricher:

```
@Bean
public IntegrationFlow enrichHeadersInFlow() {
    return f -> f
                ...
                .enrichHeaders(h -> h.header("emailUrl", this.emailUrl)
                                     .headerExpression("from", "payload.from[0].toString()"))
                .handle(...);
}
```

Header Channel Registry

Starting with *Spring Integration 3.0*, a new sub-element `<int:header-channels-to-string/>` is available; it has no attributes. This converts existing `replyChannel` and `errorChannel` headers (when they are a `MessageChannel`) to a String and stores the channel(s) in a registry for later resolution when it is time to send a reply, or handle an error. This is useful for cases where the headers might be lost; for example when serializing a message into a message store or when transporting the message over JMS. If the header does not already exist, or it is not a `MessageChannel`, no changes are made.

Use of this functionality requires the presence of a `HeaderChannelRegistry` bean. By default, the framework creates a `DefaultHeaderChannelRegistry` with the default expiry (60 seconds). Channels are removed from the registry after this time. To change this, simply define a bean with id `integrationHeaderChannelRegistry` and configure the required default delay using a constructor argument (milliseconds).

Since *version 4.1*, you can set a property `removeOnGet` to `true` on the `<bean/>` definition, and the mapping entry will be removed immediately on first use. This might be useful in a high-volume environment and when the channel is only used once, rather than waiting for the reaper to remove it.

The `HeaderChannelRegistry` has a `size()` method to determine the current size of the registry. The `runReaper()` method cancels the current scheduled task and runs the reaper immediately; the task is then scheduled to run again based on the current delay. These methods can be invoked directly by getting a reference to the registry, or you can send a message with, for example, the following content to a control bus:

```
"@integrationHeaderChannelRegistry.runReaper()"
```

This sub-element is a convenience only, and is the equivalent of specifying:

```
<int:reply-channel
    expression="@integrationHeaderChannelRegistry.channelToChannelName(headers.replyChannel)"
    overwrite="true" />
<int:error-channel
    expression="@integrationHeaderChannelRegistry.channelToChannelName(headers.errorChannel)"
    overwrite="true" />
```

Starting with *version 4.1*, you can now override the registry’s configured reaper delay, so the the channel mapping is retained for at least the specified time, regardless of the reaper delay:

```
<int:header-enricher input-channel="inputTtl" output-channel="next">
    <int:header-channels-to-string time-to-live-expression="120000" />
</int:header-enricher>

<int:header-enricher input-channel="inputCustomTtl" output-channel="next">
    <int:header-channels-to-string
        time-to-live-expression="headers['channelTTL'] ?: 120000" />
</int:header-enricher>
```

In the first case, the time to live for every header channel mapping will be 2 minutes; in the second case, the time to live is specified in the message header and uses an elvis operator to use 2 minutes if there is no header.

Payload Enricher

In certain situations the Header Enricher, as discussed above, may not be sufficient and payloads themselves may have to be enriched with additional information. For example, order messages that enter the Spring Integration messaging system have to look up the order’s customer based on the provided customer number and then enrich the original payload with that information.

Since Spring Integration 2.1, the Payload Enricher is provided. A Payload Enricher defines an endpoint that passes a `Message` to the exposed request channel and then expects a reply message. The reply message then becomes the root object for evaluation of expressions to enrich the target payload.

The Payload Enricher provides full XML namespace support via the `enricher` element. In order to send request messages, the payload enricher has a `request-channel` attribute that allows you to dispatch messages to a request channel.

Basically by defining the request channel, the Payload Enricher acts as a Gateway, waiting for the message that were sent to the request channel to return, and the Enricher then augments the message's payload with the data provided by the reply message.

When sending messages to the request channel you also have the option to only send a subset of the original payload using the `request-payload-expression` attribute.

The enriching of payloads is configured through SpEL expressions, providing users with a maximum degree of flexibility. Therefore, users are not only able to enrich payloads with direct values from the reply channel's `Message`, but they can use SpEL expressions to extract a subset from that Message, only, or to apply addtional inline transformations, allowing them to further manipulate the data.

If you only need to enrich payloads with static values, you don't have to provide the `request-channel` attribute.

> **Note**
>
> Enrichers are a variant of Transformers and in many cases you could use a Payload Enricher or a generic Transformer implementation to add additional data to your messages payloads. Thus, familiarize yourself with all transformation-capable components that are provided by Spring Integration and carefully select the implementation that semantically fits your business case best.

Configuration

Below, please find an overview of all available configuration options that are available for the payload enricher:

```
<int:enricher request-channel=""                           ❶
              auto-startup="true"                          ❷
              id=""                                        ❸
              order=""                                     ❹
              output-channel=""                            ❺
              request-payload-expression=""                ❻
              reply-channel=""                             ❼
              error-channel=""                             ❽
              send-timeout=""                              ❾
              should-clone-payload="false">                ❿
    <int:poller></int:poller>                              ⓫
    <int:property name="" expression="" null-result-expression="'Could not determine the name'"/>   ⓬
    <int:property name="" value="23" type="java.lang.Integer" null-result-expression="'0'"/>
    <int:header name="" expression="" null-result-expression=""/>   ⓭
    <int:header name="" value="" overwrite="" type="" null-result-expression=""/>
</int:enricher>
```

❶ Channel to which a Message will be sent to get the data to use for enrichment. *Optional*.

❷ Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to true.*Optional*.

❸ Id of the underlying bean definition, which is either an `EventDrivenConsumer` or a `PollingConsumer`. *Optional*.

❹ Specifies the order for invocation when this endpoint is connected as a subscriber to a channel. This is particularly relevant when that channel is using a "failover" dispatching strategy. It has no effect when this endpoint itself is a Polling Consumer for a channel with a queue. *Optional*.

❺ Identifies the Message channel where a Message will be sent after it is being processed by this endpoint.*Optional*.

❻ By default the original message's payload will be used as payload that will be send to the `request-channel`. By specifying a SpEL expression as value for the `request-payload-expression` attribute, a subset of the original payload, a header value or any other resolvable SpEL expression can be used as the basis for the payload, that will be sent to the request-channel. For the Expression evaluation the full message is available as the *root object*. For instance the following SpEL expressions (among others) are possible: `payload.foo`, `headers.foobar`, `new java.util.Date()`, `'foo' + 'bar'`.

❼ Channel where a reply Message is expected. This is optional; typically the auto-generated temporary reply channel is sufficient. *Optional*.

❽ Channel to which an `ErrorMessage` will be sent if an `Exception` occurs downstream of the `request-channel`. This enables you to return an alternative object to use for enrichment. This is optional; if it is not set then `Exception` is thrown to the caller. *Optional*.

❾ Maximum amount of time in milliseconds to wait when sending a message to the channel, if such channel may block. For example, a Queue Channel can block until space is available, if its maximum capacity has been reached. Internally the send timeout is set on the `MessagingTemplate` and ultimately applied when invoking the send operation on the `MessageChannel`. By default the send timeout is set to *-1*, which may cause the send operation on the `MessageChannel`, depending on the implementation, to block indefinitely. *Optional*.

❿ Boolean value indicating whether any payload that implements `Cloneable` should be cloned prior to sending the Message to the request chanenl for acquiring the enriching data. The cloned version would be used as the target payload for the ultimate reply. Default is `false`. *Optional*.

11 Allows you to configure a Message Poller if this endpoint is a Polling Consumer. *Optional*.

12 Each `property` sub-element provides the name of a property (via the mandatory `name` attribute). That property should be settable on the target payload instance. Exactly one of the `value` or `expression` attributes must be provided as well. The former for a literal value to set, and the latter for a SpEL expression to be evaluated. The root object of the evaluation context is the Message that was returned from the flow initiated by this enricher, the input Message if there is no request channel, or the application context (using the *@<beanName>.<beanProperty>* SpEL syntax). Starting with *4.0*, when specifying a `value` attribute, you can also specify an optional `type` attribute. When the destination is a typed setter method, the framework will coerce the value appropriately (as long as a `PropertyEditor`) exists to handle the conversion. If however, the target payload is a `Map` the entry will be populated with the value without conversion. The `type` attribute allows you to, say, convert a String containing a number to an `Integer` value in the target payload. Starting with *4.1*, you can also specify an optional `null-result-expression` attribute. When the `enricher` returns null, it will be evaluated and the output of the evaluation will be returned instead.

13 Each `header` sub-element provides the name of a Message header (via the mandatory `name` attribute). Exactly one of the `value` or `expression` attributes must be provided as well. The former for a literal value to set, and the latter for a SpEL expression to be evaluated. The root object of the evaluation context is the Message that was returned from the flow initiated by this enricher, the input Message if there is no request channel, or the application context (using the *@<beanName>.<beanProperty>* SpEL syntax). Note, similar to the `<header-enricher>`, the `<enricher>`'s `header` element has `type` and `overwrite` attributes. However, a difference is that, with the `<enricher>`, the `overwrite` attribute is `true` by default, to be consistent with `<enricher>`'s `<property>` sub-element. Starting with *4.1*, you can also specify an optional `null-result-expression` attribute. When the `enricher` returns null, it will be evaluated and the output of the evaluation will be returned instead.

Examples

Below, please find several examples of using a Payload Enricher in various situations.

In the following example, a `User` object is passed as the payload of the `Message`. The `User` has several properties but only the `username` is set initially. The Enricher's `request-channel` attribute below is configured to pass the `User` on to the `findUserServiceChannel`.

Through the implicitly set `reply-channel` a `User` object is returned and using the `property` sub-element, properties from the reply are extracted and used to enrich the original payload.

```
<int:enricher id="findUserEnricher"
              input-channel="findUserEnricherChannel"
              request-channel="findUserServiceChannel">
    <int:property name="email"    expression="payload.email"/>
    <int:property name="password" expression="payload.password"/>
</int:enricher>
```

Note

The code samples shown here, are part of the *Spring Integration Samples* project. Please feel free to check it out in the the section called "CompletableFuture".

How do I pass only a subset of data to the request channel?

Using a `request-payload-expression` attribute a single property of the payload can be passed on to the request channel instead of the full message. In the example below on the username property is passed on to the request channel. Keep in mind, that although only the username is passed on, the resulting message send to the request channel will contain the full set of `MessageHeaders`.

```
<int:enricher id="findUserByUsernameEnricher"
              input-channel="findUserByUsernameEnricherChannel"
              request-channel="findUserByUsernameServiceChannel"
              request-payload-expression="payload.username">
    <int:property name="email"    expression="payload.email"/>
    <int:property name="password" expression="payload.password"/>
</int:enricher>
```

How can I enrich payloads that consist of Collection data?

In the following example, instead of a `User` object, a `Map` is passed in. The `Map` contains the username under the map key `username`. Only the `username` is passed on to the request channel. The reply contains a full `User` object, which is ultimately added to the `Map` under the `user` key.

```
<int:enricher id="findUserWithMapEnricher"
              input-channel="findUserWithMapEnricherChannel"
              request-channel="findUserByUsernameServiceChannel"
              request-payload-expression="payload.username">
    <int:property name="user" expression="payload"/>
</int:enricher>
```

How can I enrich payloads with static information without using a request channel?

Here is an example that does not use a request channel at all, but solely enriches the message's payload with static values. But please be aware that the word *static* is used loosely here. You can still use SpEL expressions for setting those values.

```
<int:enricher id="userEnricher"
              input-channel="input">
    <int:property name="user.updateDate" expression="new java.util.Date()"/>
    <int:property name="user.firstName" value="foo"/>
    <int:property name="user.lastName"  value="bar"/>
    <int:property name="user.age"       value="42"/>
</int:enricher>
```

7.3 Claim Check

Introduction

In the earlier sections we've covered several Content Enricher type components that help you deal with situations where a message is missing a piece of data. We also discussed Content Filtering which lets you remove data items from a message. However there are times when we want to hide data temporarily. For example, in a distributed system we may receive a Message with a very large payload. Some intermittent message processing steps may not need access to this payload and some may only need to access certain headers, so carrying the large Message payload through each processing step may cause performance degradation, may produce a security risk, and may make debugging more difficult.

The Claim Check pattern describes a mechanism that allows you to store data in a well known place while only maintaining a pointer (Claim Check) to where that data is located. You can pass that pointer around as a payload of a new Message thereby allowing any component within the message flow to get the actual data as soon as it needs it. This approach is very similar to the Certified Mail process where you'll get a Claim Check in your mailbox and would have to go to the Post Office to claim your actual package. Of course it's also the same idea as baggage-claim on a flight or in a hotel.

Spring Integration provides two types of Claim Check transformers:

- *Incoming Claim Check Transformer*
- *Outgoing Claim Check Transformer*

Convenient namespace-based mechanisms are available to configure them.

Incoming Claim Check Transformer

An *Incoming Claim Check Transformer* will transform an incoming Message by storing it in the Message Store identified by its `message-store` attribute.

```
<int:claim-check-in id="checkin"
        input-channel="checkinChannel"
        message-store="testMessageStore"
        output-channel="output"/>
```

In the above configuration the Message that is received on the `input-channel` will be persisted to the Message Store identified with the `message-store` attribute and indexed with generated ID. That ID is the Claim Check for that Message. The Claim Check will also become the payload of the new (transformed) Message that will be sent to the `output-channel`.

Now, lets assume that at some point you do need access to the actual Message. You can of course access the Message Store manually and get the contents of the Message, or you can use the same approach as before except now you will be transforming the Claim Check to the actual Message by using an *Outgoing Claim Check Transformer*.

Here is an overview of all available parameters of an Incoming Claim Check Transformer:

```
<int:claim-check-in auto-startup="true"  ❶
                    id=""                          ❷
                    input-channel=""               ❸
                    message-store="messageStore"   ❹
                    order=""                       ❺
                    output-channel=""              ❻
                    send-timeout="">               ❼
    <int:poller></int:poller>                      ❽
</int:claim-check-in>
```

❶ Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to true. Attribute is not available inside a `Chain` element. *Optional*.

❷ Id identifying the underlying bean definition (`MessageTransformingHandler`). Attribute is not available inside a `Chain` element. *Optional*.

❸ The receiving Message channel of this endpoint. Attribute is not available inside a `Chain` element. *Optional*.

❹ Reference to the MessageStore to be used by this Claim Check transformer. If not specified, the default reference will be to a bean named *messageStore*. *Optional*.

❺ Specifies the order for invocation when this endpoint is connected as a subscriber to a channel. This is particularly relevant when that channel is using a *failover* dispatching strategy. It has no effect when this endpoint itself is a Polling Consumer for a channel with a queue. Attribute is not available inside a `Chain` element. *Optional*.

❻ Identifies the Message channel where Message will be sent after its being processed by this endpoint. Attribute is not available inside a `Chain` element. *Optional*.

❼ Specify the maximum amount of time in milliseconds to wait when sending a reply Message to the output channel. Defaults to `-1` - blocking indefinitely. Attribute is not available inside a `Chain` element. *Optional*.

❽ Defines a poller. Element is not available inside a `Chain` element. *Optional*.

Outgoing Claim Check Transformer

An *Outgoing Claim Check Transformer* allows you to transform a Message with a Claim Check payload into a Message with the original content as its payload.

```
<int:claim-check-out id="checkout"
        input-channel="checkoutChannel"
        message-store="testMessageStore"
        output-channel="output"/>
```

In the above configuration, the Message that is received on the `input-channel` should have a Claim Check as its payload and the *Outgoing Claim Check Transformer* will transform it into a Message with the original payload by simply querying the Message store for a Message identified by the provided Claim Check. It then sends the newly checked-out Message to the `output-channel`.

Here is an overview of all available parameters of an Outgoing Claim Check Transformer:

```
<int:claim-check-out auto-startup="true"  ❶
                     id=""                          ❷
                     input-channel=""               ❸
                     message-store="messageStore"   ❹
                     order=""                       ❺
                     output-channel=""              ❻
                     remove-message="false"         ❼
                     send-timeout="">               ❽
    <int:poller></int:poller>                       ❾
</int:claim-check-out>
```

❶ Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to true. Attribute is not available inside a `Chain` element. *Optional*.

❷ Id identifying the underlying bean definition (`MessageTransformingHandler`). Attribute is not available inside a `Chain` element. *Optional*.

❸ The receiving Message channel of this endpoint. Attribute is not available inside a `Chain` element. *Optional*.

❹ Reference to the MessageStore to be used by this Claim Check transformer. If not specified, the default reference will be to a bean named *messageStore*. *Optional*.

❺ Specifies the order for invocation when this endpoint is connected as a subscriber to a channel. This is particularly relevant when that channel is using a *failover* dispatching strategy. It has no effect when this endpoint itself is a Polling Consumer for a channel with a queue. Attribute is not available inside a `Chain` element. *Optional*.

❻ Identifies the Message channel where Message will be sent after its being processed by this endpoint. Attribute is not available inside a `Chain` element. *Optional*.

❼ If set to `true` the Message will be removed from the MessageStore by this transformer. Useful when Message can be "claimed" only once. Defaults to `false`. *Optional*.

❽ Specify the maximum amount of time in milliseconds to wait when sending a reply Message to the output channel. Defaults to `-1` - blocking indefinitely. Attribute is not available inside a `Chain` element. *Optional*.

❾ Defines a poller. Element is not available inside a `Chain` element. *Optional*.

Claim Once

There are scenarios when a particular message must be claimed only once. As an analogy, consider the airplane luggage check-in/out process. Checking-in your luggage on departure and and then claiming it on arrival is a classic example of such a scenario. Once the luggage has been claimed, it can not be claimed again without first checking it back in. To accommodate such cases, we introduced a `remove-message` boolean attribute on the `claim-check-out` transformer. This attribute is set to `false` by default. However, if set to `true`, the claimed Message will be removed from the MessageStore, so that it can no longer be claimed again.

This is also something to consider in terms of storage space, especially in the case of the in-memory Map-based `SimpleMessageStore`, where failing to remove the Messages could ultimately lead to an `OutOfMemoryException`. Therefore, if you don't expect multiple claims to be made, it's recommended that you set the `remove-message` attribute's value to `true`.

```
<int:claim-check-out id="checkout"
        input-channel="checkoutChannel"
        message-store="testMessageStore"
        output-channel="output"
        remove-message="true"/>
```

A word on Message Store

Although we rarely care about the details of the claim checks as long as they work, it is still worth knowing that the current implementation of the actual Claim Check (the pointer) in Spring Integration is a UUID to ensure uniqueness.

`org.springframework.integration.store.MessageStore` is a strategy interface for storing and retrieving messages. Spring Integration provides two convenient implementations of it. `SimpleMessageStore`: an in-memory, Map-based implementation (the default, good for testing) and `JdbcMessageStore`: an implementation that uses a relational database via JDBC.

7.4 Codec

Introduction

Spring Integration *version 4.2* introduces the `Codec` abstraction. Codecs are used to encode/decode objects to/from `byte[]`. They are an alternative to Java Serialization. One advantage is, typically, objects do not have to implement `Serializable`. One implementation, using Kryo for serialization, is provided but you can provide your own implementation for use in any of these components:

- `EncodingPayloadTransformer`
- `DecodingTransformer`
- `CodecMessageConverter`

See their JavaDocs for more information.

EncodingPayloadTransformer

This transformer encodes the payload to a `byte[]` using the codec. It does not affect message headers.

DecodingTransformer

This transformer decodes a `byte[]` using the codec; it needs to be configured with the Class to which the object should be decoded (or an expression that resolves to a Class). If the resulting object is a `Message<?>`, inbound headers will not be retained.

CodecMessageConverter

Certain endpoints (e.g. TCP, Redis) have no concept of message headers; they support the use of a `MessageConverter` and the `CodecMessageConverter` can be used to convert a message to/from a `byte[]` for transmission.

Kryo

Currently, this is the only implementation of `Codec`. There are two `Codec` s - `PojoCodec` which can be used in the transformers and `MessageCodec` which can be used in the `CodecMessageConverter`.

Several custom serializers are provided by the framework:

- `FileSerializer`
- `MessageHeadersSerializer`
- `MutableMessageHeadersSerializer`

The first can be used with the `PojoCodec`, by initializing it with the `FileKryoRegistrar`. The second and third are used with the `MessageCodec`, which is initialized with the `MessageKryoRegistrar`.

Customizing Kryo

By default, Kryo delegates unknown Java types to its `FieldSerializer`. Kryo also registers default serializers for each primitive type along with `String`, `Collection` and `Map` serializers.

`FieldSerializer` uses reflection to navigate the object graph. A more efficient approach is to implement a custom serializer that is aware of the object's structure and can directly serialize selected primitive fields:

```
public class AddressSerializer extends Serializer<Address> {

    @Override
    public void write(Kryo kryo, Output output, Address address) {
        output.writeString(address.getStreet());
        output.writeString(address.getCity());
        output.writeString(address.getCountry());
    }

    @Override
    public Address read(Kryo kryo, Input input, Class<Address> type) {
        return new Address(input.readString(), input.readString(), input.readString());
    }
}
```

The `Serializer` interface exposes `Kryo`, `Input`, and `Output` which provide complete control over which fields are included and other internal settings as described in the documentation.

Note

When registering your custom serializer, you need a registration ID. The registration IDs are arbitrary but in our case must be explicitly defined because each Kryo instance across the distributed application must use the same IDs. Kryo recommends small positive integers, and reserves a few ids (value < 10). Spring Integration currently defaults to using 40, 41 and 42 (for the file and message header serializers mentioned above); we recommend you start at, say 60, to allow for expansion in the framework. These framework defaults can be overridden by configuring the registrars mentioned above.

Using a Custom Kryo Serializer

If custom serialization is indicated, please consult the Kryo documentation since you will be using the native API. For an example, see the `MessageCodec`.

Implementing KryoSerializable

If you have write access to the domain object source code it may implement `KryoSerializable` as described here. In this case the class provides the serialization methods itself and no further configuration is required. This has the advantage of being much simpler to use with XD, however benchmarks have shown this is not quite as efficient as registering a custom serializer explicitly:

```
public class Address implements KryoSerializable {
    ...

    @Override
    public void write(Kryo kryo, Output output) {
        output.writeString(this.street);
        output.writeString(this.city);
        output.writeString(this.country);
    }

    @Override
    public void read(Kryo kryo, Input input) {
        this.street = input.readString();
        this.city = input.readString();
        this.country = input.readString();
    }
}
```

Note that this technique can also be used to wrap a serialization library other than Kryo.

Using DefaultSerializer Annotation

Kryo also provides an annotation as described here.

```
@DefaultSerializer(SomeClassSerializer.class)
public class SomeClass {
       // ...
}
```

If you have write access to the domain object this may be a simpler alternative to specify a custom serializer. Note this does not register the class with an ID, so your mileage may vary.

8. Messaging Endpoints

8.1 Message Endpoints

The first part of this chapter covers some background theory and reveals quite a bit about the underlying API that drives Spring Integration's various messaging components. This information can be helpful if you want to really understand what's going on behind the scenes. However, if you want to get up and running with the simplified namespace-based configuration of the various elements, feel free to skip ahead to the section called "Endpoint Namespace Support" for now.

As mentioned in the overview, Message Endpoints are responsible for connecting the various messaging components to channels. Over the next several chapters, you will see a number of different components that consume Messages. Some of these are also capable of sending reply Messages. Sending Messages is quite straightforward. As shown above in Section 4.1, "Message Channels", it's easy to *send* a Message to a Message Channel. However, receiving is a bit more complicated. The main reason is that there are two types of consumers: Polling Consumers and Event Driven Consumers.

Of the two, Event Driven Consumers are much simpler. Without any need to manage and schedule a separate poller thread, they are essentially just listeners with a callback method. When connecting to one of Spring Integration's subscribable Message Channels, this simple option works great. However, when connecting to a buffering, pollable Message Channel, some component has to schedule and manage the polling thread(s). Spring Integration provides two different endpoint implementations to accommodate these two types of consumers. Therefore, the consumers themselves can simply implement the callback interface. When polling is required, the endpoint acts as a *container* for the consumer instance. The benefit is similar to that of using a container for hosting Message Driven Beans, but since these consumers are simply Spring-managed Objects running within an ApplicationContext, it more closely resembles Spring's own MessageListener containers.

Message Handler

Spring Integration's `MessageHandler` interface is implemented by many of the components within the framework. In other words, this is not part of the public API, and a developer would not typically implement `MessageHandler` directly. Nevertheless, it is used by a Message Consumer for actually handling the consumed Messages, and so being aware of this strategy interface does help in terms of understanding the overall role of a consumer. The interface is defined as follows:

```
public interface MessageHandler {

    void handleMessage(Message<?> message);

}
```

Despite its simplicity, this provides the foundation for most of the components that will be covered in the following chapters (Routers, Transformers, Splitters, Aggregators, Service Activators, etc). Those components each perform very different functionality with the Messages they handle, but the requirements for actually receiving a Message are the same, and the choice between polling and event-driven behavior is also the same. Spring Integration provides two endpoint implementations that *host* these callback-based handlers and allow them to be connected to Message Channels.

Event Driven Consumer

Because it is the simpler of the two, we will cover the Event Driven Consumer endpoint first. You may recall that the `SubscribableChannel` interface provides a `subscribe()` method and that the method accepts a `MessageHandler` parameter (as shown in the section called “SubscribableChannel”):

```
subscribableChannel.subscribe(messageHandler);
```

Since a handler that is subscribed to a channel does not have to actively poll that channel, this is an Event Driven Consumer, and the implementation provided by Spring Integration accepts a a `SubscribableChannel` and a `MessageHandler`:

```
SubscribableChannel channel = context.getBean("subscribableChannel", SubscribableChannel.class);

EventDrivenConsumer consumer = new EventDrivenConsumer(channel, exampleHandler);
```

Polling Consumer

Spring Integration also provides a `PollingConsumer`, and it can be instantiated in the same way except that the channel must implement `PollableChannel`:

```
PollableChannel channel = context.getBean("pollableChannel", PollableChannel.class);

PollingConsumer consumer = new PollingConsumer(channel, exampleHandler);
```

Note

For more information regarding Polling Consumers, please also read Section 4.2, “Poller” as well as Section 4.3, “Channel Adapter”.

There are many other configuration options for the Polling Consumer. For example, the trigger is a required property:

```
PollingConsumer consumer = new PollingConsumer(channel, handler);

consumer.setTrigger(new IntervalTrigger(30, TimeUnit.SECONDS));
```

Spring Integration currently provides two implementations of the `Trigger` interface: `IntervalTrigger` and `CronTrigger`. The `IntervalTrigger` is typically defined with a simple interval (in milliseconds), but also supports an *initialDelay* property and a boolean *fixedRate* property (the default is false, i.e. fixed delay):

```
IntervalTrigger trigger = new IntervalTrigger(1000);
trigger.setInitialDelay(5000);
trigger.setFixedRate(true);
```

The `CronTrigger` simply requires a valid cron expression (see the Javadoc for details):

```
CronTrigger trigger = new CronTrigger("*/10 * * * * MON-FRI");
```

In addition to the trigger, several other polling-related configuration properties may be specified:

```
PollingConsumer consumer = new PollingConsumer(channel, handler);

consumer.setMaxMessagesPerPoll(10);
consumer.setReceiveTimeout(5000);
```

The *maxMessagesPerPoll* property specifies the maximum number of messages to receive within a given poll operation. This means that the poller will continue calling receive() *without waiting* until either `null` is returned or that max is reached. For example, if a poller has a 10 second interval trigger and a *maxMessagesPerPoll* setting of 25, and it is polling a channel that has 100 messages in its queue, all 100 messages can be retrieved within 40 seconds. It grabs 25, waits 10 seconds, grabs the next 25, and so on.

The *receiveTimeout* property specifies the amount of time the poller should wait if no messages are available when it invokes the receive operation. For example, consider two options that seem similar on the surface but are actually quite different: the first has an interval trigger of 5 seconds and a receive timeout of 50 milliseconds while the second has an interval trigger of 50 milliseconds and a receive timeout of 5 seconds. The first one may receive a message up to 4950 milliseconds later than it arrived on the channel (if that message arrived immediately after one of its poll calls returned). On the other hand, the second configuration will never miss a message by more than 50 milliseconds. The difference is that the second option requires a thread to wait, but as a result it is able to respond much more quickly to arriving messages. This technique, known as *long polling*, can be used to emulate event-driven behavior on a polled source.

A Polling Consumer may also delegate to a Spring `TaskExecutor`, as illustrated in the following example:

```
PollingConsumer consumer = new PollingConsumer(channel, handler);

TaskExecutor taskExecutor = context.getBean("exampleExecutor", TaskExecutor.class);
consumer.setTaskExecutor(taskExecutor);
```

Furthermore, a `PollingConsumer` has a property called *adviceChain*. This property allows you to specify a `List` of AOP Advices for handling additional cross cutting concerns including transactions. These advices are applied around the `doPoll()` method. For more in-depth information, please see the sections *AOP Advice chains* and *Transaction Support* under the section called “Endpoint Namespace Support”.

The examples above show dependency lookups, but keep in mind that these consumers will most often be configured as Spring *bean definitions*. In fact, Spring Integration also provides a `FactoryBean` called `ConsumerEndpointFactoryBean` that creates the appropriate consumer type based on the type of channel, and there is full XML namespace support to even further hide those details. The namespace-based configuration will be featured as each component type is introduced.

Note

Many of the `MessageHandler` implementations are also capable of generating reply Messages. As mentioned above, sending Messages is trivial when compared to the Message reception. Nevertheless,*when* and *how many* reply Messages are sent depends on the handler type. For example, an *Aggregator* waits for a number of Messages to arrive and is often configured as a downstream consumer for a *Splitter* which may generate multiple replies for each Message it handles. When using the namespace configuration, you do not strictly need to know all of the details, but it still might be worth knowing that several of these components share a common base class, the `AbstractReplyProducingMessageHandler`, and it provides a `setOutputChannel(..)` method.

Endpoint Namespace Support

Throughout the reference manual, you will see specific configuration examples for endpoint elements, such as router, transformer, service-activator, and so on. Most of these will support an *input-channel* attribute and many will support an *output-channel* attribute. After being parsed, these endpoint elements produce an instance of either the `PollingConsumer` or the `EventDrivenConsumer` depending on the type of the *input-channel* that is referenced: `PollableChannel` or `SubscribableChannel` respectively. When the channel is pollable, then the polling behavior is determined based on the endpoint element's *poller* sub-element and its attributes.

In the configuration below you find a *poller* with all available configuration options:

```
<int:poller cron=""                                   ❶
            default="false"                           ❷
            error-channel=""                          ❸
            fixed-delay=""                            ❹
            fixed-rate=""                             ❺
            id=""                                     ❻
            max-messages-per-poll=""                  ❼
            receive-timeout=""                        ❽
            ref=""                                    ❾
            task-executor=""                          ❿
            time-unit="MILLISECONDS"                  11
            trigger="">                               12
            <int:advice-chain />                      13
            <int:transactional />                     14
</int:poller>
```

❶ Provides the ability to configure Pollers using Cron expressions. The underlying implementation uses an `org.springframework.scheduling.support.CronTrigger`. If this attribute is set, none of the following attributes must be specified: `fixed-delay`, `trigger`, `fixed-rate`, `ref`.

❷ By setting this attribute to *true*, it is possible to define exactly one (1) global default poller. An exception is raised if more than one default poller is defined in the application context. Any endpoints connected to a PollableChannel (PollingConsumer) or any SourcePollingChannelAdapter that does not have any explicitly configured poller will then use the global default Poller. *Optional*. Defaults to `false`.

❸ Identifies the channel which error messages will be sent to if a failure occurs in this poller's invocation. To completely suppress Exceptions, provide a reference to the `nullChannel`. *Optional*.

❹ The fixed delay trigger uses a `PeriodicTrigger` under the covers. If the `time-unit` attribute is not used, the specified value is represented in milliseconds. If this attribute is set, none of the following attributes must be specified: `fixed-rate`, `trigger`, `cron`, `ref`.

❺ The fixed rate trigger uses a `PeriodicTrigger` under the covers. If the `time-unit` attribute is not used the specified value is represented in milliseconds. If this attribute is set, none of the following attributes must be specified: `fixed-delay`, `trigger`, `cron`, `ref`.

❻ The Id referring to the Poller's underlying bean-definition, which is of type `org.springframework.integration.scheduling.PollerMetadata`. The *id* attribute is required for a top-level poller element unless it is the default poller (`default="true"`).

❼ Please see the section called "Configuring An Inbound Channel Adapter" for more information. *Optional*. If not specified the default values used depends on the context. If a `PollingConsumer` is used, this atribute will default to *-1*. However, if a `SourcePollingChannelAdapter` is used, then the `max-messages-per-poll` attribute defaults to *1*.

❽ Value is set on the underlying class `PollerMetadata`. *Optional*. If not specified it defaults to 1000 (milliseconds).

❾ Bean reference to another top-level poller. The `ref` attribute must not be present on the top-level `poller` element. However, if this attribute is set, none of the following attributes must be specified: `fixed-rate`, `trigger`, `cron`, `fixed-delay`.

❿ Provides the ability to reference a custom *task executor*. Please see the section below titled *TaskExecutor Support* for further information. *Optional*.

11 This attribute specifies the `java.util.concurrent.TimeUnit` enum value on the underlying `org.springframework.scheduling.support.PeriodicTrigger`. Therefore, this attribute can *ONLY* be used in combination with the `fixed-delay` or `fixed-rate` attributes. If combined with either `cron` or a `trigger` reference attribute, it will cause a failure. The minimal supported granularity for a `PeriodicTrigger` is MILLISECONDS. Therefore, the only available options are MILLISECONDS and SECONDS. If this value is not provided, then any `fixed-delay` or `fixed-rate` value will be interpreted as MILLISECONDS by default. Basically this enum provides a convenience for SECONDS-based interval trigger values. For hourly, daily, and monthly settings, consider using a `cron` trigger instead.

12 Reference to any spring configured bean which implements the `org.springframework.scheduling.Trigger` interface. *Optional*. However, if this attribute is set, none of the following attributes must be specified: `fixed-delay`, `fixed-rate`, `cron`, `ref`.

13 Allows to specify extra AOP Advices to handle additional cross cutting concerns. Please see the section below titled *Transaction Support* for further information. *Optional*.

14 Pollers can be made transactional. Please see the section below titled *AOP Advice chains* for further information. *Optional*.

Examples

For example, a simple interval-based poller with a 1-second interval would be configured like this:

```
<int:transformer input-channel="pollable"
    ref="transformer"
    output-channel="output">
    <int:poller fixed-rate="1000"/>
</int:transformer>
```

As an alternative to *fixed-rate* you can also use the *fixed-delay* attribute.

For a poller based on a Cron expression, use the *cron* attribute instead:

```
<int:transformer input-channel="pollable"
    ref="transformer"
    output-channel="output">
    <int:poller cron="*/10 * * * * MON-FRI"/>
</int:transformer>
```

If the input channel is a `PollableChannel`, then the poller configuration is required. Specifically, as mentioned above, the *trigger* is a required property of the PollingConsumer class. Therefore, if you omit the *poller* sub-element for a Polling Consumer endpoint's configuration, an Exception may be thrown. The exception will also be thrown if you attempt to configure a poller on the element that is connected to a non-pollable channel.

It is also possible to create top-level pollers in which case only a *ref* is required:

```
<int:poller id="weekdayPoller" cron="*/10 * * * * MON-FRI"/>

<int:transformer input-channel="pollable"
    ref="transformer"
    output-channel="output">
    <int:poller ref="weekdayPoller"/>
</int:transformer>
```

Note

The *ref* attribute is only allowed on the inner-poller definitions. Defining this attribute on a top-level poller will result in a configuration exception thrown during initialization of the Application Context.

Global Default Pollers

In fact, to simplify the configuration even further, you can define a global default poller. A single top-level poller within an ApplicationContext may have the `default` attribute with a value of *true*. In that case, any endpoint with a PollableChannel for its input-channel that is defined within the same ApplicationContext and has no explicitly configured *poller* sub-element will use that default.

```
<int:poller id="defaultPoller" default="true" max-messages-per-poll="5" fixed-rate="3000"/>

<!-- No <poller/> sub-element is necessary since there is a default -->
<int:transformer input-channel="pollable"
                 ref="transformer"
                 output-channel="output"/>
```

Transaction Support

Spring Integration also provides transaction support for the pollers so that each receive-and-forward operation can be performed as an atomic unit-of-work. To configure transactions for a poller, simply add the_<transactional/>_ sub-element. The attributes for this element should be familiar to anyone who has experience with Spring's Transaction management:

```
<int:poller fixed-delay="1000">
    <int:transactional transaction-manager="txManager"
                       propagation="REQUIRED"
                       isolation="REPEATABLE_READ"
                       timeout="10000"
                       read-only="false"/>
</int:poller>
```

For more information please refer to the section called "CompletableFuture".

AOP Advice chains

Since Spring transaction support depends on the Proxy mechanism with `TransactionInterceptor` (AOP Advice) handling transactional behavior of the message flow initiated by the poller, some times there is a need to provide extra Advice(s) to handle other cross cutting behavior associated with the poller. For that poller defines an *advice-chain* element allowing you to add more advices - class that implements `MethodInterceptor` interface…

```
<int:service-activator id="advicedSa" input-channel="goodInputWithAdvice" ref="testBean"
  method="good" output-channel="output">
 <int:poller max-messages-per-poll="1" fixed-rate="10000">
   <int:advice-chain>
   <ref bean="adviceA" />
   <beans:bean class="org.bar.SampleAdvice" />
   <ref bean="txAdvice" />
  </int:advice-chain>
 </int:poller>
</int:service-activator>
```

For more information on how to implement MethodInterceptor please refer to AOP sections of Spring reference manual (section 8 and 9). Advice chain can also be applied on the poller that does not have any transaction configuration essentially allowing you to enhance the behavior of the message flow initiated by the poller.

Important

When using an advice chain, the `<transactional/>` child element cannot be specified; instead, declare a `<tx:advice/>` bean and add it to the `<advice-chain/>`. See the section called "CompletableFuture" for complete configuration.

TaskExecutor Support

The polling threads may be executed by any instance of Spring's `TaskExecutor` abstraction. This enables concurrency for an endpoint or group of endpoints. As of Spring 3.0, there is a *task* namespace in the core Spring Framework, and its <executor/> element supports the creation of a simple thread pool executor. That element accepts attributes for common concurrency settings such as pool-size and queue-capacity. Configuring a thread-pooling executor can make a substantial difference in how the endpoint performs under load. These settings are available per-endpoint since the performance of an endpoint is one of the major factors to consider (the other major factor being the expected volume on the channel to which the endpoint subscribes). To enable concurrency for a polling endpoint that is configured with the XML namespace support, provide the *task-executor* reference on its <poller/> element and then provide one or more of the properties shown below:

```
<int:poller task-executor="pool" fixed-rate="1000"/>

<task:executor id="pool"
               pool-size="5-25"
               queue-capacity="20"
               keep-alive="120"/>
```

If no *task-executor* is provided, the consumer's handler will be invoked in the caller's thread. Note that the *caller* is usually the default `TaskScheduler` (see the section called "CompletableFuture"). Also, keep in mind that the *task-executor* attribute can provide a reference to any implementation of Spring's `TaskExecutor` interface by specifying the bean name. The *executor* element above is simply provided for convenience.

As mentioned in the background section for Polling Consumers above, you can also configure a Polling Consumer in such a way as to emulate event-driven behavior. With a long receive-timeout and a short interval-trigger, you can ensure a very timely reaction to arriving messages even on a polled message source. Note that this will only apply to sources that have a blocking wait call with a timeout. For example, the File poller does not block, each receive() call returns immediately and either contains new files or not. Therefore, even if a poller contains a long receive-timeout, that value would never be usable in such a scenario. On the other hand when using Spring Integration's own queue-based channels, the timeout value does have a chance to participate. The following example demonstrates how a Polling Consumer will receive Messages nearly instantaneously.

```
<int:service-activator input-channel="someQueueChannel"
    output-channel="output">
    <int:poller receive-timeout="30000" fixed-rate="10"/>

</int:service-activator>
```

Using this approach does not carry much overhead since internally it is nothing more then a timed-wait thread which does not require nearly as much CPU resource usage as a thrashing, infinite while loop for example.

Change Polling Rate at Runtime

When configuring Pollers with a `fixed-delay` or `fixed-rate` attribute, the default implementation will use a `PeriodicTrigger` instance. The `PeriodicTrigger` is part of the Core Spring Framework and it accepts the *interval* as a constructor argument, only. Therefore it cannot be changed at runtime.

However, you can define your own implementation of the `org.springframework.scheduling.Trigger` interface. You could even use the PeriodicTrigger as a starting point. Then, you can add a setter for the interval (period), or you could even embed your own throttling logic within the trigger itself if desired. The *period* property will be used with each call to *nextExecutionTime* to schedule the next poll. To use this custom trigger within pollers, declare the bean definition of the custom Trigger in your application context and inject the dependency into your Poller configuration using the `trigger` attribute, which references the custom Trigger bean instance. You can now obtain a reference to the Trigger bean and the polling interval can be changed between polls.

For an example, please see the Spring Integration Samples project. It contains a sample called *dynamic-poller*, which uses a custom Trigger and demonstrates the ability to change the polling interval at runtime.

https://github.com/SpringSource/spring-integration-samples/tree/master/intermediate

The sample provides a custom Trigger which implements the *org.springframework.scheduling.Trigger* interface. The sample's Trigger is based on Spring's PeriodicTrigger implementation. However, the fields of the custom trigger are not final and the properties have explicit getters and setters, allowing to dynamically change the polling period at runtime.

Note

It is important to note, though, that because the Trigger method is *nextExecutionTime()*, any changes to a dynamic trigger will not take effect until the next poll, based on the existing configuration. It is not possible to force a trigger to fire before it's currently configured next execution time.

Payload Type Conversion

Throughout the reference manual, you will also see specific configuration and implementation examples of various endpoints which can accept a Message or any arbitrary Object as an input parameter. In the case of an Object, such a parameter will be mapped to a Message payload or part of the payload or header (when using the Spring Expression Language). However there are times when the type of input parameter of the endpoint method does not match the type of the payload or its part. In this scenario we need to perform type conversion. Spring Integration provides a convenient way for registering type converters (using the Spring `ConversionService`) within its own instance of a conversion service bean named *integrationConversionService*. That bean is automatically created as soon as the first converter is defined using the Spring Integration infrastructure. To register a Converter all you need is to implement `org.springframework.core.convert.converter.Converter`, `org.springframework.core.convert.converter.GenericConverter` or `org.springframework.core.convert.converter.ConverterFactory`.

The `Converter` implementation is the simplest and converts from a single type to another. For more sophistication, such as converting to a class hierarchy, you would implement a `GenericConverter` and possibly a `ConditionalConverter`. These give you complete access to the *from* and *to* type descriptors enabling complex conversions. For example, if you have an abstract class `Foo` that is the target of your conversion (parameter type, channel data type etc) and you have two concrete implementations `Bar` and `Baz` and you wish to convert to one or the other based on the input type, the `GenericConverter` would be a good fit. Refer to the JavaDocs for these interfaces for more information.

When you have implemented your converter, you can register it with convenient namespace support:

```xml
<int:converter ref="sampleConverter"/>

<bean id="sampleConverter" class="foo.bar.TestConverter"/>
```

or as an inner bean:

```
<int:converter>
    <bean class="o.s.i.config.xml.ConverterParserTests$TestConverter3"/>
</int:converter>
```

Starting with *Spring Integration 4.0*, the above configuration is available using annotations:

```
@Component
@IntegrationConverter
public class TestConverter implements Converter<Boolean, Number> {

 public Number convert(Boolean source) {
  return source ? 1 : 0;
 }

}
```

or as a `@Configuration` part:

```
@Configuration
@EnableIntegration
public class ContextConfiguration {

 @Bean
 @IntegrationConverter
 public SerializingConverter serializingConverter() {
  return new SerializingConverter();
 }

}
```

> **Important**
>
> When configuring an *Application Context*, the Spring Framework allows you to add a *conversionService* bean (see Configuring a ConversionService chapter). This service is used, when needed, to perform appropriate conversions during bean creation and configuration.
>
> In contrast, the *integrationConversionService* is used for runtime conversions. These uses are quite different; converters that are intended for use when wiring bean constructor-args and properties may produce unintended results if used at runtime for Spring Integration expression evaluation against Messages within Datatype Channels, Payload Type transformers etc.
>
> However, if you do want to use the Spring *conversionService* as the Spring Integration *integrationConversionService*, you can configure an *alias* in the Application Context:
>
> ```
> <alias name="conversionService" alias="integrationConversionService"/>
> ```
>
> In this case the *conversionService*'s Converters will be available for Spring Integration runtime conversion.

Content Type Conversion

Starting with *version 5.0*, by default, the method invocation mechanism is based on the `org.springframework.messaging.handler.invocation.InvocableHandlerMethod` infrastructure. Its `HandlerMethodArgumentResolver` implementations (e.g. `PayloadArgumentResolver` and `MessageMethodArgumentResolver`) can use the `MessageConverter` abstraction to convert an incoming `payload` to the target method argument type. The conversion can be based on the `contentType` message header. For this purpose Spring Integration provides the `ConfigurableCompositeMessageConverter` that delegates to a list of registered converters to be invoked until one of them returns a non-null result. By default this converter provides (in strict order):

- `MappingJackson2MessageConverter` if Jackson processor is present in classpath;
- `ByteArrayMessageConverter`
- `ObjectStringMessageConverter`
- `GenericMessageConverter`

Please, consult their JavaDocs for more information about their purpose and appropriate `contentType` value for conversion. The `ConfigurableCompositeMessageConverter` is used because it can be be supplied with any other `MessageConverter` s including or excluding above mentioned default converters and registered as an appropriate bean in the application context overriding the default one:

```
@Bean(name = IntegrationContextUtils.ARGUMENT_RESOLVER_MESSAGE_CONVERTER_BEAN_NAME)
public ConfigurableCompositeMessageConverter compositeMessageConverter() {
    List<MessageConverter> converters =
        Arrays.asList(new MarshallingMessageConverter(jaxb2Marshaller()),
                 new JavaSerializationMessageConverter());
    return new ConfigurableCompositeMessageConverter(converters);
}
```

And those two new converters will be registered in the composite before the defaults. You can also not use a `ConfigurableCompositeMessageConverter`, but provide your own `MessageConverter` by registering a bean with the name `integrationArgumentResolverMessageConverter` (`IntegrationContextUtils.ARGUMENT_RESOLVER_MESSAGE_CONVERTER_BEAN_NAME` constant).

Note

The `MessageConverter`-based (including `contentType` header) conversion isn't available when using SpEL method invocation. In this case, only regular class to class conversion mentioned above in the the section called “Payload Type Conversion” is available.

Asynchronous polling

If you want the polling to be asynchronous, a Poller can optionally specify a *task-executor* attribute pointing to an existing instance of any `TaskExecutor` bean (Spring 3.0 provides a convenient namespace configuration via the `task` namespace). However, there are certain things you must understand when configuring a Poller with a TaskExecutor.

The problem is that there are two configurations in place. The *Poller* and the *TaskExecutor*, and they both have to be in tune with each other otherwise you might end up creating an artificial memory leak.

Let's look at the following configuration provided by one of the users on the Spring Integration Forum:

```
<int:channel id="publishChannel">
    <int:queue />
</int:channel>

<int:service-activator input-channel="publishChannel" ref="myService">
 <int:poller receive-timeout="5000" task-executor="taskExecutor" fixed-rate="50" />
</int:service-activator>

<task:executor id="taskExecutor" pool-size="20" />
```

The above configuration demonstrates one of those out of tune configurations.

By default, the task executor has an unbounded task queue. The poller keeps scheduling new tasks even though all the threads are blocked waiting for either a new message to arrive, or the timeout to expire. Given that there are 20 threads executing tasks with a 5 second timeout, they will be executed at a rate of 4 per second (5000/20 = 250ms). But, new tasks are being scheduled at a rate of 20 per second, so the internal queue in the task executor will grow at a rate of 16 per second (while the process is idle), so we essentially have a memory leak.

One of the ways to handle this is to set the `queue-capacity` attribute of the Task Executor; and even 0 is a reasonable value. You can also manage it by specifying what to do with messages that can not be queued by setting the `rejection-policy` attribute of the Task Executor (e.g., DISCARD). In other words, there are certain details you must understand with regard to configuring the TaskExecutor. Please refer to Task Execution and Scheduling of the Spring reference manual for more detail on the subject.

Endpoint Inner Beans

Many endpoints are composite beans; this includes all consumers and all polled inbound channel adapters. Consumers (polled or event- driven) delegate to a `MessageHandler`; polled adapters obtain messages by delegating to a `MessageSource`. Often, it is useful to obtain a reference to the delegate bean, perhaps to change configuration at runtime, or for testing. These beans can be obtained from the `ApplicationContext` with well-known names. `MessageHandler s` are registered with the application context with a bean id `someConsumer.handler` (where *consumer* is the endpoint's `id` attribute). `MessageSource s` are registered with a bean id `somePolledAdapter.source`, again where *somePolledAdapter* is the id of the adapter.

The above only applies to the framework component itself. If you use an inner bean definition such as this:

```
<int:service-activator id="exampleServiceActivator" input-channel="inChannel"
            output-channel = "outChannel" method="foo">
    <beans:bean class="org.foo.ExampleServiceActivator"/>
</int:service-activator>
```

the bean is treated like any inner bean declared that way and is not registered with the application context. If you wish to access this bean in some other manner, declare it at the top level with an `id` and use the `ref` attribute instead. See the Spring Documentation for more information.

8.2 Endpoint Roles

Starting with *version 4.2*, endpoints can be assigned to roles. Roles allow endpoints to be started and stopped as a group; this is particularly useful when using leadership election where a set of endpoints can be started or stopped when leadership is granted or revoked respectively.

You can assign endpoints to roles using XML, Java configuration, or programmatically:

```
<int:inbound-channel-adapter id="ica" channel="someChannel" expression="'foo'" role="cluster"
        auto-startup="false">
    <int:poller fixed-rate="60000" />
</int:inbound-channel-adapter>
```

```
@Bean
@ServiceActivator(inputChannel = "sendAsyncChannel", autoStartup="false")
@Role("cluster")
public MessageHandler sendAsyncHandler() {
    return // some MessageHandler
}
```

```
@Payload("#args[0].toLowerCase()")
@Role("cluster")
public String handle(String payload) {
    return payload.toUpperCase();
}
```

```
@Autowired
private SmartLifecycleRoleController roleController;

...

    this.roleController.addSmartLifeCycleToRole("cluster", someEndpoint);
...
```

```
IntegrationFlow flow -> flow
        .handle(..., e -> e.role("cluster"));
```

Each of these adds the endpoint to the role `cluster`.

Invoking `roleController.startLifecyclesInRole("cluster")` (and the corresponding `stop...` method) will start/stop the endpoints.

Note

Any object implementing `SmartLifecycle` can be programmatically added, not just endpoints.

The `SmartLifecycleRoleController` implements `ApplicationListener<AbstractLeaderEvent>` and it will automatically start/stop its configured `SmartLifecycle` objects when leadership is granted/revoked (when some bean publishes `OnGrantedEvent` or `OnRevokedEvent` respectively).

Important

When using leadership election to start/stop components, it is important to set the `auto-startup` XML attribute (`autoStartup` bean property) to `false` so the application context does not start the components during context intialization.

Starting with _version 4.3.8, the `SmartLifecycleRoleController` provides several status methods:

```
public Collection<String> getRoles() ❶

public boolean allEndpointsRunning(String role) ❷

public boolean noEndpointsRunning(String role) ❸

public Map<String, Boolean> getEndpointsRunningStatus(String role) ❹
```

❶ Returns a list of the roles being managed.

❷ Returns true if all endpoints in the role are running.

❸ Returns true if none of the endpoints in the role are running.

❹ Returns a map of `component name : running status` - the component name is usually the bean name.

8.3 Leadership Event Handling

Groups of endpoints can be started/stopped based on leadership being granted or revoked respectively. This is useful in clustered scenarios where shared resources must only be consumed by a single instance. An example of this is a file inbound channel adapter that is polling a shared directory. (See the section called “CompletableFuture”).

To participate in a leader election and be notified when elected leader, when leadership is revoked or, failure to acquire the resources to become leader, an application creates a component in the application context called a "leader initiator". Normally a leader initiator is a `SmartLifecycle` so it starts up (optionally) automatically when the context starts, and then publishes notifications when leadership changes. Users can also receive failure notifications by setting the `publishFailedEvents` to `true` (starting with *version 5.0*), in cases when they want take a specific action if a failure occurs. By convention, the user provides a `Candidate` that receives the callbacks and also can revoke the leadership through a `Context` object provided by the framework. User code can also listen for `org.springframework.integration.leader.event.AbstractLeaderEvent` s (the super class of `OnGrantedEvent` and `OnRevokedEvent`), and respond accordingly, for instance using a `SmartLifecycleRoleController`. The events contain a reference to the `Context` object:

```
public interface Context {

 boolean isLeader();

 void yield();

 String getRole();

}
```

Starting with *version 5.0.6*, the context provides a reference to the candidate’s role.

There is a basic implementation of a leader initiator based on the `LockRegistry` abstraction. To use it you just need to create an instance as a bean, for example:

```
@Bean
public LockRegistryLeaderInitiator leaderInitiator(LockRegistry locks) {
    return new LockRegistryLeaderInitiator(locks);
}
```

If the lock registry is implemented correctly, there will only ever be at most one leader. If the lock registry also provides locks which throw exceptions (ideally `InterruptedException`) when they expire or are broken, then the duration of the leaderless periods can be as short as is allowed by the inherent latency in the lock implementation. By default there is a `busyWaitMillis` property that adds some additional latency to prevent CPU starvation in the (more usual) case that the locks are imperfect and you only know they expired by trying to obtain one again.

See the section called “CompletableFuture” for more information about leadership election and events using Zookeeper.

8.4 Messaging Gateways

The primary purpose of a Gateway is to hide the messaging API provided by Spring Integration. It allows your application’s business logic to be completely unaware of the Spring Integration API and using a generic Gateway, your code interacts instead with a simple interface, only.

Enter the GatewayProxyFactoryBean

As mentioned above, it would be great to have no dependency on the Spring Integration API at all - including the gateway class. For that reason, Spring Integration provides the `GatewayProxyFactoryBean` that generates a proxy for any interface and internally invokes the gateway methods shown below. Using dependency injection you can then expose the interface to your business methods.

Here is an example of an interface that can be used to interact with Spring Integration:

```
package org.cafeteria;

public interface Cafe {

    void placeOrder(Order order);

}
```

Gateway XML Namespace Support

Namespace support is also provided which allows you to configure such an interface as a service as demonstrated by the following example.

```
<int:gateway id="cafeService"
         service-interface="org.cafeteria.Cafe"
         default-request-channel="requestChannel"
         default-reply-timeout="10000"
         default-reply-channel="replyChannel"/>
```

With this configuration defined, the "cafeService" can now be injected into other beans, and the code that invokes the methods on that proxied instance of the Cafe interface has no awareness of the Spring Integration API. The general approach is similar to that of Spring Remoting (RMI, HttpInvoker, etc.). See the "Samples" Appendix for an example that uses this "gateway" element (in the Cafe demo).

The defaults in the configuration above are applied to all methods on the gateway interface; if a reply timeout is not specified, the calling thread will wait indefinitely for a reply. See the section called “CompletableFuture”.

The defaults can be overridden for individual methods; see the section called “Gateway Configuration with Annotations and/or XML”.

Setting the Default Reply Channel

Typically you don’t have to specify the `default-reply-channel`, since a Gateway will auto-create a temporary, anonymous reply channel, where it will listen for the reply. However, there are some cases which may prompt you to define a `default-reply-channel` (or `reply-channel` with adapter gateways such as HTTP, JMS, etc.).

For some background, we’ll quickly discuss some of the inner-workings of the Gateway. A Gateway will create a temporary point-to-point reply channel which is anonymous and is added to the Message Headers with the name `replyChannel`. When providing an explicit `default-reply-channel` (`reply-channel` with remote adapter gateways), you have the option to point to a publish-subscribe channel, which is so named because you can add more than one subscriber to it. Internally Spring Integration will create a Bridge between the temporary `replyChannel` and the explicitly defined `default-reply-channel`.

So let’s say you want your reply to go not only to the gateway, but also to some other consumer. In this case you would want two things: *a) a named channel you can subscribe to and b) that channel is a publish-subscribe-channel.* The default strategy used by the gateway will not satisfy those needs, because the reply channel added to the header is anonymous and point-to-point. This means that no other subscriber can get a handle to it and even if it could, the channel has point-to-point behavior such that only one subscriber would get the Message. So by defining a `default-reply-channel` you can point to a channel of your choosing, which in this case would be a `publish-subscribe-channel`. The Gateway would create a bridge from it to the temporary, anonymous reply channel that is stored in the header.

Another case where you might want to provide a reply channel explicitly is for monitoring or auditing via an interceptor (e.g., wiretap). You need a named channel in order to configure a Channel Interceptor.

Gateway Configuration with Annotations and/or XML

```
public interface Cafe {

    @Gateway(requestChannel="orders")
    void placeOrder(Order order);

}
```

You may alternatively provide such content in `method` sub-elements if you prefer XML configuration (see the next paragraph).

It is also possible to pass values to be interpreted as Message headers on the Message that is created and sent to the request channel by using the `@Header` annotation:

```
public interface FileWriter {

    @Gateway(requestChannel="filesOut")
    void write(byte[] content, @Header(FileHeaders.FILENAME) String filename);

}
```

If you prefer the XML approach of configuring Gateway methods, you can provide *method* sub-elements to the gateway configuration.

```
<int:gateway id="myGateway" service-interface="org.foo.bar.TestGateway"
      default-request-channel="inputC">
  <int:default-header name="calledMethod" expression="#gatewayMethod.name"/>
  <int:method name="echo" request-channel="inputA" reply-timeout="2" request-timeout="200"/>
  <int:method name="echoUpperCase" request-channel="inputB"/>
  <int:method name="echoViaDefault"/>
</int:gateway>
```

You can also provide individual headers per method invocation via XML. This could be very useful if the headers you want to set are static in nature and you don’t want to embed them in the gateway’s method signature via `@Header` annotations. For example, in the Loan Broker example we want to influence how aggregation of the Loan quotes will be done based on what type of request was initiated (single quote or all quotes). Determining the type of the request by evaluating what gateway method was invoked, although possible, would violate the separation of concerns paradigm (the method is a java artifact), but expressing your intention (meta information) via Message headers is natural in a Messaging architecture.

```
<int:gateway id="loanBrokerGateway"
         service-interface="org.springframework.integration.loanbroker.LoanBrokerGateway">
  <int:method name="getLoanQuote" request-channel="loanBrokerPreProcessingChannel">
    <int:header name="RESPONSE_TYPE" value="BEST"/>
  </int:method>
  <int:method name="getAllLoanQuotes" request-channel="loanBrokerPreProcessingChannel">
    <int:header name="RESPONSE_TYPE" value="ALL"/>
  </int:method>
</int:gateway>
```

In the above case you can clearly see how a different value will be set for the *RESPONSE_TYPE* header based on the gateway's method.

Expressions and "Global" Headers

The `<header/>` element supports `expression` as an alternative to `value`. The SpEL expression is evaluated to determine the value of the header. There is no `#root` object but the following variables are available:

#args - an `Object[]` containing the method arguments

#gatewayMethod - the `java.reflect.Method` object representing the method in the `service-interface` that was invoked. A header containing this variable can be used later in the flow, for example, for routing. For example, if you wish to route on the simple method name, you might add a header, with expression `#gatewayMethod.name`.

> **Note**
>
> The `java.reflect.Method` is not serializable; a header with expression `#gatewayMethod` will be lost if you later serialize the message. So, you may wish to use `#gatewayMethod.name` or `#gatewayMethod.toString()` in those cases; the `toString()` method provides a String representation of the method, including parameter and return types.

Since 3.0, `<default-header/>` s can be defined to add headers to all messages produced by the gateway, regardless of the method invoked. Specific headers defined for a method take precedence over default headers. Specific headers defined for a method here will override any `@Header` annotations in the service interface. However, default headers will NOT override any `@Header` annotations in the service interface.

The gateway now also supports a `default-payload-expression` which will be applied for all methods (unless overridden).

Mapping Method Arguments to a Message

Using the configuration techniques in the previous section allows control of how method arguments are mapped to message elements (payload and header(s)). When no explicit configuration is used, certain conventions are used to perform the mapping. In some cases, these conventions cannot determine which argument is the payload and which should be mapped to headers.

```
public String send1(Object foo, Map bar);

public String send2(Map foo, Map bar);
```

In the first case, the convention will map the first argument to the payload (as long as it is not a `Map`) and the contents of the second become headers.

In the second case (or the first when the argument for parameter `foo` is a `Map`), the framework cannot determine which argument should be the payload; mapping will fail. This can generally be resolved using a `payload-expression`, a `@Payload` annotation and/or a `@Headers` annotation.

Alternatively, and whenever the conventions break down, you can take the entire responsibility for mapping the method calls to messages. To do this, implement an `MethodArgsMessageMapper` and provide it to the `<gateway/>` using the `mapper` attribute. The mapper maps a `MethodArgsHolder`, which is a simple class wrapping the `java.reflect.Method` instance and an `Object[]` containing the arguments. When providing a custom mapper, the `default-payload-expression` attribute and `<default-header/>` elements are not allowed on the gateway; similarly, the `payload-expression` attribute and `<header/>` elements are not allowed on any `<method/>` elements.

Mapping Method Arguments

Here are examples showing how method arguments can be mapped to the message (and some examples of invalid configuration):

```
public interface MyGateway {

    void payloadAndHeaderMapWithoutAnnotations(String s, Map<String, Object> map);

    void payloadAndHeaderMapWithAnnotations(@Payload String s, @Headers Map<String, Object> map);

    void headerValuesAndPayloadWithAnnotations(@Header("k1") String x, @Payload String s, @Header("k2")
 String y);

    void mapOnly(Map<String, Object> map); // the payload is the map and no custom headers are added

    void twoMapsAndOneAnnotatedWithPayload(@Payload Map<String, Object> payload, Map<String, Object>
 headers);

    @Payload("#args[0] + #args[1] + '!'")
    void payloadAnnotationAtMethodLevel(String a, String b);

    @Payload("@someBean.exclaim(#args[0])")
    void payloadAnnotationAtMethodLevelUsingBeanResolver(String s);

    void payloadAnnotationWithExpression(@Payload("toUpperCase()") String s);

    void payloadAnnotationWithExpressionUsingBeanResolver(@Payload("@someBean.sum(#this)") String s); //
  ❶

    // invalid
    void twoMapsWithoutAnnotations(Map<String, Object> m1, Map<String, Object> m2);

    // invalid
    void twoPayloads(@Payload String s1, @Payload String s2);

    // invalid
    void payloadAndHeaderAnnotationsOnSameParameter(@Payload @Header("x") String s);

    // invalid
    void payloadAndHeadersAnnotationsOnSameParameter(@Payload @Headers Map<String, Object> map);

}
```

❶ Note that in this example, the SpEL variable `#this` refers to the argument - in this case, the value of `'s'`.

The XML equivalent looks a little different, since there is no `#this` context for the method argument, but expressions can refer to method arguments using the `#args` variable:

```
<int:gateway id="myGateway" service-interface="org.foo.bar.MyGateway">
  <int:method name="send1" payload-expression="#args[0] + 'bar'"/>
  <int:method name="send2" payload-expression="@someBean.sum(#args[0])"/>
  <int:method name="send3" payload-expression="#method"/>
  <int:method name="send4">
    <int:header name="foo" expression="#args[2].toUpperCase()"/>
  </int:method>
</int:gateway>
```

@MessagingGateway Annotation

Starting with *version 4.0*, gateway service interfaces can be marked with a `@MessagingGateway` annotation instead of requiring the definition of a `<gateway />` xml element for configuration. The following compares the two approaches for configuring the same gateway:

```
<int:gateway id="myGateway" service-interface="org.foo.bar.TestGateway"
      default-request-channel="inputC">
  <int:default-header name="calledMethod" expression="#gatewayMethod.name"/>
  <int:method name="echo" request-channel="inputA" reply-timeout="2" request-timeout="200"/>
  <int:method name="echoUpperCase" request-channel="inputB">
    <int:header name="foo" value="bar"/>
  </int:method>
  <int:method name="echoViaDefault"/>
</int:gateway>
```

```
@MessagingGateway(name = "myGateway", defaultRequestChannel = "inputC",
    defaultHeaders = @GatewayHeader(name = "calledMethod",
                             expression="#gatewayMethod.name"))
public interface TestGateway {

   @Gateway(requestChannel = "inputA", replyTimeout = 2, requestTimeout = 200)
   String echo(String payload);

   @Gateway(requestChannel = "inputB", headers = @GatewayHeader(name = "foo", value="bar"))
   String echoUpperCase(String payload);

   String echoViaDefault(String payload);

}
```

Important

As with the XML version, Spring Integration creates the `proxy` implementation with its messaging infrastructure, when discovering these annotations during a component scan. To perform this scan and register the `BeanDefinition` in the application context, add the `@IntegrationComponentScan` annotation to a `@Configuration` class. The standard `@ComponentScan` infrastructure doesn't deal with interfaces, therefore the custom `@IntegrationComponentScan` logic has been introduced to determine `@MessagingGateway` annotation on the interfaces and register `GatewayProxyFactoryBean` s for them. See also the section called “CompletableFuture”

Along with the `@MessagingGateway` annotation you can mark a service interface with the `@Profile` annotation to avoid the bean creation, if such a profile is not active.

Note

If you have no XML configuration, the `@EnableIntegration` annotation is required on at least one `@Configuration` class. See Section 3.5, “Configuration and @EnableIntegration” for more information.

Invoking No-Argument Methods

When invoking methods on a Gateway interface that do not have any arguments, the default behavior is to *receive* a `Message` from a `PollableChannel`.

At times however, you may want to trigger no-argument methods so that you can in fact interact with other components downstream that do not require user-provided parameters, e.g. triggering no-argument SQL calls or Stored Procedures.

In order to achieve *send-and-receive* semantics, you must provide a payload. In order to generate a payload, method parameters on the interface are not necessary. You can either use the `@Payload` annotation or the `payload-expression` attribute in XML on the `method` sub-element. Below please find a few examples of what the payloads could be:

- a literal string
- #gatewayMethod.name
- new java.util.Date()
- @someBean.someMethod()'s return value

Here is an example using the `@Payload` annotation:

```
public interface Cafe {

    @Payload("new java.util.Date()")
    List<Order> retrieveOpenOrders();

}
```

If a method has no argument and no return value, but does contain a payload expression, it will be treated as a *send-only* operation.

Error Handling

Of course, the Gateway invocation might result in errors. By default, any error that occurs downstream will be re-thrown as is upon the Gateway's method invocation. For example, consider the following simple flow:

```
gateway -> service-activator
```

If the service invoked by the service activator throws a `FooException`, the framework wraps it in a `MessagingException`, attaching the message passed to the service activator in the `failedMessage` property. Any logging performed by the framework will therefore have full context of the failure. When the exception is caught by the gateway, by default, the `FooException` will be unwrapped and thrown to the caller. You can configure a `throws` clause on the gateway method declaration for matching the particular exception type in the cause chain. For example if you would like to catch a whole `MessagingException` with all the messaging information of the reason of downstream error, you should have a gateway method like this:

```
public interface MyGateway {

    void performProcess() throws MessagingException;

}
```

Since we encourage POJO programming, you may not want to expose the caller to messaging infrastructure.

If your gateway method does not have a `throws` clause, the gateway will traverse the cause tree looking for a `RuntimeException` (that is not a `MessagingException`). If none is found, the framework will simply throw the `MessagingException`. If the `FooException` in the discussion above has a cause `BarException` and your method `throws BarException` then the gateway will further unwrap that and throw it to the caller.

When a gateway is declared with no `service-interface`, an internal framework interface `RequestReplyExchanger` is used.

```
public interface RequestReplyExchanger {

 Message<?> exchange(Message<?> request) throws MessagingException;

}
```

Before *version 5.0* this `exchange` method did not have a `throws` clause and therefore the exception was unwrapped. If you are using this interface, and wish to restore the previous unwrap behavior, use a custom `service-interface` instead, or simply access the `cause` of the `MessagingException` yourself.

However there are times when you may want to simply log the error rather than propagating it, or you may want to treat an Exception as a valid reply, by mapping it to a Message that will conform to some "error message" contract that the caller understands. To accomplish this, the Gateway provides support for a Message Channel dedicated to the errors via the *error-channel* attribute. In the example below, you can see that a *transformer* is used to create a reply `Message` from the `Exception`.

```
<int:gateway id="sampleGateway"
    default-request-channel="gatewayChannel"
    service-interface="foo.bar.SimpleGateway"
    error-channel="exceptionTransformationChannel"/>

<int:transformer input-channel="exceptionTransformationChannel"
        ref="exceptionTransformer" method="createErrorResponse"/>
```

The *exceptionTransformer* could be a simple POJO that knows how to create the expected error response objects. That would then be the payload that is sent back to the caller. Obviously, you could do many more elaborate things in such an "error flow" if necessary. It might involve routers (including Spring Integration's `ErrorMessageExceptionTypeRouter`), filters, and so on. Most of the time, a simple *transformer* should be sufficient, however.

Alternatively, you might want to only log the Exception (or send it somewhere asynchronously). If you provide a one-way flow, then nothing would be sent back to the caller. In the case that you want to completely suppress Exceptions, you can provide a reference to the global "nullChannel" (essentially a /dev/null approach). Finally, as mentioned above, if no "error-channel" is defined at all, then the Exceptions will propagate as usual.

When using the `@MessagingGateway` annotation (see the section called “@MessagingGateway Annotation”), use the `errroChannel` attribute.

Starting with *version 5.0*, when using a gateway method with a `void` return type (one-way flow), the `error-channel` reference (if provided) is populated in the standard `errorChannel` header of each message sent. This allows a downstream async flow, based on the standard `ExecutorChannel` configuration (or a `QueueChannel`), to override a default global `errorChannel` exceptions sending behavior. Previously you had to specify an `errorChannel` header manually via `@GatewayHeader` annotation or `<header>` sub-element. The `error-channel` property was ignored for `void` methods with an asynchronous flow; error messages were sent to the default `errorChannel` instead.

Important

Exposing the messaging system via simple POJI Gateways obviously provides benefits, but "hiding" the reality of the underlying messaging system does come at a price so there are certain things you should consider. We want our Java method to return as quickly as possible and not hang for an indefinite amount of time while the caller is waiting on it to return (void, return value, or a thrown Exception). When regular methods are used as a proxies in front of the Messaging system, we have to take into account the potentially asynchronous nature of the underlying messaging. This means that there might be a chance that a Message that was initiated by a Gateway could be dropped by a Filter, thus never reaching a component that is responsible for producing a reply. Some Service Activator method might result in an Exception, thus providing no reply (as we don't generate Null messages). So as you can see there are multiple scenarios where a reply message might not be coming. That is perfectly natural in messaging systems. However think about the implication on the gateway method. The Gateway's method input arguments were incorporated into a Message and sent downstream. The reply Message would be converted to a return value of the Gateway's method. So you might want to ensure that for each Gateway call there will always be a reply Message. Otherwise, your Gateway method might never return and will hang indefinitely. One of the ways of handling this situation is via an Asynchronous Gateway (explained later in this section). Another way of handling it is to explicitly set the reply-timeout attribute. That way, the gateway will not hang any longer than the time specified by the reply-timeout and will return *null* if that timeout does elapse. Finally, you might want to consider setting downstream flags such as *requires-reply* on a service-activator or *throw-exceptions-on-rejection* on a filter. These options will be discussed in more detail in the final section of this chapter.

Note

If the downstream flow returns an `ErrorMessage`, its `payload` (a `Throwable`) is treated as a regular downstream error: if there is an `error-channel` configured, it will be sent there, to the error flow; otherwise the payload is thrown to the caller of gateway. Similarly, if the error flow on the `error-channel` returns an `ErrorMessage` its payload is thrown to the caller. The same applies to any message with a `Throwable` payload. This can be useful in asynchronous situations when when you need to propagate an `Exception` directly to the caller. To do so, you can either return an `Exception` (as the `reply` from some service) or throw it. Generally, even with an asynchronous flow, the framework takes care of propagating an exception thrown by the downstream flow back to the gateway. The TCP Client-Server Multiplex sample demonstrates both techniques to return the exception to the caller. It emulates a socket IO error to the waiting thread by using an `aggregator` with `group-timeout` (see the section called "Aggregator and Group Timeout") and a `MessagingTimeoutException` reply on the discard flow.

Gateway Timeouts

There are two properties `requestTimeout` and `replyTimeout`. The request timeout only applies if the channel can block (e.g. a bounded `QueueChannel` that is full). The reply timeout is how long the gateway will wait for a reply, or return `null`; it defaults to infinity.

The timeouts can be set as defaults for all methods on the gateway (`defaultRequestTimeout`, `defaultReplyTimeout`) (or on the `MessagingGateway` interface annotation). Individual methods can override these defaults (in `<method/>` child elements) or on the `@Gateway` annotation.

Starting with *version 5.0*, the timeouts can be defined as expressions:

```
@Gateway(payloadExpression = "#args[0]", requestChannel = "someChannel",
        requestTimeoutExpression = "#args[1]", replyTimeoutExpression = "#args[2]")
String lateReply(String payload, long requestTimeout, long replyTimeout);
```

The evaluation context has a `BeanResolver` (use `@someBean` to reference other beans) and the `#args` array variable is available.

When configuring with XML, the timeout attributes can be a simple long value or a SpEL expression.

```
<method name="someMethod" request-channel="someRequestChannel"
                      payload-expression="#args[0]"
                      request-timeout="1000"
                      reply-timeout="#args[1]">
</method>
```

Asynchronous Gateway

Introduction

As a pattern, the Messaging Gateway is a very nice way to hide messaging-specific code while still exposing the full capabilities of the messaging system. As you've seen, the `GatewayProxyFactoryBean` provides a convenient way to expose a Proxy over a service-interface thus giving you POJO-based access to a messaging system (based on objects in your own domain, or primitives/Strings, etc). But when a gateway is exposed via simple POJO methods which return values it does imply that for each Request message (generated when the method is invoked) there must be a Reply message (generated when the method has returned). Since Messaging systems naturally are asynchronous you may not always be able to guarantee the contract where *"for each request there will always be be a reply"*. With Spring Integration 2.0 we introduced support for an *Asynchronous Gateway* which is a convenient way to initiate flows where you may not know if a reply is expected or how long will it take for replies to arrive.

A natural way to handle these types of scenarios in Java would be relying upon *java.util.concurrent.Future* instances, and that is exactly what Spring Integration uses to support an *Asynchronous Gateway*.

From the XML configuration, there is nothing different and you still define *Asynchronous Gateway* the same way as a regular Gateway.

```
<int:gateway id="mathService"
     service-interface="org.springframework.integration.sample.gateway.futures.MathServiceGateway"
     default-request-channel="requestChannel"/>
```

However the Gateway Interface (service-interface) is a little different:

```
public interface MathServiceGateway {

  Future<Integer> multiplyByTwo(int i);

}
```

As you can see from the example above, the return type for the gateway method is a `Future`. When `GatewayProxyFactoryBean` sees that the return type of the gateway method is a `Future`, it immediately switches to the async mode by utilizing an `AsyncTaskExecutor`. That is all. The call to such a method always returns immediately with a `Future` instance. Then, you can interact with the `Future` at your own pace to get the result, cancel, etc. And, as with any other use of Future instances, calling get() may reveal a timeout, an execution exception, and so on.

```
MathServiceGateway mathService = ac.getBean("mathService", MathServiceGateway.class);
Future<Integer> result = mathService.multiplyByTwo(number);
// do something else here since the reply might take a moment
int finalResult =  result.get(1000, TimeUnit.SECONDS);
```

For a more detailed example, please refer to the async-gateway sample distributed within the Spring Integration samples.

ListenableFuture

Starting with *version 4.1*, async gateway methods can also return `ListenableFuture` (introduced in Spring Framework 4.0). These return types allow you to provide a callback which is invoked when the result is available (or an exception occurs). When the gateway detects this return type, and the task executor (see below) is an `AsyncListenableTaskExecutor`, the executor's `submitListenable()` method is invoked.

```
ListenableFuture<String> result = this.asyncGateway.async("foo");
result.addCallback(new ListenableFutureCallback<String>() {

    @Override
    public void onSuccess(String result) {
        ...
    }

    @Override
    public void onFailure(Throwable t) {
        ...
    }
});
```

AsyncTaskExecutor

By default, the `GatewayProxyFactoryBean` uses `org.springframework.core.task.SimpleAsyncTaskExecutor` when submitting internal `AsyncInvocationTask` instances for any gateway method whose return type is `Future`. However the `async-executor` attribute in the `<gateway/>` element's configuration allows you to provide a reference to any implementation of `java.util.concurrent.Executor` available within the Spring application context.

The (default) `SimpleAsyncTaskExecutor` supports both `Future` and `ListenableFuture` return types, returning `FutureTask` or `ListenableFutureTask` respectively. Also see the section called "CompletableFuture" below. Even though there is a default executor, it is often useful to provide an external one so that you can identify its threads in logs (when using XML, the thread name is based on the executor's bean name):

```
@Bean
public AsyncTaskExecutor exec() {
    SimpleAsyncTaskExecutor simpleAsyncTaskExecutor = new SimpleAsyncTaskExecutor();
    simpleAsyncTaskExecutor.setThreadNamePrefix("exec-");
    return simpleAsyncTaskExecutor;
}

@MessagingGateway(asyncExecutor = "exec")
public interface ExecGateway {

    @Gateway(requestChannel = "gatewayChannel")
    Future<?> doAsync(String foo);

}
```

If you wish to return a different `Future` implementation, you can provide a custom executor, or disable the executor altogether and return the `Future` in the reply message payload from the downstream flow. To disable the executor, simply set it to `null` in the `GatewayProxyFactoryBean` (`setAsyncTaskExecutor(null)`). When configuring the gateway with XML, use `async-executor=""`; when configuring using the `@MessagingGateway` annotation, use:

```
@MessagingGateway(asyncExecutor = AnnotationConstants.NULL)
public interface NoExecGateway {

    @Gateway(requestChannel = "gatewayChannel")
    Future<?> doAsync(String foo);

}
```

Important

If the return type is a specific concrete `Future` implementation or some other sub-interface that is not supported by the configured executor, the flow will run on the caller's thread and the flow must return the required type in the reply message payload.

CompletableFuture

Starting with *version 4.2*, gateway methods can now return `CompletableFuture<?>`. There are several modes of operation when returning this type:

When an async executor is provided **and** the return type is exactly `CompletableFuture` (not a subclass), the framework will run the task on the executor and immediately return a `CompletableFuture` to the caller. `CompletableFuture.supplyAsync(Supplier<U> supplier, Executor executor)` is used to create the future.

When the async executor is explicitly set to `null` and the return type is `CompletableFuture` **or** the return type is a subclass of `CompletableFuture`, the flow is invoked on the caller's thread. In this scenario, it is expected that the downstream flow will return a `CompletableFuture` of the appropriate type.

Usage Scenarios

In the following scenario, the caller thread returns immediately with a `CompletableFuture<Invoice>`, which is completed when the downstream flow replies to the gateway (with an `Invoice` object).

```
CompletableFuture<Invoice> order(Order order);
```

```
<int:gateway service-interface="foo.Service" default-request-channel="orders" />
```

In the following scenario, the caller thread returns with a `CompletableFuture<Invoice>` when the downstream flow provides it as the payload of the reply to the gateway. Some other process must complete the future when the invoice is ready.

```
CompletableFuture<Invoice> order(Order order);
```

```
<int:gateway service-interface="foo.Service" default-request-channel="orders"
    async-executor="" />
```

In the following scenario, the caller thread returns with a `CompletableFuture<Invoice>` when the downstream flow provides it as the payload of the reply to the gateway. Some other process must complete the future when the invoice is ready.

```
MyCompletableFuture<Invoice> order(Order order);
```

```
<int:gateway service-interface="foo.Service" default-request-channel="orders" />
```

In this scenario, the caller thread will return with a CompletableFuture<Invoice> when the downstream flow provides it as the payload of the reply to the gateway. Some other process must complete the future when the invoice is ready. If `DEBUG` logging is enabled, a log is emitted indicating that the async executor cannot be used for this scenario.

`CompletableFuture` s can be used to perform additional manipulation on the reply, such as:

```
CompletableFuture<String> process(String data);

...

CompletableFuture result = process("foo")
    .thenApply(t -> t.toUpperCase());

...

String out = result.get(10, TimeUnit.SECONDS);
```

===== Reactor Mono

Starting with *version 5.0*, the `GatewayProxyFactoryBean` allows the use of the Project Reactor with gateway interface methods, utilizing a `Mono<T>` return type. The internal `AsyncInvocationTask` is wrapped in a `Mono.fromCallable()`.

A `Mono` can be used to retrieve the result later (similar to a `Future<?>`) or you can consume from it with the dispatcher invoking your `Consumer` when the result is returned to the gateway.

Important

The `Mono` isn't *flushed* immediately by the framework. Hence the underlying message flow won't be started before the gateway method returns (as it is with `Future<?>` `Executor` task). The flow will be started when the `Mono` is *subscribed*. Alternatively, the `Mono` (being a **Composable**) might be a part of Reactor stream, when the `subscribe()` is related to the entire `Flux`. For example:

```
@MessagingGateway
public static interface TestGateway {

 @Gateway(requestChannel = "promiseChannel")
 Mono<Integer> multiply(Integer value);

 }

     ...

 @ServiceActivator(inputChannel = "promiseChannel")
 public Integer multiply(Integer value) {
   return value * 2;
 }

  ...

    Flux.just("1", "2", "3", "4", "5")
            .map(Integer::parseInt)
            .flatMap(this.testGateway::multiply)
            .collectList()
            .subscribe(integers -> ...);
```

Another example is a simple callback scenario:

```
Mono<Invoice> mono = service.process(myOrder);

mono.subscribe(invoice -> handleInvoice(invoice));
```

The calling thread continues, with `handleInvoice()` being called when the flow completes.

==== Gateway behavior when no response arrives

As it was explained earlier, the Gateway provides a convenient way of interacting with a Messaging system via POJO method invocations, but realizing that a typical method invocation, which is generally expected to always return (even with an Exception), might not always map one-to-one to message exchanges (e.g., a reply message might not arrive - which is equivalent to a method not returning). It is important to go over several scenarios especially in the Sync Gateway case and understand the default behavior of the Gateway and how to deal with these scenarios to make the Sync Gateway behavior more predictable regardless of the outcome of the message flow that was initialed from such Gateway.

There are certain attributes that could be configured to make Sync Gateway behavior more predictable, but some of them might not always work as you might have expected. One of them is *reply-timeout* (at the method level or *default-reply-timeout* at the gateway level). So, lets look at the *reply-timeout* attribute and see how it can/can't influence the behavior of the Sync Gateway in various scenarios. We will look at single-threaded scenario (all components downstream are connected via Direct Channel) and multi-threaded scenarios (e.g., somewhere downstream you may have Pollable or Executor Channel which breaks single-thread boundary)

Long running process downstream

Sync Gateway - single-threaded. If a component downstream is still running (e.g., infinite loop or a very slow service), then setting a *reply-timeout* has no effect and the Gateway method call will not return until such downstream service exits (via return or exception). *Sync Gateway - multi-threaded*. If a component downstream is still running (e.g., infinite loop or a very slow service), in a multi-threaded message flow setting the *reply-timeout* will have an effect by allowing gateway method invocation to return once the timeout has been reached, since the `GatewayProxyFactoryBean` will simply poll on the reply channel waiting for a message until the timeout expires. However it could result in a *null* return from the Gateway method if the timeout has been reached before the actual reply was produced. It is also important to understand that the reply message (if produced) will be sent to a reply channel after the Gateway method invocation might have returned, so you must be aware of that and design your flow with this in mind.

Downstream component returns 'null'

Sync Gateway - single-threaded. If a component downstream returns *null* and no *reply-timeout* has been configured, the Gateway method call will hang indefinitely unless: a) a *reply-timeout* has been configured or b) the *requires-reply* attribute has been set on the downstream component (e.g., service-activator) that might return *null*. In this case, an Exception would be thrown and propagated to the Gateway.*Sync Gateway - multi-threaded*. Behavior is the same as above.

Downstream component return signature is void *while Gateway method signature is non-void*

Sync Gateway - single-threaded. If a component downstream returns *void* and no *reply-timeout* has been configured, the Gateway method call will hang indefinitely unless a *reply-timeout* has been configured *Sync Gateway - multi-threaded* Behavior is the same as above.

Downstream component results in Runtime Exception (regardless of the method signature)

Sync Gateway - single-threaded. If a component downstream throws a Runtime Exception, such exception will be propagated via an Error Message back to the gateway and re-thrown. *Sync Gateway - multi-threaded* Behavior is the same as above.

Important

It is also important to understand that by default *reply-timeout* is unbounded* which means that if not explicitly set there are several scenarios (described above) where your Gateway method invocation might hang indefinitely. So, make sure you analyze your flow and if there is even a remote possibility of one of these scenarios to occur, set the *reply-timeout* attribute to a *safe* value or, even better, set the *requires-reply* attribute of the downstream component to *true* to ensure a timely response as produced by the throwing of an Exception as soon as that downstream component does return null internally. But also, realize that there are some scenarios (see the very first one) where *reply-timeout* will not help. That means it is also important to analyze your message flow and decide when to use a Sync Gateway vs an Async Gateway. As you've seen the latter case is simply a matter of defining Gateway methods that return Future instances. Then, you are guaranteed to receive that return value, and you will have more granular control over the results of the invocation.Also, when dealing with a Router you should remember that setting the *resolution-required* attribute to *true* will result in an Exception thrown by the router if it can not resolve a particular channel. Likewise, when dealing with a Filter, you can set the *throw-exception-on-rejection* attribute. In both of these cases, the resulting flow will behave like that containing a service-activator with the *requires-reply* attribute. In other words, it will help to ensure a timely response from the Gateway method invocation.

Note

* *reply-timeout* is unbounded for *<gateway/>* elements (created by the GatewayProxyFactoryBean). Inbound gateways for external integration (ws, http, etc.) share many characteristics and attributes with these gateways. However, for those inbound gateways, the default *reply-timeout* is 1000 milliseconds (1 second). If a downstream async hand-off is made to another thread, you may need to increase this attribute to allow enough time for the flow to complete before the gateway times out.

> **Important**
>
> It is important to understand that the timer starts when the thread returns to the gateway, i.e. when the flow completes or a message is handed off to another thread. At that time, the calling thread starts waiting for the reply. If the flow was completely synchronous, the reply will be immediately available; for asynchronous flows, the thread will wait for up to this time.

Also see the section called “CompletableFuture” in the Java DSL chapter for options to define gateways via `IntegrationFlows`.

=== Service Activator

==== Introduction

The Service Activator is the endpoint type for connecting any Spring-managed Object to an input channel so that it may play the role of a service. If the service produces output, it may also be connected to an output channel. Alternatively, an output producing service may be located at the end of a processing pipeline or message flow in which case, the inbound Message’s "replyChannel" header can be used. This is the default behavior if no output channel is defined and, as with most of the configuration options you’ll see here, the same behavior actually applies for most of the other components we have seen.

==== Configuring Service Activator

To create a Service Activator, use the *service-activator* element with the *input-channel* and *ref* attributes:

```
<int:service-activator input-channel="exampleChannel" ref="exampleHandler"/>
```

The configuration above selects all methods from the `exampleHandler` which meet one of the Messaging requirements:

- annotated with `@ServiceActivator`;
- is `public`;
- not `void` return if `requiresReply == true`.

The target method for invocation at runtime is selected for each request message by their `payload` type. Or as a fallback to `Message<?>` type if such a method is present on target class.

Starting with *version 5.0*, one service method can be marked with the `@org.springframework.integration.annotation.Default` as a fallback for all non-matching cases. This can be useful when using the section called “Content Type Conversion” with the target method being invoked after conversion.

To delegate to an explicitly defined method of any object, simply add the "method" attribute.

```
<int:service-activator input-channel="exampleChannel" ref="somePojo" method="someMethod"/>
```

In either case, when the service method returns a non-null value, the endpoint will attempt to send the reply message to an appropriate reply channel. To determine the reply channel, it will first check if an "output-channel" was provided in the endpoint configuration:

```
<int:service-activator input-channel="exampleChannel" output-channel="replyChannel"
                       ref="somePojo" method="someMethod"/>
```

If the method returns a result and no "output-channel" is defined, the framework will then check the request Message’s `replyChannel` header value. If that value is available, it will then check its type.

If it is a `MessageChannel`, the reply message will be sent to that channel. If it is a `String`, then the endpoint will attempt to resolve the channel name to a channel instance. If the channel cannot be resolved, then a `DestinationResolutionException` will be thrown. It it can be resolved, the Message will be sent there. If the request Message doesn't have `replyChannel` header and and the `reply` object is a `Message`, its `replyChannel` header is consulted for a target destination. This is the technique used for Request Reply messaging in Spring Integration, and it is also an example of the Return Address pattern.

If your method returns a result, and you want to discard it and end the flow, you should configure the `output-channel` to send to a `NullChannel`. For convenience, the framework registers one with the name `nullChannel`. See the section called “Special Channels” for more information.

The Service Activator is one of those components that is not required to produce a reply message. If your method returns `null` or has a `void` return type, the Service Activator exits after the method invocation, without any signals. This behavior can be controlled by the `AbstractReplyProducingMessageHandler.requiresReply` option, also exposed as `requires-reply` when configuring with the XML namespace. If the flag is set to `true` and the method returns null, a `ReplyRequiredException` is thrown.

The argument in the service method could be either a Message or an arbitrary type. If the latter, then it will be assumed that it is a Message payload, which will be extracted from the message and injected into such service method. This is generally the recommended approach as it follows and promotes a POJO model when working with Spring Integration. Arguments may also have @Header or @Headers annotations as described in the section called “CompletableFuture”

Note

The service method is not required to have any arguments at all, which means you can implement event-style Service Activators, where all you care about is an invocation of the service method, not worrying about the contents of the message. Think of it as a NULL JMS message. An example use-case for such an implementation could be a simple counter/monitor of messages deposited on the input channel.

Starting with *version 4.1* the framework correct converts Message properties (`payload` and `headers`) to the Java 8 `Optional` POJO method parameters:

```
public class MyBean {
    public String computeValue(Optional<String> payload,
               @Header(value="foo", required=false) String foo1,
               @Header(value="foo") Optional<String> foo2) {
        if (payload.isPresent()) {
            String value = payload.get();
            ...
        }
        else {
           ...
       }
    }

}
```

Using a `ref` attribute is generally recommended if the custom Service Activator handler implementation can be reused in other `<service-activator>` definitions. However if the custom Service Activator handler implementation is only used within a single definition of the `<service-activator>`, you can provide an inner bean definition:

```
<int:service-activator id="exampleServiceActivator" input-channel="inChannel"
            output-channel = "outChannel" method="foo">
    <beans:bean class="org.foo.ExampleServiceActivator"/>
</int:service-activator>
```

Note

Using both the "ref" attribute and an inner handler definition in the same `<service-activator>` configuration is not allowed, as it creates an ambiguous condition and will result in an Exception being thrown.

Important

If the "ref" attribute references a bean that extends `AbstractMessageProducingHandler` (such as handlers provided by the framework itself), the configuration is optimized by injecting the output channel into the handler directly. In this case, each "ref" must be to a separate bean instance (or a `prototype`-scoped bean), or use the inner `<bean/>` configuration type. If you inadvertently reference the same message handler from multiple beans, you will get a configuration exception.

Service Activators and the Spring Expression Language (SpEL)

Since Spring Integration 2.0, Service Activators can also benefit from SpEL (https://docs.spring.io/spring/docs/3.0.x/spring-framework-reference/html/expressions.html).

For example, you may now invoke any bean method without pointing to the bean via a `ref` attribute or including it as an inner bean definition. For example:

```
<int:service-activator input-channel="in" output-channel="out"
 expression="@accountService.processAccount(payload, headers.accountId)"/>

 <bean id="accountService" class="foo.bar.Account"/>
```

In the above configuration instead of injecting *accountService* using a `ref` or as an inner bean, we are simply using SpEL's `@beanId` notation and invoking a method which takes a type compatible with Message payload. We are also passing a header value. As you can see, any valid SpEL expression can be evaluated against any content in the Message. For simple scenarios your *Service Activators* do not even have to reference a bean if all logic can be encapsulated by such an expression.

```
<int:service-activator input-channel="in" output-channel="out" expression="payload * 2"/>
```

In the above configuration our service logic is to simply multiply the payload value by 2, and SpEL lets us handle it relatively easy.

See the section called "CompletableFuture" in Java DSL chapter for more information about configuring Service Activator.

==== Asynchronous Service Activator

The service activator is invoked by the calling thread; this would be some upstream thread if the input channel is a `SubscribableChannel`, or a poller thread for a `PollableChannel`. If the service returns a `ListenableFuture<?>` the default action is to send that as the payload of the message sent to the output (or reply) channel. Starting with *version 4.3*, you can now set the `async` attribute to true (`setAsync(true)` when using Java configuration). If the service returns a `ListenableFuture<?`

> when this is true, the calling thread is released immediately, and the reply message is sent on the thread (from within your service) that completes the future. This is particularly advantageous for long-running services using a `PollableChannel` because the poller thread is freed up to perform other services within the framework.

If the service completes the future with an `Exception`, normal error processing will occur - an `ErrorMessage` is sent to the `errorChannel` message header, if present or otherwise to the default `errorChannel` (if available).

=== Delayer

==== Introduction

A Delayer is a simple endpoint that allows a Message flow to be delayed by a certain interval. When a Message is delayed, the original sender will not block. Instead, the delayed Messages will be scheduled with an instance of `org.springframework.scheduling.TaskScheduler` to be sent to the output channel after the delay has passed. This approach is scalable even for rather long delays, since it does not result in a large number of blocked sender Threads. On the contrary, in the typical case a thread pool will be used for the actual execution of releasing the Messages. Below you will find several examples of configuring a Delayer.

==== Configuring a Delayer

The `<delayer>` element is used to delay the Message flow between two Message Channels. As with the other endpoints, you can provide the *input-channel* and *output-channel* attributes, but the delayer also has *default-delay* and *expression* attributes (and *expression* sub-element) that are used to determine the number of milliseconds that each Message should be delayed. The following delays all messages by 3 seconds:

```
<int:delayer id="delayer" input-channel="input"
             default-delay="3000" output-channel="output"/>
```

If you need per-Message determination of the delay, then you can also provide the SpEL expression using the *expression* attribute:

```
<int:delayer id="delayer" input-channel="input" output-channel="output"
             default-delay="3000" expression="headers['delay']"/>
```

In the example above, the 3 second delay would only apply when the expression evaluates to *null* for a given inbound Message. If you only want to apply a delay to Messages that have a valid result of the expression evaluation, then you can use a *default-delay* of 0 (the default). For any Message that has a delay of 0 (or less), the Message will be sent immediately, on the calling Thread.

The java configuration equivalent of the second example is:

```
@ServiceActivator(inputChannel = "input")
@Bean
public DelayHandler delayer() {
    DelayHandler handler = new DelayHandler("delayer.messageGroupId");
    handler.setDefaultDelay(3_000L);
    handler.setDelayExpressionString("headers['delay']");
    handler.setOutputChannelName("output");
    return handler;
}
```

and with the Java DSL:

```
@Bean
public IntegrationFlow flow() {
    return IntegrationFlows.from("input")
            .delay("delayer.messageGroupId", d -> d
                    .defaultDelay(3_000L)
                    .delayExpression("headers['delay']"))
            .channel("output")
            .get();
}
```

Note

The XML parser uses a message group id `<beanName>.messageGroupId`.

Tip

The delay handler supports expression evaluation results that represent an interval in milliseconds (any Object whose `toString()` method produces a value that can be parsed into a Long) as well as `java.util.Date` instances representing an absolute time. In the first case, the milliseconds will be counted from the current time (e.g. a value of 5000 would delay the Message for at least 5 seconds from the time it is received by the Delayer). With a Date instance, the Message will not be released until the time represented by that Date object. In either case, a value that equates to a non-positive delay, or a Date in the past, will not result in any delay. Instead, it will be sent directly to the output channel on the original sender's Thread. If the expression evaluation result is not a Date, and can not be parsed as a Long, the default delay (if any) will be applied.

Important

The expression evaluation may throw an evaluation Exception for various reasons, including an invalid expression, or other conditions. By default, such exceptions are ignored (logged at DEBUG level) and the delayer falls back to the default delay (if any). You can modify this behavior by setting the `ignore-expression-failures` attribute. By default this attribute is set to `true` and the Delayer behavior is as described above. However, if you wish to not ignore expression evaluation exceptions, and throw them to the delayer's caller, set the `ignore-expression-failures` attribute to `false`.

Tip

Notice in the example above that the delay expression is specified as `headers['delay']`. This is the SpEL `Indexer` syntax to access a `Map` element (`MessageHeaders` implements `Map`), it invokes: `headers.get("delay")`. For simple map element names (that do not contain .) you can also use the SpEL *dot accessor* syntax, where the above header expression can be specified as `headers.delay`. But, different results are achieved if the header is missing. In the first case, the expression will evaluate to `null`; the second will result in something like:

```
org.springframework.expression.spel.SpelEvaluationException: EL1008E:(pos 8):
    Field or property 'delay' cannot be found on object of
type 'org.springframework.messaging.MessageHeaders'
```

So, if there is a possibility of the header being omitted, and you want to fall back to the default delay, it is generally more efficient (and recommended) to use the *Indexer* syntax instead of *dot property accessor* syntax, because detecting the null is faster than catching an exception.

The delayer delegates to an instance of Spring's `TaskScheduler` abstraction. The default scheduler used by the delayer is the `ThreadPoolTaskScheduler` instance provided by Spring Integration on startup: the section called "CompletableFuture". If you want to delegate to a different scheduler, you can provide a reference through the delayer element's *scheduler* attribute:

```
<int:delayer id="delayer" input-channel="input" output-channel="output"
    expression="headers.delay"
    scheduler="exampleTaskScheduler"/>

<task:scheduler id="exampleTaskScheduler" pool-size="3"/>
```

Tip

If you configure an external `ThreadPoolTaskScheduler` you can set on this scheduler property `waitForTasksToCompleteOnShutdown = true`. It allows successful completion of *delay* tasks, which already in the execution state (releasing the Message), when the application is shutdown. Before Spring Integration 2.2 this property was available on the `<delayer>` element, because `DelayHandler` could create its own scheduler on the background. Since 2.2 delayer requires an external scheduler instance and `waitForTasksToCompleteOnShutdown` was deleted; you should use the scheduler's own configuration.

Tip

Also keep in mind `ThreadPoolTaskScheduler` has a property `errorHandler` which can be injected with some implementation of `org.springframework.util.ErrorHandler`. This handler allows to process an `Exception` from the thread of the scheduled task sending the delayed message. By default it uses an `org.springframework.scheduling.support.TaskUtils$LoggingErrorHandler` and you will see a stack trace in the logs. You might want to consider using an `org.springframework.integration.channel.MessagePublishingErrorHandler`, which sends an `ErrorMessage` into an `error-channel`, either from the failed Message's header or into the default `error-channel`. This error handling is performed after a transaction rolls back (if present). See the section called "CompletableFuture".

==== Delayer and a Message Store

The `DelayHandler` persists delayed Messages into the Message Group in the provided `MessageStore`. (The *groupId* is based on required *id* attribute of `<delayer>` element.) A delayed message is removed from the `MessageStore` by the scheduled task just before the `DelayHandler` sends the Message to the `output-channel`. If the provided `MessageStore` is persistent (e.g. `JdbcMessageStore`) it provides the ability to not lose Messages on the application shutdown. After application startup, the `DelayHandler` reads Messages from its Message Group in the `MessageStore` and reschedules them with a delay based on the original arrival time of the Message (if the delay is numeric). For messages where the delay header was a `Date`, that is used when rescheduling. If a delayed Message remained in the `MessageStore` more than its *delay*, it will be sent immediately after startup.

The `<delayer>` can be enriched with mutually exclusive sub-elements `<transactional>` or `<advice-chain>`. The List of these AOP Advices is applied to the proxied internal `DelayHandler.ReleaseMessageHandler`, which has the responsibility to release the Message, after the delay, on a `Thread` of the scheduled task. It might be used, for example, when the downstream message flow throws an Exception and the `ReleaseMessageHandler`'s transaction will be rolled back. In this case the delayed Message will remain in the persistent `MessageStore`. You can use any custom `org.aopalliance.aop.Advice` implementation within the `<advice-chain>`. A sample configuration of the `<delayer>` may look like this:

```
<int:delayer id="delayer" input-channel="input" output-channel="output"
    expression="headers.delay"
    message-store="jdbcMessageStore">
    <int:advice-chain>
        <beans:ref bean="customAdviceBean"/>
        <tx:advice>
            <tx:attributes>
                <tx:method name="*" read-only="true"/>
            </tx:attributes>
        </tx:advice>
    </int:advice-chain>
</int:delayer>
```

The `DelayHandler` can be exported as a JMX `MBean` with managed operations (`getDelayedMessageCount` and `reschedulePersistedMessages`), which allows the rescheduling of delayed persisted messages at runtime — for example, if the `TaskScheduler` has previously been stopped. These operations can be invoked through a `Control Bus` command, as the following example shows:

```
Message<String> delayerReschedulingMessage =
    MessageBuilder.withPayload("@'delayer.handler'.reschedulePersistedMessages()").build();
    controlBusChannel.send(delayerReschedulingMessage);
```

Note

For more information regarding the message store, JMX, and the control bus, see the section called “CompletableFuture”.

==== Release Failures

Starting with version 5.0.8, there are two new properties on the delayer:

- `maxAttempts` (default 5)
- `retryDelay` (default 1 second)

When a message is released, if the downstream flow fails, the release will be attempted after the `retryDelay`. If the `maxAttempts` is reached, the message is discarded (unless the release is transactional, in which case the message will remain in the store, but will no longer be scheduled for release, until the application is restarted, or the `reschedulePersistedMessages()` method is invoked, as discussed above).

In addition, you can configure a `delayedMessageErrorChannel`; when a release fails, an `ErrorMessage` is sent to that channel with the exception as the payload and has the `originalMessage` property. The `ErrorMessage` contains a header `IntegrationMessageHeaderAccessor`.DELIVERY_ATTEMPT containing the current count.

If the error flow consumes the error message and exits normally, no further action is taken; if the release is transactional, the transaction will commit and the message deleted from the store. If the error flow throws an exception, the release will be retried up to `maxAttempts` as discussed above.

=== Scripting support

With Spring Integration 2.1 we've added support for the JSR223 Scripting for Java specification, introduced in Java version 6. This allows you to use scripts written in any supported language including Ruby/JRuby, Javascript and Groovy to provide the logic for various integration components similar to the way the Spring Expression Language (SpEL) is used in Spring Integration. For more information about JSR223 please refer to the documentation

Important

Note that this feature requires Java 6 or higher. Sun developed a JSR223 reference implementation which works with Java 5 but it is not officially supported and we have not tested it with Spring Integration.

In order to use a JVM scripting language, a JSR223 implementation for that language must be included in your class path. Java 6 natively supports Javascript. The Groovy and JRuby projects provide JSR233 support in their standard distribution. Other language implementations may be available or under development. Please refer to the appropriate project website for more information.

Important

Various JSR223 language implementations have been developed by third parties. A particular implementation's compatibility with Spring Integration depends on how well it conforms to the specification and/or the implementer's interpretation of the specification.

Tip

If you plan to use Groovy as your scripting language, we recommended you use Spring-Integration's Groovy Support as it offers additional features specific to Groovy. *However you will find this section relevant as well*.

==== Script configuration

Depending on the complexity of your integration requirements scripts may be provided inline as CDATA in XML configuration or as a reference to a Spring resource containing the script. To enable scripting support Spring Integration defines a `ScriptExecutingMessageProcessor` which will bind the Message Payload to a variable named `payload` and the Message Headers to a `headers` variable, both accessible within the script execution context. All that is left for you to do is write a script that uses these variables. Below are a couple of sample configurations:

Filter

```
<int:filter input-channel="referencedScriptInput">
   <int-script:script lang="ruby" location="some/path/to/ruby/script/RubyFilterTests.rb"/>
</int:filter>

<int:filter input-channel="inlineScriptInput">
     <int-script:script lang="groovy">
     <![CDATA[
     return payload == 'good'
   ]]>
  </int-script:script>
</int:filter>
```

Here, you see that the script can be included inline or can reference a resource location via the `location` attribute. Additionally the `lang` attribute corresponds to the language name (or JSR223 alias)

Other Spring Integration endpoint elements which support scripting include *router*, *service-activator*, *transformer*, and *splitter*. The scripting configuration in each case would be identical to the above (besides the endpoint element).

Another useful feature of Scripting support is the ability to update (reload) scripts without having to restart the Application Context. To accomplish this, specify the `refresh-check-delay` attribute on the *script* element:

```
<int-script:script location="..." refresh-check-delay="5000"/>
```

In the above example, the script location will be checked for updates every 5 seconds. If the script is updated, any invocation that occurs later than 5 seconds since the update will result in execution of the new script.

```
<int-script:script location="..." refresh-check-delay="0"/>
```

In the above example the context will be updated with any script modifications as soon as such modification occurs, providing a simple mechanism for *real-time* configuration. Any negative number value means the script will not be reloaded after initialization of the application context. This is the default behavior.

Important

Inline scripts can not be reloaded.

```
<int-script:script location="..." refresh-check-delay="-1"/>
```

Script variable bindings

Variable bindings are required to enable the script to reference variables externally provided to the script's execution context. As we have seen, `payload` and `headers` are used as binding variables by default. You can bind additional variables to a script via `<variable>` sub-elements:

```
<script:script lang="js" location="foo/bar/MyScript.js">
    <script:variable name="foo" value="foo"/>
    <script:variable name="bar" value="bar"/>
    <script:variable name="date" ref="date"/>
</script:script>
```

As shown in the above example, you can bind a script variable either to a scalar value or a Spring bean reference. Note that `payload` and `headers` will still be included as binding variables.

With *Spring Integration 3.0*, in addition to the `variable` sub-element, the `variables` attribute has been introduced. This attribute and `variable` sub-elements aren't mutually exclusive and you can combine them within one `script` component. However variables must be unique, regardless of where they are defined. Also, since *Spring Integration 3.0*, variable bindings are allowed for inline scripts too:

```
<service-activator input-channel="input">
    <script:script lang="ruby" variables="foo=FOO, date-ref=dateBean">
        <script:variable name="bar" ref="barBean"/>
        <script:variable name="baz" value="bar"/>
        <![CDATA[
            payload.foo = foo
            payload.date = date
            payload.bar = bar
            payload.baz = baz
            payload
        ]]>
    </script:script>
</service-activator>
```

The example above shows a combination of an inline script, a `variable` sub-element and a `variables` attribute. The `variables` attribute is a comma-separated value, where each segment contains an = separated pair of the variable and its value. The variable name can be suffixed with `-ref`, as in the `date-ref` variable above. That means that the binding variable will have the name `date`, but the value will be a reference to the `dateBean` bean from the application context. This may be useful when using *Property Placeholder Configuration* or command line arguments.

If you need more control over how variables are generated, you can implement your own Java class using the `ScriptVariableGenerator` strategy:

```
public interface ScriptVariableGenerator {

    Map<String, Object> generateScriptVariables(Message<?> message);

}
```

This interface requires you to implement the method `generateScriptVariables(Message)`. The Message argument allows you to access any data available in the Message payload and headers and the return value is the Map of bound variables. This method will be called every time the script is executed for a Message. All you need to do is provide an implementation of `ScriptVariableGenerator` and reference it with the `script-variable-generator` attribute:

```
<int-script:script location="foo/bar/MyScript.groovy"
        script-variable-generator="variableGenerator"/>

<bean id="variableGenerator" class="foo.bar.MyScriptVariableGenerator"/>
```

If a `script-variable-generator` is not provided, script components use `DefaultScriptVariableGenerator`, which merges any provided <`variable`> s with *payload* and *headers* variables from the `Message` in its `generateScriptVariables(Message)` method.

Important

You cannot provide both the `script-variable-generator` attribute and <`variable`> sub-element(s) as they are mutually exclusive.

=== Groovy support

In Spring Integration 2.0 we added Groovy support allowing you to use the Groovy scripting language to provide the logic for various integration components similar to the way the Spring Expression Language (SpEL) is supported for routing, transformation and other integration concerns. For more information about Groovy please refer to the Groovy documentation which you can find on the project website.

==== Groovy configuration

With Spring Integration 2.1, Groovy Support's configuration namespace is an extension of Spring Integration's Scripting Support and shares the core configuration and behavior described in detail in the Scripting Support section. Even though Groovy scripts are well supported by generic Scripting Support, Groovy Support provides the *Groovy* configuration namespace which is backed by the Spring Framework's `org.springframework.scripting.groovy.GroovyScriptFactory` and related components, offering extended capabilities for using Groovy. Below are a couple of sample configurations:

Filter

```
<int:filter input-channel="referencedScriptInput">
   <int-groovy:script location="some/path/to/groovy/file/GroovyFilterTests.groovy"/>
</int:filter>

<int:filter input-channel="inlineScriptInput">
     <int-groovy:script><![CDATA[
     return payload == 'good'
   ]]></int-groovy:script>
</int:filter>
```

As the above examples show, the configuration looks identical to the general Scripting Support configuration. The only difference is the use of the Groovy namespace as indicated in the examples by the *int-groovy* namespace prefix. Also note that the `lang` attribute on the `<script>` tag is not valid in this namespace.

Groovy object customization

If you need to customize the Groovy object itself, beyond setting variables, you can reference a bean that implements `GroovyObjectCustomizer` via the `customizer` attribute. For example, this might be useful if you want to implement a domain-specific language (DSL) by modifying the `MetaClass` and registering functions to be available within the script:

```
<int:service-activator input-channel="groovyChannel">
    <int-groovy:script location="foo/SomeScript.groovy" customizer="groovyCustomizer"/>
</int:service-activator>

<beans:bean id="groovyCustomizer" class="org.foo.MyGroovyObjectCustomizer"/>
```

Setting a custom `GroovyObjectCustomizer` is not mutually exclusive with `<variable>` sub-elements or the `script-variable-generator` attribute. It can also be provided when defining an inline script.

With *Spring Integration 3.0*, in addition to the `variable` sub-element, the `variables` attribute has been introduced. Also, groovy scripts have the ability to resolve a variable to a bean in the `BeanFactory`, if a binding variable was not provided with the name:

```
<int-groovy:script>
    <![CDATA[
        entityManager.persist(payload)
        payload
    ]]>
</int-groovy:script>
```

where variable `entityManager` is an appropriate bean in the application context.

For more information regarding `<variable>`, `variables`, and `script-variable-generator`, see the paragraph Script variable bindings of the section called “CompletableFuture”.

Groovy Script Compiler Customization

The `@CompileStatic` hint is the most popular Groovy compiler customization option, which can be used on the class or method level. See more information in the Groovy Reference Manual and, specifically, @CompileStatic. To utilize this feature for short scripts (in integration scenarios), we are forced to change a simple script like this (a `<filter>` script):

```
headers.type == 'good'
```

to more Java-like code:

```
@groovy.transform.CompileStatic
String filter(Map headers) {
 headers.type == 'good'
}

filter(headers)
```

With that, the `filter()` method will be transformed and compiled to static Java code, bypassing the Groovy dynamic phases of invocation, like `getProperty()` factories and `CallSite` proxies.

Starting with *version 4.3*, Spring Integration Groovy components can be configured with the `compile-static` `boolean` option, specifying that `ASTTransformationCustomizer` for `@CompileStatic` should be added to the internal `CompilerConfiguration`. With that in place, we can omit the method declaration with `@CompileStatic` in our script code and still get compiled plain Java code. In this case our script can still be short but still needs to be a little more verbose than interpreted script:

```
binding.variables.headers.type == 'good'
```

Where we can access the `headers` and `payload` (or any other) variables only through the `groovy.lang.Script` `binding` property since, with `@CompileStatic`, we don't have the dynamic `GroovyObject.getProperty()` capability.

In addition, the `compiler-configuration` bean reference has been introduced. With this attribute, you can provide any other required Groovy compiler customizations, e.g. `ImportCustomizer`. For more information about this feature, please, refer to the Groovy Documentation: Advanced compiler configuration.

Note

Using `compilerConfiguration` does not automatically add a `ASTTransformationCustomizer` for `@CompileStatic` and overrides the `compileStatic` option. If `CompileStatic` is still requirement, a new `ASTTransformationCustomizer(CompileStatic.class)` should be manually added into the `CompilationCustomizers` of that custom `compilerConfiguration`.

Note

The Groovy compiler customization does not have any effect to the `refresh-check-delay` option and reloadable scripts can be statically compiled, too.

==== Control Bus

As described in (EIP), the idea behind the Control Bus is that the same messaging system can be used for monitoring and managing the components within the framework as is used for "application-level" messaging. In Spring Integration we build upon the adapters described above so that it's possible to send Messages as a means of invoking exposed operations. One option for those operations is Groovy scripts.

```
<int-groovy:control-bus input-channel="operationChannel"/>
```

The Control Bus has an input channel that can be accessed for invoking operations on the beans in the application context.

The Groovy Control Bus executes messages on the input channel as Groovy scripts. It takes a message, compiles the body to a Script, customizes it with a `GroovyObjectCustomizer`, and then executes it. The Control Bus' `MessageProcessor` exposes all beans in the application context that are annotated with `@ManagedResource`, implement Spring's `Lifecycle` interface or extend Spring's `CustomizableThreadCreator` base class (e.g. several of the `TaskExecutor` and `TaskScheduler` implementations).

> **Important**
>
> Be careful about using managed beans with custom scopes (e.g. *request*) in the Control Bus' command scripts, especially inside an *async* message flow. If The Control Bus' `MessageProcessor` can't expose a bean from the application context, you may end up with some `BeansException` during *command script's* executing. For example, if a custom scope's context is not established, the attempt to get a bean within that scope will trigger a `BeanCreationException`.

If you need to further customize the Groovy objects, you can also provide a reference to a bean that implements `GroovyObjectCustomizer` via the `customizer` attribute.

```
<int-groovy:control-bus input-channel="input"
        output-channel="output"
        customizer="groovyCustomizer"/>

<beans:bean id="groovyCustomizer" class="org.foo.MyGroovyObjectCustomizer"/>
```

=== Adding Behavior to Endpoints

==== Introduction

Prior to Spring Integration *2.2*, you could add behavior to an entire Integration flow by adding an AOP Advice to a poller's `<advice-chain/>` element. However, let's say you want to retry, say, just a REST Web Service call, and not any downstream endpoints.

For example, consider the following flow:

inbound-adapter#poller#http-gateway1#http-gateway2#jdbc-outbound-adapter

If you configure some retry-logic into an advice chain on the poller, and, the call to *http-gateway2* failed because of a network glitch, the retry would cause both *http-gateway1* and *http-gateway2* to be called a second time. Similarly, after a transient failure in the *jdbc-outbound-adapter*, both http-gateways would be called a second time before again calling the *jdbc-outbound-adapter*.

Spring Integration 2.2 adds the ability to add behavior to individual endpoints. This is achieved by the addition of the `<request-handler-advice-chain/>` element to many endpoints. For example:

```
<int-http:outbound-gateway id="withAdvice"
    url-expression="'http://localhost/test1'"
    request-channel="requests"
    reply-channel="nextChannel">
    <int:request-handler-advice-chain>
        <ref bean="myRetryAdvice" />
    </request-handler-advice-chain>
</int-http:outbound-gateway>
```

In this case, *myRetryAdvice* will only be applied locally to this gateway and will not apply to further actions taken downstream after the reply is sent to the *nextChannel*. The scope of the advice is limited to the endpoint itself.

> **Important**
>
> At this time, you cannot advise an entire `<chain/>` of endpoints. The schema does not allow a `<request-handler-advice-chain/>` as a child element of the chain itself.
>
> However, a `<request-handler-advice-chain/>` can be added to individual reply-producing endpoints *within* a `<chain/>` element. An exception is that, in a chain that produces no reply, because the last element in the chain is an *outbound-channel-adapter*, that *last* element cannot be advised. If you need to advise such an element, it must be moved outside of the chain (with the *output-channel* of the chain being the *input-channel* of the adapter. The adapter can then be advised as normal. For chains that produce a reply, every child element can be advised.

==== Provided Advice Classes

In addition to providing the general mechanism to apply AOP Advice classes in this way, three standard Advices are provided:

- `RequestHandlerRetryAdvice`
- `RequestHandlerCircuitBreakerAdvice`
- `ExpressionEvaluatingRequestHandlerAdvice`

These are each described in detail in the following sections.

===== Retry Advice

The retry advice (`o.s.i.handler.advice.RequestHandlerRetryAdvice`) leverages the rich retry mechanisms provided by the Spring Retry project. The core component of `spring-retry` is the `RetryTemplate`, which allows configuration of sophisticated retry scenarios, including `RetryPolicy` and `BackoffPolicy` strategies, with a number of implementations, as well as a `RecoveryCallback` strategy to determine the action to take when retries are exhausted.

Stateless Retry

Stateless retry is the case where the retry activity is handled entirely within the advice, where the thread pauses (if so configured) and retries the action.

Stateful Retry

Stateful retry is the case where the retry state is managed within the advice, but where an exception is thrown and the caller resubmits the request. An example for stateful retry is when we want the message originator (e.g. JMS) to be responsible for resubmitting, rather than performing it on the current thread. Stateful retry needs some mechanism to detect a retried submission.

Further Information

For more information on `spring-retry`, refer to the project's javadocs, as well as the reference documentation for Spring Batch, where `spring-retry` originated.

> **Warning**
>
> The default back off behavior is no back off - retries are attempted immediately. Using a back off policy that causes threads to pause between attempts may cause performance issues, including excessive memory use and thread starvation. In high volume environments, back off policies should be used with caution.

====== Configuring the Retry Advice

The following examples use a simple `<service-activator/>` that always throws an exception:

```
public class FailingService {

    public void service(String message) {
        throw new RuntimeException("foo");
    }
}
```

Simple Stateless Retry

This example uses the default `RetryTemplate` which has a `SimpleRetryPolicy` which tries 3 times. There is no `BackOffPolicy` so the 3 attempts are made back-to-back-to-back with no delay between attempts. There is no `RecoveryCallback` so, the result is to throw the exception to the caller after the final failed retry occurs. In a *Spring Integration* environment, this final exception might be handled using an `error-channel` on the inbound endpoint.

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean class="o.s.i.handler.advice.RequestHandlerRetryAdvice"/>
    </request-handler-advice-chain>
</int:service-activator>

DEBUG [task-scheduler-2]preSend on channel 'input', message: [Payload=...]
DEBUG [task-scheduler-2]Retry: count=0
DEBUG [task-scheduler-2]Checking for rethrow: count=1
DEBUG [task-scheduler-2]Retry: count=1
DEBUG [task-scheduler-2]Checking for rethrow: count=2
DEBUG [task-scheduler-2]Retry: count=2
DEBUG [task-scheduler-2]Checking for rethrow: count=3
DEBUG [task-scheduler-2]Retry failed last attempt: count=3
```

Simple Stateless Retry with Recovery

This example adds a `RecoveryCallback` to the above example; it uses a `ErrorMessageSendingRecoverer` to send an `ErrorMessage` to a channel.

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean class="o.s.i.handler.advice.RequestHandlerRetryAdvice">
            <property name="recoveryCallback">
                <bean class="o.s.i.handler.advice.ErrorMessageSendingRecoverer">
                    <constructor-arg ref="myErrorChannel" />
                </bean>
            </property>
        </bean>
    </request-handler-advice-chain>
</int:int:service-activator>

DEBUG [task-scheduler-2]preSend on channel 'input', message: [Payload=...]
DEBUG [task-scheduler-2]Retry: count=0
DEBUG [task-scheduler-2]Checking for rethrow: count=1
DEBUG [task-scheduler-2]Retry: count=1
DEBUG [task-scheduler-2]Checking for rethrow: count=2
DEBUG [task-scheduler-2]Retry: count=2
DEBUG [task-scheduler-2]Checking for rethrow: count=3
DEBUG [task-scheduler-2]Retry failed last attempt: count=3
DEBUG [task-scheduler-2]Sending ErrorMessage :failedMessage:[Payload=...]
```

Stateless Retry with Customized Policies, and Recovery

For more sophistication, we can provide the advice with a customized `RetryTemplate`. This example continues to use the `SimpleRetryPolicy` but it increases the attempts to 4. It also adds an `ExponentialBackoffPolicy` where the first retry waits 1 second, the second waits 5 seconds and the third waits 25 (for 4 attempts in all).

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean class="o.s.i.handler.advice.RequestHandlerRetryAdvice">
            <property name="recoveryCallback">
                <bean class="o.s.i.handler.advice.ErrorMessageSendingRecoverer">
                    <constructor-arg ref="myErrorChannel" />
                </bean>
            </property>
            <property name="retryTemplate" ref="retryTemplate" />
        </bean>
    </request-handler-advice-chain>
</int:service-activator>

<bean id="retryTemplate" class="org.springframework.retry.support.RetryTemplate">
    <property name="retryPolicy">
        <bean class="org.springframework.retry.policy.SimpleRetryPolicy">
            <property name="maxAttempts" value="4" />
        </bean>
    </property>
    <property name="backOffPolicy">
        <bean class="org.springframework.retry.backoff.ExponentialBackOffPolicy">
            <property name="initialInterval" value="1000" />
            <property name="multiplier" value="5.0" />
            <property name="maxInterval" value="60000" />
        </bean>
    </property>
</bean>

27.058 DEBUG [task-scheduler-1]preSend on channel 'input', message: [Payload=...]
27.071 DEBUG [task-scheduler-1]Retry: count=0
27.080 DEBUG [task-scheduler-1]Sleeping for 1000
28.081 DEBUG [task-scheduler-1]Checking for rethrow: count=1
28.081 DEBUG [task-scheduler-1]Retry: count=1
28.081 DEBUG [task-scheduler-1]Sleeping for 5000
33.082 DEBUG [task-scheduler-1]Checking for rethrow: count=2
33.082 DEBUG [task-scheduler-1]Retry: count=2
33.083 DEBUG [task-scheduler-1]Sleeping for 25000
58.083 DEBUG [task-scheduler-1]Checking for rethrow: count=3
58.083 DEBUG [task-scheduler-1]Retry: count=3
58.084 DEBUG [task-scheduler-1]Checking for rethrow: count=4
58.084 DEBUG [task-scheduler-1]Retry failed last attempt: count=4
58.086 DEBUG [task-scheduler-1]Sending ErrorMessage :failedMessage:[Payload=...]
```

Namespace Support for Stateless Retry

Starting with *version 4.0*, the above configuration can be greatly simplified with the namespace support for the retry advice:

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean ref="retrier" />
    </request-handler-advice-chain>
</int:service-activator>

<int:handler-retry-advice id="retrier" max-attempts="4" recovery-channel="myErrorChannel">
    <int:exponential-back-off initial="1000" multiplier="5.0" maximum="60000" />
</int:handler-retry-advice>
```

In this example, the advice is defined as a top level bean so it can be used in multiple `request-handler-advice-chain` s. You can also define the advice directly within the chain:

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <int:retry-advice id="retrier" max-attempts="4" recovery-channel="myErrorChannel">
            <int:exponential-back-off initial="1000" multiplier="5.0" maximum="60000" />
        </int:retry-advice>
    </request-handler-advice-chain>
</int:service-activator>
```

A `<handler-retry-advice/>` with no child element uses no back off; it can have a `fixed-back-off` or `exponential-back-off` child element. If there is no `recovery-channel`, the exception is thrown when retries are exhausted. The namespace can only be used with stateless retry.

For more complex environments (custom policies etc), use normal `<bean/>` definitions.

Simple Stateful Retry with Recovery

To make retry stateful, we need to provide the Advice with a RetryStateGenerator implementation. This class is used to identify a message as being a resubmission so that the `RetryTemplate` can determine the current state of retry for this message. The framework provides a `SpelExpressionRetryStateGenerator` which determines the message identifier using a SpEL expression. This is shown below; this example again uses the default policies (3 attempts with no back off); of course, as with stateless retry, these policies can be customized.

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean class="o.s.i.handler.advice.RequestHandlerRetryAdvice">
            <property name="retryStateGenerator">
                <bean class="o.s.i.handler.advice.SpelExpressionRetryStateGenerator">
                    <constructor-arg value="headers['jms_messageId']" />
                </bean>
            </property>
            <property name="recoveryCallback">
                <bean class="o.s.i.handler.advice.ErrorMessageSendingRecoverer">
                    <constructor-arg ref="myErrorChannel" />
                </bean>
            </property>
        </bean>
    </int:request-handler-advice-chain>
</int:service-activator>

24.351 DEBUG [Container#0-1]preSend on channel 'input', message: [Payload=...]
24.368 DEBUG [Container#0-1]Retry: count=0
24.387 DEBUG [Container#0-1]Checking for rethrow: count=1
24.387 DEBUG [Container#0-1]Rethrow in retry for policy: count=1
24.387 WARN  [Container#0-1]failure occurred in gateway sendAndReceive
org.springframework.integration.MessagingException: Failed to invoke handler
...
Caused by: java.lang.RuntimeException: foo
...
24.391 DEBUG [Container#0-1]Initiating transaction rollback on application exception
...
25.412 DEBUG [Container#0-1]preSend on channel 'input', message: [Payload=...]
25.412 DEBUG [Container#0-1]Retry: count=1
25.413 DEBUG [Container#0-1]Checking for rethrow: count=2
25.413 DEBUG [Container#0-1]Rethrow in retry for policy: count=2
25.413 WARN  [Container#0-1]failure occurred in gateway sendAndReceive
org.springframework.integration.MessagingException: Failed to invoke handler
...
Caused by: java.lang.RuntimeException: foo
...
25.414 DEBUG [Container#0-1]Initiating transaction rollback on application exception
...
26.418 DEBUG [Container#0-1]preSend on channel 'input', message: [Payload=...]
26.418 DEBUG [Container#0-1]Retry: count=2
26.419 DEBUG [Container#0-1]Checking for rethrow: count=3
26.419 DEBUG [Container#0-1]Rethrow in retry for policy: count=3
26.419 WARN  [Container#0-1]failure occurred in gateway sendAndReceive
org.springframework.integration.MessagingException: Failed to invoke handler
...
Caused by: java.lang.RuntimeException: foo
...
26.420 DEBUG [Container#0-1]Initiating transaction rollback on application exception
...
27.425 DEBUG [Container#0-1]preSend on channel 'input', message: [Payload=...]
27.426 DEBUG [Container#0-1]Retry failed last attempt: count=3
27.426 DEBUG [Container#0-1]Sending ErrorMessage :failedMessage:[Payload=...]
```

Comparing with the stateless examples, you can see that with stateful retry, the exception is thrown to the caller on each failure.

Exception Classification for Retry

Spring Retry has a great deal of flexibility for determining which exceptions can invoke retry. The default configuration will retry for all exceptions and the exception classifier just looks at the top level exception. If you configure it to, say, only retry on `BarException` and your application throws a `FooException` where the cause is a `BarException`, retry will not occur.

Since *Spring Retry 1.0.3*, the `BinaryExceptionClassifier` has a property `traverseCauses` (default `false`). When `true` it will traverse exception causes until it finds a match or there is no cause.

To use this classifier for retry, use a `SimpleRetryPolicy` created with the constructor that takes the max attempts, the `Map` of `Exception` s and the boolean (traverseCauses), and inject this policy into the `RetryTemplate`.

===== Circuit Breaker Advice

The general idea of the Circuit Breaker Pattern is that, if a service is not currently available, then don't waste time (and resources) trying to use it. The `o.s.i.handler.advice.RequestHandlerCircuitBreakerAdvice` implements this pattern. When the circuit breaker is in the *closed* state, the endpoint will attempt to invoke the service. The circuit breaker goes to the *open* state if a certain number of consecutive attempts fail; when it is in the *open* state, new requests will "fail fast" and no attempt will be made to invoke the service until some time has expired.

When that time has expired, the circuit breaker is set to the *half-open* state. When in this state, if even a single attempt fails, the breaker will immediately go to the *open* state; if the attempt succeeds, the breaker will go to the *closed* state, in which case, it won't go to the *open* state again until the configured number of consecutive failures again occur. Any successful attempt resets the state to zero failures for the purpose of determining when the breaker might go to the *open* state again.

Typically, this Advice might be used for external services, where it might take some time to fail (such as a timeout attempting to make a network connection).

The `RequestHandlerCircuitBreakerAdvice` has two properties: `threshold` and `halfOpenAfter`. The *threshold* property represents the number of consecutive failures that need to occur before the breaker goes *open*. It defaults to 5. The *halfOpenAfter* property represents the time after the last failure that the breaker will wait before attempting another request. Default is 1000 milliseconds.

Example:

```
<int:service-activator input-channel="input" ref="failer" method="service">
    <int:request-handler-advice-chain>
        <bean class="o.s.i.handler.advice.RequestHandlerCircuitBreakerAdvice">
            <property name="threshold" value="2" />
            <property name="halfOpenAfter" value="12000" />
        </bean>
    </int:request-handler-advice-chain>
</int:service-activator>

05.617 DEBUG [task-scheduler-1]preSend on channel 'input', message: [Payload=...]
05.638 ERROR [task-scheduler-1]org.springframework.messaging.MessageHandlingException:
 java.lang.RuntimeException: foo
...
10.598 DEBUG [task-scheduler-2]preSend on channel 'input', message: [Payload=...]
10.600 ERROR [task-scheduler-2]org.springframework.messaging.MessageHandlingException:
 java.lang.RuntimeException: foo
...
15.598 DEBUG [task-scheduler-3]preSend on channel 'input', message: [Payload=...]
15.599 ERROR [task-scheduler-3]org.springframework.messaging.MessagingException: Circuit Breaker is Open
 for ServiceActivator
...
20.598 DEBUG [task-scheduler-2]preSend on channel 'input', message: [Payload=...]
20.598 ERROR [task-scheduler-2]org.springframework.messaging.MessagingException: Circuit Breaker is Open
 for ServiceActivator
...
25.598 DEBUG [task-scheduler-5]preSend on channel 'input', message: [Payload=...]
25.601 ERROR [task-scheduler-5]org.springframework.messaging.MessageHandlingException:
 java.lang.RuntimeException: foo
...
30.598 DEBUG [task-scheduler-1]preSend on channel 'input', message: [Payload=foo...]
30.599 ERROR [task-scheduler-1]org.springframework.messaging.MessagingException: Circuit Breaker is Open
 for ServiceActivator
```

In the above example, the threshold is set to 2 and halfOpenAfter is set to 12 seconds; a new request arrives every 5 seconds. You can see that the first two attempts invoked the service; the third and fourth failed with an exception indicating the circuit breaker is open. The fifth request was attempted because the request was 15 seconds after the last failure; the sixth attempt fails immediately because the breaker immediately went to *open*.

===== Expression Evaluating Advice

The final supplied advice class is the `o.s.i.handler.advice.ExpressionEvaluatingRequestHandlerAdvice`. This advice is more general than the other two advices. It provides a mechanism to evaluate an expression on the original inbound message sent to the endpoint. Separate expressions are available to be evaluated, either after success, or failure. Optionally, a message containing the evaluation result, together with the input message, can be sent to a message channel.

A typical use case for this advice might be with an `<ftp:outbound-channel-adapter/>`, perhaps to move the file to one directory if the transfer was successful, or to another directory if it fails:

The Advice has properties to set an expression when successful, an expression for failures, and corresponding channels for each. For the successful case, the message sent to the *successChannel* is an `AdviceMessage`, with the payload being the result of the expression evaluation, and an additional property `inputMessage` which contains the original message sent to the handler. A message sent to the *failureChannel* (when the handler throws an exception) is an `ErrorMessage` with a payload of `MessageHandlingExpressionEvaluatingAdviceException`. Like all `MessagingException` s, this payload has `failedMessage` and `cause` properties, as well as an additional property `evaluationResult`, containing the result of the expression evaluation.

When an exception is thrown in the scope of the advice, by default, that exception is thrown to caller after any `failureExpression` is evaluated. If you wish to suppress throwing the exception, set the `trapException` property to `true`.

Example - Configuring the Advice with Java DSL.

```
@SpringBootApplication
public class EerhaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context = SpringApplication.run(EerhaApplication.class, args);
        MessageChannel in = context.getBean("advised.input", MessageChannel.class);
        in.send(new GenericMessage<>("good"));
        in.send(new GenericMessage<>("bad"));
        context.close();
    }

    @Bean
    public IntegrationFlow advised() {
        return f -> f.handle((GenericHandler<String>) (payload, headers) -> {
            if (payload.equals("good")) {
                return null;
            }
            else {
                throw new RuntimeException("some failure");
            }
        }, c -> c.advice(expressionAdvice()));
    }

    @Bean
    public Advice expressionAdvice() {
        ExpressionEvaluatingRequestHandlerAdvice advice = new
 ExpressionEvaluatingRequestHandlerAdvice();
        advice.setSuccessChannelName("success.input");
        advice.setOnSuccessExpressionString("payload + ' was successful'");
        advice.setFailureChannelName("failure.input");
        advice.setOnFailureExpressionString(
                "payload + ' was bad, with reason: ' + #exception.cause.message");
        advice.setTrapException(true);
        return advice;
    }

    @Bean
    public IntegrationFlow success() {
        return f -> f.handle(System.out::println);
    }

    @Bean
    public IntegrationFlow failure() {
        return f -> f.handle(System.out::println);
    }

}
```

==== Custom Advice Classes

In addition to the provided Advice classes above, you can implement your own Advice classes. While you can provide any implementation of `org.aopalliance.aop.Advice` (usually `org.aopalliance.intercept.MethodInterceptor`), it is generally recommended that you subclass `o.s.i.handler.advice.AbstractRequestHandlerAdvice`. This has the benefit of avoiding writing low-level *Aspect Oriented Programming* code as well as providing a starting point that is specifically tailored for use in this environment.

Subclasses need to implement the `doInvoke()`` method:

```
/**
 * Subclasses implement this method to apply behavior to the {@link MessageHandler} callback.execute()
 * invokes the handler method and returns its result, or null).
 * @param callback Subclasses invoke the execute() method on this interface to invoke the handler
 method.
 * @param target The target handler.
 * @param message The message that will be sent to the handler.
 * @return the result after invoking the {@link MessageHandler}.
 * @throws Exception
 */
protected abstract Object doInvoke(ExecutionCallback callback, Object target, Message<?> message) throws
 Exception;
```

The *callback* parameter is simply a convenience to avoid subclasses dealing with AOP directly; invoking the `callback.execute()` method invokes the message handler.

The *target* parameter is provided for those subclasses that need to maintain state for a specific handler, perhaps by maintaining that state in a `Map`, keyed by the target. This allows the same advice to be applied to multiple handlers. The `RequestHandlerCircuitBreakerAdvice` uses this to keep circuit breaker state for each handler.

The *message* parameter is the message that will be sent to the handler. While the advice cannot modify the message before invoking the handler, it can modify the payload (if it has mutable properties). Typically, an advice would use the message for logging and/or to send a copy of the message somewhere before or after invoking the handler.

The return value would normally be the value returned by `callback.execute()`; but the advice does have the ability to modify the return value. Note that only `AbstractReplyProducingMessageHandler` s return a value.

```
public class MyAdvice extends AbstractRequestHandlerAdvice {

    @Override
    protected Object doInvoke(ExecutionCallback callback, Object target, Message<?> message) throws
 Exception {
        // add code before the invocation
        Object result = callback.execute();
        // add code after the invocation
        return result;
    }
}
```

Note

In addition to the `execute()` method, the `ExecutionCallback` provides an additional method `cloneAndExecute()`. This method must be used in cases where the invocation might be called multiple times within a single execution of `doInvoke()`, such as in the `RequestHandlerRetryAdvice`. This is required because the Spring AOP `org.springframework.aop.framework.ReflectiveMethodInvocation` object maintains state of which advice in a chain was last invoked; this state must be reset for each call.

For more information, see the ReflectiveMethodInvocation JavaDocs.

==== Other Advice Chain Elements

While the abstract class mentioned above is provided as a convenience, you can add any `Advice` to the chain, including a transaction advice.

==== Handle Message Advice

As discussed in the introduction to this section, advice objects in a request handler advice chain are applied to just the current endpoint, not the downstream flow (if any). For `MessageHandler` s that produce a reply (`AbstractReplyProducingMessageHandler`), the advice is applied to an internal method `handleRequestMessage()` (called from `MessageHandler.handleMessage()`). For other message handlers, the advice is applied to `MessageHandler.handleMessage()`.

There are some circumstances where, even if a message handler is an `AbstractReplyProducingMessageHandler`, the advice must be applied to the `handleMessage` method - for example, the Idempotent Receiver might return `null` and this would cause an exception if the handler's `replyRequired` property is true.

Starting with *version 4.3.1*, a new `HandleMessageAdvice` and the `AbstractHandleMessageAdvice` base implementation have been introduced. `Advice` s that implement `HandleMessageAdvice` will always be applied to the `handleMessage()` method, regardless of the handler type.

It is important to understand that `HandleMessageAdvice` implementations (such as Idempotent Receiver), when applied to a handler that returns a response, are dissociated from the `adviceChain` and properly applied to the `MessageHandler.handleMessage()` method. Bear in mind, however, that this means the advice chain order is not complied with; and, with configuration such as:

```
<some-reply-producing-endpoint ... >
    <int:request-handler-advice-chain>
        <tx:advice ... />
        <bean ref="myHandleMessageAdvice" />
    </int:request-handler-advice-chain>
</some-reply-producing-endpoint>
```

The `<tx:advice>` is applied to the `AbstractReplyProducingMessageHandler.handleRequestMessage()`, but `myHandleMessageAdvice` is applied for to `MessageHandler.handleMessage()` and, therefore, invoked **before** the `<tx:advice>`. To retain the order, you should follow with standard Spring AOP configuration approach and use endpoint `id` together with the `.handler` suffix to obtain the target `MessageHandler` bean. Note, however, that in that case, the entire downstream flow would be within the transaction scope.

In the case of a `MessageHandler` that does **not** return a response, the advice chain order is retained.

==== Transaction Support

Starting with *version 5.0* a new `TransactionHandleMessageAdvice` has been introduced to make the whole downstream flow transactional, thanks to the `HandleMessageAdvice` implementation. When regular `TransactionInterceptor` is used in the `<request-handler-advice-chain>`, for example via `<tx:advice>` configuration, a started transaction is only applied only for an internal `AbstractReplyProducingMessageHandler.handleRequestMessage()` and isn't propagated to the downstream flow.

To simplify XML configuration, alongside with the `<request-handler-advice-chain>`, a `<transactional>` sub-element has been added to all `<outbound-gateway>` and `<service-activator>` & family components:

```
<int-rmi:outbound-gateway remote-channel="foo" host="localhost"
    request-channel="good" reply-channel="reply" port="#{@port}">
        <int-rmi:transactional/>
</int-rmi:outbound-gateway>

<bean id="transactionManager" class="org.mockito.Mockito" factory-method="mock">
    <constructor-arg value="org.springframework.transaction.PlatformTransactionManager"/>
</bean>
```

For whom is familiar with JPA Integration components such a configuration isn't new, but now we can start transaction from any point in our flow, not only from the `<poller>` or Message Driven Channel Adapter like in JMS.

Java & Annotation configuration can be simplified via newly introduced `TransactionInterceptorBuilder` and the result bean name can be used in the Messaging Annotations `adviceChain` attribute:

```
@Bean
public ConcurrentMetadataStore store() {
    return new SimpleMetadataStore(hazelcastInstance()
                       .getMap("idempotentReceiverMetadataStore"));
}

@Bean
public IdempotentReceiverInterceptor idempotentReceiverInterceptor() {
    return new IdempotentReceiverInterceptor(
            new MetadataStoreSelector(
                    message -> message.getPayload().toString(),
                    message -> message.getPayload().toString().toUpperCase(), store()));
}

@Bean
public TransactionInterceptor transactionInterceptor() {
    return new TransactionInterceptorBuilder(true)
                .transactionManager(this.transactionManager)
                .isolation(Isolation.READ_COMMITTED)
                .propagation(Propagation.REQUIRES_NEW)
                .build();
}

@Bean
@org.springframework.integration.annotation.Transformer(inputChannel = "input",
         outputChannel = "output",
         adviceChain = { "idempotentReceiverInterceptor",
                 "transactionInterceptor" })
public Transformer transformer() {
    return message -> message;
}
```

Note the `true` for the `TransactionInterceptorBuilder` constructor, which means produce `TransactionHandleMessageAdvice`, not regular `TransactionInterceptor`.

Java DSL supports such an `Advice` via `.transactional()` options on the endpoint configuration:

```
@Bean
public IntegrationFlow updatingGatewayFlow() {
    return f -> f
        .handle(Jpa.updatingGateway(this.entityManagerFactory),
                e -> e.transactional(true))
        .channel(c -> c.queue("persistResults"));
}
```

==== Advising Filters

There is an additional consideration when advising `Filter` s. By default, any discard actions (when the filter returns false) are performed *within* the scope of the advice chain. This could include all the flow downstream of the *discard channel*. So, for example if an element downstream of the *discard-channel* throws an exception, and there is a retry advice, the process will be retried. This is also the case if *throwExceptionOnRejection* is set to true (the exception is thrown within the scope of the advice).

Setting *discard-within-advice* to "false" modifies this behavior and the discard (or exception) occurs after the advice chain is called.

==== Advising Endpoints Using Annotations

When configuring certain endpoints using annotations (`@Filter`, `@ServiceActivator`, `@Splitter`, and `@Transformer`), you can supply a bean name for the advice chain in the `adviceChain` attribute. In addition, the `@Filter` annotation also has the `discardWithinAdvice` attribute, which can be used to configure the discard behavior as discussed in the section called “CompletableFuture”. An example with the discard being performed after the advice is shown below.

```
@MessageEndpoint
public class MyAdvisedFilter {

    @Filter(inputChannel="input", outputChannel="output",
            adviceChain="adviceChain", discardWithinAdvice="false")
    public boolean filter(String s) {
        return s.contains("good");
    }
}
```

==== Ordering Advices within an Advice Chain

Advice classes are "around" advices and are applied in a nested fashion. The first advice is the outermost, the last advice the innermost (closest to the handler being advised). It is important to put the advice classes in the correct order to achieve the functionality you desire.

For example, let’s say you want to add a retry advice and a transaction advice. You may want to place the retry advice advice first, followed by the transaction advice. Then, each retry will be performed in a new transaction. On the other hand, if you want all the attempts, and any recovery operations (in the retry `RecoveryCallback`), to be scoped within the transaction, you would put the transaction advice first.

==== Advised Handler Properties

Sometimes, it is useful to access handler properties from within the advice. For example, most handlers implement `NamedComponent` and you can access the component name.

The target object can be accessed via the `target` argument when subclassing `AbstractRequestHandlerAdvice` or `invocation.getThis()` when implementing `org.aopalliance.intercept.MethodInterceptor`.

When the entire handler is advised (such as when the handler does not produce replies, or the advice implements `HandleMessageAdvice`), you can simply cast the target object to the desired implemented interface, such as `NamedComponent`.

```
String componentName = ((NamedComponent) target).getComponentName();
```

or

```
String componentName = ((NamedComponent) invocation.getThis()).getComponentName();
```

when implementing `MethodInterceptor` directly.

When only the `handleRequestMessage()` method is advised (in a reply-producing handler), you need to access the full handler, which is an `AbstractReplyProducingMessageHandler`…

```
AbstractReplyProducingMessageHandler handler =
    ((AbstractReplyProducingMessageHandler.RequestHandler) target).getAdvisedHandler();

String componentName = handler.getComponentName();
```

==== Idempotent Receiver Enterprise Integration Pattern

Starting with *version 4.1*, Spring Integration provides an implementation of the Idempotent Receiver Enterprise Integration Pattern. It is a *functional* pattern and the whole *idempotency* logic should be implemented in the application, however to simplify the decision-making, the `IdempotentReceiverInterceptor` component is provided. This is an AOP `Advice`, which is applied to the `MessageHandler.handleMessage()` method and can `filter` a request message or mark it as a `duplicate`, according to its configuration.

Previously, users could have implemented this pattern, by using a custom MessageSelector in a `<filter/>` (Section 6.2, “Filter”), for example. However, since this pattern is really behavior of an endpoint rather than being an endpoint itself, the Idempotent Receiver implementation doesn’t provide an *endpoint* component; rather, it is applied to endpoints declared in the application.

The logic of the `IdempotentReceiverInterceptor` is based on the provided `MessageSelector` and, if the message isn’t accepted by that selector, it will be enriched with the `duplicateMessage` header set to `true`. The target `MessageHandler` (or downstream flow) can consult this header to implement the correct *idempotency* logic. If the `IdempotentReceiverInterceptor` is configured with a `discardChannel` and/or `throwExceptionOnRejection = true`, the *duplicate* Message won’t be sent to the target `MessageHandler.handleMessage()`, but discarded. If you simply want to discard (do nothing with) the *duplicate* Message, the `discardChannel` should be configured with a `NullChannel`, such as the default `nullChannel` bean.

To maintain *state* between messages and provide the ability to compare messages for the idempotency, the `MetadataStoreSelector` is provided. It accepts a `MessageProcessor` implementation (which creates a lookup key based on the `Message`) and an optional `ConcurrentMetadataStore` (the section called “CompletableFuture”). See the `MetadataStoreSelector` JavaDocs for more information. The `value` for `ConcurrentMetadataStore` also can be customized using additional `MessageProcessor`. By default `MetadataStoreSelector` uses `timestamp` message header.

For convenience, the `MetadataStoreSelector` options are configurable directly on the `<idempotent-receiver>` component:

```
<idempotent-receiver
        id=""  ❶
        endpoint=""  ❷
        selector=""  ❸
        discard-channel=""  ❹
        metadata-store=""  ❺
        key-strategy=""  ❻
        key-expression=""  ❼
        value-strategy=""  ❽
        value-expression=""  ❾
        throw-exception-on-rejection="" />  ❿
```

❶ The id of the `IdempotentReceiverInterceptor` bean. *Optional*.

❷ Consumer Endpoint name(s) or pattern(s) to which this interceptor will be applied. Separate names (patterns) with commas (`,`) e.g. `endpoint="aaa, bbb*, *ccc, *ddd*, eee*fff"`. Endpoint bean names matching these patterns are then used to retrieve the target endpoint's `MessageHandler` bean (using its `.handler` suffix), and the `IdempotentReceiverInterceptor` will be applied to those beans. *Required*.

❸ A `MessageSelector` bean reference. Mutually exclusive with `metadata-store` and `key-strategy (key-expression)`. When `selector` is not provided, one of `key-strategy` or `key-strategy-expression` is required.

❹ Identifies the channel to which to send a message when the `IdempotentReceiverInterceptor` doesn't accept it. When omitted, duplicate messages are forwarded to the handler with a `duplicateMessage` header. *Optional*.

❺ A `ConcurrentMetadataStore` reference. Used by the underlying `MetadataStoreSelector`. Mutually exclusive with `selector`. *Optional*. The default `MetadataStoreSelector` uses an internal `SimpleMetadataStore` which does not maintain state across application executions.

❻ A `MessageProcessor` reference. Used by the underlying `MetadataStoreSelector`. Evaluates an `idempotentKey` from the request Message. Mutually exclusive with `selector` and `key-expression`. When a `selector` is not provided, one of `key-strategy` or `key-strategy-expression` is required.

❼ A SpEL expression to populate an `ExpressionEvaluatingMessageProcessor`. Used by the underlying `MetadataStoreSelector`. Evaluates an `idempotentKey` using the request Message as the evaluation context root object. Mutually exclusive with `selector` and `key-strategy`. When a `selector` is not provided, one of `key-strategy` or `key-strategy-expression` is required.

❽ A `MessageProcessor` reference. Used by the underlying `MetadataStoreSelector`. Evaluates a `value` for the `idempotentKey` from the request Message. Mutually exclusive with `selector` and `value-expression`. By default, the *MetadataStoreSelector* uses the *timestamp* message header as the Metadata *value*.

❾ A SpEL expression to populate an `ExpressionEvaluatingMessageProcessor`. Used by the underlying `MetadataStoreSelector`. Evaluates a `value` for the `idempotentKey` using the request Message as the evaluation context root object. Mutually exclusive with `selector` and `value-strategy`. By default, the *MetadataStoreSelector* uses the *timestamp* message header as the Metadata *value*.

❿ Throw an exception if the `IdempotentReceiverInterceptor` rejects the message defaults to `false`. It is applied regardless of whether or not a `discard-channel` is provided.

For Java configuration, the method level `IdempotentReceiver` annotation is provided. It is used to mark a `method` that has a Messaging annotation (`@ServiceActivator`, `@Router` etc.) to specify which `IdempotentReceiverInterceptor` s will be applied to this endpoint:

```
@Bean
public IdempotentReceiverInterceptor idempotentReceiverInterceptor() {
   return new IdempotentReceiverInterceptor(new MetadataStoreSelector(m ->
                                                    m.getHeaders().get(INVOICE_NBR_HEADER)));
}

@Bean
@ServiceActivator(inputChannel = "input", outputChannel = "output")
@IdempotentReceiver("idempotentReceiverInterceptor")
public MessageHandler myService() {
    ....
}
```

And with the Java DSL, the interceptor is added to the endpoint's advice chain:

```
@Bean
public IntegrationFlow flow() {
    ...
        .handle("someBean", "someMethod",
            e -> e.advice(idempotentReceiverInterceptor())
    ...
}
```

Note

The `IdempotentReceiverInterceptor` is designed only for the `MessageHandler.handleMessage(Message<?>)` method and starting with *version 4.3.1* it implements `HandleMessageAdvice`, with the `AbstractHandleMessageAdvice` as a base class, for better dissociation. See the section called “CompletableFuture” for more information.

=== Logging Channel Adapter

The `<logging-channel-adapter/>` is often used in conjunction with a Wire Tap, as discussed in the section called “Wire Tap”. However, it can also be used as the ultimate consumer of any flow. For example, consider a flow that ends with a `<service-activator/>` that returns a result, but you wish to discard that result. To do that, you could send the result to `NullChannel`. Alternatively, you can route it to an `INFO` level `<logging-channel-adapter/>`; that way, you can see the discarded message when logging at `INFO` level, but not see it when logging at, say, `WARN` level. With a `NullChannel`, you would only see the discarded message when logging at `DEBUG` level.

```
<int:logging-channel-adapter
    channel="" ❶
    level="INFO" ❷
    expression="" ❸
    log-full-message="false" ❹
    logger-name="" /> ❺
```

❶ The channel connecting the logging adapter to an upstream component.

❷ The logging level at which messages sent to this adapter will be logged. Default: `INFO`.

❸ A SpEL expression representing exactly what part(s) of the message will be logged. Default: `payload` - just the payload will be logged. This attribute cannot be specified if `log-full-message` is specified.

❹ When `true`, the entire message will be logged (including headers). Default: `false` - just the payload will be logged. This attribute cannot be specified if `expression` is specified.

❺ Specifies the *name* of the logger (known as `category` in `log4j`) used for log messages created by this adapter. This enables setting the log name (in the logging subsystem) for individual adapters. By default, all adapters will log under the name `org.springframework.integration.handler.LoggingHandler`.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the `LoggingHandler` using Java configuration:

```
@SpringBootApplication
public class LoggingJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
             new SpringApplicationBuilder(LoggingJavaApplication.class)
                    .web(false)
                    .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         gateway.sendToLogger("foo");
    }

    @Bean
    @ServiceActivator(inputChannel = "logChannel")
    public LoggingHandler logging() {
        LoggingHandler adapter = new LoggingHandler(LoggingHandler.Level.DEBUG);
        adapter.setLoggerName("TEST_LOGGER");
        adapter.setLogExpressionString("headers.id + ': ' + payload");
        return adapter;
    }

    @MessagingGateway(defaultRequestChannel = "logChannel")
    public interface MyGateway {

        void sendToLogger(String data);

    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the logging channel adapter using the Java DSL:

```
@SpringBootApplication
public class LoggingJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
             new SpringApplicationBuilder(LoggingJavaApplication.class)
                    .web(false)
                    .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         gateway.sendToLogger("foo");
    }

    @Bean
    public IntegrationFlow loggingFlow() {
        return IntegrationFlows.from(MyGateway.class)
                     .log(LoggingHandler.Level.DEBUG, "TEST_LOGGER",
                           m -> m.getHeaders().getId() + ": " + m.getPayload());
    }

    @MessagingGateway
    public interface MyGateway {

        void sendToLogger(String data);

    }

}
```

== Java DSL

The Spring Integration JavaConfig and DSL provides a set of convenient Builders and a fluent API to configure Spring Integration message flows from Spring `@Configuration` classes.

=== Example Configurations

```
@Configuration
@EnableIntegration
public class MyConfiguration {

    @Bean
    public AtomicInteger integerSource() {
        return new AtomicInteger();
    }

    @Bean
    public IntegrationFlow myFlow() {
        return IntegrationFlows.from(integerSource::getAndIncrement,
                                         c -> c.poller(Pollers.fixedRate(100)))
                    .channel("inputChannel")
                    .filter((Integer p) -> p > 0)
                    .transform(Object::toString)
                    .channel(MessageChannels.queue())
                    .get();
    }
}
```

As the result after `ApplicationContext` start up Spring Integration endpoints and Message Channels will be created as is the case after XML parsing. Such configuration can be used to replace XML configuration or along side with it.

=== Introduction

The Java DSL for Spring Integration is essentially a facade for Spring Integration. The DSL provides a simple way to embed Spring Integration Message Flows into your application using the fluent `Builder` pattern together with existing Java and Annotation configurations from Spring Framework and Spring Integration as well. Another useful tool to simplify configuration is Java 8 Lambdas.

The cafe is a good example of using the DSL.

The DSL is presented by the `IntegrationFlows` Factory for the `IntegrationFlowBuilder`. This produces the `IntegrationFlow` component, which should be registered as a Spring bean (`@Bean`). The builder pattern is used to express arbitrarily complex structures as a hierarchy of methods that may accept Lambdas as arguments.

The `IntegrationFlowBuilder` just collects integration components (`MessageChannel` s, `AbstractEndpoint` s etc.) in the `IntegrationFlow` bean for further parsing and registration of concrete beans in the application context by the `IntegrationFlowBeanPostProcessor`.

The Java DSL uses Spring Integration classes directly and bypasses any XML generation and parsing. However, the DSL offers more than syntactic sugar on top of XML. One of its most compelling features is the ability to define inline Lambdas to implement endpoint logic, eliminating the need for external classes to implement custom logic. In some sense, Spring Integration's support for the Spring Expression Language (SpEL) and inline scripting address this, but Java Lambdas are easier and much more powerful.

=== DSL Basics

The `org.springframework.integration.dsl` package contains the `IntegrationFlowBuilder` API mentioned above and a bunch of `IntegrationComponentSpec` implementations which are builders too and provide the fluent API to configure concrete endpoints. The `IntegrationFlowBuilder` infrastructure provides common EIP for message based applications, such as channels, endpoints, pollers and channel interceptors.

Endpoints are expressed as verbs in the DSL to improve readability. The following list includes the common DSL method names and the associated EIP endpoint:

- transform # `Transformer`
- filter # `Filter`
- handle # `ServiceActivator`
- split # `Splitter`
- aggregate # `Aggregator`
- route # `Router`
- bridge # `Bridge`

Conceptually, integration processes are constructed by composing these endpoints into one or more message flows. Note that EIP does not formally define the term *message flow*, but it is useful to think of it as a unit of work that uses well known messaging patterns. The DSL provides an `IntegrationFlow` component to define a composition of channels and endpoints between them, but now `IntegrationFlow` plays only the configuration role to populate real beans in the application context and isn't used at runtime:

```
@Bean
public IntegrationFlow integerFlow() {
    return IntegrationFlows.from("input")
            .<String, Integer>transform(Integer::parseInt)
            .get();
}
```

Here we use the `IntegrationFlows` factory to define an `IntegrationFlow` bean using EIP-methods from `IntegrationFlowBuilder`.

The `transform` method accepts a Lambda as an endpoint argument to operate on the message payload. The real argument of this method is `GenericTransformer<S, T>`, hence any out-of-the-box transformers (`ObjectToJsonTransformer`, `FileToStringTransformer` etc.) can be used here.

Under the covers, `IntegrationFlowBuilder` recognizes the `MessageHandler` and endpoint for that: `MessageTransformingHandler` and `ConsumerEndpointFactoryBean`, respectively. Let's look at another example:

```
@Bean
public IntegrationFlow myFlow() {
    return IntegrationFlows.from("input")
                .filter("World"::equals)
                .transform("Hello "::concat)
                .handle(System.out::println)
                .get();
}
```

The above example composes a sequence of `Filter -> Transformer -> Service Activator`. The flow is *one way*, that is it does not provide a a reply message but simply prints the payload to STDOUT. The endpoints are automatically wired together using direct channels.

Lambdas And Message<?> Arguments

When using lambdas in EIP methods, the "input" argument is generally the message payload. If you wish to access the entire message, use one of the overloaded methods that take a `Class<?>` as the first parameter. For example, this won't work:

```
.<Message<?>, Foo>transform(m -> newFooFromMessage(m))
```

This will fail at runtime with a `ClassCastException` because the lambda doesn't retain the argument type and the framework will attempt to cast the payload to a `Message<?>`.

Instead, use:

```
.(Message.class, m -> newFooFromMessage(m))
```

=== Message Channels

In addition to the `IntegrationFlowBuilder` with EIP-methods the Java DSL provides a fluent API to configure `MessageChannel` s. For this purpose the `MessageChannels` builder factory is provided:

```
@Bean
public MessageChannel priorityChannel() {
    return MessageChannels.priority(this.mongoDbChannelMessageStore, "priorityGroup")
                        .interceptor(wireTap())
                        .get();
}
```

The same `MessageChannels` builder factory can be used in the `channel()` EIP-method from `IntegrationFlowBuilder` to wire endpoints similar to an `input-channel`/`output-channel` pair in the XML configuration. By default endpoints are wired via `DirectChannel` s where the bean name is based on the pattern: `[IntegrationFlow.beanName].channel#[channelNameIndex]`. This rule is applied for unnamed channels produced by inline `MessageChannels` builder factory usage, too. However all `MessageChannels` methods have a `channelId` -aware variant to create the bean names for `MessageChannel` s. The `MessageChannel` references can be used as well as `beanName`, as bean-method invocations. Here is a sample with possible variants of `channel()` EIP-method usage:

```
@Bean
public MessageChannel queueChannel() {
    return MessageChannels.queue().get();
}

@Bean
public MessageChannel publishSubscribe() {
    return MessageChannels.publishSubscribe().get();
}

@Bean
public IntegrationFlow channelFlow() {
    return IntegrationFlows.from("input")
                .fixedSubscriberChannel()
                .channel("queueChannel")
                .channel(publishSubscribe())
                .channel(MessageChannels.executor("executorChannel", this.taskExecutor))
                .channel("output")
                .get();
}
```

- `from("input")` means: *find and use the `MessageChannel` with the "input" id, or create one*;
- `fixedSubscriberChannel()` produces an instance of `FixedSubscriberChannel` and registers it with name `channelFlow.channel#0`;

- `channel("queueChannel")` works the same way but, of course, uses an existing "queueChannel" bean;
- `channel(publishSubscribe())` - the bean-method reference;
- `channel(MessageChannels.executor("executorChannel", this.taskExecutor))` the `IntegrationFlowBuilder` unwraps `IntegrationComponentSpec` to the `ExecutorChannel` and registers it as "executorChannel";
- `channel("output")` - registers the `DirectChannel` bean with "output" name as long as there are no beans with this name.

Note: the `IntegrationFlow` definition shown above is valid and all of its channels are applied to endpoints with `BridgeHandler` s.

Important

Be careful to use the same inline channel definition via `MessageChannels` factory from different `IntegrationFlow` s. Even if the DSL parsers register non-existing objects as beans, it can't determine the same object (`MessageChannel`) from different `IntegrationFlow` containers. This is wrong:

```
@Bean
public IntegrationFlow startFlow() {
    return IntegrationFlows.from("input")
                .transform(...)
                .channel(MessageChannels.queue("queueChannel"))
                .get();
}

@Bean
public IntegrationFlow endFlow() {
    return IntegrationFlows.from(MessageChannels.queue("queueChannel"))
                .handle(...)
                .get();
}
```

You end up with:

```
Caused by: java.lang.IllegalStateException:
Could not register object [queueChannel] under bean name 'queueChannel':
     there is already object [queueChannel] bound
     at o.s.b.f.s.DefaultSingletonBeanRegistry.registerSingleton(DefaultSingletonBeanRegistry.java:129)
```

To make it working there is just need to declare `@Bean` for that channel and use its bean-method from different `IntegrationFlow` s.

=== Pollers

A similar fluent API is provided to configure `PollerMetadata` for `AbstractPollingEndpoint` implementations. The `Pollers` builder factory can be used to configure common bean definitions or those created from `IntegrationFlowBuilder` EIP-methods:

```
@Bean(name = PollerMetadata.DEFAULT_POLLER)
public PollerSpec poller() {
    return Pollers.fixedRate(500)
        .errorChannel("myErrors");
}
```

See `Pollers` and `PollerSpec` Java Docs for more information.

> **Important**
>
> If you use the DSL to construct a `PollerSpec` as a `@Bean`, do not call the `get()` method in the bean definition; the `PollerSpec` is a `FactoryBean` that will generate the `PollerMetadata` object from the specification and initialize all of its properties as needed.

=== DSL and Endpoint Configuration

All `IntegrationFlowBuilder` EIP-methods have a variant to apply the Lambda parameter to provide options for `AbstractEndpoint` s: `SmartLifecycle`, `PollerMetadata`, `request-handler-advice-chain` etc. Each of them has generic arguments, so it allows you to simply configure an endpoint and even its `MessageHandler` in the context:

```
@Bean
public IntegrationFlow flow2() {
    return IntegrationFlows.from(this.inputChannel)
                .transform(new PayloadSerializingTransformer(),
                       c -> c.autoStartup(false).id("payloadSerializingTransformer"))
                .transform((Integer p) -> p * 2, c -> c.advice(this.expressionAdvice()))
                .get();
}
```

In addition the `EndpointSpec` provides an `id()` method to allow you to register an endpoint bean with a given bean name, rather than a generated one.

=== Transformers

The DSL API provides a convenient, fluent `Transformers` factory to be used as inline target object definition within `.transform()` EIP-method:

```
@Bean
public IntegrationFlow transformFlow() {
    return IntegrationFlows.from("input")
            .transform(Transformers.fromJson(MyPojo.class))
            .transform(Transformers.serializer())
            .get();
}
```

It avoids inconvenient coding using setters and makes the flow definition more straightforward. Note, that `Transformers` can be use to declare target `Transformer` s as `@Bean` s and, again, use them from `IntegrationFlow` definition as bean-methods. Nevertheless, the DSL parser takes care about bean declarations for inline objects, if they aren't defined as beans yet.

See `Transformers` Java Docs for more information and supported factory methods.

Also see Lambdas And `Message<?>` Arguments.

=== Inbound Channel Adapters

Typically message flows start from some Inbound Channel Adapter (e.g. `<int-jdbc:inbound-channel-adapter>`). The adapter is configured with `<poller>` and it asks a `MessageSource<?>` for producing messages periodically. Java DSL allows to start `IntegrationFlow` from a `MessageSource<?>`, too. For this purpose `IntegrationFlows` builder factory provides overloaded `IntegrationFlows.from(MessageSource<?> messageSource)` method. The `MessageSource<?>` may be configured as a bean and provided as argument for that method. The second parameter of `IntegrationFlows.from()` is a `Consumer<SourcePollingChannelAdapterSpec>` Lambda and allows to provide options for the `SourcePollingChannelAdapter`, e.g. `PollerMetadata` or `SmartLifecycle`:

```
@Bean
public MessageSource<Object> jdbcMessageSource() {
    return new JdbcPollingChannelAdapter(this.dataSource, "SELECT * FROM foo");
}

@Bean
public IntegrationFlow pollingFlow() {
    return IntegrationFlows.from(jdbcMessageSource(),
                c -> c.poller(Pollers.fixedRate(100).maxMessagesPerPoll(1)))
            .transform(Transformers.toJson())
            .channel("furtherProcessChannel")
            .get();
}
```

There is also an `IntegrationFlows.from()` variant based on the `java.util.function.Supplier` if there is no requirements to build `Message` objects directly. The result of the `Supplier.get()` is wrapped to the `Message` (if it isn't message already) by Framework automatically.

The next sections discuss selected endpoints which require further explanation.

=== Message Routers

Spring Integration natively provides specialized router types including:

- `HeaderValueRouter`
- `PayloadTypeRouter`
- `ExceptionTypeRouter`
- `RecipientListRouter`
- `XPathRouter`

As with many other DSL `IntegrationFlowBuilder` EIP-methods the `route()` method can apply any out-of-the-box `AbstractMessageRouter` implementation, or for convenience a `String` as a SpEL expression, or a `ref`/`method` pair. In addition `route()` can be configured with a Lambda - the inline method invocation case, and with a Lambda for a `Consumer<RouterSpec<MethodInvokingRouter>>`. The fluent API also provides `AbstractMappingMessageRouter` options like `channelMapping(String key, String channelName)` pairs:

```
@Bean
public IntegrationFlow routeFlow() {
    return IntegrationFlows.from("routerInput")
            .<Integer, Boolean>route(p -> p % 2 == 0,
                    m -> m.suffix("Channel")
                            .channelMapping("true", "even")
                            .channelMapping("false", "odd")
            )
            .get();
}
```

A simple expression-based router:

```
@Bean
public IntegrationFlow routeFlow() {
    return IntegrationFlows.from("routerInput")
            .route("headers['destChannel']")
            .get();
}
```

The `routeToRecipients()` method takes a `Consumer<RecipientListRouterSpec>`:

```
@Bean
public IntegrationFlow recipientListFlow() {
    return IntegrationFlows.from("recipientListInput")
            .<String, String>transform(p -> p.replaceFirst("Payload", ""))
                        .routeToRecipients(r -> r
                .recipient("foo-channel", "'foo' == payload")
                .recipient("bar-channel", m ->
                    m.getHeaders().containsKey("recipient")
                        && (boolean) m.getHeaders().get("recipient"))
                .recipientFlow("'foo' == payload or 'bar' == payload or 'baz' == payload",
                    f -> f.<String, String>transform(String::toUpperCase)
                        .channel(c -> c.queue("recipientListSubFlow1Result")))
                .recipientFlow((String p) -> p.startsWith("baz"),
                    f -> f.transform("Hello "::concat)
                        .channel(c -> c.queue("recipientListSubFlow2Result")))
                .recipientFlow(new FunctionExpression<Message<?>>(m ->
                                             "bax".equals(m.getPayload())),
                    f -> f.channel(c -> c.queue("recipientListSubFlow3Result")))
                .defaultOutputToParentFlow())
            .get();
}
```

The `.defaultOutputToParentFlow()` of the `.routeToRecipients()` allows to make the router's `defaultOutput` as a gateway to continue a process for the unmatched messages in the main flow.

Also see Lambdas And `Message<?>` Arguments.

=== Splitters

A splitter is created using the `split()` EIP-method. By default, if the payload is a `Iterable`, `Iterator`, `Array`, `Stream` or Reactive `Publisher`, this will output each item as an individual message. This takes a Lambda, SpEL expression, any `AbstractMessageSplitter` implementation, or can be used without parameters to provide the `DefaultMessageSplitter`. For example:

```
@Bean
public IntegrationFlow splitFlow() {
    return IntegrationFlows.from("splitInput")
              .split(s ->
                      s.applySequence(false).get().getT2().setDelimiters(","))
              .channel(MessageChannels.executor(this.taskExecutor()))
              .get();
}
```

This creates a splitter that splits a message containing a comma delimited String. Note: the `getT2()` method comes from `Tuple Collection` which is the result of `EndpointSpec.get()` and represents a pair of `ConsumerEndpointFactoryBean` and `DefaultMessageSplitter` for the example above.

Also see Lambdas And `Message<?>` Arguments.

=== Aggregators and Resequencers

An `Aggregator` is conceptually the converse of a `Splitter`. It aggregates a sequence of individual messages into a single message and is necessarily more complex. By default, an aggregator will return a message containing a collection of payloads from incoming messages. The same rules are applied for the `Resequencer`:

```
@Bean
public IntegrationFlow splitAggregateFlow() {
    return IntegrationFlows.from("splitAggregateInput")
            .split()
            .channel(MessageChannels.executor(this.taskExecutor()))
            .resequence()
            .aggregate()
            .get();
}
```

The above is a canonical example of splitter/aggregator pattern. The `split()` method splits the list into individual messages and sends them to the `ExecutorChannel`. The `resequence()` method reorders messages by sequence details from message headers. The `aggregate()` method just collects those messages to the result list.

However, you may change the default behavior by specifying a release strategy and correlation strategy, among other things. Consider the following:

```
.aggregate(a ->
        a.correlationStrategy(m -> m.getHeaders().get("myCorrelationKey"))
            .releaseStrategy(g -> g.size() > 10)
            .messageStore(messageStore()))
```

The similar Lambda configurations are provided for the `resequence()` EIP-method.

=== ServiceActivators (.handle())

The `.handle()` EIP-method's goal is to invoke any `MessageHandler` implementation or any method on some POJO. Another option to define "activity" via Lambda expression. Hence a generic `GenericHandler<P>` functional interface has been introduced. Its `handle` method requires two arguments - `P payload` and `Map<String, Object> headers`. Having that we can define a flow like this:

```
@Bean
public IntegrationFlow myFlow() {
    return IntegrationFlows.from("flow3Input")
        .<Integer>handle((p, h) -> p * 2)
        .get();
}
```

However one main goal of Spring Integration an achieving of `loose coupling` via runtime type conversion from message payload to target arguments of message handler. Since Java doesn't support generic type resolution for Lambda classes, we introduced a workaround with additional `payloadType` argument for the most EIP-methods and `LambdaMessageProcessor`, which delegates the hard conversion work to the Spring's `ConversionService` using provided `type` and requested message to target method arguments. The `IntegrationFlow` might look like this:

```
@Bean
public IntegrationFlow integerFlow() {
    return IntegrationFlows.from("input")
            .<byte[], String>transform(p - > new String(p, "UTF-8"))
            .handle(Integer.class, (p, h) -> p * 2)
            .get();
}
```

Of course we register some custom `BytesToIntegerConverter` within `ConversionService` and get rid of that additional `.transform()`.

Also see Lambdas And `Message<?>` Arguments.

=== Operator log()

For convenience to log the message journey throw the Spring Integration flow (`<logging-channel-adapter>`), a `log()` operator is presented. Underneath it is represented by the `WireTap` `ChannelInterceptor` and `LoggingHandler` as subscriber. It is responsible to log message incoming into the next endpoint or for the current channel:

```
.filter(...)
.log(LoggingHandler.Level.ERROR, "test.category", m -> m.getHeaders().getId())
.route(...)
```

In this example an `id` header will be logged with `ERROR` level onto "test.category" only for messages passed the filter and before routing.

=== MessageChannelSpec.wireTap()

A `.wireTap()` fluent API exists for `MessageChannelSpec` builders. A target configuration gains much more from Java DSL usage:

```
@Bean
public QueueChannelSpec myChannel() {
    return MessageChannels.queue()
            .wireTap("loggingFlow.input");
}

@Bean
public IntegrationFlow loggingFlow() {
    return f -> f.log();
}
```

The `log()` or `wireTap()` opearators are applied to the current `MessageChannel` (if it is an instance of `ChannelInterceptorAware`) or an intermediate `DirectChannel` is injected into the flow for the currently configured endpoint. In the example below the `WireTap` interceptor is added to the `myChannel` directly, because `DirectChannel` implements `ChannelInterceptorAware`:

```
@Bean
MessageChannel myChannel() {
    return new DirectChannel();
}

...
    .channel(myChannel())
    .log()
}
```

When current `MessageChannel` doesn't implement `ChannelInterceptorAware`, an implicit `DirectChannel` and `BridgeHandler` are injected into the `IntegrationFlow` and the `WireTap` is added to this new `DirectChannel`. And when there is not any channel declaration like in this sample:

```
.handle(...)
.log()
}
```

an implicit `DirectChannel` is injected in the current position of the `IntegrationFlow` and it is used as an output channel for the currently configured `ServiceActivatingHandler` (the `.handle()` above).

Important

If `log()` or `wireTap()` are used in the end of flow they are considered one-way `MessageHandler` s. If the integration flow is expected to return a reply, a `bridge()` should be added to the end, after `log()` or `wireTap()`:

```
@Bean
public IntegrationFlow sseFlow() {
    return IntegrationFlows
        .from(WebFlux.inboundGateway("/sse")
            .requestMapping(m ->
                m.produces(MediaType.TEXT_EVENT_STREAM_VALUE)))
        .handle((p, h) -> Flux.just("foo", "bar", "baz"))
        .log(LoggingHandler.Level.WARN)
        .bridge()
        .get();
}
```

=== Working With Message Flows

As we have seen, `IntegrationFlowBuilder` provides a top level API to produce Integration components wired to message flows. This is convenient if your integration may be accomplished with a single flow (which is often the case). Alternately `IntegrationFlow` s can be joined via `MessageChannel` s.

By default, the **MessageFlow** behaves as a **Chain** in Spring Integration parlance. That is, the endpoints are automatically wired implicitly via `DirectChannel` s. The message flow is not actually constructed as a chain, affording much more flexibility. For example, you may send a message to any component within the flow, if you know its `inputChannel` name, i.e., explicitly define it. You may also reference externally defined channels within a flow to allow the use of channel adapters to enable remote transport protocols, file I/O, and the like, instead of direct channels. As such, the DSL does not support the Spring Integration **chain** element since it doesn't add much value.

Since the Spring Integration Java DSL produces the same bean definition model as any other configuration options and is based on the existing Spring Framework `@Configuration` infrastructure, it can be used together with Integration XML definitions and wired with Spring Integration Messaging Annotations configuration.

Another alternative to define **direct** `IntegrationFlow` s is based on a fact that `IntegrationFlow` can be declared as **Lambda** too:

```
@Bean
public IntegrationFlow lambdaFlow() {
    return f -> f.filter("World"::equals)
                   .transform("Hello "::concat)
                   .handle(System.out::println);
}
```

The result of this definition is the same bunch of Integration components wired with implicit direct channel. Only limitation is here, that this flow is started with named direct channel - `lambdaFlow.input`. And Lambda flow can't start from `MessageSource` or `MessageProducer`.

Starting with *version 5.0.6*, the generated bean names for the components in an `IntegrationFlow` include the flow bean followed by a dot as a prefix. For example the `ConsumerEndpointFactoryBean` for the `.transform("Hello "::concat)` in the sample above, will end up with te bean name like `lambdaFlow.org.springframework.integration.config.ConsumerEndpointFactoryBean#0`. The `Transformer` implementation bean for that endpoint will have a bean name such as `lambdaFlow.org.springframework.integration.transformer.MethodInvokingTransformer#0`. These generated bean names are prepended with the flow id prefix for purposes such as parsing logs or grouping components together in some analysis tool, as well as to avoid a race condition when we concurrently register integration flows at runtime. See the section called “CompletableFuture” for more information.

=== FunctionExpression

The `FunctionExpression` (an implementation of SpEL `Expression`) has been introduced to get a gain of Java and Lambda usage for the method and its `generics` context. The `Function<T, R>` option is provided for the DSL components alongside with `expression` option, when there is the implicit `Strategy` variant from Core Spring Integration. The usage may look like:

```
.enrich(e -> e.requestChannel("enrichChannel")
            .requestPayload(Message::getPayload)
            .propertyFunction("date", m -> new Date()))
```

The `FunctionExpression` also supports runtime type conversion as it is done in the standard `SpelExpression`.

=== Sub Flows support

Some of `if...else` and `publish-subscribe` components provide the support to specify their logic or mapping using **Sub Flows**. The simplest sample is `.publishSubscribeChannel()`:

```
@Bean
public IntegrationFlow subscribersFlow() {
    return flow -> flow
            .publishSubscribeChannel(Executors.newCachedThreadPool(), s -> s
                    .subscribe(f -> f
                            .<Integer>handle((p, h) -> p / 2)
                            .channel(c -> c.queue("subscriber1Results")))
                    .subscribe(f -> f
                            .<Integer>handle((p, h) -> p * 2)
                            .channel(c -> c.queue("subscriber2Results"))))
            .<Integer>handle((p, h) -> p * 3)
            .channel(c -> c.queue("subscriber3Results"));
}
```

Of course the same result we can achieve with separate `IntegrationFlow` `@Bean` definitions, but we hope you’ll find the subflow style of logic composition useful.

Similar `publish-subscribe` subflow composition provides `.routeToRecipients()`.

Another sample is `.discardFlow()` on the `.filter()` instead of `.discardChannel()`.

The `.route()` deserves special attention. As a sample:

```
@Bean
public IntegrationFlow routeFlow() {
    return f -> f
            .<Integer, Boolean>route(p -> p % 2 == 0,
                    m -> m.channelMapping("true", "evenChannel")
                            .subFlowMapping("false", sf ->
                                    sf.<Integer>handle((p, h) -> p * 3)))
            .transform(Object::toString)
            .channel(c -> c.queue("oddChannel"));
}
```

The `.channelMapping()` continues to work as in regular `Router` mapping, but the `.subFlowMapping()` tied that subflow with main flow. In other words, any router’s subflow returns to the main flow after `.route()`.

Of course, subflows can be nested with any depth, but we don't recommend to do that because, in fact, even in the router case, adding complex subflows within a flow would quickly begin to look like a plate of spaghetti and difficult for a human to parse.

=== Using Protocol Adapters

All of the examples so far illustrate how the DSL supports a messaging architecture using the Spring Integration programming model, but we haven't done any real integration yet. This requires access to remote resources via http, jms, amqp, tcp, jdbc, ftp, smtp, and the like, or access to the local file system. Spring Integration supports all of these and more. Ideally, the DSL should offer first class support for all of them but it is a daunting task to implement all of these and keep up as new adapters are added to Spring Integration. So the expectation is that the DSL will continually be catching up with Spring Integration.

Anyway we are providing the hi-level API to define protocol-specific seamlessly. This is achieved with **Factory** and **Builder** patterns and, of course, with Lambdas. The factory classes can be considered "Namespace Factories", because they play the same role as XML namespace for components from the concrete protocol-specific Spring Integration modules. Currently, Spring Integration Java DSL supports `Amqp`, `Feed`, `Jms`, `Files`, `(S)Ftp`, `Http`, `JPA`, `MongoDb`, `TCP/UDP`, `Mail`, `WebFlux` and `Scripts` namespace factories:

```java
@Bean
public IntegrationFlow amqpFlow() {
    return IntegrationFlows.from(Amqp.inboundGateway(this.rabbitConnectionFactory, queue()))
            .transform("hello "::concat)
            .transform(String.class, String::toUpperCase)
            .get();
}

@Bean
public IntegrationFlow jmsOutboundGatewayFlow() {
    return IntegrationFlows.from("jmsOutboundGatewayChannel")
            .handle(Jms.outboundGateway(this.jmsConnectionFactory)
                        .replyContainer(c ->
                                    c.concurrentConsumers(3)
                                            .sessionTransacted(true))
                        .requestDestination("jmsPipelineTest"))
            .get();
}

@Bean
public IntegrationFlow sendMailFlow() {
    return IntegrationFlows.from("sendMailChannel")
            .handle(Mail.outboundAdapter("localhost")
                            .port(smtpPort)
                            .credentials("user", "pw")
                            .protocol("smtp")
                            .javaMailProperties(p -> p.put("mail.debug", "true")),
                    e -> e.id("sendMailEndpoint"))
            .get();
}
```

We show here the usage of namespace factories as inline adapters declarations, however they can be used from `@Bean` definitions to make the `IntegrationFlow` method-chain more readable.

We are soliciting community feedback on these namespace factories before we spend effort on others; we'd also appreciate some prioritization for which adapters/gateways we should support next.

See more Java DSL samples in the protocol-specific chapter throughout this reference manual.

All other protocol channel adapters may be configured as generic beans and wired to the `IntegrationFlow`:

```
@Bean
public QueueChannelSpec wrongMessagesChannel() {
    return MessageChannels
            .queue()
            .wireTap("wrongMessagesWireTapChannel");
}

@Bean
public IntegrationFlow xpathFlow(MessageChannel wrongMessagesChannel) {
    return IntegrationFlows.from("inputChannel")
            .filter(new StringValueTestXPathMessageSelector("namespace-uri(/*)", "my:namespace"),
                    e -> e.discardChannel(wrongMessagesChannel))
            .log(LoggingHandler.Level.ERROR, "test.category", m -> m.getHeaders().getId())
            .route(xpathRouter(wrongMessagesChannel))
            .get();
}

@Bean
public AbstractMappingMessageRouter xpathRouter(MessageChannel wrongMessagesChannel) {
    XPathRouter router = new XPathRouter("local-name(/*)");
    router.setEvaluateAsString(true);
    router.setResolutionRequired(false);
    router.setDefaultOutputChannel(wrongMessagesChannel);
    router.setChannelMapping("Tags", "splittingChannel");
    router.setChannelMapping("Tag", "receivedChannel");
    return router;
}
```

=== IntegrationFlowAdapter

The `IntegrationFlow` as an interface can be implemented directly and specified as component for scanning:

```
@Component
public class MyFlow implements IntegrationFlow {

    @Override
    public void configure(IntegrationFlowDefinition<?> f) {
        f.<String, String>transform(String::toUpperCase);
    }

}
```

And yes, it is picked up by the `IntegrationFlowBeanPostProcessor` and correctly parsed and registered in the application context.

For convenience and loosely coupled architecture the `IntegrationFlowAdapter` base class implementation is provided. It requires a `buildFlow()` method implementation to produce an `IntegrationFlowDefinition` using one of `from()` support methods:

```
@Component
public class MyFlowAdapter extends IntegrationFlowAdapter {

    private final AtomicBoolean invoked = new tomicBoolean();

    public Date nextExecutionTime(TriggerContext triggerContext) {
          return this.invoked.getAndSet(true) ? null : new Date();
    }

    @Override
    protected IntegrationFlowDefinition<?> buildFlow() {
        return from(this, "messageSource",
                      e -> e.poller(p -> p.trigger(this::nextExecutionTime)))
                 .split(this)
      .transform(this)
      .aggregate(a -> a.processor(this, null), null)
      .enrichHeaders(Collections.singletonMap("foo", "FOO"))
      .filter(this)
      .handle(this)
      .channel(c -> c.queue("myFlowAdapterOutput"));
    }

    public String messageSource() {
         return "B,A,R";
    }

    @Splitter
    public String[] split(String payload) {
         return StringUtils.commaDelimitedListToStringArray(payload);
    }

    @Transformer
    public String transform(String payload) {
         return payload.toLowerCase();
    }

    @Aggregator
    public String aggregate(List<String> payloads) {
           return payloads.stream().collect(Collectors.joining());
    }

    @Filter
    public boolean filter(@Header Optional<String> foo) {
            return foo.isPresent();
    }

    @ServiceActivator
    public String handle(String payload, @Header String foo) {
           return payload + ":" + foo;
    }

}
```

=== Dynamic and runtime Integration Flows

The `IntegrationFlow` s and therefore all its dependant components can be registered at runtime. This was done previously by the `BeanFactory.registerSingleton()` hook and now via newly introduced in the Spring Framework `5.0` programmatic `BeanDefinition` registration with the `instanceSupplier` hook:

```
BeanDefinition beanDefinition =
         BeanDefinitionBuilder.genericBeanDefinition((Class<Object>) bean.getClass(), () -> bean)
               .getRawBeanDefinition();

((BeanDefinitionRegistry) this.beanFactory).registerBeanDefinition(beanName, beanDefinition);
```

and all the necessary bean initialization and lifecycle is done automatically as it is with the standard context configuration bean definitions.

To simplify the development experience Spring Integration introduced `IntegrationFlowContext` to register and manage `IntegrationFlow` instances at runtime:

```
@Autowired
private AbstractServerConnectionFactory server1;

@Autowired
private IntegrationFlowContext flowContext;

...

@Test
public void testTcpGateways() {
    TestingUtilities.waitListening(this.server1, null);

    IntegrationFlow flow = f -> f
            .handle(Tcp.outboundGateway(Tcp.netClient("localhost", this.server1.getPort())
                    .serializer(TcpCodecs.crlf())
                    .deserializer(TcpCodecs.lengthHeader1())
                    .id("client1"))
                .remoteTimeout(m -> 5000))
            .transform(Transformers.objectToString());

    IntegrationFlowRegistration theFlow = this.flowContext.registration(flow).register();
    assertThat(theFlow.getMessagingTemplate().convertSendAndReceive("foo", String.class),
 equalTo("FOO"));
}
```

This is useful when we have multi configuration options and have to create several instances of similar flows. So, we can iterate our options and create and register `IntegrationFlow` s within loop. Another variant when our source of data isn't Spring-based and we must create it on the fly. Such a sample is Reactive Streams event source:

```
Flux<Message<?>> messageFlux =
    Flux.just("1,2,3,4")
        .map(v -> v.split(","))
        .flatMapIterable(Arrays::asList)
        .map(Integer::parseInt)
        .map(GenericMessage<Integer>::new);

QueueChannel resultChannel = new QueueChannel();

IntegrationFlow integrationFlow =
    IntegrationFlows.from(messageFlux)
        .<Integer, Integer>transform(p -> p * 2)
        .channel(resultChannel)
        .get();

this.integrationFlowContext.registration(integrationFlow)
            .register();
```

The `IntegrationFlowRegistrationBuilder` (as a result of the `IntegrationFlowContext.registration()`) can be used to specify a bean name for the `IntegrationFlow` to register, to control its `autoStartup` and also for additional, non Integration beans registration. Usually those additional beans are connection factories (AMQP, JMS, (S)FTP, TCP/UDP etc.), serializers/deserializers or any other required support components.

Such a dynamically registered `IntegrationFlow` and all its dependant beans can be removed afterwards using `IntegrationFlowRegistration.destroy()` callback. See `IntegrationFlowContext` JavaDocs for more information.

> **Note**
>
> Starting with *version 5.0.6*, all generated bean names in an `IntegrationFlow` definition are prepended with flow id as a prefix. It is recommended to always specify an explicit flow id, otherwise a synchronization barrier is initiated in the `IntegrationFlowContext` to generate the bean name for the `IntegrationFlow` and register its beans. We synchronize on these two operations to avoid a race condition when the same generated bean name may be used for different `IntegrationFlow` instances.

Also, starting with *version 5.0.6*, the registration builder API has a new method `useFlowIdAsPrefix()`. This is useful if you wish to declare multiple instances of the same flow and avoid bean name collisions if components in the flows have the same id.

For example:

```
private void registerFlows() {
    IntegrationFlowRegistration flow1 =
              this.flowContext.registration(buildFlow(1234))
                    .id("tcp1")
                    .useFlowIdAsPrefix()
                    .register();

    IntegrationFlowRegistration flow2 =
              this.flowContext.registration(buildFlow(1235))
                    .id("tcp2")
                    .useFlowIdAsPrefix()
                    .register();
}

private IntegrationFlow buildFlow(int port) {
    return f -> f
            .handle(Tcp.outboundGateway(Tcp.netClient("localhost", port)
                    .serializer(TcpCodecs.crlf())
                    .deserializer(TcpCodecs.lengthHeader1())
                    .id("client"))
                .remoteTimeout(m -> 5000))
            .transform(Transformers.objectToString());
}
```

In this case, the message handler for the first flow can be referenced with bean name `tcp1.client.handler`.

> **Note**
>
> an `id` is required when using `useFlowIdAsPrefix()`.

=== IntegrationFlow as Gateway

The `IntegrationFlow` can start from the service interface providing `GatewayProxyFactoryBean` component:

```
public interface ControlBusGateway {

    void send(String command);
}

...

@Bean
public IntegrationFlow controlBusFlow() {
    return IntegrationFlows.from(ControlBusGateway.class)
            .controlBus()
            .get();
}
```

All the proxy for interface methods are supplied with the channel to send messages to the next integration component in the `IntegrationFlow`. The service interface can be marked with the `@MessagingGateway` as well as methods with the `@Gateway` annotations. Nevertheless the `requestChannel` is ignored and overridden with that internal channel for the next component in the `IntegrationFlow`. Otherwise such a configuration via `IntegrationFlow` won't make sense.

By default a `GatewayProxyFactoryBean` gets a conventional bean name like `[FLOW_BEAN_NAME.gateway]`. That id can be changed via `@MessagingGateway.name()` attribute or the overloaded `from(Class<?> serviceInterface, String beanName)` factory method.

With the Java 8 on board we even can create such an Integration Gateway with the `java.util.function` interfaces:

```
@Bean
public IntegrationFlow errorRecovererFlow() {
    return IntegrationFlows.from(Function.class, "errorRecovererFunction")
            .handle((GenericHandler<?>) (p, h) -> {
                throw new RuntimeException("intentional");
            }, e -> e.advice(retryAdvice()))
            .get();
}
```

That can be used lately as:

```
@Autowired
@Qualifier("errorRecovererFunction")
private Function<String, String> errorRecovererFlowGateway;
```

== System Management

=== Metrics and Management

==== Configuring Metrics Capture

> **Note**
>
> Prior to *version 4.2* metrics were only available when JMX was enabled. See the section called “CompletableFuture”.

To enable `MessageSource`, `MessageChannel` and `MessageHandler` metrics, add an `<int:management/>` bean to the application context, or annotate one of your `@Configuration` classes with `@EnableIntegrationManagement`. `MessageSource` s only maintain counts, `MessageChannel` s and `MessageHandler` s maintain duration statistics in addition to counts. See the section called “CompletableFuture” and the section called “CompletableFuture” below.

This causes the automatic registration of the `IntegrationManagementConfigurer` bean in the application context. Only one such bean can exist in the context and it must have the bean name `integrationManagementConfigurer` if registered manually via a `<bean/>` definition. This bean applies it's configuration to beans after all beans in the context have been instantiated.

In addition to metrics, you can control **debug** logging in the main message flow. It has been found that in very high volume applications, even calls to `isDebugEnabled()` can be quite expensive with some logging subsystems. You can disable all such logging to avoid this overhead; exception logging (debug or otherwise) are not affected by this setting.

A number of options are available:

```
<int:management
    default-logging-enabled="true" ❶
    default-counts-enabled="false" ❷
    default-stats-enabled="false" ❸
    counts-enabled-patterns="foo, !baz, ba*" ❹
    stats-enabled-patterns="fiz, buz" ❺
    metrics-factory="myMetricsFactory" /> ❻
```

```
@Configuration
@EnableIntegration
@EnableIntegrationManagement(
    defaultLoggingEnabled = "true", ❶
    defaultCountsEnabled = "false", ❷
    defaultStatsEnabled = "false", ❸
    countsEnabled = { "foo", "${count.patterns}" }, ❹
    statsEnabled = { "qux", "!*" }, ❺
    MetricsFactory = "myMetricsFactory") ❻
public static class ContextConfiguration {
...
}
```

❶❶ Set to `false` to disable all logging in the main message flow, regardless of the log system category settings. Set to *true* to enable debug logging (if also enabled by the logging subsystem). Only applied if you have not explicitly configured the setting in a bean definition. Default `true`.

❷❷ Enable or disable count metrics for components not matching one of the patterns in <4>. Only applied if you have not explicitly configured the setting in a bean definition. Default `false`.

❸❸ Enable or disable statistical metrics for components not matching one of the patterns in <5>. Only applied if you have not explicitly configured the setting in a bean definition. Default *false*.

❹❹ A comma-delimited list of patterns for beans for which counts should be enabled; negate the pattern with `!`. First match wins (positive or negative). In the unlikely event that you have a bean name starting with `!`, escape the `!` in the pattern: `\!foo` positively matches a bean named `!foo`.

❺❺ A comma-delimited list of patterns for beans for which statistical metrics should be enabled; negate the pattern with `!`. First match wins (positive or negative). In the unlikely event that you have a bean name starting with `!`, escape the `!` in the pattern: `\!foo` positively matches a bean named `!foo`. Stats implies counts.

❻❻ A reference to a `MetricsFactory`. See the section called “CompletableFuture”.

At runtime, counts and statistics can be obtained by calling `IntegrationManagementConfigurer` `getChannelMetrics`, `getHandlerMetrics` and `getSourceMetrics`, returning `MessageChannelMetrics`, `MessageHandlerMetrics` and `MessageSourceMetrics` respectively.

See the javadocs for complete information about these classes.

When JMX is enabled (see the section called “CompletableFuture”), these metrics are also exposed by the `IntegrationMBeanExporter`.

`defaultLoggingEnabled`, `defaultCountsEnabled`, and `defaultStatsEnabled` are only applied if you have not explicitly configured the corresponding setting in a bean definition.

Starting with *version 5.0.2*, the framework will automatically detect if there is a single `MetricsFactory` bean in the application context and use it instead of the default metrics factory.

==== Micrometer Integration

Starting with *version 5.0.3*, the presence of a Micrometer `MeterRegistry` in the application context will trigger support for Micrometer metrics in addition to the inbuilt metrics (inbuilt metrics will be removed in a future release).

> **Important**
>
> Micrometer was first supported in *version 5.0.2*, but changes were made to the Micrometer `Meters` in *version 5.0.3* to make them more suitable for use in dimensional systems. Further changes were made in 5.0.4; if using Micrometer, a minimum of version 5.0.4 is recommended since some of the changes in 5.0.4 were breaking API changes.

Simply add a `MeterRegistry` bean of choice to the application context. If the `IntegrationManagementConfigurer` detects exactly one `MeterRegistry` bean, it will configure a `MicrometerMetricsCaptor` bean with name `integrationMicrometerMetricsCaptor`.

For each `MessageHandler` and `MessageChannel`, timers are registered. For each `MessageSource`, a counter is registered.

This only applies to objects that extend `AbstractMessageHandler`, `AbstractMessageChannel` and `AbstractMessageSource` respectively (which is the case for most framework components).

With Micrometer metrics, the `statsEnabled` flag takes no effect, since statistics capture is delegated to Micrometer. The `countsEnabled` flag controls whether the Micrometer `Meter` s are updated when processing each message.

The `Timer` Meters for send operations on message channels have the following name/tags:

- `name` : `spring.integration.send`
- `tag` : `type:channel`
- `tag` : `name:<componentName>`
- `tag` : `result:(success|failure)`
- `tag` : `exception:(none|exception simple class name)`
- `description` : `Send processing time`

(A `failure` result with a none exception means the channel `send()` operation returned `false`).

The `Counter` Meters for receive operations on pollable message channels have the following names/tags:

- `name` : `spring.integration.receive`
- `tag` : `type:channel`
- `tag` : `name:<componentName>`
- `tag` : `result:(success|failure)`
- `tag` : `exception:(none|exception simple class name)`
- `description` : `Messages received`

The `Timer` Meters for operations on message handlers have the following name/tags:

- `name` : `spring.integration.send`
- `tag` : `type:handler`
- `tag` : `name:<componentName>`
- `tag` : `result:(success|failure)`
- `tag` : `exception:(none|exception simple class name)`
- `description` : `Send processing time`

The `Counter` meters for message sources have the following names/tags:

- `name` : `spring.integration.receive`
- `tag` : `type:source`
- `tag` : `name:<componentName>`
- `tag` : `result:success`
- `tag` : `exception:none`
- `description` : `Messages received`

In addition, there are three `Gauge` Meters:

`spring.integration.channels` - the number of `MessageChannels` in the application. `spring.integration.handlers` - the number of `MessageHandlers` in the application. `spring.integration.sources` - the number of `MessageSources` in the application.

==== MessageChannel Metric Features

These legacy metrics will be removed in a future release; see the section called “CompletableFuture”.

Message channels report metrics according to their concrete type. If you are looking at a `DirectChannel`, you will see statistics for the send operation. If it is a `QueueChannel`, you will also see statistics for the receive operation, as well as the count of messages that are currently buffered by this `QueueChannel`. In both cases there are some metrics that are simple counters (message count and error count), and some that are estimates of averages of interesting quantities. The algorithms used to calculate these estimates are described briefly in the section below.

Metric Type	Example	Algorithm
Count	Send Count	Simple incrementer. Increases by one when an event occurs.
Error Count	Send Error Count	Simple incrementer. Increases by one when an send results in an error.
Duration	Send Duration (method execution time in milliseconds)	Exponential Moving Average with decay factor (10 by default). Average of the method execution time over roughly the last 10 (default) measurements.
Rate	Send Rate (number of operations per second)	Inverse of Exponential Moving Average of the interval between events with decay in time (lapsing over 60 seconds by default) and per measurement (last 10 events by default).
Error Rate	Send Error Rate (number of errors per second)	Inverse of Exponential Moving Average of the interval between error events with decay in time (lapsing over 60 seconds by default) and per measurement (last 10 events by default).
Ratio	Send Success Ratio (ratio of successful to total sends)	Estimate the success ratio as the Exponential Moving Average of the series composed of values 1 for success and 0 for failure (decaying as per the rate measurement over time and events by default). Error ratio is 1 - success ratio.

==== MessageHandler Metric Features

These legacy metrics will be removed in a future release; see the section called “CompletableFuture”.

The following table shows the statistics maintained for message handlers. Some metrics are simple counters (message count and error count), and one is an estimate of averages of send duration. The algorithms used to calculate these estimates are described briefly in the table below:

Metric Type	Example	Algorithm
Count	Handle Count	Simple incrementer. Increases by one when an event occurs.
Error Count	Handler Error Count	Simple incrementer. Increases by one when an invocation results in an error.
Active Count	Handler Active Count	Indicates the number of currently active threads currently invoking the handler (or any downstream synchronous flow).
Duration	Handle Duration (method execution time in milliseconds)	Exponential Moving Average with decay factor (10 by default). Average of the method execution time over roughly the last 10 (default) measurements.

==== Time-Based Average Estimates

A feature of the time-based average estimates is that they decay with time if no new measurements arrive. To help interpret the behaviour over time, the time (in seconds) since the last measurement is also exposed as a metric.

There are two basic exponential models: decay per measurement (appropriate for duration and anything where the number of measurements is part of the metric), and decay per time unit (more suitable for rate measurements where the time in between measurements is part of the metric). Both models depend on the fact that

`S(n) = sum(i=0,i=n) w(i) x(i)` has a special form when `w(i) = r^i`, with `r=constant`:

`S(n) = x(n) + r S(n-1)` (so you only have to store `S(n-1)`, not the whole series `x(i)`, to generate a new metric estimate from the last measurement). The algorithms used in the duration metrics use `r=exp(-1/M)` with `M=10`. The net effect is that the estimate `S(n)` is more heavily weighted to recent measurements and is composed roughly of the last `M` measurements. So `M` is the "window" or lapse rate of the estimate In the case of the vanilla moving average, `i` is a counter over the number of measurements. In the case of the rate we interpret `i` as the elapsed time, or a combination of elapsed time and a counter (so the metric estimate contains contributions roughly from the last `M` measurements and the last `T` seconds).

==== Metrics Factory

A strategy interface `MetricsFactory` has been introduced allowing you to provide custom channel metrics for your `MessageChannel` s and `MessageHandler` s. By default, a `DefaultMetricsFactory` provides default implementation of `MessageChannelMetrics` and `MessageHandlerMetrics` which are described above. To override the default `MetricsFactory` configure it as described above, by providing a reference to your `MetricsFactory` bean instance. You can either customize the default implementations as described in the next bullet, or provide completely different implementations by extending `AbstractMessageChannelMetrics` and/or `AbstractMessageHandlerMetrics`.

Also see the section called “CompletableFuture”.

In addition to the default metrics factory described above, the framework provides the `AggregatingMetricsFactory`. This factory creates `AggregatingMessageChannelMetrics` and `AggregatingMessageHandlerMetrics`. In very high volume scenarios, the cost of capturing statistics can be prohibitive (2 calls to the system time and storing the data for each message). The aggregating metrics aggregate the response time over a sample of messages. This can save significant CPU time.

Caution

The statistics will be skewed if messages arrive in bursts. These metrics are intended for use with high, constant-volume, message rates.

```xml
<bean id="aggregatingMetricsFactory"
            class="org.springframework.integration.support.management.AggregatingMetricsFactory">
    <constructor-arg value="1000" /> <!-- sample size -->
</bean>
```

The above configuration aggregates the duration over 1000 messages. Counts (send, error) are maintained per-message but the statistics are per 1000 messages.

- **Customizing the Default Channel/Handler Statistics**

See the section called “CompletableFuture” and the Javadocs for the `ExponentialMovingAverage*` classes for more information about these values.

By default, the `DefaultMessageChannelMetrics` and `DefaultMessageHandlerMetrics` use a `window` of 10 measurements, a rate period of 1 second (rate per second) and a decay lapse period of 1 minute.

If you wish to override these defaults, you can provide a custom `MetricsFactory` that returns appropriately configured metrics and provide a reference to it to the MBean exporter as described above.

Example:

```
public static class CustomMetrics implements MetricsFactory {

    @Override
    public AbstractMessageChannelMetrics createChannelMetrics(String name) {
        return new DefaultMessageChannelMetrics(name,
                new ExponentialMovingAverage(20, 1000000.),
                new ExponentialMovingAverageRate(2000, 120000, 30, true),
                new ExponentialMovingAverageRatio(130000, 40, true),
                new ExponentialMovingAverageRate(3000, 140000, 50, true));
    }

    @Override
    public AbstractMessageHandlerMetrics createHandlerMetrics(String name) {
        return new DefaultMessageHandlerMetrics(name, new ExponentialMovingAverage(20, 1000000.));
    }

}
```

- **Advanced Customization**

The customizations described above are wholesale and will apply to all appropriate beans exported by the MBean exporter. This is the extent of customization available using XML configuration.

Individual beans can be provided with different implementations using java `@Configuration` or programmatically at runtime, after the application context has been refreshed, by invoking the `configureMetrics` methods on `AbstractMessageChannel` and `AbstractMessageHandler`.

- **Performance Improvement**

Previously, the time-based metrics (see the section called “CompletableFuture”) were calculated in real time. The statistics are now calculated when retrieved instead. This resulted in a significant performance improvement, at the expense of a small amount of additional memory for each statistic. As discussed in the bullet above, the statistics can be disabled altogether, while retaining the MBean allowing the invocation of `Lifecycle` methods.

=== JMX Support

Spring Integration provides *Channel Adapters* for receiving and publishing JMX Notifications. There is also an_Inbound Channel Adapter_ for polling JMX MBean attribute values, and an *Outbound Channel Adapter* for invoking JMX MBean operations.

==== Notification Listening Channel Adapter

The *Notification-listening Channel Adapter* requires a JMX ObjectName for the MBean that publishes notifications to which this listener should be registered. A very simple configuration might look like this:

```
<int-jmx:notification-listening-channel-adapter id="adapter"
    channel="channel"
    object-name="example.domain:name=publisher"/>
```

Tip

The *notification-listening-channel-adapter* registers with an `MBeanServer` at startup, and the default bean name is *mbeanServer* which happens to be the same bean name generated when using Spring's *<context:mbean-server/>* element. If you need to use a different name, be sure to include the_mbean-server_ attribute.

The adapter can also accept a reference to a `NotificationFilter` and a *handback* Object to provide some context that is passed back with each Notification. Both of those attributes are optional. Extending the above example to include those attributes as well as an explicit `MBeanServer` bean name would produce the following:

```
<int-jmx:notification-listening-channel-adapter id="adapter"
    channel="channel"
    mbean-server="someServer"
    object-name="example.domain:name=somePublisher"
    notification-filter="notificationFilter"
    handback="myHandback"/>
```

The *Notification-listening Channel Adapter* is event-driven and registered with the `MBeanServer` directly. It does not require any poller configuration.

Note

For this component only, the *object-name* attribute can contain an ObjectName pattern (e.g. "org.foo:type=Bar,name=*") and the adapter will receive notifications from all MBeans with ObjectNames that match the pattern. In addition, the *object-name* attribute can contain a SpEL reference to a <util:list/> of ObjectName patterns:

```
<jmx:notification-listening-channel-adapter id="manyNotificationsAdapter"
    channel="manyNotificationsChannel"
    object-name="#{patterns}"/>

<util:list id="patterns">
    <value>org.foo:type=Foo,name=*</value>
    <value>org.foo:type=Bar,name=*</value>
</util:list>
```

The names of the located MBean(s) will be logged when DEBUG level logging is enabled.

==== Notification Publishing Channel Adapter

The *Notification-publishing Channel Adapter* is relatively simple. It only requires a JMX ObjectName in its configuration as shown below.

```
<context:mbean-export/>

<int-jmx:notification-publishing-channel-adapter id="adapter"
    channel="channel"
    object-name="example.domain:name=publisher"/>
```

It does also require that an `MBeanExporter` be present in the context. That is why the *<context:mbean-export/>* element is shown above as well.

When Messages are sent to the channel for this adapter, the Notification is created from the Message content. If the payload is a String it will be passed as the *message* text for the Notification. Any other payload type will be passed as the *userData* of the Notification.

JMX Notifications also have a *type*, and it should be a dot-delimited String. There are two ways to provide the *type*. Precedence will always be given to a Message header value associated with the `JmxHeaders.NOTIFICATION_TYPE` key. On the other hand, you can rely on a fallback *default-notification-type* attribute provided in the configuration.

```
<context:mbean-export/>

<int-jmx:notification-publishing-channel-adapter id="adapter"
    channel="channel"
    object-name="example.domain:name=publisher"
    default-notification-type="some.default.type"/>
```

==== Attribute Polling Channel Adapter

The *Attribute Polling Channel Adapter* is useful when you have a requirement, to periodically check on some value that is available through an MBean as a managed attribute. The poller can be configured in the same way as any other polling adapter in Spring Integration (or it's possible to rely on the default poller). The *object-name* and *attribute-name* are required. An MBeanServer reference is also required, but it will automatically check for a bean named *mbeanServer* by default, just like the *Notification-listening Channel Adapter* described above.

```
<int-jmx:attribute-polling-channel-adapter id="adapter"
    channel="channel"
    object-name="example.domain:name=someService"
    attribute-name="InvocationCount">
        <int:poller max-messages-per-poll="1" fixed-rate="5000"/>
</int-jmx:attribute-polling-channel-adapter>
```

==== Tree Polling Channel Adapter

The *Tree Polling Channel Adapter* queries the JMX MBean tree and sends a message with a payload that is the graph of objects that matches the query. By default the MBeans are mapped to primitives and simple Objects like Map, List and arrays - permitting simple transformation, for example, to JSON. An MBeanServer reference is also required, but it will automatically check for a bean named *mbeanServer* by default, just like the *Notification-listening Channel Adapter* described above. A basic configuration would be:

```
<int-jmx:tree-polling-channel-adapter id="adapter"
    channel="channel"
    query-name="example.domain:type=*">
        <int:poller max-messages-per-poll="1" fixed-rate="5000"/>
</int-jmx:tree-polling-channel-adapter>
```

This will include all attributes on the MBeans selected. You can filter the attributes by providing an `MBeanObjectConverter` that has an appropriate filter configured. The converter can be provided as a reference to a bean definition using the `converter` attribute, or as an inner <bean/> definition. A `DefaultMBeanObjectConverter` is provided which can take a `MBeanAttributeFilter` in its constructor argument.

Two standard filters are provided; the `NamedFieldsMBeanAttributeFilter` allows you to specify a list of attributes to include and the `NotNamedFieldsMBeanAttributeFilter` allows you to specify a list of attributes to exclude. You can also implement your own filter

==== Operation Invoking Channel Adapter

The *operation-invoking-channel-adapter* enables Message-driven invocation of any managed operation exposed by an MBean. Each invocation requires the operation name to be invoked and the ObjectName of the target MBean. Both of these must be explicitly provided via adapter configuration:

```
<int-jmx:operation-invoking-channel-adapter id="adapter"
    object-name="example.domain:name=TestBean"
    operation-name="ping"/>
```

Then the adapter only needs to be able to discover the *mbeanServer* bean. If a different bean name is required, then provide the *mbean-server* attribute with a reference.

The payload of the Message will be mapped to the parameters of the operation, if any. A Map-typed payload with String keys is treated as name/value pairs, whereas a List or array would be passed as a simple argument list (with no explicit parameter names). If the operation requires a single parameter value, then the payload can represent that single value, and if the operation requires no parameters, then the payload would be ignored.

If you want to expose a channel for a single common operation to be invoked by Messages that need not contain headers, then that option works well.

==== Operation Invoking Outbound Gateway

Similar to the *operation-invoking-channel-adapter* Spring Integration also provides a *operation-invoking-outbound-gateway*, which could be used when dealing with non-void operations and a return value is required. Such return value will be sent as message payload to the *reply-channel* specified by this Gateway.

```
<int-jmx:operation-invoking-outbound-gateway request-channel="requestChannel"
   reply-channel="replyChannel"
   object-name="o.s.i.jmx.config:type=TestBean,name=testBeanGateway"
   operation-name="testWithReturn"/>
```

If the *reply-channel* attribute is not provided, the reply message will be sent to the channel that is identified by the `IntegrationMessageHeaderAccessor.REPLY_CHANNEL` header. That header is typically auto-created by the entry point into a message flow, such as any *Gateway* component. However, if the message flow was started by manually creating a Spring Integration Message and sending it directly to a *Channel*, then you must specify the message header explicitly or use the provided *reply-channel* attribute.

==== MBean Exporter

Spring Integration components themselves may be exposed as MBeans when the `IntegrationMBeanExporter` is configured. To create an instance of the `IntegrationMBeanExporter`, define a bean and provide a reference to an `MBeanServer` and a domain name (if desired). The domain can be left out, in which case the default domain is *org.springframework.integration*.

```
<int-jmx:mbean-export id="integrationMBeanExporter"
            default-domain="my.company.domain" server="mbeanServer"/>

<bean id="mbeanServer" class="org.springframework.jmx.support.MBeanServerFactoryBean">
    <property name="locateExistingServerIfPossible" value="true"/>
</bean>
```

Important

The MBean exporter is orthogonal to the one provided in Spring core - it registers message channels and message handlers, but not itself. You can expose the exporter itself, and certain other components in Spring Integration, using the standard `<context:mbean-export/>` tag. The exporter has a some metrics attached to it, for instance a count of the number of active handlers and the number of queued messages.

It also has a useful operation, as discussed in the section called “CompletableFuture”.

Starting with *Spring Integration 4.0* the `@EnableIntegrationMBeanExport` annotation has been introduced for convenient configuration of a default (`integrationMbeanExporter`) bean of type `IntegrationMBeanExporter` with several useful options at the `@Configuration` class level. For example:

```
@Configuration
@EnableIntegration
@EnableIntegrationMBeanExport(server = "mbeanServer", managedComponents = "input")
public class ContextConfiguration {

 @Bean
 public MBeanServerFactoryBean mbeanServer() {
  return new MBeanServerFactoryBean();
 }
}
```

If there is a need to provide more options, or have several `IntegrationMBeanExporter` beans e.g. for different MBean Servers, or to avoid conflicts with the standard Spring `MBeanExporter` (e.g. via `@EnableMBeanExport`), you can simply configure an `IntegrationMBeanExporter` as a generic bean.

===== MBean ObjectNames

All the `MessageChannel`, `MessageHandler` and `MessageSource` instances in the application are wrapped by the MBean exporter to provide management and monitoring features. The generated JMX object names for each component type are listed in the table below:

Component Type	ObjectName
MessageChannel	`o.s.i:type=MessageChannel,name=<channelName>`
MessageSource	`o.s.i:type=MessageSource,name=<channelName>,bean=<source>`
MessageHandler	`o.s.i:type=MessageSource,name=<channelName>,bean=<source>`

The *bean* attribute in the object names for sources and handlers takes one of the values in the table below:

Bean Value	Description
endpoint	The bean name of the enclosing endpoint (e.g. <service-activator>) if there is one
anonymous	An indication that the enclosing endpoint didn’t have a user-specified bean name, so the JMX name is the input channel name
internal	For well-known Spring Integration default components
handler/source	None of the above: fallback to the `toString()` of the object being monitored (handler or source)

Custom elements can be appended to the object name by providing a reference to a `Properties` object in the `object-name-static-properties` attribute.

Also, since *Spring Integration 3.0*, you can use a custom ObjectNamingStrategy using the `object-naming-strategy` attribute. This permits greater control over the naming of the MBeans. For example, to group all Integration MBeans under an *Integration* type. A simple custom naming strategy implementation might be:

```
public class Namer implements ObjectNamingStrategy {

 private final ObjectNamingStrategy realNamer = new KeyNamingStrategy();
 @Override
 public ObjectName getObjectName(Object managedBean, String beanKey) throws MalformedObjectNameException
 {
  String actualBeanKey = beanKey.replace("type=", "type=Integration,componentType=");
  return realNamer.getObjectName(managedBean, actualBeanKey);
 }

}
```

The `beanKey` argument is a String containing the standard object name beginning with the `default-domain` and including any additional static properties. This example simply moves the standard `type` part to `componentType` and sets the `type` to *Integration*, enabling selection of all Integration MBeans in one query:"`my.domain:type=Integration,*`. This also groups the beans under one tree entry under the domain in tools like VisualVM.

Note

The default naming strategy is a MetadataNamingStrategy. The exporter propagates the `default-domain` to that object to allow it to generate a fallback object name if parsing of the bean key fails. If your custom naming strategy is a `MetadataNamingStrategy` (or subclass), the exporter will **not** propagate the `default-domain`; you will need to configure it on your strategy bean.

Starting with version 5.0.9; any bean names (represented by the `name` key in the object name) can be quoted if they contain any characters that are not allowed in a Java identifier (or period `.`). This requires setting `spring.integration.jmx.quote.names=true` in a `META-INF/spring.integration.properties` file on the class path. In 5.1 it will not be configurable.

===== JMX Improvements

Version 4.2 introduced some important improvements, representing a fairly major overhaul to the JMX support in the framework. These resulted in a significant performance improvement of the JMX statistics collection and much more control thereof, but has some implications for user code in a few specific (uncommon) situations. These changes are detailed below, with a **caution** where necessary.

- **Metrics Capture**

Previously, `MessageSource`, `MessageChannel` and `MessageHandler` metrics were captured by wrapping the object in a JDK dynamic proxy to intercept appropriate method calls and capture the statistics. The proxy was added when an integration MBean exporter was declared in the context.

Now, the statistics are captured by the beans themselves; see the section called “CompletableFuture” for more information.

Warning

This change means that you no longer automatically get an MBean or statistics for custom `MessageHandler` implementations, unless those custom handlers extend

> `AbstractMessageHandler`. The simplest way to resolve this is to extend `AbstractMessageHandler`. If that's not possible, or desired, another work-around is to implement the `MessageHandlerMetrics` interface. For convenience, a `DefaultMessageHandlerMetrics` is provided to capture and report statistics. Invoke the `beforeHandle` and `afterHandle` at the appropriate times. Your `MessageHandlerMetrics` methods can then delegate to this object to obtain each statistic. Similarly, `MessageSource` implementations must extend `AbstractMessageSource` or implement `MessageSourceMetrics`. Message sources only capture a count so there is no provided convenience class; simply maintain the count in an `AtomicLong` field.

The removal of the proxy has two additional benefits; 1) stack traces in exceptions are reduced (when JMX is enabled) because the proxy is not on the stack; 2) cases where 2 MBeans were exported for the same bean now only export a single MBean with consolidated attributes/operations (see the MBean consolidation bullet below).

- **Resolution**

`System.nanoTime()` is now used to capture times instead of `System.currentTimeMillis()`. This may provide more accuracy on some JVMs, espcially when durations of less than 1 millisecond are expected

- **Setting Initial Statistics Collection State**

Previously, when JMX was enabled, all sources, channels, handlers captured statistics. It is now possible to control whether the statisics are enabled on an individual component. Further, it is possible to capture simple counts on `MessageChannel` s and `MessageHandler` s instead of the complete time-based statistics. This can have significant performance implications because you can selectively configure where you need detailed statistics, as well as enable/disable at runtime.

See the section called “CompletableFuture”.

- **@IntegrationManagedResource**

Similar to the `@ManagedResource` annotation, the `@IntegrationManagedResource` marks a class as eligible to be exported as an MBean; however, it will only be exported if there is an `IntegrationMBeanExporter` in the application context.

Certain Spring Integration classes (in the `org.springframework.integration`) package) that were previously annotated with`@ManagedResource` are now annotated with both `@ManagedResource` and `@IntegrationManagedResource`. This is for backwards compatibility (see the next bullet). Such MBeans will be exported by any context `MBeanServer`**or** an `IntegrationMBeanExporter` (but not both - if both exporters are present, the bean is exported by the integration exporter if the bean matches a `managed-components` pattern).

- **Consolidated MBeans**

Certain classes within the framework (mapping routers for example) have additional attributes/ operations over and above those provided by metrics and `Lifecycle`. We will use a `Router` as an example here.

Previously, beans of these types were exported as two distinct MBeans:

1) the metrics MBean (with an objectName such as: `intDomain:type=MessageHandler,name=myRouter,bean=endpoint`). This MBean had metrics attributes and metrics/Lifecycle operations.

2) a second MBean (with an objectName such as: `ctxDomain:name=org.springframework.integration.config.RouterFactoryBean#0,type=MethodInvokingRouter`) was exported with the channel mappings attribute and operations.

Now, the attributes and operations are consolidated into a single MBean. The objectName will depend on the exporter. If exported by the integration MBean exporter, the objectName will be, for example: `intDomain:type=MessageHandler,name=myRouter,bean=endpoint`. If exported by another exporter, the objectName will be, for example: `ctxDomain:name=org.springframework.integration.config.RouterFactoryBean#0,type=MethodInvokingRouter`. There is no difference between these MBeans (aside from the objectName), except that the statistics will **not** be enabled (the attributes will be 0) by exporters other than the integration exporter; statistics can be enabled at runtime using the JMX operations. When exported by the integration MBean exporter, the initial state can be managed as described above.

Warning

If you are currently using the second MBean to change, for example, channel mappings, **and** you are using the integration MBean exporter, note that the objectName has changed because of the MBean consolidation. There is no change if you are not using the integration MBean exporter.

- **MBean Exporter Bean Name Patterns**

Previously, the `managed-components` patterns were inclusive only. If a bean name matched one of the patterns it would be included. Now, the pattern can be negated by prefixing it with `!`. i.e. `"!foo*, foox"` will match all beans that don't start with `foo`, except `foox`. Patterns are evaluated left to right and the first match (positive or negative) wins and no further patterns are applied.

Warning

The addition of this syntax to the pattern causes one possible (although perhaps unlikely) problem. If you have a bean `"!foo"`**and** you included a pattern `"!foo"` in your MBean exporter's `managed-components` patterns; it will no long match; the pattern will now match all beans **not** named `foo`. In this case, you can escape the `!` in the pattern with `\`. The pattern `"\!foo"` means match a bean named `"!foo"`.

- **IntegrationMBeanExporter changes**

The `IntegrationMBeanExporter` no longer implements `SmartLifecycle`; this means that `start()` and `stop()` operations are no longer available to register/unregister MBeans. The MBeans are now registered during context initialization and unregistered when the context is destroyed.

===== Orderly Shutdown Managed Operation

The MBean exporter provides a JMX operation to shut down the application in an orderly manner, intended for use before terminating the JVM.

```
public void stopActiveComponents(long howLong)
```

Its use and operation are described in the section called “CompletableFuture”.

=== Message History

The key benefit of a messaging architecture is loose coupling where participating components do not maintain any awareness about one another. This fact alone makes your application extremely flexible, allowing you to change components without affecting the rest of the flow, change messaging routes, message consuming styles (polling vs event driven), and so on. However, this unassuming style of architecture could prove to be difficult when things go wrong. When debugging, you would probably like to get as much information about the message as you can (its origin, channels it has traversed, etc.)

Message History is one of those patterns that helps by giving you an option to maintain some level of awareness of a message path either for debugging purposes or to maintain an audit trail. Spring integration provides a simple way to configure your message flows to maintain the Message History by adding a header to the Message and updating that header every time a message passes through a tracked component.

==== Message History Configuration

To enable Message History all you need is to define the `message-history` element in your configuration.

```
<int:message-history/>
```

Now every named component (component that has an *id* defined) will be tracked. The framework will set the *history* header in your Message. Its value is very simple - `List<Properties>`.

```
<int:gateway id="sampleGateway"
    service-interface="org.springframework.integration.history.sample.SampleGateway"
    default-request-channel="bridgeInChannel"/>

<int:chain id="sampleChain" input-channel="chainChannel" output-channel="filterChannel">
  <int:header-enricher>
    <int:header name="baz" value="baz"/>
  </int:header-enricher>
</int:chain>
```

The above configuration will produce a very simple Message History structure:

```
[{name=sampleGateway, type=gateway, timestamp=1283281668091},
 {name=sampleChain, type=chain, timestamp=1283281668094}]
```

To get access to Message History all you need is access the MessageHistory header. For example:

```
Iterator<Properties> historyIterator =
    message.getHeaders().get(MessageHistory.HEADER_NAME, MessageHistory.class).iterator();
assertTrue(historyIterator.hasNext());
Properties gatewayHistory = historyIterator.next();
assertEquals("sampleGateway", gatewayHistory.get("name"));
assertTrue(historyIterator.hasNext());
Properties chainHistory = historyIterator.next();
assertEquals("sampleChain", chainHistory.get("name"));
```

You might not want to track all of the components. To limit the history to certain components based on their names, all you need is provide the `tracked-components` attribute and specify a comma-delimited list of component names and/or patterns that match the components you want to track.

```
<int:message-history tracked-components="*Gateway, sample*, foo"/>
```

In the above example, Message History will only be maintained for all of the components that end with *Gateway*, start with *sample*, or match the name *foo* exactly.

Starting with *version 4.0*, you can also use the `@EnableMessageHistory` annotation in a `@Configuration` class. In addition, the `MessageHistoryConfigurer` bean is now exposed as a JMX MBean by the `IntegrationMBeanExporter` (see the section called “CompletableFuture”), allowing the patterns to be changed at runtime. Note, however, that the bean must be stopped (turning off message history) in order to change the patterns. This feature might be useful to temporarily turn on history to analyze a system. The MBean's object name is `"<domain>:name=messageHistoryConfigurer,type=MessageHistoryConfigurer"`.

> **Important**
>
> If multiple beans (declared by `@EnableMessageHistory` and/or `<message-history/>`) they all must have identical component name patterns (when trimmed and sorted). **Do not use a generic `<bean/>` definition for the `MessageHistoryConfigurer`**.

> **Note**
>
> Remember that by definition the Message History header is immutable (you can't re-write history, although some try). Therefore, when writing Message History values, the components are either creating brand new Messages (when the component is an origin), or they are copying the history from a request Message, modifying it and setting the new list on a reply Message. In either case, the values can be appended even if the Message itself is crossing thread boundaries. That means that the history values can greatly simplify debugging in an asynchronous message flow.

=== Message Store

Enterprise Integration Patterns (EIP) identifies several patterns that have the capability to buffer messages. For example, an *Aggregator* buffers messages until they can be released and a *QueueChannel* buffers messages until consumers explicitly receive those messages from that channel. Because of the failures that can occur at any point within your message flow, EIP components that buffer messages also introduce a point where messages could be lost.

To mitigate the risk of losing Messages, EIP defines the Message Store pattern which allows EIP components to store *Messages* typically in some type of persistent store (e.g. RDBMS).

Spring Integration provides support for the *Message Store* pattern by a) defining a `org.springframework.integration.store.MessageStore` strategy interface, b) providing several implementations of this interface, and c) exposing a `message-store` attribute on all components that have the capability to buffer messages so that you can inject any instance that implements the `MessageStore` interface.

Details on how to configure a specific *Message Store* implementation and/or how to inject a `MessageStore` implementation into a specific buffering component are described throughout the manual (see the specific component, such as *QueueChannel*, *Aggregator*, *Delayer* etc.), but here are a couple of samples to give you an idea:

QueueChannel

```
<int:channel id="myQueueChannel">
    <int:queue message-store="refToMessageStore"/>
<int:channel>
```

Aggregator

```
<int:aggregator … message-store="refToMessageStore"/>
```

By default *Messages* are stored in-memory using `org.springframework.integration.store.SimpleMessageStore`, an implementation of

`MessageStore`. That might be fine for development or simple low-volume environments where the potential loss of non-persistent messages is not a concern. However, the typical production application will need a more robust option, not only to mitigate the risk of message loss but also to avoid potential out-of-memory errors. Therefore, we also provide MessageStore implementations for a variety of data-stores. Below is a complete list of supported implementations:

- the section called “CompletableFuture” - uses RDBMS to store Messages
- the section called “CompletableFuture” - uses Redis key/value datastore to store Messages
- the section called “CompletableFuture” - uses MongoDB document store to store Messages
- the section called “CompletableFuture” - uses Gemfire distributed cache to store Messages

Important

However be aware of some limitations while using persistent implementations of the `MessageStore`.

The Message data (payload and headers) is *serialized* and *deserialized* using different serialization strategies depending on the implementation of the `MessageStore`. For example, when using `JdbcMessageStore`, only `Serializable` data is persisted by default. In this case non-Serializable headers are removed before serialization occurs. Also be aware of the protocol specific headers that are injected by transport adapters (e.g., FTP, HTTP, JMS etc.). For example, `<http:inbound-channel-adapter/>` maps HTTP-headers into Message Headers and one of them is an `ArrayList` of non-Serializable `org.springframework.http.MediaType` instances. However you are able to inject your own implementation of the `Serializer` and/or `Deserializer` strategy interfaces into some `MessageStore` implementations (such as JdbcMessageStore) to change the behaviour of serialization and deserialization.

Special attention must be paid to the headers that represent certain types of data. For example, if one of the headers contains an instance of some *Spring Bean*, upon deserialization you may end up with a different instance of that bean, which directly affects some of the implicit headers created by the framework (e.g., REPLY_CHANNEL or ERROR_CHANNEL). Currently they are not serializable, but even if they were, the deserialized channel would not represent the expected instance.

Beginning with *Spring Integration version 3.0*, this issue can be resolved with a header enricher, configured to replace these headers with a name after registering the channel with the `HeaderChannelRegistry`.

Also when configuring a message-flow like this: *gateway # queue-channel (backed by a persistent Message Store) # service-activator* That gateway creates a *Temporary Reply Channel*, and it will be lost by the time the service-activator’s poller reads from the queue. Again, you can use the header enricher to replace the headers with a String representation.

For more information, refer to the the section called “Header Enricher”.

Spring Integration 4.0 introduced two new interfaces `ChannelMessageStore - ` to implement operations specific for `QueueChannel s`, `PriorityCapableChannelMessageStore - ` to mark `MessageStore` implementation to be used for `PriorityChannel s` and to provide *priority* order for persisted Messages. The real behaviour depends on implementation. The Framework provides these implementations, which can be used as a persistent `MessageStore` for `QueueChannel` and `PriorityChannel`:

- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”

Caution with SimpleMessageStore

Starting with *version 4.1*, the `SimpleMessageStore` no longer copies the message group when calling `getMessageGroup()`. For large message groups, this was a significant performance problem. 4.0.1 introduced a boolean `copyOnGet` allowing this to be controlled. When used internally by the aggregator, this was set to false to improve performance. It is now false by default.

Users accessing the group store outside of components such as aggregators, will now get a direct reference to the group being used by the aggregator, instead of a copy. Manipulation of the group outside of the aggregator may cause unpredictable results.

For this reason, users should not perform such manipulation, or set the `copyOnGet` property to `true`.

==== MessageGroupFactory

Starting with *version 4.3*, some `MessageGroupStore` implementations can be injected with a custom `MessageGroupFactory` strategy to create/customize the `MessageGroup` instances used by the `MessageGroupStore`. This defaults to a `SimpleMessageGroupFactory` which produces `SimpleMessageGroup` s based on the `GroupType.HASH_SET` (`LinkedHashSet`) internal collection. Other possible options are `SYNCHRONISED_SET` and `BLOCKING_QUEUE`, where the last one can be used to reinstate the previous `SimpleMessageGroup` behavior. Also the `PERSISTENT` option is available. See the next section for more information. Starting with _*version 5.0.1*, the `LIST` option is also available for use-cases when the order and uniqueness of messages in the group doesn’t matter.

==== Persistence MessageGroupStore and Lazy-Load

Starting with *version 4.3*, all persistence `MessageGroupStore` s retrieve `MessageGroup` s and their `messages` from the store with the *Lazy-Load* manner. In most cases it is useful for the Correlation `MessageHandler` s (Section 6.4, “Aggregator” and Section 6.5, “Resequencer”), when it would be an overhead to load entire `MessageGroup` from the store on each correlation operation.

To switch off the lazy-load behavior the `AbstractMessageGroupStore.setLazyLoadMessageGroups(false)` option can be used from the configuration.

Our performance tests for *lazy-load* on MongoDB `MessageStore` (the section called “CompletableFuture”) and `<aggregator>` (Section 6.4, “Aggregator”) with custom `release-strategy` like:

```
<int:aggregator input-channel="inputChannel"
                output-channel="outputChannel"
                message-store="mongoStore"
                release-strategy-expression="size() == 1000"/>
```

demonstrate this results for 1000 simple messages:

```
StopWatch 'Lazy-Load Performance': running time (millis) = 38918
-----------------------------------------
ms     %     Task name
-----------------------------------------
02652  007%  Lazy-Load
36266  093%  Eager
```

=== Metadata Store

Many external systems, services or resources aren’t transactional (Twitter, RSS, file system etc.) and there is no any ability to mark the data as read. Or there is just need to implement the Enterprise Integration Pattern Idempotent Receiver in some integration solutions. To achieve this goal and store some previous state of the Endpoint before the next interaction with external system, or deal with the next Message, Spring Integration provides the *Metadata Store* component being an implementation of the `org.springframework.integration.metadata.MetadataStore` interface with a general *key-value* contract.

The *Metadata Store* is designed to store various types of generic meta-data (e.g., published date of the last feed entry that has been processed) to help components such as the Feed adapter deal with duplicates. If a component is not directly provided with a reference to a `MetadataStore`, the algorithm for locating a metadata store is as follows: First, look for a bean with id `metadataStore` in the ApplicationContext. If one is found then it will be used, otherwise it will create a new instance of `SimpleMetadataStore` which is an in-memory implementation that will only persist metadata within the lifecycle of the currently running Application Context. This means that upon restart you may end up with duplicate entries.

If you need to persist metadata between Application Context restarts, these persistent `MetadataStores` are provided by the framework:

- `PropertiesPersistingMetadataStore`
- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”

The `PropertiesPersistingMetadataStore` is backed by a properties file and a PropertiesPersister.

By default, it only persists the state when the application context is closed normally. It implements `Flushable` so you can persist the state at will, be invoking `flush()`.

```
<bean id="metadataStore"
    class="org.springframework.integration.metadata.PropertiesPersistingMetadataStore"/>
```

Alternatively, you can provide your own implementation of the `MetadataStore` interface (e.g. JdbcMetadataStore) and configure it as a bean in the Application Context.

Starting with *version 4.0*, `SimpleMetadataStore`, `PropertiesPersistingMetadataStore` and `RedisMetadataStore` implement `ConcurrentMetadataStore`. These provide for atomic updates and can be used across multiple component or application instances.

==== Idempotent Receiver and Metadata Store

The *Metadata Store* is useful for implementing the EIP Idempotent Receiver pattern, when there is need to *filter* an incoming Message if it has already been processed, and just discard it or perform some other logic on discarding. The following configuration is an example of how to do this:

```
<int:filter input-channel="serviceChannel"
   output-channel="idempotentServiceChannel"
   discard-channel="discardChannel"
   expression="@metadataStore.get(headers.businessKey) == null"/>

<int:publish-subscribe-channel id="idempotentServiceChannel"/>

<int:outbound-channel-adapter channel="idempotentServiceChannel"
                              expression="@metadataStore.put(headers.businessKey, '')"/>

<int:service-activator input-channel="idempotentServiceChannel" ref="service"/>
```

The `value` of the idempotent entry may be some expiration date, after which that entry should be removed from *Metadata Store* by some scheduled reaper.

Also see the section called “CompletableFuture”.

==== MetadataStoreListener

Some metadata stores (currently only zookeeper) support registering a listener to receive events when items change.

```
public interface MetadataStoreListener {

 void onAdd(String key, String value);

 void onRemove(String key, String oldValue);

 void onUpdate(String key, String newValue);
}
```

See the javadocs for more information. The `MetadataStoreListenerAdapter` can be subclassed if you are only interested in a subset of events.

=== Control Bus

As described in (EIP), the idea behind the Control Bus is that the same messaging system can be used for monitoring and managing the components within the framework as is used for "application-level" messaging. In Spring Integration we build upon the adapters described above so that it’s possible to send Messages as a means of invoking exposed operations.

```
<int:control-bus input-channel="operationChannel"/>
```

The Control Bus has an input channel that can be accessed for invoking operations on the beans in the application context. It also has all the common properties of a service activating endpoint, e.g. you can specify an output channel if the result of the operation has a return value that you want to send on to a downstream channel.

The Control Bus executes messages on the input channel as Spring Expression Language expressions. It takes a message, compiles the body to an expression, adds some context, and then executes it. The default context supports any method that has been annotated with `@ManagedAttribute` or `@ManagedOperation`. It also supports the methods on Spring’s `Lifecycle` interface, and it supports methods that are used to configure several of Spring's `TaskExecutor` and `TaskScheduler` implementations. The simplest way to ensure that your own methods are available to the Control Bus is to use the `@ManagedAttribute` and/or `@ManagedOperation` annotations. Since those are also used for exposing methods to a JMX MBean registry, it's a convenient by-product (often the same types of operations you want to expose to the Control Bus would be reasonable for exposing via JMX). Resolution of any particular instance within the application context is achieved in the typical SpEL syntax. Simply provide the bean name with the SpEL prefix for beans (@). For example, to execute a method on a Spring Bean a client could send a message to the operation channel as follows:

```
Message operation = MessageBuilder.withPayload("@myServiceBean.shutdown()").build();
operationChannel.send(operation)
```

The root of the context for the expression is the `Message` itself, so you also have access to the `payload` and `headers` as variables within your expression. This is consistent with all the other expression support in Spring Integration endpoints.

With Java and Annotations the Control Bus can be configured as follows:

```
@Bean
@ServiceActivator(inputChannel = "operationChannel")
public ExpressionControlBusFactoryBean controlBus() {
    return new ExpressionControlBusFactoryBean();
}
```

Or, when using Java DSL flow definitions:

```
@Bean
public IntegrationFlow controlBusFlow() {
    return IntegrationFlows.from("controlBus")
              .controlBus()
              .get();
}
```

Or, if you prefer Lambda style with automatic `DirectChannel` creation:

```
@Bean
public IntegrationFlow controlBus() {
    return IntegrationFlowDefinition::controlBus;
}
```

In this case, the channel is named `controlBus.input`.

=== Orderly Shutdown

As described in the section called "CompletableFuture", the MBean exporter provides a JMX operation *stopActiveComponents*, which is used to stop the application in an orderly manner. The operation has a single long parameter. The parameter indicates how long (in milliseconds) the operation will wait to allow in-flight messages to complete. The operation works as follows:

The first step calls `beforeShutdown()` on all beans that implement `OrderlyShutdownCapable`. This allows such components to prepare for shutdown. Examples of components that implement this interface, and what they do with this call include: JMS and AMQP message-driven adapters stop their listener containers; TCP server connection factories stop accepting new connections (while keeping existing connections open); TCP inbound endpoints drop (log) any new messages received; http inbound endpoints return *503 - Service Unavailable* for any new requests.

The second step stops any active channels, such as JMS- or AMQP-backed channels.

The third step stops all `MessageSource` s.

The fourth step stops all inbound `MessageProducer` s (that are not `OrderlyShutdownCapable`).

The fifth step waits for any remaining time left, as defined by the value of the long parameter passed in to the operation. This is intended to allow any in-flight messages to complete their journeys. It is therefore important to select an appropriate timeout when invoking this operation.

The sixth step calls `afterShutdown()` on all OrderlyShutdownCapable components. This allows such components to perform final shutdown tasks (closing all open sockets, for example).

As discussed in the section called “CompletableFuture” this operation can be invoked using JMX. If you wish to programmatically invoke the method, you will need to inject, or otherwise get a reference to, the `IntegrationMBeanExporter`. If no `id` attribute is provided on the `<int-jmx:mbean-export/>` definition, the bean will have a generated name. This name contains a random component to avoid `ObjectName` collisions if multiple Spring Integration contexts exist in the same JVM (MBeanServer).

For this reason, if you wish to invoke the method programmatically, it is recommended that you provide the exporter with an `id` attribute so it can easily be accessed in the application context.

Finally, the operation can be invoked using the `<control-bus>`; see the monitoring Spring Integration sample application for details.

> **Important**
>
> The above algorithm was improved in *version 4.1*. Previously, all task executors and schedulers were stopped. This could cause mid-flow messages in `QueueChannel` s to remain. Now, the shutdown leaves pollers running in order to allow these messages to be drained and processed.

=== Integration Graph

Starting with *version 4.3*, Spring Integration provides access to an application’s runtime object model which can, optionally, include component metrics. It is exposed as a graph, which may be used to visualize the current state of the integration application. The `o.s.i.support.management.graph` package contains all the required classes to collect, build and render the runtime state of Spring Integration components as a single tree-like `Graph` object. The `IntegrationGraphServer` should be declared as a bean to build, retrieve and refresh the `Graph` object. The resulting `Graph` object can be serialized to any format, although JSON is flexible and convenient to parse and represent on the client side. A simple Spring Integration application with only the default components would expose a graph as follows:

```
{
  "contentDescriptor": {
    "providerVersion": "4.3.0.RELEASE",
    "providerFormatVersion": 1.0,
    "provider": "spring-integration",
    "name": "myApplication"
  },
  "nodes": [
    {
      "nodeId": 1,
      "name": "nullChannel",
      "stats": null,
      "componentType": "channel"
    },
    {
      "nodeId": 2,
      "name": "errorChannel",
      "stats": null,
      "componentType": "publish-subscribe-channel"
    },
    {
      "nodeId": 3,
      "name": "_org.springframework.integration.errorLogger",
      "stats": {
        "duration": {
          "count": 0,
          "min": 0.0,
          "max": 0.0,
          "mean": 0.0,
          "standardDeviation": 0.0,
          "countLong": 0
        },
        "errorCount": 0,
        "standardDeviationDuration": 0.0,
        "countsEnabled": true,
        "statsEnabled": true,
        "loggingEnabled": false,
        "handleCount": 0,
        "meanDuration": 0.0,
        "maxDuration": 0.0,
        "minDuration": 0.0,
        "activeCount": 0
      },
      "componentType": "logging-channel-adapter",
      "output": null,
      "input": "errorChannel"
    }
  ],
  "links": [
    {
      "from": 2,
      "to": 3,
      "type": "input"
    }
  ]
}
```

As you can see, the graph consists of three top-level elements.

The `contentDescriptor` graph element is pretty straightforward and contains general information about the application providing the data. The `name` can be customized on the `IntegrationGraphServer` bean or via `spring.application.name` application context environment property. Other properties are provided by the framework and allows you to distinguish a similar model from other sources.

The `links` graph element represents connections between nodes from the `nodes` graph element and, therefore, between integration components in the source Spring Integration application. For example *from* a `MessageChannel` *to* an `EventDrivenConsumer` with some `MessageHandler`; or *from* an `AbstractReplyProducingMessageHandler` *to* a `MessageChannel`. For the convenience and to allow to determine a link purpose, the model is supplied with the `type` attribute. The possible types are:

- *input* - identify the direction from `MessageChannel` to the endpoint; `inputChannel` or `requestChannel` property;
- *output* - the direction from `MessageHandler`, `MessageProducer` or `SourcePollingChannelAdapter` to the `MessageChannel` via an `outputChannel` or `replyChannel` property;
- *error* - from `MessageHandler` on `PollingConsumer` or `MessageProducer` or `SourcePollingChannelAdapter` to the `MessageChannel` via an `errorChannel` property;
- *discard* - from `DiscardingMessageHandler` (e.g. `MessageFilter`) to the `MessageChannel` via `errorChannel` property.
- *route* - from `AbstractMappingMessageRouter` (e.g. `HeaderValueRouter`) to the `MessageChannel`. Similar to *output* but determined at run-time. May be a configured channel mapping, or a dynamically resolved channel. Routers will typically only retain up to 100 dynamic routes for this purpose, but this can be modified using the `dynamicChannelLimit` property.

The information from this element can be used by a visualizing tool to render connections between nodes from the `nodes` graph element, where the `from` and `to` numbers represent the value from the `nodeId` property of the linked nodes. For example the link `type` can be used to determine the proper *port* on the target node:

```
              +---(discard)
              |
         +----o----+
         |         |
         |         |
         |         |
(input)--o         o---(output)
         |         |
         |         |
         |         |
         +----o----+
              |
              +---(error)
```

The `nodes` graph element is perhaps the most interesting because its elements contain not only the runtime components with their `componentType` s and `name` s, but can also optionally contain metrics exposed by the component. Node elements contain various properties which are generally self-explanatory. For example, expression-based components include the `expression` property containing the primary expression string for the component. To enable the metrics, add an `@EnableIntegrationManagement` to some `@Configuration` class or add an `<int:management/>` element to your XML configuration. You can control exactly which components in the framework collect statistics. See the section called “CompletableFuture” for complete information. See the `stats` attribute from the `_org.springframework.integration.errorLogger` component in the JSON example above. The `nullChannel` and `errorChannel` don’t provide statistics information in this case, because the configuration for this example was:

```
@Configuration
@EnableIntegration
@EnableIntegrationManagement(statsEnabled = "_org.springframework.integration.errorLogger.handler",
      countsEnabled = "!*",
      defaultLoggingEnabled = "false")
public class ManagementConfiguration {

    @Bean
    public IntegrationGraphServer integrationGraphServer() {
        return new IntegrationGraphServer();
    }

}
```

The `nodeId` represents a unique incremental identifier to distinguish one component from another. It is also used in the `links` element to represent a relationship (connection) of this component to others, if any. The `input` and `output` attributes are for the `inputChannel` and `outputChannel` properties of the `AbstractEndpoint`, `MessageHandler`, `SourcePollingChannelAdapter` or `MessageProducerSupport`. See the next paragraph for more information.

==== Graph Runtime Model

Spring Integration components have various levels of complexity. For example, any polled `MessageSource` also has a `SourcePollingChannelAdapter` and a `MessageChannel` to which to send messages from the source data periodically. Other components might be middleware request-reply components, e.g. `JmsOutboundGateway`, with a consuming `AbstractEndpoint` to subscribe to (or poll) the `requestChannel` (`input`) for messages, and a `replyChannel` (`output`) to produce a reply message to send downstream. Meanwhile, any `MessageProducerSupport` implementation (e.g. `ApplicationEventListeningMessageProducer`) simply wraps some source protocol listening logic and sends messages to the `outputChannel`.

Within the graph, Spring Integration components are represented using the `IntegrationNode` class hierarchy, which you can find in the `o.s.i.support.management.graph` package. For example the `ErrorCapableDiscardingMessageHandlerNode` could be used for the `AggregatingMessageHandler` (because it has a `discardChannel` option) and can produce errors when consuming from a `PollableChannel` using a `PollingConsumer`. Another sample is `CompositeMessageHandlerNode - for a MessageHandlerChain` when subscribed to a `SubscribableChannel`, using an `EventDrivenConsumer`.

Note

The `@MessagingGateway` (see Section 8.4, “Messaging Gateways”) provides nodes for each its method, where the `name` attribute is based on the gateway’s bean name and the short method signature. For example the gateway:

```
@MessagingGateway(defaultRequestChannel = "four")
public interface Gate {

 void foo(String foo);

 void foo(Integer foo);

 void bar(String bar);

}
```

produces nodes like:

```
{
  "nodeId" : 10,
  "name" : "gate.bar(class java.lang.String)",
  "stats" : null,
  "componentType" : "gateway",
  "output" : "four",
  "errors" : null
},
{
  "nodeId" : 11,
  "name" : "gate.foo(class java.lang.String)",
  "stats" : null,
  "componentType" : "gateway",
  "output" : "four",
  "errors" : null
},
{
  "nodeId" : 12,
  "name" : "gate.foo(class java.lang.Integer)",
  "stats" : null,
  "componentType" : "gateway",
  "output" : "four",
  "errors" : null
}
```

This `IntegrationNode` hierarchy can be used for parsing the graph model on the client side, as well as for the understanding the general Spring Integration runtime behavior. See also Section 3.8, “Programming Tips and Tricks” for more information.

=== Integration Graph Controller

If your application is WEB-based (or built on top of Spring Boot using an embedded web container) and the Spring Integration HTTP or WebFlux module (see the section called “CompletableFuture” and the section called “CompletableFuture”) is present on the classpath, you can use a `IntegrationGraphController` to expose the `IntegrationGraphServer` functionality as a REST service. For this purpose, the `@EnableIntegrationGraphController` `@Configuration` class annotation and the `<int-http:graph-controller/>` XML element, are available in the HTTP module. Together with the `@EnableWebMvc` annotation (or `<mvc:annotation-driven/>` for xml definitions), this configuration registers an `IntegrationGraphController` `@RestController` where its `@RequestMapping.path` can be configured on the `@EnableIntegrationGraphController` annotation or `<int-http:graph-controller/>` element. The default path is `/integration`.

The `IntegrationGraphController` `@RestController` provides these services:

- `@GetMapping(name = "getGraph")` - to retrieve the state of the Spring Integration components since the last `IntegrationGraphServer` refresh. The `o.s.i.support.management.graph.Graph` is returned as a `@ResponseBody` of the REST service;
- `@GetMapping(path = "/refresh", name = "refreshGraph")` - to refresh the current `Graph` for the actual runtime state and return it as a REST response. It is not necessary to refresh the graph for metrics, they are provided in real-time when the graph is retrieved. Refresh can be called if the application context has been modified since the graph was last retrieved and the graph is completely rebuilt.

Any Security and Cross Origin restrictions for the `IntegrationGraphController` can be achieved with the standard configuration options and components provided by Spring Security and Spring MVC projects. A simple example of that follows:

```
<mvc:annotation-driven />

<mvc:cors>
 <mvc:mapping path="/myIntegration/**"
     allowed-origins="http://localhost:9090"
     allowed-methods="GET" />
</mvc:cors>

<security:http>
    <security:intercept-url pattern="/myIntegration/**" access="ROLE_ADMIN" />
</security:http>


<int-http:graph-controller path="/myIntegration" />
```

The Java & Annotation Configuration variant follows; note that, for convenience, the annotation provides an `allowedOrigins` attribute; this just provides `GET` access to the `path`. For more sophistication, you can configure the CORS mappings using standard Spring MVC mechanisms.

```
@Configuration
@EnableWebMvc // or @EnableWebFlux
@EnableWebSecurity // or @EnableWebFluxSecurity
@EnableIntegration
@EnableIntegrationGraphController(path = "/testIntegration", allowedOrigins="http://localhost:9090")
public class IntegrationConfiguration extends WebSecurityConfigurerAdapter {

    @Override
    protected void configure(HttpSecurity http) throws Exception {
     http
            .authorizeRequests()
               .antMatchers("/testIntegration/**").hasRole("ADMIN")
            // ...
            .formLogin();
    }

    //...

}
```

= Integration Endpoints

This section covers the various Channel Adapters and Messaging Gateways provided by Spring Integration to support Message-based communication with external systems.

== Endpoint Quick Reference Table

As discussed in the sections above, Spring Integration provides a number of endpoints used to interface with external systems, file systems etc. The following is a summary of the various endpoints with quick links to the appropriate chapter.

To recap, **Inbound Channel Adapters** are used for one-way integration bringing data into the messaging application. **Outbound Channel Adapters** are used for one-way integration to send data out of the messaging application. **Inbound Gateways** are used for a bidirectional integration flow where some other system invokes the messaging application and receives a reply.**Outbound Gateways** are used for a bidirectional integration flow where the messaging application invokes some external service or entity, expecting a result.

Module	**Inbound Adapter**	**Outbound Adapter**	**Inbound Gateway**	**Outbound Gateway**
AMQP	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”

Module	Inbound Adapter	Outbound Adapter	Inbound Gateway	Outbound Gateway
Events	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
Feed	the section called “CompletableFuture”	N	N	N
File	the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture”	N	the section called “CompletableFuture”
FTP(S)	the section called “CompletableFuture”	the section called “CompletableFuture”	N	the section called “CompletableFuture”
Gemfire	the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
HTTP	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”
JDBC	the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture” and the section called “CompletableFuture”	N	the section called “CompletableFuture” and the section called “CompletableFuture”
JMS	the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”
JMX	the section called “CompletableFuture” and the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture” and the section called “CompletableFuture”	N	the section called “CompletableFuture”
JPA	the section called “CompletableFuture”	the section called “CompletableFuture”	N	the section called “CompletableFuture” and the section called “CompletableFuture”

Module	Inbound Adapter	Outbound Adapter	Inbound Gateway	Outbound Gateway
Mail	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
MongoDB	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
MQTT	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
Redis	the section called “CompletableFuture” and the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture” and the section called “CompletableFuture” and the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture” and the section called “CompletableFuture”
Resource	the section called “CompletableFuture”	N	N	N
RMI	N	N	the section called “CompletableFuture”	the section called “CompletableFuture”
SFTP	the section called “CompletableFuture”	the section called “CompletableFuture”	N	the section called “CompletableFuture”
STOMP	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
Stream	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
Syslog	the section called “CompletableFuture”	N	N	N
TCP	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”	the section called “CompletableFuture”
Twitter	the section called “CompletableFuture”	the section called “CompletableFuture”	N	the section called “CompletableFuture”
UDP	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
Web Services	N	N	the section called “CompletableFuture”	the section called “CompletableFuture”
Web Sockets	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N
XMPP	the section called “CompletableFuture”	the section called “CompletableFuture”	N	N

Module	Inbound Adapter	Outbound Adapter	Inbound Gateway	Outbound Gateway
	and the section called “CompletableFuture”	and the section called “CompletableFuture”		

In addition, as discussed in Part IV, “Core Messaging”, endpoints are provided for interfacing with Plain Old Java Objects (POJOs). As discussed in Section 4.3, “Channel Adapter”, the `<int:inbound-channel-adapter>` allows polling a java method for data; the `<int:outbound-channel-adapter>` allows sending data to a `void` method, and as discussed in Section 8.4, “Messaging Gateways”, the `<int:gateway>` allows any Java program to invoke a messaging flow. Each of these without requiring any source level dependencies on Spring Integration. The equivalent of an outbound gateway in this context would be to use a the section called “CompletableFuture” to invoke a method that returns an Object of some kind.

== AMQP Support

=== Introduction

Spring Integration provides Channel Adapters for receiving and sending messages using the Advanced Message Queuing Protocol (AMQP). The following adapters are available:

- Inbound Channel Adapter
- Inbound Gateway
- Outbound Channel Adapter
- Outbound Gateway
- Async Outbound Gateway

Spring Integration also provides a point-to-point Message Channel as well as a publish/subscribe Message Channel backed by AMQP Exchanges and Queues.

In order to provide AMQP support, Spring Integration relies on (Spring AMQP) which "applies core Spring concepts to the development of AMQP-based messaging solutions". Spring AMQP provides similar semantics to (Spring JMS).

Whereas the provided AMQP Channel Adapters are intended for unidirectional Messaging (send or receive) only, Spring Integration also provides inbound and outbound AMQP Gateways for request/reply operations.

Tip

Please familiarize yourself with the reference documentation of the Spring AMQP project as well. It provides much more in-depth information regarding Spring’s integration with AMQP in general and RabbitMQ in particular.

=== Inbound Channel Adapter

A configuration sample for an AMQP Inbound Channel Adapter is shown below.

```
<int-amqp:inbound-channel-adapter
                                  id="inboundAmqp" ❶
                                  channel="inboundChannel" ❷
                                  queue-names="si.test.queue" ❸
                                  acknowledge-mode="AUTO" ❹
                                  advice-chain="" ❺
                                  channel-transacted="" ❻
                                  concurrent-consumers="" ❼
                                  connection-factory="" ❽
                                  error-channel="" ❾
                                  expose-listener-channel="" ❿
                                  header-mapper="" 11
                                  mapped-request-headers="" 12
                                  listener-container="" 13
                                  message-converter="" 14
                                  message-properties-converter="" 15
                                  phase="" 16
                                  prefetch-count="" 17
                                  receive-timeout="" 18
                                  recovery-interval="" 19
                                  missing-queues-fatal="" 20
                                  shutdown-timeout="" 21
                                  task-executor="" 22
                                  transaction-attribute="" 23
                                  transaction-manager="" 24
                                  tx-size="" 25
                                  consumers-per-queue /> 26
```

❶ Unique ID for this adapter. *Optional*.

❷ Message Channel to which converted Messages should be sent. *Required*.

❸ Names of the AMQP Queues from which Messages should be consumed (comma-separated list).*Required*.

❹ Acknowledge Mode for the `MessageListenerContainer`. When set to MANUAL, the delivery tag and channel are provided in message headers `amqp_deliveryTag` and `amqp_channel` respectively; the user application is responsible for acknowledgement. NONE means no acknowledgements (autoAck); AUTO means the adapter's container will acknowledge when the downstream flow completes.*Optional (Defaults to AUTO)* see the section called "CompletableFuture".

❺ Extra AOP Advice(s) to handle cross cutting behavior associated with this Inbound Channel Adapter. *Optional*.

❻ Flag to indicate that channels created by this component will be transactional. If true, tells the framework to use a transactional channel and to end all operations (send or receive) with a commit or rollback depending on the outcome, with an exception signalling a rollback. *Optional (Defaults to false)*.

❼ Specify the number of concurrent consumers to create. Default is 1. Raising the number of concurrent consumers is recommended in order to scale the consumption of messages coming in from a queue. However, note that any ordering guarantees are lost once multiple consumers are registered. In general, use 1 consumer for low-volume queues. Not allowed when *consumers-per-queue* is set. *Optional*.

❽ Bean reference to the RabbitMQ ConnectionFactory. *Optional (Defaults to* connectionFactory*)*.

❾ Message Channel to which error Messages should be sent. *Optional*.

❿ Shall the listener channel (com.rabbitmq.client.Channel) be exposed to a registered `ChannelAwareMessageListener`. *Optional (Defaults to true)*.

11 A reference to an `AmqpHeaderMapper` to use when receiving AMQP Messages. *Optional*. By default only standard AMQP properties (e.g. `contentType`) will be copied to Spring Integration `MessageHeaders`. Any user-defined headers within the AMQP `MessageProperties` will NOT

be copied to the Message by the default `DefaultAmqpHeaderMapper`. Not allowed if *request-header-names* is provided.

12 Comma-separated list of names of AMQP Headers to be mapped from the AMQP request into the MessageHeaders. This can only be provided if the *header-mapper* reference is not provided. The values in this list can also be simple patterns to be matched against the header names (e.g. "*" or "foo*, bar" or "*foo").

13 Reference to the `AbstractMessageListenerContainer` to use for receiving AMQP Messages. If this attribute is provided, then no other attribute related to the listener container configuration should be provided. In other words, by setting this reference, you must take full responsibility of the listener container configuration. The only exception is the MessageListener itself. Since that is actually the core responsibility of this Channel Adapter implementation, the referenced listener container must NOT already have its own MessageListener configured. *Optional*.

14 The MessageConverter to use when receiving AMQP Messages. *Optional*.

15 The MessagePropertiesConverter to use when receiving AMQP Messages. *Optional*.

16 Specify the phase in which the underlying `AbstractMessageListenerContainer` should be started and stopped. The startup order proceeds from lowest to highest, and the shutdown order is the reverse of that. By default this value is Integer.MAX_VALUE meaning that this container starts as late as possible and stops as soon as possible. *Optional*.

17 Tells the AMQP broker how many messages to send to each consumer in a single request. Often this can be set quite high to improve throughput. It should be greater than or equal to the transaction size (see attribute "tx-size"). *Optional (Defaults to 1)*.

18 Receive timeout in milliseconds. *Optional (Defaults to 1000)*.

19 Specifies the interval between recovery attempts of the underlying `AbstractMessageListenerContainer` (in milliseconds) .*Optional (Defaults to 5000)*.

20 If *true*, and none of the queues are available on the broker, the container will throw a fatal exception during startup and will stop if the queues are deleted when the container is running (after making 3 attempts to passively declare the queues). If false, the container will not throw an exception and go into recovery mode, attempting to restart according to the `recovery-interval`. *Optional (Defaults to `true`)*.

21 The time to wait for workers in milliseconds after the underlying `AbstractMessageListenerContainer` is stopped, and before the AMQP connection is forced closed. If any workers are active when the shutdown signal comes they will be allowed to finish processing as long as they can finish within this timeout. Otherwise the connection is closed and messages remain unacked (if the channel is transactional). *Optional (Defaults to 5000)*.

22 By default, the underlying `AbstractMessageListenerContainer` uses a SimpleAsyncTaskExecutor implementation, that fires up a new Thread for each task, executing it asynchronously. By default, the number of concurrent threads is unlimited. **NOTE:** This implementation does not reuse threads. Consider a thread-pooling TaskExecutor implementation as an alternative. *Optional (Defaults to SimpleAsyncTaskExecutor)*.

23 By default the underlying `AbstractMessageListenerContainer` creates a new instance of the DefaultTransactionAttribute (takes the EJB approach to rolling back on runtime, but not checked exceptions. *Optional (Defaults to DefaultTransactionAttribute)*.

24 Sets a Bean reference to an external `PlatformTransactionManager` on the underlying AbstractMessageListenerContainer. The transaction manager works in conjunction with the "channel-transacted" attribute. If there is already a transaction in progress when the framework is sending or receiving a message, and the channelTransacted flag is true, then the commit or rollback of the messaging transaction will be deferred until the end of the current transaction. If the channelTransacted flag is false, then no transaction semantics apply to the messaging operation (it is auto-acked). For further information see Transactions with Spring AMQP. *Optional*.

25 Tells the `SimpleMessageListenerContainer` how many messages to process in a single transaction (if the channel is transactional). For best results it should be less than or equal to the set "prefetch-count". Not allowed when *consumers-per-queue* is set. *Optional (Defaults to 1)*.

26 Indicates that the underlying listener container should be a `DirectMessageListenerContainer` instead of the default `SimpleMessageListenerContainer`. Refer to the Spring AMQP Reference Manual for more information.

container

Note that when configuring an external container, you cannot use the **Spring AMQP** namespace to define the container. This is because the namespace requires at least one `<listener/>` element. In this environment, the listener is internal to the adapter. For this reason, you must define the container using a normal Spring `<bean/>` definition, such as:

```
<bean id="container"
 class="org.springframework.amqp.rabbit.listener.SimpleMessageListenerContainer">
    <property name="connectionFactory" ref="connectionFactory" />
    <property name="queueNames" value="foo.queue" />
    <property name="defaultRequeueRejected" value="false"/>
</bean>
```

Important

Even though the Spring Integration JMS and AMQP support is very similar, important differences exist. The JMS Inbound Channel Adapter is using a `JmsDestinationPollingSource` under the covers and expects a configured Poller. The AMQP Inbound Channel Adapter uses an `AbstractMessageListenerContainer` and is message driven. In that regard, it is more similar to the JMS Message Driven Channel Adapter.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class AmqpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(AmqpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public MessageChannel amqpInputChannel() {
        return new DirectChannel();
    }

    @Bean
    public AmqpInboundChannelAdapter inbound(SimpleMessageListenerContainer listenerContainer,
            @Qualifier("amqpInputChannel") MessageChannel channel) {
        AmqpInboundChannelAdapter adapter = new AmqpInboundChannelAdapter(listenerContainer);
        adapter.setOutputChannel(channel);
        return adapter;
    }

    @Bean
    public SimpleMessageListenerContainer container(ConnectionFactory connectionFactory) {
        SimpleMessageListenerContainer container =
                                   new SimpleMessageListenerContainer(connectionFactory);
        container.setQueueNames("foo");
        container.setConcurrentConsumers(2);
        // ...
        return container;
    }

    @Bean
    @ServiceActivator(inputChannel = "amqpInputChannel")
    public MessageHandler handler() {
        return new MessageHandler() {

            @Override
            public void handleMessage(Message<?> message) throws MessagingException {
                System.out.println(message.getPayload());
            }

        };
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class AmqpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(AmqpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow amqpInbound(ConnectionFactory connectionFactory) {
        return IntegrationFlows.from(Amqp.inboundAdapter(connectionFactory, "foo"))
                .handle(m -> System.out.println(m.getPayload()))
                .get();
    }

}
```

=== Polled Inbound Channel Adapter

Starting with *version 5.0.1*, a polled channel adapter is provided, allowing fetching individual messages on-demand, for example with a `MessageSourcePollingTemplate` or a poller. See the section called “Deferred Acknowledgment Pollable Message Source” for more information.

It does not currently have XML configuration.

```
@Bean
public AmqpMessageSource source(ConnectionFactory connectionFactory) {
    return new AmpqpMessageSource(connectionFactory, "someQueue");
}
```

Refer to the javadocs for configuration properties.

With the Java DSL:

```
@Bean
public IntegrationFlow flow() {
    return IntegrationFlows.from(Amqp.inboundPolledAdapter(connectionFactory(), DSL_QUEUE),
                    e -> e.poller(Pollers.fixedDelay(1_000)).autoStartup(false))
            .handle(p -> {
                ...
            })
            .get();
}
```

=== Inbound Gateway

The inbound gateway supports all the attributes on the inbound channel adapter (except *channel* is replaced by *request-channel*), plus some additional attributes:

```
<int-amqp:inbound-gateway
                          id="inboundGateway" ❶
                          request-channel="myRequestChannel" ❷
                          header-mapper="" ❸
                          mapped-request-headers="" ❹
                          mapped-reply-headers="" ❺
                          reply-channel="myReplyChannel" ❻
                          reply-timeout="1000"  ❼
                          amqp-template="" ❽
                          default-reply-to="" /> ❾
```

❶ Unique ID for this adapter. *Optional*.

❷ Message Channel to which converted Messages should be sent. *Required*.

❸ A reference to an `AmqpHeaderMapper` to use when receiving AMQP Messages. *Optional*. By default only standard AMQP properties (e.g. `contentType`) will be copied to and from Spring Integration `MessageHeaders`. Any user-defined headers within the AMQP `MessageProperties` will NOT be copied to or from an AMQP Message by the default `DefaultAmqpHeaderMapper`. Not allowed if *request-header-names* or *reply-header-names* is provided.

❹ Comma-separated list of names of AMQP Headers to be mapped from the AMQP request into the `MessageHeaders`. This can only be provided if the *header-mapper* reference is not provided. The values in this list can also be simple patterns to be matched against the header names (e.g. `"\*"` or `"foo*, bar"` or `"*foo"`).

❺ Comma-separated list of names of `MessageHeaders` to be mapped into the AMQP Message Properties of the AMQP reply message. All standard Headers (e.g., `contentType`) will be mapped to AMQP Message Properties while user-defined headers will be mapped to the *headers* property.

This can only be provided if the *header-mapper* reference is not provided. The values in this list can also be simple patterns to be matched against the header names (e.g. `"\*"` or `"foo*, bar"` or `"*foo"`).

❻ Message Channel where reply Messages will be expected. *Optional*.

❼ Used to set the `receiveTimeout` on the underlying `org.springframework.integration.core.MessagingTemplate` for receiving messages from the reply channel. If not specified this property will default to "1000" (1 second). Only applies if the container thread hands off to another thread before the reply is sent.

❽ The customized `AmqpTemplate` bean reference to have more control for the reply messages to send or you can provide an alternative implementation to the `RabbitTemplate`.

❾ The `replyTo` `org.springframework.amqp.core.Address` to be used when the `requestMessage` doesn't have `replyTo` property. If this option isn't specified, no `amqp-template` is provided, and no `replyTo` property exists in the request message, an `IllegalStateException` is thrown because the reply can't be routed. If this option isn't specified, and an external `amqp-template` is provided, no exception will be thrown. You *must* either specify this option, or configure a default `exchange` and `routingKey` on that template, if you anticipate cases when no `replyTo` property exists in the request message.

See the note in the section called “CompletableFuture” about configuring the `listener-container` attribute.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound gateway using Java configuration:

```
@SpringBootApplication
public class AmqpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(AmqpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public MessageChannel amqpInputChannel() {
        return new DirectChannel();
    }

    @Bean
    public AmqpInboundGateway inbound(SimpleMessageListenerContainer listenerContainer,
            @Qualifier("amqpInputChannel") MessageChannel channel) {
        AmqpInboundGateway gateway = new AmqpInboundGateway(listenerContainer);
        gateway.setRequestChannel(channel);
        gateway.setDefaultReplyTo("bar");
        return gateway;
    }

    @Bean
    public SimpleMessageListenerContainer container(ConnectionFactory connectionFactory) {
        SimpleMessageListenerContainer container =
                        new SimpleMessageListenerContainer(connectionFactory);
        container.setQueueNames("foo");
        container.setConcurrentConsumers(2);
        // ...
        return container;
    }

    @Bean
    @ServiceActivator(inputChannel = "amqpInputChannel")
    public MessageHandler handler() {
        return new AbstractReplyProducingMessageHandler() {

            @Override
            protected Object handleRequestMessage(Message<?> requestMessage) {
                return "reply to " + requestMessage.getPayload();
            }

        };
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound gateway using the Java DSL:

```
@SpringBootApplication
public class AmqpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(AmqpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean // return the upper cased payload
    public IntegrationFlow amqpInboundGateway(ConnectionFactory connectionFactory) {
        return IntegrationFlows.from(Amqp.inboundGateway(connectionFactory, "foo"))
                .transform(String.class, String::toUpperCase)
                .get();
    }

}
```

=== Inbound Endpoint Acknowledge Mode

By default the inbound endpoints use acknowledge mode `AUTO`, which means the container automatically *acks* the message when the downstream integration flow completes (or a message is handed off to another thread using a `QueueChannel` or `ExecutorChannel`). Setting the mode to `NONE` configures the consumer such that acks are not used at all (the broker automatically acks the message as soon as it is sent). Setting the mode to `MANUAL` allows user code to ack the message at some other point during processing. To support this, with this mode, the endpoints provide the `Channel` and `deliveryTag` in the `amqp_channel` and `amqp_deliveryTag` headers respectively.

You can perform any valid rabbit command on the `Channel` but, generally, only `basicAck` and `basicNack` (or `basicReject`) would be used. In order to not interfere with the operation of the container, you should not retain a reference to the channel and just use it in the context of the current message.

Note

Since the `Channel` is a reference to a "live" object, it cannot be serialized and will be lost if a message is persisted.

This is an example of how you might use `MANUAL` acknowledgement:

```
@ServiceActivator(inputChannel = "foo", outputChannel = "bar")
public Object handle(@Payload String payload, @Header(AmqpHeaders.CHANNEL) Channel channel,
        @Header(AmqpHeaders.DELIVERY_TAG) Long deliveryTag) throws Exception {

    // Do some processing

    if (allOK) {
        channel.basicAck(deliveryTag, false);

        // perhaps do some more processing

    }
    else {
        channel.basicNack(deliveryTag, false, true);
    }
    return someResultForDownStreamProcessing;
}
```

=== Outbound Channel Adapter

A configuration sample for an AMQP Outbound Channel Adapter is shown below.

```
<int-amqp:outbound-channel-adapter id="outboundAmqp" ❶
                               channel="outboundChannel" ❷
                               amqp-template="myAmqpTemplate" ❸
                               exchange-name="" ❹
                               exchange-name-expression="" ❺
                               order="1" ❻
                               routing-key="" ❼
                               routing-key-expression="" ❽
                               default-delivery-mode"" ❾
                               confirm-correlation-expression="" ❿
                               confirm-ack-channel="" 11
                               confirm-nack-channel="" 12
                               return-channel="" 13
                               error-message-strategy="" 14
                               header-mapper="" 15
                               mapped-request-headers="" 16
                               lazy-connect="true" /> 17
```

❶ Unique ID for this adapter. *Optional*.

❷ Message Channel to which Messages should be sent in order to have them converted and published to an AMQP Exchange. *Required*.

❸ Bean Reference to the configured AMQP Template *Optional (Defaults to "amqpTemplate")*.

❹ The name of the AMQP Exchange to which Messages should be sent. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name-expression*. *Optional*.

❺ A SpEL expression that is evaluated to determine the name of the AMQP Exchange to which Messages should be sent, with the message as the root object. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name*. *Optional*.

❻ The order for this consumer when multiple consumers are registered thereby enabling load-balancing and/or failover. *Optional (Defaults to Ordered.LOWEST_PRECEDENCE [=Integer.MAX_VALUE])*.

❼ The fixed routing-key to use when sending Messages. By default, this will be an empty String. Mutually exclusive with *routing-key-expression*.*Optional*.

❽ A SpEL expression that is evaluated to determine the routing-key to use when sending Messages, with the message as the root object (e.g. *payload.key*). By default, this will be an empty String. Mutually exclusive with *routing-key*. *Optional*.

❾ The default delivery mode for messages; `PERSISTENT` or `NON_PERSISTENT`. Overridden if the `header-mapper` sets the delivery mode. The `DefaultHeaderMapper` sets the value if the Spring Integration message header `amqp_deliveryMode` is present. If this attribute is not supplied and the header mapper doesn't set it, the default depends on the underlying spring-amqp `MessagePropertiesConverter` used by the `RabbitTemplate`. If that is not customized at all, the default is `PERSISTENT`. *Optional*.

❿ An expression defining correlation data. When provided, this configures the underlying amqp template to receive publisher confirms. Requires a dedicated `RabbitTemplate` and a `CachingConnectionFactory` with the `publisherConfirms` property set to `true`. When a publisher confirm is received, and correlation data is supplied, it is written to either the confirm-ack-channel, or the confirm-nack-channel, depending on the confirmation type. The payload of the confirm is the correlation data as defined by this expression and the message will have a header *amqp_publishConfirm* set to true (ack) or false (nack). Examples: "`headers['myCorrelationData']`", "`payload`". Starting with *version 4.1* the `amqp_publishConfirmNackCause` message header has been added. It contains the `cause` of a *nack* for publisher confirms. Starting with *version 4.2*, if the expression resolves to a `Message<?>` instance (such as "`#this`"), the message emitted on the ack/nack channel is based on that message, with the additional header(s) added. Previously, a new message was created with the correlation data as its payload, regardless of type. *Optional*.

11 The channel to which positive (ack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression*. If the expression is `#root` or `#this`, the message is built from the original message, with the `amqp_publishConfirm` header set to `true`. *Optional, default=nullChannel*.

12 The channel to which negative (nack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression* (if there is no `ErrorMessageStrategy` configured). If the expression is `#root` or `#this`, the message is built from the original message, with the `amqp_publishConfirm` header set to `false`. When there is an `ErrorMessageStrategy`, the message will be an `ErrorMessage` with a `NackedAmqpMessageException` payload. *Optional, default=nullChannel*.

13 The channel to which returned messages are sent. When provided, the underlying amqp template is configured to return undeliverable messages to the adapter. When there is no `ErrorMessageStrategy` configured, the message will be constructed from the data received from amqp, with the following additional headers: *amqp_returnReplyCode, amqp_returnReplyText, amqp_returnExchange, amqp_returnRoutingKey*. When there is an `ErrorMessageStrategy`, the message will be an `ErrorMessage` with a `ReturnedAmqpMessageException` payload. *Optional*.

14 A reference to an `ErrorMessageStrategy` implementation used to build `ErrorMessage` s when sending returned or negatively acknowedged messages.

15 A reference to an `AmqpHeaderMapper` to use when sending AMQP Messages. By default only standard AMQP properties (e.g. `contentType`) will be copied to the Spring Integration `MessageHeaders`. Any user-defined headers will NOT be copied to the Message by the default`DefaultAmqpHeaderMapper`. Not allowed if *request-header-names* is provided. *Optional*.

16 Comma-separated list of names of AMQP Headers to be mapped from the `MessageHeaders` to the AMQP Message. Not allowed if the *header-mapper* reference is provided. The values in this list can also be simple patterns to be matched against the header names (e.g. `"\*"` or `"foo*, bar"` or `"*foo"`).

17 When set to `false`, the endpoint will attempt to connect to the broker during application context initialization. This allows "fail fast" detection of bad configuration, but will also cause initialization to fail if the broker is down. When true (default), the connection is established (if it doesn't already exist because some other component established it) when the first message is sent.

return-channel

Using a `return-channel` requires a `RabbitTemplate` with the `mandatory` property set to `true`, and a `CachingConnectionFactory` with the `publisherReturns` property set to `true`. When using multiple outbound endpoints with returns, a separate `RabbitTemplate` is needed for each endpoint.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the outbound adapter using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class AmqpJavaApplication {

    public static void main(String[] args) {
         ConfigurableApplicationContext context =
              new SpringApplicationBuilder(AmqpJavaApplication.class)
                       .web(false)
                       .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         gateway.sendToRabbit("foo");
    }

    @Bean
    @ServiceActivator(inputChannel = "amqpOutboundChannel")
    public AmqpOutboundEndpoint amqpOutbound(AmqpTemplate amqpTemplate) {
        AmqpOutboundEndpoint outbound = new AmqpOutboundEndpoint(amqpTemplate);
        outbound.setRoutingKey("foo"); // default exchange - route to queue 'foo'
        return outbound;
    }

    @Bean
    public MessageChannel amqpOutboundChannel() {
        return new DirectChannel();
    }

    @MessagingGateway(defaultRequestChannel = "amqpOutboundChannel")
    public interface MyGateway {

        void sendToRabbit(String data);

    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the outbound adapter using the Java DSL:

```
@SpringBootApplication
@IntegrationComponentScan
public class AmqpJavaApplication {

    public static void main(String[] args) {
         ConfigurableApplicationContext context =
                  new SpringApplicationBuilder(AmqpJavaApplication.class)
                          .web(false)
                          .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         gateway.sendToRabbit("foo");
    }

    @Bean
    public IntegrationFlow amqpOutbound(AmqpTemplate amqpTemplate) {
        return IntegrationFlows.from(amqpOutboundChannel())
                .handle(Amqp.outboundAdapter(amqpTemplate)
                            .routingKey("foo")) // default exchange - route to queue 'foo'
                .get();
    }

    @Bean
    public MessageChannel amqpOutboundChannel() {
        return new DirectChannel();
    }

    @MessagingGateway(defaultRequestChannel = "amqpOutboundChannel")
    public interface MyGateway {

        void sendToRabbit(String data);

    }
}
```

=== Outbound Gateway

Configuration for an AMQP Outbound Gateway is shown below.

```
<int-amqp:outbound-gateway id="inboundGateway" ❶
                           request-channel="myRequestChannel" ❷
                           amqp-template="" ❸
                           exchange-name="" ❹
                           exchange-name-expression="" ❺
                           order="1" ❻
                           reply-channel="" ❼
                           reply-timeout="" ❽
                           requires-reply="" ❾
                           routing-key="" ❿
                           routing-key-expression="" 11
                           default-delivery-mode"" 12
                           confirm-correlation-expression="" 13
                           confirm-ack-channel="" 14
                           confirm-nack-channel="" 15
                           return-channel="" 16
                           error-message-strategy="" 17
                           lazy-connect="true" /> 18
```

❶ Unique ID for this adapter. *Optional*.

❷ Message Channel to which Messages should be sent in order to have them converted and published to an AMQP Exchange. *Required*.

❸ Bean Reference to the configured AMQP Template *Optional (Defaults to "amqpTemplate")*.

❹ The name of the AMQP Exchange to which Messages should be sent. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name-expression*. *Optional*.

5 A SpEL expression that is evaluated to determine the name of the AMQP Exchange to which Messages should be sent, with the message as the root object. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name*. *Optional*.

6 The order for this consumer when multiple consumers are registered thereby enabling load-balancing and/or failover. *Optional (Defaults to Ordered.LOWEST_PRECEDENCE [=Integer.MAX_VALUE])*.

7 Message Channel to which replies should be sent after being received from an AMQP Queue and converted.*Optional*.

8 The time the gateway will wait when sending the reply message to the `reply-channel`. This only applies if the `reply-channel` can block - such as a `QueueChannel` with a capacity limit that is currently full. Default: infinity.

9 When `true`, the gateway will throw an exception if no reply message is received within the `AmqpTemplate`'s `replyTimeout` property. Default: `true`.

10 The routing-key to use when sending Messages. By default, this will be an empty String. Mutually exclusive with *routing-key-expression*. *Optional*.

11 A SpEL expression that is evaluated to determine the routing-key to use when sending Messages, with the message as the root object (e.g. *payload.key*). By default, this will be an empty String. Mutually exclusive with *routing-key*. *Optional*.

12 The default delivery mode for messages; `PERSISTENT` or `NON_PERSISTENT`. Overridden if the `header-mapper` sets the delivery mode. The `DefaultHeaderMapper` sets the value if the Spring Integration message header `amqp_deliveryMode` is present. If this attribute is not supplied and the header mapper doesn't set it, the default depends on the underlying spring-amqp `MessagePropertiesConverter` used by the `RabbitTemplate`. If that is not customized at all, the default is `PERSISTENT`. *Optional*.

13 Since *version 4.2*. An expression defining correlation data. When provided, this configures the underlying amqp template to receive publisher confirms. Requires a dedicated `RabbitTemplate` and a `CachingConnectionFactory` with the `publisherConfirms` property set to `true`. When a publisher confirm is received, and correlation data is supplied, it is written to either the confirm-ack-channel, or the confirm-nack-channel, depending on the confirmation type. The payload of the confirm is the correlation data as defined by this expression and the message will have a header *amqp_publishConfirm* set to true (ack) or false (nack). For nacks, an additional header `amqp_publishConfirmNackCause` is provided. Examples: "headers[*myCorrelationData*]", "payload". If the expression resolves to a `Message<?>` instance (such as "`#this`"), the message emitted on the ack/nack channel is based on that message, with the additional header(s) added. Previously, a new message was created with the correlation data as its payload, regardless of type. *Optional*.

14 The channel to which positive (ack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression*. If the expression is `#root` or `#this`, the message is built from the original message, with the `amqp_publishConfirm` header set to `true`. *Optional, default=nullChannel*.

15 The channel to which negative (nack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression* (if there is no `ErrorMessageStrategy` configured). If the expression is `#root` or `#this`, the message is built from the original message, with the `amqp_publishConfirm` header set to `false`. When there is an `ErrorMessageStrategy`, the message will be an `ErrorMessage` with a `NackedAmqpMessageException` payload. *Optional, default=nullChannel*.

16 The channel to which returned messages are sent. When provided, the underlying amqp template is configured to return undeliverable messages to the adapter. When there is no `ErrorMessageStrategy` configured, the message will be constructed from the data received from amqp, with the following additional headers: *amqp_returnReplyCode, amqp_returnReplyText,*

amqp_returnExchange, amqp_returnRoutingKey. When there is an `ErrorMessageStrategy`, the message will be an `ErrorMessage` with a `ReturnedAmqpMessageException` payload. *Optional*.

17 A reference to an `ErrorMessageStrategy` implementation used to build `ErrorMessage` s when sending returned or negatively acknowedged messages.

18 When set to `false`, the endpoint will attempt to connect to the broker during application context initialization. This allows "fail fast" detection of bad configuration, by logging an error message if the broker is down. When true (default), the connection is established (if it doesn't already exist because some other component established it) when the first message is sent.

return-channel

Using a `return-channel` requires a `RabbitTemplate` with the `mandatory` property set to `true`, and a `CachingConnectionFactory` with the `publisherReturns` property set to `true`. When using multiple outbound endpoints with returns, a separate `RabbitTemplate` is needed for each endpoint.

Important

The underlying `AmqpTemplate` has a default `replyTimeout` of 5 seconds. If you require a longer timeout, it must be configured on the `template`.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the outbound gateway using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class AmqpJavaApplication {

    public static void main(String[] args) {
         ConfigurableApplicationContext context =
                new SpringApplicationBuilder(AmqpJavaApplication.class)
                       .web(false)
                       .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         String reply = gateway.sendToRabbit("foo");
         System.out.println(reply);
    }

    @Bean
    @ServiceActivator(inputChannel = "amqpOutboundChannel")
    public AmqpOutboundEndpoint amqpOutbound(AmqpTemplate amqpTemplate) {
        AmqpOutboundEndpoint outbound = new AmqpOutboundEndpoint(amqpTemplate);
        outbound.setExpectReply(true);
        outbound.setRoutingKey("foo"); // default exchange - route to queue 'foo'
        return outbound;
    }

    @Bean
    public MessageChannel amqpOutboundChannel() {
        return new DirectChannel();
    }

    @MessagingGateway(defaultRequestChannel = "amqpOutboundChannel")
    public interface MyGateway {

        String sendToRabbit(String data);

    }

}
```

Notice that the only difference between the outbound adapter and outbound gateway configuration is the setting of the `expectReply` property.

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the outbound adapter using the Java DSL:

```
@SpringBootApplication
@IntegrationComponentScan
public class AmqpJavaApplication {

    public static void main(String[] args) {
         ConfigurableApplicationContext context =
                 new SpringApplicationBuilder(AmqpJavaApplication.class)
                      .web(false)
                      .run(args);
         RabbitTemplate template = context.getBean(RabbitTemplate.class);
         MyGateway gateway = context.getBean(MyGateway.class);
         String reply = gateway.sendToRabbit("foo");
         System.out.println(reply);
    }

    @Bean
    public IntegrationFlow amqpOutbound(AmqpTemplate amqpTemplate) {
        return IntegrationFlows.from(amqpOutboundChannel())
                .handle(Amqp.outboundGateway(amqpTemplate)
                        .routingKey("foo")) // default exchange - route to queue 'foo'
                .get();
    }

    @Bean
    public MessageChannel amqpOutboundChannel() {
        return new DirectChannel();
    }

    @MessagingGateway(defaultRequestChannel = "amqpOutboundChannel")
    public interface MyGateway {

        String sendToRabbit(String data);

    }
}
```

=== Async Outbound Gateway

The gateway discussed in the previous section is synchronous, in that the sending thread is suspended until a reply is received (or a timeout occurs). Spring Integration *version 4.3* added this asynchronous gateway, which uses the `AsyncRabbitTemplate` from Spring AMQP. When a message is sent, the thread returns immediately after the send completes, and the reply is sent on the template's listener container thread when it is received. This can be useful when the gateway is invoked on a poller thread; the thread is released and is available for other tasks in the framework.

Configuration for an AMQP Async Outbound Gateway is shown below.

```
<int-amqp:outbound-gateway id="inboundGateway" ❶
                           request-channel="myRequestChannel" ❷
                           async-template="" ❸
                           exchange-name="" ❹
                           exchange-name-expression="" ❺
                           order="1" ❻
                           reply-channel="" ❼
                           reply-timeout="" ❽
                           requires-reply="" ❾
                           routing-key="" ❿
                           routing-key-expression="" 11
                           default-delivery-mode"" 12
                           confirm-correlation-expression="" 13
                           confirm-ack-channel="" 14
                           confirm-nack-channel="" 15
                           return-channel="" 16
                           lazy-connect="true" /> 17
```

❶ Unique ID for this adapter. *Optional*.

❷ Message Channel to which Messages should be sent in order to have them converted and published to an AMQP Exchange. *Required*.

❸ Bean Reference to the configured `AsyncRabbitTemplate` *Optional (Defaults to "asyncRabbitTemplate")*.

❹ The name of the AMQP Exchange to which Messages should be sent. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name-expression*. *Optional*.

❺ A SpEL expression that is evaluated to determine the name of the AMQP Exchange to which Messages should be sent, with the message as the root object. If not provided, Messages will be sent to the default, no-name Exchange. Mutually exclusive with *exchange-name*. *Optional*.

❻ The order for this consumer when multiple consumers are registered thereby enabling load-balancing and/or failover. *Optional (Defaults to Ordered.LOWEST_PRECEDENCE [=Integer.MAX_VALUE])*.

❼ Message Channel to which replies should be sent after being received from an AMQP Queue and converted. *Optional*.

❽ The time the gateway will wait when sending the reply message to the `reply-channel`. This only applies if the `reply-channel` can block - such as a `QueueChannel` with a capacity limit that is currently full. Default: infinity.

❾ When `true`, the gateway will send an error message to the inbound message's `errorChannel` header, if present or otherwise to the default `errorChannel` (if available), when no reply message is received within the `AsyncRabbitTemplate`'s `receiveTimeout` property. Default: `true`.

❿ The routing-key to use when sending Messages. By default, this will be an empty String. Mutually exclusive with *routing-key-expression*. *Optional*.

11 A SpEL expression that is evaluated to determine the routing-key to use when sending Messages, with the message as the root object (e.g. *payload.key*). By default, this will be an empty String. Mutually exclusive with *routing-key*. *Optional*.

12 The default delivery mode for messages; `PERSISTENT` or `NON_PERSISTENT`. Overridden if the `header-mapper` sets the delivery mode. The `DefaultHeaderMapper` sets the value if the Spring Integration message header `amqp_deliveryMode` is present. If this attribute is not supplied and the header mapper doesn't set it, the default depends on the underlying spring-amqp `MessagePropertiesConverter` used by the `RabbitTemplate`. If that is not customized at all, the default is `PERSISTENT`. *Optional*.

13 An expression defining correlation data. When provided, this configures the underlying amqp template to receive publisher confirms. Requires a dedicated `RabbitTemplate` and a `CachingConnectionFactory` with the `publisherConfirms` property set to `true`. When a publisher confirm is received, and correlation data is supplied, it is written to either the confirm-ack-channel, or the confirm-nack-channel, depending on the confirmation type. The payload of the confirm is the correlation data as defined by this expression and the message will have a header *amqp_publishConfirm* set to true (ack) or false (nack). For nacks, an additional header `amqp_publishConfirmNackCause` is provided. Examples: "headers[*myCorrelationData*]", "payload". If the expression resolves to a `Message<?>` instance (such as "`#this`"), the message emitted on the ack/nack channel is based on that message, with the additional header(s) added. *Optional*.

14 The channel to which positive (ack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression*. Requires the underlying `AsyncRabbitTemplate` to have its `enableConfirms` property set to true. *Optional, default=nullChannel*.

15 Since *version 4.2*. The channel to which negative (nack) publisher confirms are sent; payload is the correlation data defined by the *confirm-correlation-expression*. Requires the

underlying `AsyncRabbitTemplate` to have its `enableConfirms` property set to true. *Optional, default=nullChannel*.

16 The channel to which returned messages are sent. When provided, the underlying amqp template is configured to return undeliverable messages to the gateway. The message will be constructed from the data received from amqp, with the following additional headers: *amqp_returnReplyCode, amqp_returnReplyText, amqp_returnExchange, amqp_returnRoutingKey*. Requires the underlying `AsyncRabbitTemplate` to have its `mandatory` property set to true. *Optional*.

17 When set to `false`, the endpoint will attempt to connect to the broker during application context initialization. This allows "fail fast" detection of bad configuration, by logging an error message if the broker is down. When true (default), the connection is established (if it doesn't already exist because some other component established it) when the first message is sent.

Also see the section called "CompletableFuture" for more information.

RabbitTemplate

When using confirms and returns, it is recommended that the `RabbitTemplate` wired into the `AsyncRabbitTemplate` be dedicated. Otherwise, unexpected side-effects may be encountered.

==== Configuring with Java Configuration

The following configuration provides an example of configuring the outbound gateway using Java configuration:

```java
@Configuration
public class AmqpAsyncConfig {

    @Bean
    @ServiceActivator(inputChannel = "amqpOutboundChannel")
    public AsyncAmqpOutboundGateway amqpOutbound(AmqpTemplate asyncTemplate) {
        AsyncAmqpOutboundGateway outbound = new AsyncAmqpOutboundGateway(asyncTemplate);
        outbound.setRoutingKey("foo"); // default exchange - route to queue 'foo'
        return outbound;
    }

    @Bean
    public AsyncRabbitTemplate asyncTemplate(RabbitTemplate rabbitTemplate,
                     SimpleMessageListenerContainer replyContainer) {
        return new AsyncRabbitTemplate(rabbitTemplate, replyContainer);
    }

    @Bean
    public SimpleMessageListenerContainer replyContainer() {
        SimpleMessageListenerContainer container = new SimpleMessageListenerContainer(ccf);
        container.setQueueNames("asyncRQ1");
        return container;
    }

    @Bean
    public MessageChannel amqpOutboundChannel() {
        return new DirectChannel();
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the outbound adapter using the Java DSL:

```
@SpringBootApplication
public class AmqpAsyncApplication {

    public static void main(String[] args) {
         ConfigurableApplicationContext context =
                 new SpringApplicationBuilder(AmqpAsyncApplication.class)
                      .web(false)
                      .run(args);
         MyGateway gateway = context.getBean(MyGateway.class);
         String reply = gateway.sendToRabbit("foo");
         System.out.println(reply);
    }

    @Bean
    public IntegrationFlow asyncAmqpOutbound(AsyncRabbitTemplate asyncRabbitTemplate) {
        return f -> f
                .handle(Amqp.asyncOutboundGateway(asyncRabbitTemplate)
                        .routingKey("foo")); // default exchange - route to queue 'foo'
    }

    @MessagingGateway(defaultRequestChannel = "asyncAmqpOutbound.input")
    public interface MyGateway {

        String sendToRabbit(String data);

    }

}
```

=== Outbound Message Conversion

Spring AMQP 1.4 introduced the `ContentTypeDelegatingMessageConverter` where the actual converter is selected based on the incoming content type message property. This could be used by inbound endpoints.

Spring Integration *version 4.3* now allows the `ContentTypeDelegatingMessageConverter` to be used on outbound endpoints as well - with the `contentType` header specifiying which converter will be used.

The following configures a `ContentTypeDelegatingMessageConverter` with the default converter being the `SimpleMessageConverter` (which handles java serialization and plain text), together with a JSON converter:

```
<amqp:outbound-channel-adapter id="withContentTypeConverter" channel="ctRequestChannel"
                               exchange-name="someExchange"
                               routing-key="someKey"
                               amqp-template="amqpTemplateContentTypeConverter" />

<int:channel id="ctRequestChannel"/>

<rabbit:template id="amqpTemplateContentTypeConverter"
        connection-factory="connectionFactory" message-converter="ctConverter" />

<bean id="ctConverter"
        class="o.s.amqp.support.converter.ContentTypeDelegatingMessageConverter">
    <property name="delegates">
        <map>
            <entry key="application/json">
                <bean class="o.s.amqp.support.converter.Jackson2JsonMessageConverter" />
            </entry>
        </map>
    </property>
</bean>
```

Sending a message to `ctRequestChannel` with the `contentType` header set to `application/json` will cause the JSON converter to be selected.

This applies to both the outbound channel adapter and gateway.

Starting with *version 5.0*, headers that are added to the `MessageProperties` of the outbound message are never overwritten by mapped headers (by default). Previously, this was only the case if the message converter was a `ContentTypeDelegatingMessageConverter` (in that case, the header was mapped first, so that the proper converter could be selected). For other converters, such as the `SimpleMessageConverter`, mapped headers overwrote any headers added by the converter. This caused problems when an outbound message had some left over `contentType` header (perhaps from an inbound channel adapter) and the correct outbound `contentType` was incorrectly overwritten. The work-around was to use a header filter to remove the header before sending the message to the outbound endpoint.

There are, however, cases where the previous behavior is desired. For example, with a `String` payload containing JSON, the `SimpleMessageConverter` is not aware of the content and sets the `contentType` message property to `text/plain`, but your application would like to override that to `application/json` by setting the the `contentType` header of the message sent to the outbound endpoint. The `ObjectToJsonTransformer` does exactly that (by default).

There is now a property on the outbound channel adapter and gateway (as well as AMQP-backed channels) `headersMappedLast`. Setting this to `true` will restore the behavior of overwriting the property added by the converter.

=== Outbound User Id

Spring AMQP *version 1.6* introduced a mechanism to allow the specification of a default user id for outbound messages. It has always been possible to set the `AmqpHeaders.USER_ID` header which will now take precedence over the default. This might be useful to message recipients; for inbound messages, if the message publisher sets the property, it is made available in the `AmqpHeaders.RECEIVED_USER_ID` header. Note that RabbitMQ validates that the user id is the actual user id for the connection or one for which impersonation is allowed.

To configure a default user id for outbound messages, configure it on a `RabbitTemplate` and configure the outbound adapter or gateway to use that template. Similarly, to set the user id property on replies, inject an appropriately configured template into the inbound gateway. See the Spring AMQP documentation for more information.

=== Delayed Message Exchange

Spring AMQP supports the RabbitMQ Delayed Message Exchange Plugin. For inbound messages, the `x-delay` header is mapped to the `AmqpHeaders.RECEIVED_DELAY` header. Setting the `AMQPHeaders.DELAY` header will cause the corresponding `x-delay` header to be set in outbound messages. You can also specify the `delay` and `delayExpression` properties on outbound endpoints (`delay-expression` when using XML configuration). This takes precedence over the `AmqpHeaders.DELAY` header.

=== AMQP Backed Message Channels

There are two Message Channel implementations available. One is point-to-point, and the other is publish/subscribe. Both of these channels provide a wide range of configuration attributes for the underlying AmqpTemplate and SimpleMessageListenerContainer as you have seen on the Channel Adapters and Gateways. However, the examples we'll show here are going to have minimal configuration. Explore the XML schema to view the available attributes.

A point-to-point channel would look like this:

```
<int-amqp:channel id="p2pChannel"/>
```

Under the covers a Queue named "si.p2pChannel" would be declared, and this channel will send to that Queue (technically by sending to the no-name Direct Exchange with a routing key that matches this Queue's name). This channel will also register a consumer on that Queue. If you want the channel to be "pollable" instead of message-driven, then simply provide the "message-driven" flag with a value of `false`:

```
<int-amqp:channel id="p2pPollableChannel"  message-driven="false"/>
```

A publish/subscribe channel would look like this:

```
<int-amqp:publish-subscribe-channel id="pubSubChannel"/>
```

Under the covers a Fanout Exchange named "si.fanout.pubSubChannel" would be declared, and this channel will send to that Fanout Exchange. This channel will also declare a server-named exclusive, auto-delete, non-durable Queue and bind that to the Fanout Exchange while registering a consumer on that Queue to receive Messages. There is no "pollable" option for a publish-subscribe-channel; it must be message-driven.

Starting with *version 4.1* AMQP Backed Message Channels, alongside with `channel-transacted`, support `template-channel-transacted` to separate `transactional` configuration for the `AbstractMessageListenerContainer` and for the `RabbitTemplate`. Note, previously, the `channel-transacted` was `true` by default, now it changed to `false` as standard default value for the `AbstractMessageListenerContainer`.

Prior to *version 4.3*, AMQP-backed channels only supported messages with `Serializable` payloads and headers. The entire message was converted (serialized) and sent to RabbitMQ. Now, you can set the `extract-payload` attribute (or `setExtractPayload()` when using Java configuration) to true. When this flag is `true`, the message payload is converted and the headers mapped, in a similar manner to when using channel adapters. This allows AMQP-backed channels to be used with non-serializable payloads (perhaps with another message converter such as the `Jackson2JsonMessageConverter`). The default mapped headers are discussed in the section called "CompletableFuture". You can modify the mapping by providing custom mappers using the `outbound-header-mapper` and `inbound-header-mapper` attributes. You can now also specify a `default-delivery-mode`, used to set the delivery mode when there is no `amqp_deliveryMode` header. By default, Spring AMQP `MessageProperties` uses `PERSISTENT` delivery mode.

Important

Just as with other persistence-backed channels, AMQP-backed channels are intended to provide message persistence to avoid message loss. They are not intended to distribute work to other peer applications; for that purpose, use channel adapters instead.

Important

Starting with *version 5.0*, the pollable channel now blocks the poller thread for the specified `receiveTimeout` (default 1 second). Previously, unlike other `PollableChannel` s, the thread returned immediately to the scheduler if no message was available, regardless of the receive timeout. Blocking is a little more expensive than just using a `basicGet()` to retrieve a message

> (with no timeout) because a consumer has to be created to receive each message. To restore the previous behavior, set the poller `receiveTimeout` to 0.

==== Configuring with Java Configuration

The following provides an example of configuring the channels using Java configuration:

```
@Bean
public AmqpChannelFactoryBean pollable(ConnectionFactory connectionFactory) {
    AmqpChannelFactoryBean factoryBean = new AmqpChannelFactoryBean();
    factoryBean.setConnectionFactory(connectionFactory);
    factoryBean.setQueueName("foo");
    factoryBean.setPubSub(false);
    return factoryBean;
}

@Bean
public AmqpChannelFactoryBean messageDriven(ConnectionFactory connectionFactory) {
    AmqpChannelFactoryBean factoryBean = new AmqpChannelFactoryBean(true);
    factoryBean.setConnectionFactory(connectionFactory);
    factoryBean.setQueueName("bar");
    factoryBean.setPubSub(false);
    return factoryBean;
}

@Bean
public AmqpChannelFactoryBean pubSub(ConnectionFactory connectionFactory) {
    AmqpChannelFactoryBean factoryBean = new AmqpChannelFactoryBean(true);
    factoryBean.setConnectionFactory(connectionFactory);
    factoryBean.setQueueName("baz");
    factoryBean.setPubSub(false);
    return factoryBean;
}
```

==== Configuring with the Java DSL

The following provides an example of configuring the channels using the Java DSL:

```
@Bean
public IntegrationFlow pollableInFlow(ConnectionFactory connectionFactory) {
    return IntegrationFlows.from(...)
            ...
            .channel(Amqp.pollableChannel(connectionFactory)
                    .queueName("foo"))
            ...
            .get();
}

@Bean
public IntegrationFlow messageDrivenInFow(ConnectionFactory connectionFactory) {
    return IntegrationFlows.from(...)
            ...
            .channel(Amqp.channel(connectionFactory)
                    .queueName("bar"))
            ...
            .get();
}

@Bean
public IntegrationFlow pubSubInFlow(ConnectionFactory connectionFactory) {
    return IntegrationFlows.from(...)
            ...
            .channel(Amqp.publisSubscribeChannel(connectionFactory)
                    .queueName("baz"))
            ...
            .get();
}
```

=== AMQP Message Headers

The Spring Integration AMQP Adapters will map all AMQP properties and headers automatically. (This is a change in 4.3 - previously, only standard headers were mapped). These properties will be copied by default to and from Spring Integration `MessageHeaders` using the DefaultAmqpHeaderMapper.

Of course, you can pass in your own implementation of AMQP specific header mappers, as the adapters have respective properties to support that.

Any user-defined headers within the AMQP MessageProperties WILL be copied to or from an AMQP Message, unless explicitly negated by the *requestHeaderNames* and/or *replyHeaderNames* properties of the `DefaultAmqpHeaderMapper`. For an outbound mapper, no `x-*` headers are mapped by default; see the caution below for the reason why.

To override the default, and revert to the pre-4.3 behavior, use `STANDARD_REQUEST_HEADERS` and `STANDARD_REPLY_HEADERS` in the properties.

> **Tip**
>
> When mapping user-defined headers, the values can also contain simple wildcard patterns (e.g. "foo*" or "*foo") to be matched. * matches all headers.

Starting with *version 4.1*, the `AbstractHeaderMapper` (a `DefaultAmqpHeaderMapper` superclass) allows the `NON_STANDARD_HEADERS` token to be configured for the *requestHeaderNames* and/or *replyHeaderNames* properties (in addition to the existing `STANDARD_REQUEST_HEADERS` and `STANDARD_REPLY_HEADERS`) to map all user-defined headers.

Class `org.springframework.amqp.support.AmqpHeaders` identifies the default headers that will be used by the `DefaultAmqpHeaderMapper`:

- amqp_appId
- amqp_clusterId
- amqp_contentEncoding
- amqp_contentLength
- content-type
- amqp_correlationId
- amqp_delay
- amqp_deliveryMode
- amqp_deliveryTag
- amqp_expiration
- amqp_messageCount
- amqp_messageId

- amqp_receivedDelay
- amqp_receivedDeliveryMode
- amqp_receivedExchange
- amqp_receivedRoutingKey
- amqp_redelivered
- amqp_replyTo
- amqp_timestamp
- amqp_type
- amqp_userId
- amqp_publishConfirm
- amqp_publishConfirmNackCause
- amqp_returnReplyCode
- amqp_returnReplyText
- amqp_returnExchange
- amqp_returnRoutingKey
- amqp_channel
- amqp_consumerTag
- amqp_consumerQueue

Caution

As mentioned above, using a header mapping pattern `*` is a common way to copy all headers. However, this can have some unexpected side-effects because certain RabbitMQ proprietary properties/headers will be copied as well. For example, when you use Federation, the received message may have a property named `x-received-from` which contains the node that sent the message. If you use the wildcard character `*` for the request and reply header mapping on the Inbound Gateway, this header will be copied as well, which may cause some issues with federation; this reply message may be federated back to the sending broker, which will think that a message is looping and is thus silently dropped. If you wish to use the convenience of wildcard header mapping, you may need to filter out some headers in the downstream flow. For example, to avoid copying the `x-received-from` header back to the reply you can use `<int:header-filter ... header-names="x-received-from">` before sending the reply to the AMQP Inbound Gateway. Alternatively, you could explicitly list those properties that you actually want mapped instead of using wildcards. For these reasons, for inbound messages, the mapper by default does not map any `x-*` headers; it also does not map the `deliveryMode` to `amqp_deliveryMode` header, to avoid propagation of that header from an inbound message to an outbound message. Instead, this header is mapped to `amqp_receivedDeliveryMode`, which is not mapped on output.

Starting with *version 4.3*, patterns in the header mappings can be negated by preceding the pattern with `!`. Negated patterns get priority, so a list such as `STANDARD_REQUEST_HEADERS,foo,ba*,!bar,!baz,qux,!foo` will **NOT** map `foo` (nor `bar` nor `baz`); the standard headers plus `bad`, `qux` will be mapped.

Important

If you have a user defined header that begins with `!` that you **do** wish to map, you need to escape it with `\` thus: `STANDARD_REQUEST_HEADERS,\!myBangHeader` and it **WILL** be mapped.

=== AMQP Samples

To experiment with the AMQP adapters, check out the samples available in the Spring Integration Samples Git repository at:

- https://github.com/SpringSource/spring-integration-samples

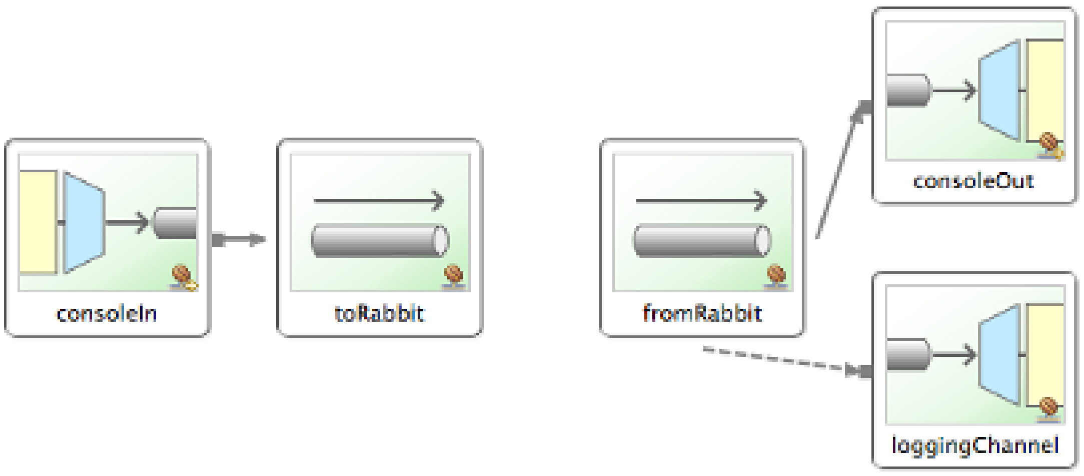
Currently there is one sample available that demonstrates the basic functionality of the Spring Integration AMQP Adapter using an Outbound Channel Adapter and an Inbound Channel Adapter. As AMQP Broker implementation the sample uses RabbitMQ (https://www.rabbitmq.com/).

Note

In order to run the example you will need a running instance of RabbitMQ. A local installation with just the basic defaults will be sufficient. For detailed RabbitMQ installation procedures please visit: https://www.rabbitmq.com/install.html

Once the sample application is started, you enter some text on the command prompt and a message containing that entered text is dispatched to the AMQP queue. In return that message is retrieved via Spring Integration and then printed to the console.

The image belows illustrates the basic set of Spring Integration components used in this sample.



== Spring ApplicationEvent Support

Spring Integration provides support for inbound and outbound `ApplicationEvents` as defined by the underlying Spring Framework. For more information about Spring's support for events and listeners, refer to the [Spring Reference Manual](https://docs.spring.io/spring/docs/current/spring-framework-reference/core.html#context-functionality-events).

=== Receiving Spring Application Events

To receive events and send them to a channel, simply define an instance of Spring Integration's `ApplicationEventListeningMessageProducer`. This class is an implementation of Spring's `ApplicationListener` interface. By default it will pass all received events as Spring Integration Messages. To limit based on the type of event, configure the list of event types that you want to receive with the *eventTypes* property. If a received event has a Message instance as its *source*, then that will be passed as-is. Otherwise, if a SpEL-based "payloadExpression" has been provided, that will be evaluated against the ApplicationEvent instance. If the event's source is not a Message instance and no "payloadExpression" has been provided, then the ApplicationEvent itself will be passed as the payload.

Starting with *version 4.2* the `ApplicationEventListeningMessageProducer` implements `GenericApplicationListener` and can be configured to accept not only `ApplicationEvent` types, but any type for treating *payload events* which are supported since Spring Framework 4.2, too. When the accepted event is an instance of `PayloadApplicationEvent`, its `payload` is used for the message to send.

For convenience namespace support is provided to configure an `ApplicationEventListeningMessageProducer` via the *inbound-channel-adapter* element.

```
<int-event:inbound-channel-adapter channel="eventChannel"
                                   error-channel="eventErrorChannel"
                                   event-types="example.FooEvent, example.BarEvent, java.util.Date"/>

<int:publish-subscribe-channel id="eventChannel"/>
```

In the above example, all Application Context events that match one of the types specified by the *event-types* (optional) attribute will be delivered as Spring Integration Messages to the Message Channel named *eventChannel*. If a downstream component throws an exception, a MessagingException containing the failed message and exception will be sent to the channel named *eventErrorChannel*. If no "error-channel" is specified and the downstream channels are synchronous, the Exception will be propagated to the caller.

=== Sending Spring Application Events

To send Spring `ApplicationEvents`, create an instance of the `ApplicationEventPublishingMessageHandler` and register it within an endpoint. This implementation of the `MessageHandler` interface also implements Spring's `ApplicationEventPublisherAware` interface and thus acts as a bridge between Spring Integration Messages and `ApplicationEvents`.

For convenience namespace support is provided to configure an `ApplicationEventPublishingMessageHandler` via the *outbound-channel-adapter* element.

```
<int:channel id="eventChannel"/>

<int-event:outbound-channel-adapter channel="eventChannel"/>
```

If you are using a PollableChannel (e.g., Queue), you can also provide *poller* as a sub-element of the *outbound-channel-adapter* element. You can also optionally provide a *task-executor* reference for that poller. The following example demonstrates both.

```
<int:channel id="eventChannel">
  <int:queue/>
</int:channel>

<int-event:outbound-channel-adapter channel="eventChannel">
  <int:poller max-messages-per-poll="1" task-executor="executor" fixed-rate="100"/>
</int-event:outbound-channel-adapter>

<task:executor id="executor" pool-size="5"/>
```

In the above example, all messages sent to the *eventChannel* channel will be published as ApplicationEvents to any relevant ApplicationListener instances that are registered within the same Spring ApplicationContext. If the payload of the Message is an ApplicationEvent, it will be passed as-is. Otherwise the Message itself will be wrapped in a `MessagingEvent` instance.

Starting with *version 4.2* the `ApplicationEventPublishingMessageHandler` (`<int-event:outbound-channel-adapter>`) can be configured with the `publish-payload` boolean attribute to publish to the application context `payload` as is, instead of wrapping it to a `MessagingEvent` instance.

== Feed Adapter

Spring Integration provides support for Syndication via Feed Adapters. The implementation is based on the ROME Framework.

=== Introduction

Web syndication is a form of publishing material such as news stories, press releases, blog posts, and other items typically available on a website but also made available in a feed format such as RSS or ATOM.

Spring integration provides support for Web Syndication via its *feed* adapter and provides convenient namespace-based configuration for it. To configure the *feed* namespace, include the following elements within the headers of your XML configuration file:

```
xmlns:int-feed="http://www.springframework.org/schema/integration/feed"
xsi:schemaLocation="http://www.springframework.org/schema/integration/feed
 https://www.springframework.org/schema/integration/feed/spring-integration-feed.xsd"
```

=== Feed Inbound Channel Adapter

The only adapter that is really needed to provide support for retrieving feeds is an *inbound channel adapter*. This allows you to subscribe to a particular URL. Below is an example configuration:

```
<int-feed:inbound-channel-adapter id="feedAdapter"
        channel="feedChannel"
        url="https://feeds.bbci.co.uk/news/rss.xml">
    <int:poller fixed-rate="10000" max-messages-per-poll="100" />
</int-feed:inbound-channel-adapter>
```

In the above configuration, we are subscribing to a URL identified by the `url` attribute.

As news items are retrieved they will be converted to Messages and sent to a channel identified by the `channel` attribute. The payload of each message will be a `com.sun.syndication.feed.synd.SyndEntry` instance. That encapsulates various data about a news item (content, dates, authors, etc.).

You can also see that the *Inbound Feed Channel Adapter* is a Polling Consumer. That means you have to provide a poller configuration. However, one important thing you must understand with regard to Feeds is that its inner-workings are slightly different then most other poling consumers. When an Inbound Feed adapter is started, it does the first poll and receives a `com.sun.syndication.feed.synd.SyndEntryFeed` instance. That is an object that contains multiple `SyndEntry` objects. Each entry is stored in the local entry queue and is released based on the value in the `max-messages-per-poll` attribute such that each Message will contain a single entry. If during retrieval of the entries from the entry queue the queue had become empty, the adapter will attempt to update the Feed thereby populating the queue with more entries (`SyndEntry` instances) if available. Otherwise the next attempt to poll for a feed will be determined by the trigger of the poller (e.g., every 10 seconds in the above configuration).

Duplicate Entries

Polling for a Feed might result in entries that have already been processed ("I already read that news item, why are you showing it to me again?"). Spring Integration provides a convenient mechanism to eliminate the need to worry about duplicate entries. Each feed entry will have a *published date* field. Every time a new `Message` is generated and sent, Spring Integration will store the value of the latest *published date* in an instance of the `MetadataStore` strategy (the section called “CompletableFuture”).

> **Note**
>
> The key used to persist the latest *published date* is the value of the (required) `id` attribute of the Feed Inbound Channel Adapter component plus the `feedUrl` (if any) from the adapter’s configuration.

Other Options

Starting with *version 5.0*, the deprecated `com.rometools.fetcher.FeedFetcher` option has been removed and an overloaded `FeedEntryMessageSource` constructor for an `org.springframework.core.io.Resource` is provided. This is useful when Feed source isn’t an HTTP endpoint, but any other resource, local or remote on FTP, for example. In the `FeedEntryMessageSource` logic such a resource (or provided `URL`) is parsed by the `SyndFeedInput` to the `SyndFeed` object for processing mentioned above. A customized `SyndFeedInput` (for example with the `allowDoctypes` option) instance also can be injected to the `FeedEntryMessageSource`.

=== Java DSL and Annotation configuration

The following Spring Boot application provides an example of configuring the Inbound Adapter using the Java DSL:

```
@SpringBootApplication
public class FeedJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FeedJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Value("org/springframework/integration/feed/sample.rss")
    private Resource feedResource;

    @Bean
    public MetadataStore metadataStore() {
        PropertiesPersistingMetadataStore metadataStore = new PropertiesPersistingMetadataStore();
        metadataStore.setBaseDirectory(tempFolder.getRoot().getAbsolutePath());
        return metadataStore;
    }

    @Bean
    public IntegrationFlow feedFlow() {
        return IntegrationFlows
                .from(Feed.inboundAdapter(this.feedResource, "feedTest")
                                .metadataStore(metadataStore()),
                        e -> e.poller(p -> p.fixedDelay(100)))
                .channel(c -> c.queue("entries"))
                .get();
    }

}
```

== File Support

=== Introduction

Spring Integration's File support extends the Spring Integration Core with a dedicated vocabulary to deal with reading, writing, and transforming files. It provides a namespace that enables elements defining Channel Adapters dedicated to files and support for Transformers that can read file contents into strings or byte arrays.

This section will explain the workings of `FileReadingMessageSource` and `FileWritingMessageHandler` and how to configure them as *beans*. Also the support for dealing with files through file specific implementations of `Transformer` will be discussed. Finally the file specific namespace will be explained.

=== Reading Files

A `FileReadingMessageSource` can be used to consume files from the filesystem. This is an implementation of `MessageSource` that creates messages from a file system directory.

```
<bean id="pollableFileSource"
    class="org.springframework.integration.file.FileReadingMessageSource"
    p:directory="${input.directory}"/>
```

To prevent creating messages for certain files, you may supply a `FileListFilter`. By default the following 2 filters are used:

- `IgnoreHiddenFileListFilter`
- `AcceptOnceFileListFilter`

The `IgnoreHiddenFileListFilter` ensures that **hidden** files are not being processed. Please keep in mind that the exact definition of **hidden** is system-dependent. For example, on *UNIX*-based systems, a file beginning with a period character is considered to be hidden. *Microsoft Windows*, on the other hand, has a dedicated file attribute to indicate hidden files.

> **Important**
>
> The `IgnoreHiddenFileListFilter` was introduced with *version 4.2*. In prior versions hidden files were included. With the default configuration, the `IgnoreHiddenFileListFilter` will be triggered first, then the `AcceptOnceFileListFilter`.

The `AcceptOnceFileListFilter` ensures files are picked up only once from the directory.

> **Note**
>
> The `AcceptOnceFileListFilter` stores its state in memory. If you wish the state to survive a system restart, consider using the `FileSystemPersistentAcceptOnceFileListFilter` instead. This filter stores the accepted file names in a `MetadataStore` implementation (the section called “CompletableFuture”). This filter matches on the filename and modified time.
>
> Since *version 4.0*, this filter requires a `ConcurrentMetadataStore`. When used with a shared data store (such as `Redis` with the `RedisMetadataStore`) this allows filter keys to be shared across multiple application instances, or when a network file share is being used by multiple servers.
>
> Since *version 4.1.5*, this filter has a new property `flushOnUpdate` which will cause it to flush the metadata store on every update (if the store implements `Flushable`).

```
<bean id="pollableFileSource"
    class="org.springframework.integration.file.FileReadingMessageSource"
    p:inputDirectory="${input.directory}"
    p:filter-ref="customFilterBean"/>
```

A common problem with reading files is that a file may be detected before it is ready. The default `AcceptOnceFileListFilter` does not prevent this. In most cases, this can be prevented if the file-writing process renames each file as soon as it is ready for reading. A `filename-pattern` or `filename-regex` filter that accepts only files that are ready (e.g. based on a known suffix), composed with the default `AcceptOnceFileListFilter` allows for this. The `CompositeFileListFilter` enables the composition.

```
<bean id="pollableFileSource"
    class="org.springframework.integration.file.FileReadingMessageSource"
    p:inputDirectory="${input.directory}"
    p:filter-ref="compositeFilter"/>

<bean id="compositeFilter"
    class="org.springframework.integration.file.filters.CompositeFileListFilter">
    <constructor-arg>
        <list>
            <bean class="o.s.i.file.filters.AcceptOnceFileListFilter"/>
            <bean class="o.s.i.file.filters.RegexPatternFileListFilter">
                <constructor-arg value="^test.*$"/>
            </bean>
        </list>
    </constructor-arg>
</bean>
```

If it is not possible to create the file with a temporary name and rename to the final name, another alternative is provided. The `LastModifiedFileListFilter` was added in *version 4.2*. This filter can be configured with an age property and only files older than this will be passed by the filter. The age defaults to 60 seconds, but you should choose an age that is large enough to avoid picking up a file early, due to, say, network glitches.

```
<bean id="filter" class="org.springframework.integration.file.filters.LastModifiedFileListFilter">
    <property name="age" value="120" />
</bean>
```

Starting with *version 4.3.7* a `ChainFileListFilter` (an extension of `CompositeFileListFilter`) has been introduced to allow scenarios when subsequent filters should only see the result of the previous filter. (With the `CompositeFileListFilter`, all filters see all the files, but only files that pass all filters are passed by the `CompositeFileListFilter`). An example of where the new behavior is required is a combination of `LastModifiedFileListFilter` and `AcceptOnceFileListFilter`, when we do not wish to accept the file until some amount of time has elapsed. With the `CompositeFileListFilter`, since the `AcceptOnceFileListFilter` sees all the files on the first pass, it won't pass it later when the other filter does. The `CompositeFileListFilter` approach is useful when a pattern filter is combined with a custom filter that looks for a secondary indicating file transfer is complete. The pattern filter might only pass the primary file (e.g. `foo.txt`) but the "done" filter needs to see if, say `foo.done` is present.

Say we have files `a.txt`, `a.done`, and `b.txt`.

The pattern filter only passes `a.txt` and `b.txt`, the "done" filter will see all three files and only pass `a.txt`. The final result of the composite filter is only `a.txt` is released.

Note

With the `ChainFileListFilter`, if any filter in the chain returns an empty list, the remaining filters are not invoked.

Starting with *version 5.0* an `ExpressionFileListFilter` has been introduced to allow to execute SpEL expression against file as a context evaluation root object. For this purpose all the XML components for file handling (local and remote), alongside with an existing `filter` attribute, have been supplied with the `filter-expression` option:

```
<int-file:inbound-channel-adapter
        directory="${inputdir}"
        filter-expression="name matches '.text'"
        auto-startup="false"/>
```

Starting with *version 5.0.5*, a `DiscardAwareFileListFilter` is provided for implementations when there is an interest in the event of the rejected files. For this purpose such a filter implementation should be supplied with a callback via `addDiscardCallback(Consumer<File>)`. In the Framework this functionality is used from the `FileReadingMessageSource.WatchServiceDirectoryScanner` in combination with `LastModifiedFileListFilter`. Unlike the regular `DirectoryScanner`, the `WatchService` provides files for processing according the events on the target file system. At the moment of polling an internal queue with those files, the `LastModifiedFileListFilter` may discard them because they are too young in regards to its configured `age`. Therefore we lose the file for the future possible considerations. The discard callback hook allows us to retain the file in the internal queue, so it is available to be checked against the `age` in the subsequent polls. The `CompositeFileListFilter` also implements a `DiscardAwareFileListFilter` and populates provided discard callback to all its `DiscardAwareFileListFilter` delegates.

> **Note**
>
> Since `CompositeFileListFilter` matches the files against all delegates, the `discardCallback` may be called several times for the same file.

Message Headers

Starting with *version 5.0* the `FileReadingMessageSource`, in addition to the `payload` as a polled `File`, populates these headers to the outbound `Message`:

- `FileHeaders.FILENAME` - the `File.getName()` of the file to send. Can be used for subsequent rename or copy logic;
- `FileHeaders.ORIGINAL_FILE` - the `File` object itself. Typically this header is populated automatically by Framework components, like the section called “CompletableFuture” or the section called “CompletableFuture”, when we lose the original `File` object. But for consistency and convenience with any other custom use-cases this header can be useful to get access to the original file;
- `FileHeaders.RELATIVE_PATH` - a new header introduced to represent the part of file path relative to the root directory for the scan. This header can be useful when the requirement is to restore a source directory hierarchy in the other places. For this purpose the `DefaultFileNameGenerator` (the section called “CompletableFuture”) can be configured to use this header.

Directory scanning and polling

The `FileReadingMessageSource` doesn’t produce messages for files from the directory immediately. It uses an internal queue for *eligible files* returned by the `scanner`. The `scanEachPoll` option is used to ensure that the internal queue is refreshed with the latest input directory content on each poll. By default (`scanEachPoll = false`), the `FileReadingMessageSource` empties its queue before scanning the directory again. This default behavior is particularly useful to reduce scans of large numbers of files in a directory. However, in cases where custom ordering is required, it is important to consider the effects of setting this flag to `true`; the order in which files are processed may not be as expected. By default, files in the queue are processed in their natural (`path`) order. New files added by a scan, even when the queue already has files, are inserted in the appropriate position to maintain that natural order. To customize the order, the `FileReadingMessageSource` can accept a `Comparator<File>` as a constructor argument. It is used by the internal (`PriorityBlockingQueue`) to reorder its content according to the business requirements. Therefore, to process files in a specific order, you should provide a comparator to the `FileReadingMessageSource`, rather than ordering the list produced by a custom `DirectoryScanner`.

Starting with *version 5.0*, a new `RecursiveDirectoryScanner` is presented to perform file tree visiting. The implementation is based on the `Files.walk(Path start, int maxDepth, FileVisitOption... options)` functionality. The root directory (`DirectoryScanner.listFiles(File)` argument) is excluded from the result. All other sub-directories includes/excludes are based on the target `FileListFilter` implementation. For example the `SimplePatternFileListFilter` filters directories by default. See `AbstractDirectoryAwareFileListFilter` and its implementations for more information.

==== Namespace Support

The configuration for file reading can be simplified using the file specific namespace. To do this use the following template.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-file="http://www.springframework.org/schema/integration/file"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/file
    https://www.springframework.org/schema/integration/file/spring-integration-file.xsd">
</beans>
```

Within this namespace you can reduce the `FileReadingMessageSource` and wrap it in an inbound Channel Adapter like this:

```
<int-file:inbound-channel-adapter id="filesIn1"
    directory="file:${input.directory}" prevent-duplicates="true" ignore-hidden="true"/>

<int-file:inbound-channel-adapter id="filesIn2"
    directory="file:${input.directory}"
    filter="customFilterBean" />

<int-file:inbound-channel-adapter id="filesIn3"
    directory="file:${input.directory}"
    filename-pattern="test*" />

<int-file:inbound-channel-adapter id="filesIn4"
    directory="file:${input.directory}"
    filename-regex="test[0-9]+\.txt" />
```

The first channel adapter example is relying on the default `FileListFilter` s:

- `IgnoreHiddenFileListFilter` (Do not process hidden files)
- `AcceptOnceFileListFilter` (Prevents duplication)

Therefore, you can also leave off the 2 attributes `prevent-duplicates` and `ignore-hidden` as they are `true` by default.

Important

The `ignore-hidden` attribute was introduced with *Spring Integration 4.2*. In prior versions hidden files were included.

The second channel adapter example is using a custom filter, the third is using the *filename-pattern* attribute to add an `AntPathMatcher` based filter, and the fourth is using the *filename-regex* attribute to add a regular expression Pattern based filter to the `FileReadingMessageSource`. The *filename-pattern* and *filename-regex* attributes are each mutually exclusive with the regular *filter* reference attribute. However, you can use the *filter* attribute to reference an instance of `CompositeFileListFilter` that combines any number of filters, including one or more pattern based filters to fit your particular needs.

When multiple processes are reading from the same directory it can be desirable to lock files to prevent them from being picked up concurrently. To do this you can use a `FileLocker`. There is a java.nio based implementation available out of the box, but it is also possible to implement your own locking scheme. The nio locker can be injected as follows

```
<int-file:inbound-channel-adapter id="filesIn"
    directory="file:${input.directory}" prevent-duplicates="true">
    <int-file:nio-locker/>
</int-file:inbound-channel-adapter>
```

A custom locker you can configure like this:

```
<int-file:inbound-channel-adapter id="filesIn"
    directory="file:${input.directory}" prevent-duplicates="true">
    <int-file:locker ref="customLocker"/>
</int-file:inbound-channel-adapter>
```

Note

When a file inbound adapter is configured with a locker, it will take the responsibility to acquire a lock before the file is allowed to be received. **It will not assume the responsibility to unlock the file.** If you have processed the file and keeping the locks hanging around you have a memory leak. If this is a problem in your case you should call `FileLocker.unlock(File file)` yourself at the appropriate time.

When filtering and locking files is not enough it might be needed to control the way files are listed entirely. To implement this type of requirement you can use an implementation of `DirectoryScanner`. This scanner allows you to determine entirely what files are listed each poll. This is also the interface that Spring Integration uses internally to wire `FileListFilter` s and `FileLocker` to the `FileReadingMessageSource`. A custom `DirectoryScanner` can be injected into the `<int-file:inbound-channel-adapter/>` on the `scanner` attribute.

```
<int-file:inbound-channel-adapter id="filesIn" directory="file:${input.directory}"
     scanner="customDirectoryScanner"/>
```

This gives you full freedom to choose the ordering, listing and locking strategies.

It is also important to understand that filters (including `patterns`, `regex`, `prevent-duplicates` etc) and `locker` s, are actually used by the `scanner`. Any of these attributes set on the adapter are subsequently injected into the internal `scanner`. For the case of an external `scanner`, all filter and locker attributes are prohibited on the `FileReadingMessageSource`; they must be specified (if required) on that custom `DirectoryScanner`. In other words, if you inject a `scanner` into the `FileReadingMessageSource`, you should supply `filter` and `locker` on that `scanner` not on the `FileReadingMessageSource`.

Note

The `DefaultDirectoryScanner` uses a `IgnoreHiddenFileListFilter` and `AcceptOnceFileListFilter` by default. To prevent their use, you should configure your own filter (e.g. `AcceptAllFileListFilter`) or even set it to `null`.

==== WatchServiceDirectoryScanner

The `FileReadingMessageSource.WatchServiceDirectoryScanner` relies on file system events when new files are added to the directory. During initialization, the directory is registered to generate events; the initial file list is also built. While walking the directory tree, any subdirectories encountered are also registered to generate events. On the first poll, the initial file list from walking the directory is returned. On subsequent polls, files from new creation events are returned. If a new subdirectory is added, its creation event is used to walk the new subtree to find existing files, as well as registering any new subdirectories found.

Note

There is a case with `WatchKey`, when its internal events `queue` isn't drained by the program as quickly as the directory modification events occur. If the queue size is exceeded, a `StandardWatchEventKinds.OVERFLOW` is emitted to indicate that some file system events may be lost. In this case, the root directory is re-scanned completely. To avoid duplicates consider using an appropriate `FileListFilter` such as the `AcceptOnceFileListFilter` and/or remove files when processing is completed.

The `WatchServiceDirectoryScanner` can be enable via `FileReadingMessageSource.use-watch-service` option, which is mutually exclusive with the `scanner` option. An internal `FileReadingMessageSource.WatchServiceDirectoryScanner` instance is populated for the provided `directory`.

In addition, now the `WatchService` polling logic can track the `StandardWatchEventKinds.ENTRY_MODIFY` and `StandardWatchEventKinds.ENTRY_DELETE`, too.

The `ENTRY_MODIFY` events logic should be implemented properly in the `FileListFilter` to track not only new files but also the modification, if that is requirement. Otherwise the files from those events are treated the same way.

The `ENTRY_DELETE` events have effect for the `ResettableFileListFilter` implementations and, therefore, their files are provided for the `remove()` operation. This means that (when this event is enabled), filters such as the `AcceptOnceFileListFilter` will have the file removed, meaning that, if a file with the same name appears, it will pass the filter and be sent as a message.

For this purpose the `watch-events` (`FileReadingMessageSource.setWatchEvents(WatchEventType... watchEvents)`) has been introduced (`WatchEventType` is a public inner enum in `FileReadingMessageSource`). With such an option we can implement some scenarios, when we would like to do one downstream flow logic for new files, and other for modified. We can achieve that with different `<int-file:inbound-channel-adapter>` definitions, but for the same directory:

```
<int-file:inbound-channel-adapter id="newFiles"
     directory="${input.directory}"
     use-watch-service="true"/>

<int-file:inbound-channel-adapter id="modifiedFiles"
     directory="${input.directory}"
     use-watch-service="true"
     filter="acceptAllFilter"
     watch-events="MODIFY"/> <!-- CREATE by default -->
```

==== Limiting Memory Consumption

A `HeadDirectoryScanner` can be used to limit the number of files retained in memory. This can be useful when scanning large directories. With XML configuration, this is enabled using the `queue-size` property on the inbound channel adapter.

Prior to *version 4.2*, this setting was incompatible with the use of any other filters. Any other filters (including `prevent-duplicates="true"`) overwrote the filter used to limit the size.

Note

The use of a `HeadDirectoryScanner` is incompatible with an `AcceptOnceFileListFilter`. Since all filters are consulted during the poll decision, the `AcceptOnceFileListFilter` does not know that other filters might be temporarily filtering files. Even if files that were previously filtered by the `HeadDirectoryScanner.HeadFilter` are now available, the `AcceptOnceFileListFilter` will filter them.

Generally, instead of using an `AcceptOnceFileListFilter` in this case, one would simply remove the processed files so that the previously filtered files will be available on a future poll.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class FileReadingJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FileReadingJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public MessageChannel fileInputChannel() {
        return new DirectChannel();
    }

    @Bean
    @InboundChannelAdapter(value = "fileInputChannel", poller = @Poller(fixedDelay = "1000"))
    public MessageSource<File> fileReadingMessageSource() {
         FileReadingMessageSource source = new FileReadingMessageSource();
         source.setDirectory(new File(INBOUND_PATH));
         source.setFilter(new SimplePatternFileListFilter("*.txt"));
         return source;
    }

    @Bean
    @Transformer(inputChannel = "fileInputChannel", outputChannel = "processFileChannel")
    public FileToStringTransformer fileToStringTransformer() {
        return new FileToStringTransformer();
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class FileReadingJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FileReadingJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow fileReadingFlow() {
         return IntegrationFlows
                  .from(s -> s.file(new File(INBOUND_PATH))
                              .patternFilter("*.txt"),
                          e -> e.poller(Pollers.fixedDelay(1000)))
                  .transform(Files.toStringTransformer())
                  .channel("processFileChannel")
                  .get();
        }

}
```

==== 'Tail'ing Files

Another popular use case is to get *lines* from the end (or tail) of a file, capturing new lines when they are added. Two implementations are provided; the first, `OSDelegatingFileTailingMessageProducer`, uses the native `tail` command (on operating systems that have one). This is likely the most efficient implementation on those platforms. For operating systems that do not have a `tail` command, the second implementation `ApacheCommonsFileTailingMessageProducer` which uses the Apache `commons-io` `Tailer` class.

In both cases, file system events, such as files being unavailable etc, are published as `ApplicationEvent` s using the normal Spring event publishing mechanism. Examples of such events are:

`[message=tail: cannot open `/tmp/foo' for reading: No such file or directory, file=/tmp/foo]`

`[message=tail: `/tmp/foo' has become accessible, file=/tmp/foo]`

`[message=tail: `/tmp/foo' has become inaccessible: No such file or directory, file=/tmp/foo]`

`[message=tail: `/tmp/foo' has appeared; following end of new file, file=/tmp/foo]`

This sequence of events might occur, for example, when a file is rotated.

Starting with *version 5.0*, a `FileTailingIdleEvent` is emitted when there is no data in the file during `idleEventInterval`.

`[message=Idle timeout, file=/tmp/foo] [idle time=5438]`

Note

Not all platforms supporting a `tail` command provide these status messages.

Messages emitted from these endpoints have the following headers:

- `FileHeaders.ORIGINAL_FILE` - the `File` object
- `FileHeaders.FILENAME` - the file name (`File.getName()`)

Note

In versions prior to *version 5.0*, the `FileHeaders.FILENAME` header contained a string representation of the file's absolute path. You can now obtain that by calling `getAbsolutePath()` on the original file header.

Example configurations:

```
<int-file:tail-inbound-channel-adapter id="native"
 channel="input"
 task-executor="exec"
 file="/tmp/foo"/>
```

This creates a native adapter with default *-F -n 0* options (follow the file name from the current end).

```
<int-file:tail-inbound-channel-adapter id="native"
 channel="input"
 native-options="-F -n +0"
 task-executor="exec"
 file-delay=10000
 file="/tmp/foo"/>
```

This creates a native adapter with *-F -n +0* options (follow the file name, emitting all existing lines). If the tail command fails (on some platforms, a missing file causes the `tail` to fail, even with `-F` specified), the command will be retried every 10 seconds.

```
<int-file:tail-inbound-channel-adapter id="native"
 channel="input"
 enable-status-reader="false"
 task-executor="exec"
 file="/tmp/foo"/>
```

By default native adapter capture from standard output and send them as messages and from standard error to raise events. Starting with *version 4.3.6*, you can discard the standard error events by setting the `enable-status-reader` to `false`.

```
<int-file:tail-inbound-channel-adapter id="native"
 channel="input"
 idle-event-interval="5000"
 task-executor="exec"
 file="/tmp/foo"/>
```

`IdleEventInterval` is set to 5000 then, if no lines are written for 5 second, `FileTailingIdleEvent` will be triggered every 5 second. This can be useful if we need to stop the adapter.

```
<int-file:tail-inbound-channel-adapter id="apache"
 channel="input"
 task-executor="exec"
 file="/tmp/bar"
 delay="2000"
 end="false"
 reopen="true"
 file-delay="10000"/>
```

This creates an Apache commons-io `Tailer` adapter that examines the file for new lines every 2 seconds, and checks for existence of a missing file every 10 seconds. The file will be tailed from the beginning (`end="false"`) instead of the end (which is the default). The file will be reopened for each chunk (the default is to keep the file open).

> **Important**
>
> Specifying the `delay`, `end` or `reopen` attributes, forces the use of the Apache commons-io adapter and the `native-options` attribute is not allowed.

==== Dealing With Incomplete Data

A common problem in file transfer scenarios is how to determine that the transfer is complete, so you don't start reading an incomplete file. A common technique to solve this problem is to write the file with a temporary name and then atomically rename it to the final name. This, together with a filter that masks the temporary file from being picked up by the consumer provides a robust solution. This technique is used by Spring Integration components that write files (locally or remotely); by default, they append `.writing` to the file name and remove it when the transfer is complete.

Another common technique is to write a second "marker" file to indicate the file transfer is complete. In this scenario, say, you should not consider `foo.txt` to be available for use until `foo.txt.complete` is also present. Spring Integration *version 5.0* introduces new filters to support this mechanism. Implementations are provided for the file system (`FileSystemMarkerFilePresentFileListFilter`), FTP and SFTP. They are configurable such that the marker file can have any name, although it will usually be related to the file being transferred. See the javadocs for more information.

=== Writing files

To write messages to the file system you can use a FileWritingMessageHandler. This class can deal with the following payload types:

- *File*,
- *String*
- *byte array*
- *InputStream* (since *version 4.2*)

You can configure the encoding and the charset that will be used in case of a String payload.

To make things easier, you can configure the `FileWritingMessageHandler` as part of an *Outbound Channel Adapter* or *Outbound Gateway* using the provided XML namespace support.

Starting with *version 4.3*, you can specify the buffer size to use when writing files.

==== Generating File Names

In its simplest form, the `FileWritingMessageHandler` only requires a destination directory for writing the files. The name of the file to be written is determined by the handler's FileNameGenerator. The default implementation looks for a Message header whose key matches the constant defined as FileHeaders.FILENAME.

Alternatively, you can specify an expression to be evaluated against the Message in order to generate a file name, e.g. *headers[*myCustomHeader*] + '.foo'*. The expression must evaluate to a `String`. For convenience, the `DefaultFileNameGenerator` also provides the *setHeaderName* method, allowing you to explicitly specify the Message header whose value shall be used as the filename.

Once setup, the `DefaultFileNameGenerator` will employ the following resolution steps to determine the filename for a given Message payload:

1. Evaluate the expression against the Message and, if the result is a non-empty `String`, use it as the filename.
2. Otherwise, if the payload is a `java.io.File`, use the file's filename.
3. Otherwise, use the Message ID appended with `.msg` as the filename.

When using the XML namespace support, both, the *File Outbound Channel Adapter* and the *File Outbound Gateway* support the following two mutually exclusive configuration attributes:

- `filename-generator` (a reference to a `FileNameGenerator` implementation)
- `filename-generator-expression` (an expression evaluating to a `String`)

While writing files, a temporary file suffix will be used (default: `.writing`). It is appended to the filename while the file is being written. To customize the suffix, you can set the *temporary-file-suffix* attribute on both the *File Outbound Channel Adapter* and the *File Outbound Gateway*.

> **Note**
>
> When using the *APPEND* file *mode*, the *temporary-file-suffix* attribute is ignored, since the data is appended to the file directly.

Starting with *version 4.2.5* the generated file name (as a result of `filename-generator`/`filename-generator-expression` evaluation) can represent a *sub-path* together with the target file name. It is used as a second constructor argument for `File(File parent, String child)` as before, but in the past we didn't created (`mkdirs()`) directories for *sub-path* assuming only the *file name*. This approach is useful for cases when we need to restore the file system tree according the source directory. For example we unzipping the archive and want to save all file in the target directory at the same order.

==== Specifying the Output Directory

Both, the *File Outbound Channel Adapter* and the *File Outbound Gateway* provide two configuration attributes for specifying the output directory:

- *directory*
- *directory-expression*

> **Note**
>
> The *directory-expression* attribute is available since Spring Integration 2.2.

Using the directory attribute

When using the *directory* attribute, the output directory will be set to a fixed value, that is set at initialization time of the `FileWritingMessageHandler`. If you don't specify this attribute, then you must use the *directory-expression* attribute.

Using the directory-expression attribute

If you want to have full SpEL support you would choose the *directory-expression* attribute. This attribute accepts a SpEL expression that is evaluated for each message being processed. Thus, you have full access to a Message’s payload and its headers to dynamically specify the output file directory.

The SpEL expression must resolve to either a `String` or to `java.io.File`. Furthermore the resulting `String` or `File` must point to a directory. If you don’t specify the *directory-expression* attribute, then you must set the *directory* attribute.

Using the auto-create-directory attribute

If the destination directory does not exists, yet, by default the respective destination directory and any non-existing parent directories are being created automatically. You can set the *auto-create-directory* attribute to *false* in order to prevent that. This attribute applies to both, the *directory* and the *directory-expression* attribute.

> **Note**
>
> When using the *directory* attribute and *auto-create-directory* is `false`, the following change was made starting with Spring Integration 2.2:
>
> Instead of checking for the existence of the destination directory at initialization time of the adapter, this check is now performed for each message being processed.
>
> Furthermore, if *auto-create-directory* is `true` and the directory was deleted between the processing of messages, the directory will be re-created for each message being processed.

==== Dealing with Existing Destination Files

When writing files and the destination file already exists, the default behavior is to overwrite that target file. This behavior, though, can be changed by setting the *mode* attribute on the respective File Outbound components. The following options exist:

- REPLACE (Default)
- REPLACE_IF_MODIFIED
- APPEND
- APPEND_NO_FLUSH
- FAIL
- IGNORE

> **Note**
>
> The *mode* attribute and the options *APPEND*, *FAIL* and *IGNORE*, are available since *Spring Integration 2.2*.

REPLACE

If the target file already exists, it will be overwritten. If the *mode* attribute is not specified, then this is the default behavior when writing files.

REPLACE_IF_MODIFIED

If the target file already exists, it will be overwritten only if the last modified timestamp is different to the source file. For `File` payloads, the payload `lastModified` time is compared to the existing file. For other payloads, the `FileHeaders.SET_MODIFIED` (`file_setModified`) header is compared to the existing file. If the header is missing, or has a value that is not a `Number`, the file is always replaced.

APPEND

This mode allows you to append Message content to the existing file instead of creating a new file each time. Note that this attribute is mutually exclusive with *temporary-file-suffix* attribute since when appending content to the existing file, the adapter no longer uses a temporary file. The file is closed after each message.

APPEND_NO_FLUSH

This has the same semantics as **APPEND** but the data is not flushed and the file is not closed after each message. This can provide a significant performance at the risk of data loss in the case of a failure. See the section called “CompletableFuture” for more information.

FAIL

If the target file exists, a MessageHandlingException is thrown.

IGNORE

If the target file exists, the message payload is silently ignored.

> **Note**
>
> When using a temporary file suffix (default: `.writing`), the *IGNORE* mode will apply if the final file name exists, or the temporary file name exists.

==== Flushing Files When using APPEND_NO_FLUSH

The **APPEND_NO_FLUSH** mode was added in *version 4.3*. This can improve performance because the file is not closed after each message. However, this can cause data loss in the event of a failure.

Several flushing strategies, to mitigate this data loss, are provided:

- `flushInterval` - if a file is not written to for this period of time, it is automatically flushed. This is approximate and may be up to `1.33x` this time (with an average of `1.167x`).
- Send a message to the message handler’s `trigger` method containing a regular expression. Files with absolute path names matching the pattern will be flushed.
- Provide the handler with a custom `MessageFlushPredicate` implementation to modify the action taken when a message is sent to the `trigger` method.
- Invoke one of the handler’s `flushIfNeeded` methods passing in a custom `FileWritingMessageHandler.FlushPredicate` or `FileWritingMessageHandler.MessageFlushPredicate` implementation.

The predicates are called for each open file. See the java docs for these interfaces for more information. Note that, since *version 5.0*, the predicate methods provide another parameter - the time that the current file was first written to if new or previously closed.

When using `flushInterval`, the interval starts at the last write - the file is flushed only if it is idle for the interval. Starting with *version 4.3.7*, and additional property `flushWhenIdle` can be set to `false`, meaning that the interval starts with the first write to a previously flushed (or new) file.

==== File Timestamps

By default, the destination file `lastModified` timestamp will be the time the file was created (except a rename in-place will retain the current timestamp). Starting with *version 4.3*, you can now configure `preserve-timestamp` (or `setPreserveTimestamp(true)` when using Java configuration). For `File` payloads, this will transfer the timestamp from the inbound file to the outbound (regardless of whether a copy was required). For other payloads, if the `FileHeaders.SET_MODIFIED` header (`file_setModified`) is present, it will be used to set the destination file's `lastModified` timestamp, as long as the header is a `Number`.

==== File Permissions

Starting with *version 5.0*, when writing files to a file system that supports Posix permissions, you can specify those permissions on the outbound channel adapter or gateway. The property is an integer and is usually supplied in the familiar octal format; e.g. `0640` meaning the owner has read/write permissions, the group has read only permission and others have no access.

==== File Outbound Channel Adapter

```
<int-file:outbound-channel-adapter id="filesOut" directory="${input.directory.property}"/>
```

The namespace based configuration also supports a `delete-source-files` attribute. If set to `true`, it will trigger the deletion of the original source files after writing to a destination. The default value for that flag is `false`.

```
<int-file:outbound-channel-adapter id="filesOut"
    directory="${output.directory}"
    delete-source-files="true"/>
```

Note

The `delete-source-files` attribute will only have an effect if the inbound Message has a File payload or if the `FileHeaders.ORIGINAL_FILE` header value contains either the source File instance or a String representing the original file path.

Starting with *version 4.2* The `FileWritingMessageHandler` supports an `append-new-line` option. If set to `true`, a new line is appended to the file after a message is written. The default attribute value is `false`.

```
<int-file:outbound-channel-adapter id="newlineAdapter"
 append-new-line="true"
    directory="${output.directory}"/>
```

==== Outbound Gateway

In cases where you want to continue processing messages based on the written file, you can use the `outbound-gateway` instead. It plays a very similar role as the `outbound-channel-adapter`. However, after writing the file, it will also send it to the reply channel as the payload of a Message.

```
<int-file:outbound-gateway id="mover" request-channel="moveInput"
    reply-channel="output"
    directory="${output.directory}"
    mode="REPLACE" delete-source-files="true"/>
```

As mentioned earlier, you can also specify the *mode* attribute, which defines the behavior of how to deal with situations where the destination file already exists. Please see the section called “CompletableFuture” for further details. Generally, when using the *File Outbound Gateway*, the result file is returned as the Message payload on the reply channel.

This also applies when specifying the *IGNORE* mode. In that case the pre-existing destination file is returned. If the payload of the request message was a file, you still have access to that original file through the Message Header FileHeaders.ORIGINAL_FILE.

Note

The *outbound-gateway* works well in cases where you want to first move a file and then send it through a processing pipeline. In such cases, you may connect the file namespace’s `inbound-channel-adapter` element to the `outbound-gateway` and then connect that gateway’s `reply-channel` to the beginning of the pipeline.

If you have more elaborate requirements or need to support additional payload types as input to be converted to file content you could extend the `FileWritingMessageHandler`, but a much better option is to rely on a `Transformer`.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class FileWritingJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
                      new SpringApplicationBuilder(FileWritingJavaApplication.class)
                              .web(false)
                              .run(args);
             MyGateway gateway = context.getBean(MyGateway.class);
             gateway.writeToFile("foo.txt", new File(tmpDir.getRoot(), "fileWritingFlow"), "foo");
    }

    @Bean
    @ServiceActivator(inputChannel = "writeToFileChannel")
    public MessageHandler fileWritingMessageHandler() {
         Expression directoryExpression = new
 SpelExpressionParser().parseExpression("headers.directory");
         FileWritingMessageHandler handler = new FileWritingMessageHandler(directoryExpression);
         handler.setFileExistsMode(FileExistsMode.APPEND);
         return handler;
    }

    @MessagingGateway(defaultRequestChannel = "writeToFileChannel")
    public interface MyGateway {

        void writeToFile(@Header(FileHeaders.FILENAME) String fileName,
                       @Header(FileHeaders.FILENAME) File directory, String data);

    }
}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class FileWritingJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
                 new SpringApplicationBuilder(FileWritingJavaApplication.class)
                         .web(false)
                         .run(args);
        MessageChannel fileWritingInput = context.getBean("fileWritingInput", MessageChannel.class);
        fileWritingInput.send(new GenericMessage<>("foo"));
    }

    @Bean
    public IntegrationFlow fileWritingFlow() {
        return IntegrationFlows.from("fileWritingInput")
             .enrichHeaders(h -> h.header(FileHeaders.FILENAME, "foo.txt")
                       .header("directory", new File(tmpDir.getRoot(), "fileWritingFlow")))
                .handleWithAdapter(a -> a.fileGateway(m -> m.getHeaders().get("directory")))
                .channel(MessageChannels.queue("fileWritingResultChannel"))
                .get();
    }

}
```

=== File Transformers

To transform data read from the file system to objects and the other way around you need to do some work. Contrary to `FileReadingMessageSource` and to a lesser extent `FileWritingMessageHandler`, it is very likely that you will need your own mechanism to get the job done. For this you can implement the `Transformer` interface. Or extend the `AbstractFilePayloadTransformer` for inbound messages. Some obvious implementations have been provided.

`FileToByteArrayTransformer` transforms Files into `byte[]` using Spring's `FileCopyUtils`. It is often better to use a sequence of transformers than to put all transformations in a single class. In that case the `File` to `byte[]` conversion might be a logical first step.

`FileToStringTransformer` will convert Files to Strings as the name suggests. If nothing else, this can be useful for debugging (consider using with a Wire Tap).

To configure File specific transformers you can use the appropriate elements from the file namespace.

```
<int-file:file-to-bytes-transformer  input-channel="input" output-channel="output"
    delete-files="true"/>

<int-file:file-to-string-transformer input-channel="input" output-channel="output"
    delete-files="true" charset="UTF-8"/>
```

The *delete-files* option signals to the transformer that it should delete the inbound File after the transformation is complete. This is in no way a replacement for using the `AcceptOnceFileListFilter` when the `FileReadingMessageSource` is being used in a multi-threaded environment (e.g. Spring Integration in general).

=== File Splitter

The `FileSplitter` was added in *version 4.1.2* and namespace support was added in *version 4.2*. The `FileSplitter` splits text files into individual lines, based on `BufferedReader.readLine()`.

By default, the splitter uses an `Iterator` to emit lines one-at-a-time as they are read from the file. Setting the `iterator` property to `false` causes it to read all the lines into memory before emitting them as messages. One use case for this might be if you want to detect I/O errors on the file before sending any messages containing lines. However, it is only practical for relatively short files.

Inbound payloads can be `File`, `String` (a `File` path), `InputStream`, or `Reader`. Other payload types will be emitted unchanged.

```
<int-file:splitter id="splitter" ❶
    iterator="" ❷
    markers="" ❸
    markers-json="" ❹
    apply-sequence="" ❺
    requires-reply="" ❻
    charset="" ❼
    first-line-as-header="" ❽
    input-channel="" ❾
    output-channel="" ❿
    send-timeout="" 11
    auto-startup="" 12
    order="" 13
    phase="" /> 14
```

❶ The bean name of the splitter.

❷ Set to `true` to use an iterator (default); `false` to load the file into memory before sending lines.

❸ Set to `true` to emit start/end of file marker messages before and after the file data. Markers are messages with `FileSplitter.FileMarker` payloads (with `START` and `END` values in the `mark` property). Markers might be used when sequentially processing files in a downstream flow where some lines are filtered. They enable the downstream processing to know when a file has been completely processed. In addition, a header `file_marker` containing `START` or `END` are added to these messages. The `END` marker includes a line count. If the file is empty, only `START` and `END` markers are emitted with `0` as the `lineCount`. Default: `false`. When `true`, `apply-sequence` is `false` by default. Also see `markers-json`.

❹ When `markers` is true, set this to `true` and the `FileMarker` objects will be converted to a JSON String. Requires a supported JSON processor library on the classpath (Jackson, Boon).

❺ Set to `false` to disable the inclusion of `sequenceSize` and `sequenceNumber` headers in messages. Default: `true`, unless `markers` is `true`. When `true` and `markers` is `true`, the markers are included in the sequencing. When `true` and `iterator` is `true`, the `sequenceSize` header is set to `0` because the size is unknown.

❻ Set to `true` to cause a `RequiresReplyException` to be thrown if there are no lines in the file. Default: `false`.

❼ Set the charset name to be used when reading the text data into `String` payloads. Default: platform charset.

❽ The header name for the first line to be carried as a header in the messages emitted for the remaining lines. Since *version 5.0*.

❾ Set the input channel used to send messages to the splitter.

❿ Set the output channel to which messages will be sent.

11 Set the send timeout - only applies if the `output-channel` can block - such as a full `QueueChannel`.

12 Set to `false` to disable automatically starting the splitter when the context is refreshed. Default: `true`.

13 Set the order of this endpoint if the `input-channel` is a `<publish-subscribe-channel/>`.

14 Set the startup phase for the splitter (used when `auto-startup` is `true`).

The `FileSplitter` will also split any text-based `InputStream` into lines. When used in conjunction with an FTP or SFTP streaming inbound channel adapter, or an FTP or SFTP outbound gateway using the `stream` option to retrieve a file, starting with *version 4.3*, the splitter will automatically close the session supporting the stream, when the file is completely consumed. See the section called “CompletableFuture” and the section called “CompletableFuture” as well as the section called “CompletableFuture” and the section called “CompletableFuture” for more information about these facilities.

When using Java configuration, an additional constructor is available:

```
public FileSplitter(boolean iterator, boolean markers, boolean markersJson)
```

When `markersJson` is true, the markers will be represented as a JSON string, as long as a suitable JSON processor library, such as Jackson or Boon, is on the classpath.

Starting with *version 5.0*, the `firstLineAsHeader` option is introduced to specify that the first line of content is a header (such as column names in a CSV file). The argument passed to this property is the header name under which the first line will be carried as a header in the messages emitted for the remaining lines. This line is not included in the sequence header (if `applySequence` is true) nor in the `FileMarker.END lineCount`. If file contains only the header line, the file is treated as empty and therefore only `FileMarker` s are emitted during splitting (if markers are enabled, otherwise no messages are emitted). By default (if no header name is set), the first line is considered to be data and will be the payload of the first emitted message.

If you need more complex logic about headers extraction from the file content (not first line, not the whole content of the line, not one header etc.), consider to use Header Enricher upfront of the `FileSplitter`. The lines which have been moved to the headers might be filtered downstream from the normal content process.

==== Configuring with Java Configuration

```
@Splitter(inputChannel="toSplitter")
@Bean
public MessageHandler fileSplitter() {
    FileSplitter splitter = new FileSplitter(true, true);
    splitter.setApplySequence(true);
    splitter.setOutputChannel(outputChannel);
    return splitter;
}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class FileSplitterApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FileSplitterApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow fileSplitterFlow() {
        return IntegrationFlows
            .from(Files.inboundAdapter(tmpDir.getRoot())
                 .filter(new ChainFileListFilter<File>()
                        .addFilter(new AcceptOnceFileListFilter<>())
                        .addFilter(new ExpressionFileListFilter<>(
                             new FunctionExpression<File>(f -> "foo.tmp".equals(f.getName()))))))
            .split(Files.splitter()
                     .markers()
                     .charset(StandardCharsets.US_ASCII)
                     .firstLineAsHeader("fileHeader")
                     .applySequence(true))
            .channel(c -> c.queue("fileSplittingResultChannel"))
            .get();
    }

}
```

== FTP/FTPS Adapters

Spring Integration provides support for file transfer operations via FTP and FTPS.

=== Introduction

The File Transfer Protocol (FTP) is a simple network protocol which allows you to transfer files between two computers on the Internet.

There are two actors when it comes to FTP communication: *client* and *server*. To transfer files with FTP/FTPS, you use a *client* which initiates a connection to a remote computer that is running an FTP *server*. After the connection is established, the *client* can choose to send and/or receive copies of files.

Spring Integration supports sending and receiving files over FTP/FTPS by providing three *client* side endpoints: *Inbound Channel Adapter*, *Outbound Channel Adapter*, and *Outbound Gateway*. It also provides convenient namespace-based configuration options for defining these *client* components.

To use the *FTP* namespace, add the following to the header of your XML file:

```
xmlns:int-ftp="http://www.springframework.org/schema/integration/ftp"
xsi:schemaLocation="http://www.springframework.org/schema/integration/ftp
    https://www.springframework.org/schema/integration/ftp/spring-integration-ftp.xsd"
```

=== FTP Session Factory

==== Default Factories

Important

Starting with version 3.0, sessions are no longer cached by default. See the section called “CompletableFuture”.

Before configuring FTP adapters you must configure an *FTP Session Factory*. You can configure the *FTP Session Factory* with a regular bean definition where the implementation class is `org.springframework.integration.ftp.session.DefaultFtpSessionFactory`: Below is a basic configuration:

```
<bean id="ftpClientFactory"
    class="org.springframework.integration.ftp.session.DefaultFtpSessionFactory">
    <property name="host" value="localhost"/>
    <property name="port" value="22"/>
    <property name="username" value="kermit"/>
    <property name="password" value="frog"/>
    <property name="clientMode" value="0"/>
    <property name="fileType" value="2"/>
    <property name="bufferSize" value="100000"/>
</bean>
```

For FTPS connections all you need to do is use `org.springframework.integration.ftp.session.DefaultFtpsSessionFactory` instead. Below is the complete configuration sample:

```
<bean id="ftpClientFactory"
    class="org.springframework.integration.ftp.session.DefaultFtpsSessionFactory">
    <property name="host" value="localhost"/>
    <property name="port" value="22"/>
    <property name="username" value="oleg"/>
    <property name="password" value="password"/>
    <property name="clientMode" value="1"/>
    <property name="fileType" value="2"/>
    <property name="useClientMode" value="true"/>
    <property name="cipherSuites" value="a,b.c"/>
    <property name="keyManager" ref="keyManager"/>
    <property name="protocol" value="SSL"/>
    <property name="trustManager" ref="trustManager"/>
    <property name="prot" value="P"/>
    <property name="needClientAuth" value="true"/>
    <property name="authValue" value="oleg"/>
    <property name="sessionCreation" value="true"/>
    <property name="protocols" value="SSL, TLS"/>
    <property name="implicit" value="true"/>
</bean>
```

Every time an adapter requests a session object from its `SessionFactory` the session is returned from a session pool maintained by a caching wrapper around the factory. A Session in the session pool might go stale (if it has been disconnected by the server due to inactivity) so the `SessionFactory` will perform validation to make sure that it never returns a stale session to the adapter. If a stale session was encountered, it will be removed from the pool, and a new one will be created.

Note

If you experience connectivity problems and would like to trace Session creation as well as see which Sessions are polled you may enable it by setting the logger to TRACE level (e.g., log4j.category.org.springframework.integration.file=TRACE)

Now all you need to do is inject these session factories into your adapters. Obviously the protocol (FTP or FTPS) that an adapter will use depends on the type of session factory that has been injected into the adapter.

Note

A more practical way to provide values for *FTP/FTPS Session Factories* is by using Spring's property placeholder support (See: https://docs.spring.io/spring/docs/current/spring-framework-reference/html/beans.html#beans-factory-placeholderconfigurer).

Advanced Configuration

`DefaultFtpSessionFactory` provides an abstraction over the underlying client API which, since *Spring Integration 2.0*, is Apache Commons Net. This spares you from the low level configuration details of the `org.apache.commons.net.ftp.FTPClient`. Several common properties are exposed on the session factory (since *version 4.0*, this now includes `connectTimeout`, `defaultTimeout` and `dataTimeout`). However there are times when access to lower level `FTPClient` configuration is necessary to achieve more advanced configuration (e.g., setting the port range for active mode etc.). For that purpose, `AbstractFtpSessionFactory` (the base class for all FTP Session Factories) exposes hooks, in the form of the two post-processing methods below.

```
/**
 * Will handle additional initialization after client.connect() method was invoked,
 * but before any action on the client has been taken
 */
protected void postProcessClientAfterConnect(T t) throws IOException {
    // NOOP
}
/**
 * Will handle additional initialization before client.connect() method was invoked.
 */
protected void postProcessClientBeforeConnect(T client) throws IOException {
    // NOOP
}
```

As you can see, there is no default implementation for these two methods. However, by extending `DefaultFtpSessionFactory` you can override these methods to provide more advanced configuration of the `FTPClient`. For example:

```
public class AdvancedFtpSessionFactory extends DefaultFtpSessionFactory {

    protected void postProcessClientBeforeConnect(FTPClient ftpClient) throws IOException {
       ftpClient.setActivePortRange(4000, 5000);
    }
}
```

==== FTPS and Shared SSLSession

When using FTP over SSL/TLS, some servers require the same `SSLSession` to be used on the control and data connections; this is to prevent "stealing" data connections; see here for more information.

Currently, the Apache FTPSClient does not support this feature - see NET-408.

The following solution, courtesy of Stack Overflow, uses reflection on the `sun.security.ssl.SSLSessionContextImpl` so may not work on other JVMs. The stack overflow answer was submitted in 2015 and the solution has been tested by the Spring Integration team recently on JDK 1.8.0_112.

```
@Bean
public DefaultFtpsSessionFactory sf() {
    DefaultFtpsSessionFactory sf = new DefaultFtpsSessionFactory() {

        @Override
        protected FTPSClient createClientInstance() {
            return new SharedSSLFTPSClient();
        }

    };
    sf.setHost("...");
    sf.setPort(21);
    sf.setUsername("...");
    sf.setPassword("...");
    sf.setNeedClientAuth(true);
    return sf;
}

private static final class SharedSSLFTPSClient extends FTPSClient {

    @Override
    protected void _prepareDataSocket_(final Socket socket) throws IOException {
        if (socket instanceof SSLSocket) {
            // Control socket is SSL
            final SSLSession session = ((SSLSocket) _socket_).getSession();
            final SSLSessionContext context = session.getSessionContext();
            context.setSessionCacheSize(0); // you might want to limit the cache
            try {
                final Field sessionHostPortCache = context.getClass()
                        .getDeclaredField("sessionHostPortCache");
                sessionHostPortCache.setAccessible(true);
                final Object cache = sessionHostPortCache.get(context);
                final Method method = cache.getClass().getDeclaredMethod("put", Object.class,
                        Object.class);
                method.setAccessible(true);
                String key = String.format("%s:%s", socket.getInetAddress().getHostName(),
                        String.valueOf(socket.getPort())).toLowerCase(Locale.ROOT);
                method.invoke(cache, key, session);
                key = String.format("%s:%s", socket.getInetAddress().getHostAddress(),
                        String.valueOf(socket.getPort())).toLowerCase(Locale.ROOT);
                method.invoke(cache, key, session);
            }
            catch (NoSuchFieldException e) {
                // Not running in expected JRE
                logger.warn("No field sessionHostPortCache in SSLSessionContext", e);
            }
            catch (Exception e) {
                // Not running in expected JRE
                logger.warn(e.getMessage());
            }
        }

    }

}
```

=== Delegating Session Factory

Version 4.2 introduced the `DelegatingSessionFactory` which allows the selection of the actual session factory at runtime. Prior to invoking the ftp endpoint, call `setThreadKey()` on the factory to associate a key with the current thread. That key is then used to lookup the actual session factory to be used. The key can be cleared by calling `clearThreadKey()` after use.

Convenience methods have been added so this can easily be done from a message flow:

```
<bean id="dsf" class="org.springframework.integration.file.remote.session.DelegatingSessionFactory">
    <constructor-arg>
        <bean class="o.s.i.file.remote.session.DefaultSessionFactoryLocator">
            <!-- delegate factories here -->
        </bean>
    </constructor-arg>
</bean>

<int:service-activator input-channel="in" output-channel="c1"
        expression="@dsf.setThreadKey(#root, headers['factoryToUse'])" />

<int-ftp:outbound-gateway request-channel="c1" reply-channel="c2" ... />

<int:service-activator input-channel="c2" output-channel="out"
        expression="@dsf.clearThreadKey(#root)" />
```

Important

When using session caching (see the section called “CompletableFuture”), each of the delegates should be cached; you cannot cache the `DelegatingSessionFactory` itself.

Starting with *version 5.0.7*, the `DelegatingSessionFactory` can be used in conjunction with a `RotatingServerAdvice` to poll multiple servers; see the section called “CompletableFuture”.

=== FTP Inbound Channel Adapter

The *FTP Inbound Channel Adapter* is a special listener that will connect to the FTP server and will listen for the remote directory events (e.g., new file created) at which point it will initiate a file transfer.

```
<int-ftp:inbound-channel-adapter id="ftpInbound"
    channel="ftpChannel"
    session-factory="ftpSessionFactory"
    auto-create-local-directory="true"
    delete-remote-files="true"
    filename-pattern="*.txt"
    remote-directory="some/remote/path"
    remote-file-separator="/"
    preserve-timestamp="true"
    local-filename-generator-expression="#this.toUpperCase() + '.a'"
    scanner="myDirScanner"
    local-filter="myFilter"
    temporary-file-suffix=".writing"
    max-fetch-size="-1"
    local-directory=".">
    <int:poller fixed-rate="1000"/>
</int-ftp:inbound-channel-adapter>
```

As you can see from the configuration above you can configure an *FTP Inbound Channel Adapter* via the `inbound-channel-adapter` element while also providing values for various attributes such as `local-directory`, `filename-pattern` (which is based on simple pattern matching, not regular expressions), and of course the reference to a `session-factory`.

By default the transferred file will carry the same name as the original file. If you want to override this behavior you can set the `local-filename-generator-expression` attribute which allows you to provide a SpEL Expression to generate the name of the local file. Unlike outbound gateways and adapters where the root object of the SpEL Evaluation Context is a `Message`, this inbound adapter does not yet have the Message at the time of evaluation since that’s what it ultimately generates with the transferred file as its payload. So, the root object of the SpEL Evaluation Context is the original name of the remote file (String).

The inbound channel adapter first retrieves the file to a local directory and then emits each file according to the poller configuration. Starting with *version 5.0*, you can now limit the number of files fetched from the FTP server when new file retrievals are needed. This can be beneficial when the target files are very large and/or when running in a clustered system with a persistent file list filter discussed below. Use `max-fetch-size` for this purpose; a negative value (default) means no limit and all matching files will be retrieved; see the section called “CompletableFuture” for more information. Since *version 5.0*, you can also provide a custom `DirectoryScanner` implementation to the `inbound-channel-adapter` via the `scanner` attribute.

Starting with *Spring Integration 3.0*, you can specify the `preserve-timestamp` attribute (default `false`); when `true`, the local file’s modified timestamp will be set to the value retrieved from the server; otherwise it will be set to the current time.

Starting with *version 4.2*, you can specify `remote-directory-expression` instead of `remote-directory`, allowing you to dynamically determine the directory on each poll. e.g `remote-directory-expression="@myBean.determineRemoteDir()"`.

Starting with *version 4.3*, the `remote-directory`/`remote-directory-expression` attributes can be omitted assuming `null`. In this case, according to the FTP protocol, the Client working directory is used as a default remote directory.

Sometimes file filtering based on the simple pattern specified via `filename-pattern` attribute might not be sufficient. If this is the case, you can use the `filename-regex` attribute to specify a Regular Expression (e.g. `filename-regex=".*\.test$"`). And of course if you need complete control you can use `filter` attribute and provide a reference to any custom implementation of the `org.springframework.integration.file.filters.FileListFilter`, a strategy interface for filtering a list of files. This filter determines which remote files are retrieved. You can also combine a pattern based filter with other filters, such as an `AcceptOnceFileListFilter` to avoid synchronizing files that have previously been fetched, by using a `CompositeFileListFilter`.

The `AcceptOnceFileListFilter` stores its state in memory. If you wish the state to survive a system restart, consider using the `FtpPersistentAcceptOnceFileListFilter` instead. This filter stores the accepted file names in an instance of the `MetadataStore` strategy (the section called “CompletableFuture”). This filter matches on the filename and the remote modified time.

Since *version 4.0*, this filter requires a `ConcurrentMetadataStore`. When used with a shared data store (such as `Redis` with the `RedisMetadataStore`) this allows filter keys to be shared across multiple application or server instances.

Starting with *version 5.0*, the `FtpPersistentAcceptOnceFileListFilter` with in-memory `SimpleMetadataStore` is applied by default for the `FtpInboundFileSynchronizer`. This filter is also applied together with the `regex` or `pattern` option in the XML configuration as well as via `FtpInboundChannelAdapterSpec` in Java DSL. Any other use-cases can be reached via `CompositeFileListFilter` (or `ChainFileListFilter`).

The above discussion refers to filtering the files before retrieving them. Once the files have been retrieved, an additional filter is applied to the files on the file system. By default, this is an `AcceptOnceFileListFilter` which, as discussed, retains state in memory and does not consider the file’s modified time. Unless your application removes files after processing, the adapter will re-process the files on disk by default after an application restart.

Also, if you configure the `filter` to use a `FtpPersistentAcceptOnceFileListFilter`, and the remote file timestamp changes (causing it to be re-fetched), the default local filter will not allow this new file to be processed.

Use the `local-filter` attribute to configure the behavior of the local file system filter. Starting with *version 4.3.8*, a `FileSystemPersistentAcceptOnceFileListFilter` is configured by default. This filter stores the accepted file names and modified timestamp in an instance of the `MetadataStore` strategy (the section called “CompletableFuture”), and will detect changes to the local file modified time. The default `MetadataStore` is a `SimpleMetadataStore` which stores state in memory.

Since *version 4.1.5*, these filters have a new property `flushOnUpdate` which will cause them to flush the metadata store on every update (if the store implements `Flushable`).

> **Important**
>
> Further, if you use a distributed `MetadataStore` (such as the section called “CompletableFuture” or the section called “CompletableFuture”) you can have multiple instances of the same adapter/ application and be sure that one and only one will process a file.

The actual local filter is a `CompositeFileListFilter` containing the supplied filter and a pattern filter that prevents processing files that are in the process of being downloaded (based on the `temporary-file-suffix`); files are downloaded with this suffix (default: `.writing`) and the file is renamed to its final name when the transfer is complete, making it *visible* to the filter.

The `remote-file-separator` attribute allows you to configure a file separator character to use if the default / is not applicable for your particular environment.

Please refer to the schema for more details on these attributes.

It is also important to understand that the *FTP Inbound Channel Adapter* is a *Polling Consumer* and therefore you must configure a poller (either via a global default or a local sub-element). Once a file has been transferred, a Message with a `java.io.File` as its payload will be generated and sent to the channel identified by the `channel` attribute.

More on File Filtering and Large Files

Sometimes the file that just appeared in the monitored (remote) directory is not complete. Typically such a file will be written with temporary extension (e.g., foo.txt.writing) and then renamed after the writing process finished. As a user in most cases you are only interested in files that are complete and would like to filter only files that are complete. To handle these scenarios you can use the filtering support provided by the `filename-pattern`, `filename-regex` and `filter` attributes. Here is an example that uses a custom Filter implementation.

```
<int-ftp:inbound-channel-adapter
    channel="ftpChannel"
    session-factory="ftpSessionFactory"
    filter="customFilter"
    local-directory="file:/my_transfers">
    remote-directory="some/remote/path"
    <int:poller fixed-rate="1000"/>
</int-ftp:inbound-channel-adapter>

<bean id="customFilter" class="org.example.CustomFilter"/>
```

Poller configuration notes for the inbound FTP adapter

The job of the inbound FTP adapter consists of two tasks: *1) Communicate with a remote server in order to transfer files from a remote directory to a local directory. 2) For each transferred file, generate a Message with that file as a payload and send it to the channel identified by the* channel *attribute.* That is why they are called *channel-adapters* rather than just *adapters*. The main job of such an adapter is to generate a Message to be sent to a Message Channel. Essentially, the second task mentioned above takes precedence in such a way that **IF** your local directory already has one or more files it will first generate Messages from those, and **ONLY** when all local files have been processed, will it initiate the remote communication to retrieve more files.

Also, when configuring a trigger on the poller you should pay close attention to the `max-messages-per-poll` attribute. Its default value is `1` for all `SourcePollingChannelAdapter` instances (including FTP). This means that as soon as one file is processed, it will wait for the next execution time as determined by your trigger configuration. If you happened to have one or more files sitting in the `local-directory`, it would process those files before it would initiate communication with the remote FTP server. And, if the `max-messages-per-poll` were set to `1` (default), then it would be processing only one file at a time with intervals as defined by your trigger, essentially working as *one-poll === one-file*.

For typical file-transfer use cases, you most likely want the opposite behavior: to process all the files you can for each poll and only then wait for the next poll. If that is the case, set `max-messages-per-poll` to -1. Then, on each poll, the adapter will attempt to generate as many Messages as it possibly can. In other words, it will process everything in the local directory, and then it will connect to the remote directory to transfer everything that is available there to be processed locally. Only then is the poll operation considered complete, and the poller will wait for the next execution time.

You can alternatively set the *max-messages-per-poll* value to a positive value indicating the upward limit of Messages to be created from files with each poll. For example, a value of 10 means that on each poll it will attempt to process no more than 10 files.

==== Recovering from Failures

It is important to understand the architecture of the adapter. There is a file synchronizer which fetches the files, and a `FileReadingMessageSource` to emit a message for each synchronized file. As discussed above, there are two filters involved. The `filter` attribute (and patterns) refers to the remote (FTP) file list - to avoid fetching files that have already been fetched. The `local-filter` is used by the `FileReadingMessageSource` to determine which files are to be sent as messages.

The synchronizer lists the remote files and consults its filter; the files are then transferred. If an IO error occurs during file transfer, any files that have already been added to the filter are removed so they are eligible to be re-fetched on the next poll. This only applies if the filter implements `ReversibleFileListFilter` (such as the `AcceptOnceFileListFilter`).

If, after synchronizing the files, an error occurs on the downstream flow processing a file, there is *no* automatic rollback of the filter so the failed file will *not* be reprocessed by default.

If you wish to reprocess such files after a failure, you can use configuration similar to the following to facilitate the removal of the failed file from the filter. This will work for any `ResettableFileListFilter`.

```
<int-ftp:inbound-channel-adapter id="ftpAdapter"
        session-factory="ftpSessionFactory"
        channel="requestChannel"
        remote-directory-expression="'/sftpSource'"
        local-directory="file:myLocalDir"
        auto-create-local-directory="true"
        filename-pattern="*.txt">
    <int:poller fixed-rate="1000">
        <int:transactional synchronization-factory="syncFactory" />
    </int:poller>
</int-ftp:inbound-channel-adapter>

<bean id="acceptOnceFilter"
    class="org.springframework.integration.file.filters.AcceptOnceFileListFilter" />

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-rollback expression="payload.delete()" />
</int:transaction-synchronization-factory>

<bean id="transactionManager"
    class="org.springframework.integration.transaction.PseudoTransactionManager" />
```

Starting with *version 5.0*, the Inbound Channel Adapter can build sub-directories locally according the generated local file name. That can be a remote sub-path as well. To be able to read local directory recursively for modification according the hierarchy support, an internal `FileReadingMessageSource` now can be supplied with a new `RecursiveDirectoryScanner` based on the `Files.walk()` algorithm. See `AbstractInboundFileSynchronizingMessageSource.setScanner()` for more information. Also the `AbstractInboundFileSynchronizingMessageSource` can now be switched to the `WatchService` -based `DirectoryScanner` via `setUseWatchService()` option. It is also configured for all the `WatchEventType` s to react for any modifications in local directory. The reprocessing sample above is based on the build-in functionality of the `FileReadingMessageSource.WatchServiceDirectoryScanner` to perform `ResettableFileListFilter.remove()` when the file is deleted (`StandardWatchEventKinds.ENTRY_DELETE`) from the local directory. See the section called “CompletableFuture” for more information.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class FtpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FtpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public SessionFactory<FTPFile> ftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<FTPFile>(sf);
    }

    @Bean
    public FtpInboundFileSynchronizer ftpInboundFileSynchronizer() {
        FtpInboundFileSynchronizer fileSynchronizer = new
 FtpInboundFileSynchronizer(ftpSessionFactory());
        fileSynchronizer.setDeleteRemoteFiles(false);
        fileSynchronizer.setRemoteDirectory("foo");
        fileSynchronizer.setFilter(new FtpSimplePatternFileListFilter("*.xml"));
        return fileSynchronizer;
    }

    @Bean
    @InboundChannelAdapter(channel = "ftpChannel", poller = @Poller(fixedDelay = "5000"))
    public MessageSource<File> ftpMessageSource() {
        FtpInboundFileSynchronizingMessageSource source =
                new FtpInboundFileSynchronizingMessageSource(ftpInboundFileSynchronizer());
        source.setLocalDirectory(new File("ftp-inbound"));
        source.setAutoCreateLocalDirectory(true);
        source.setLocalFilter(new AcceptOnceFileListFilter<File>());
        source.setMaxFetchSize(1);
        return source;
    }

    @Bean
    @ServiceActivator(inputChannel = "ftpChannel")
    public MessageHandler handler() {
        return new MessageHandler() {

            @Override
            public void handleMessage(Message<?> message) throws MessagingException {
                System.out.println(message.getPayload());
            }

        };
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class FtpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FtpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow ftpInboundFlow() {
        return IntegrationFlows
            .from(s -> s.ftp(this.ftpSessionFactory)
                    .preserveTimestamp(true)
                    .remoteDirectory("foo")
                    .regexFilter(".*\\.txt$")
                    .localFilename(f -> f.toUpperCase() + ".a")
                    .localDirectory(new File("d:\\ftp_files")),
                e -> e.id("ftpInboundAdapter")
                    .autoStartup(true)
                    .poller(Pollers.fixedDelay(5000)))
            .handle(m -> System.out.println(m.getPayload()))
            .get();
    }
}
```

==== Dealing With Incomplete Data

See the section called “CompletableFuture”.

The `FtpSystemMarkerFilePresentFileListFilter` is provided to filter remote files that don’t have a corresponding marker file on the remote system. See the javadocs for configuration information.

=== FTP Streaming Inbound Channel Adapter

The streaming inbound channel adapter was introduced in *version 4.3*. This adapter produces message with payloads of type `InputStream`, allowing files to be fetched without writing to the local file system. Since the session remains open, the consuming application is responsible for closing the session when the file has been consumed. The session is provided in the `closeableResource` header (`IntegrationMessageHeaderAccessor.`CLOSEABLE_RESOURCE). Standard framework components, such as the `FileSplitter` and `StreamTransformer` will automatically close the session. See the section called “CompletableFuture” and the section called “Stream Transformer” for more information about these components.

```
<int-ftp:inbound-streaming-channel-adapter id="ftpInbound"
            channel="ftpChannel"
            session-factory="sessionFactory"
            filename-pattern="*.txt"
            filename-regex=".*\.txt"
            filter="filter"
            filter-expression="@myFilterBean.check(#root)"
            remote-file-separator="/"
            comparator="comparator"
            max-fetch-size="1"
            remote-directory-expression="'foo/bar'">
        <int:poller fixed-rate="1000" />
</int-ftp:inbound-streaming-channel-adapter>
```

Only one of `filename-pattern`, `filename-regex`, `filter` or `filter-expression` is allowed.

> **Important**
>
> Starting with *version 5.0*, by default, the `FtpStreamingMessageSource` adapter prevents duplicates for remote files via `FtpPersistentAcceptOnceFileListFilter` based on the in-memory `SimpleMetadataStore`. This filter is also applied by default together with the filename pattern (or regex) as well. If there is a requirement to allow duplicates, the `AcceptAllFileListFilter` can be used. Any other use-cases can be reached via `CompositeFileListFilter` (or `ChainFileListFilter`). The java configuration below shows one technique to remove the remote file after processing, avoiding duplicates.

Use the `max-fetch-size` attribute to limit the number of files fetched on each poll when a fetch is necessary; set to 1 and use a persistent filter when running in a clustered environment; see the section called “CompletableFuture” for more information.

The adapter puts the remote directory and file name in headers `FileHeaders.REMOTE_DIRECTORY` and `FileHeaders.REMOTE_FILE` respectively. Starting with *version 5.0*, additional remote file information, represented in JSON by default, is provided in the `FileHeaders.REMOTE_FILE_INFO` header. If you set the `fileInfoJson` property on the `FtpStreamingMessageSource` to `false`, the header will contain an `FtpFileInfo` object. The `FTPFile` object provided by the underlying Apache Net library can be accessed using the `FtpFileInfo.getFileInfo()` method. The `fileInfoJson` property is not available when using XML configuration but you can set it by injecting the `FtpStreamingMessageSource` into one of your configuration classes.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class FtpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FtpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    @InboundChannelAdapter(channel = "stream")
    public MessageSource<InputStream> ftpMessageSource() {
        FtpStreamingMessageSource messageSource = new FtpStreamingMessageSource(template());
        messageSource.setRemoteDirectory("ftpSource/");
        messageSource.setFilter(new AcceptAllFileListFilter<>());
        messageSource.setMaxFetchSize(1);
        return messageSource;
    }

    @Bean
    @Transformer(inputChannel = "stream", outputChannel = "data")
    public org.springframework.integration.transformer.Transformer transformer() {
        return new StreamTransformer("UTF-8");
    }

    @Bean
    public FtpRemoteFileTemplate template() {
        return new FtpRemoteFileTemplate(ftpSessionFactory());
    }

    @ServiceActivator(inputChannel = "data", adviceChain = "after")
    @Bean
    public MessageHandler handle() {
        return System.out::println;
    }

    @Bean
    public ExpressionEvaluatingRequestHandlerAdvice after() {
        ExpressionEvaluatingRequestHandlerAdvice advice = new
 ExpressionEvaluatingRequestHandlerAdvice();
        advice.setOnSuccessExpression(
                "@template.remove(headers['file_remoteDirectory'] + headers['file_remoteFile'])");
        advice.setPropagateEvaluationFailures(true);
        return advice;
    }

}
```

Notice that, in this example, the message handler downstream of the transformer has an advice that removes the remote file after processing.

=== Inbound Channel Adapters: Polling Multiple Servers and Directories

Starting with *version 5.0.7*, the `RotatingServerAdvice` is available; when configured as a poller advice, the inbound adapters can poll multiple servers and directories. Configure the advice and add it to the poller's advice chain as normal. A `DelegatingSessionFactory` is used to select the server see the section called “CompletableFuture” for more information. The advice configuration consists of a list of `RotatingServerAdvice.KeyDirectory` objects.

Example.

```
@Bean
public RotatingServerAdvice advice() {
    List<KeyDirectory> keyDirectories = new ArrayList<>();
    keyDirectories.add(new KeyDirectory("one", "foo"));
    keyDirectories.add(new KeyDirectory("one", "bar"));
    keyDirectories.add(new KeyDirectory("two", "baz"));
    keyDirectories.add(new KeyDirectory("two", "qux"));
    keyDirectories.add(new KeyDirectory("three", "fiz"));
    keyDirectories.add(new KeyDirectory("three", "buz"));
    return new RotatingServerAdvice(delegatingSf(), keyDirectories);
}
```

This advice will poll directory `foo` on server `one` until no new files exist then move to directory `bar` and then directory `baz` on server `two`, etc.

This default behavior can be modified with the `fair` constructor arg:

fair.

```
@Bean
public RotatingServerAdvice advice() {
    ...
    return new RotatingServerAdvice(delegatingSf(), keyDirectories, true);
}
```

In this case, the advice will move to the next server/directory regardless of whether the previous poll returned a file.

Alternatively, you can provide your own `RotatingServerAdvice.RotationPolicy` to reconfigure the message source as needed:

policy.

```
public interface RotationPolicy {

    void beforeReceive(MessageSource<?> source);

    void afterReceive(boolean messageReceived, MessageSource<?> source);

}
```

and

custom.

```
@Bean
public RotatingServerAdvice advice() {
    return new RotatingServerAdvice(myRotationPolicy());
}
```

The `local-filename-generator-expression` attribute (`localFilenameGeneratorExpression` on the synchronizer) can now contain the `#remoteDirectory` variable. This allows files retrieved from different directories to be downloaded to similar directories locally:

```
@Bean
public IntegrationFlow flow() {
    return IntegrationFlows.from(Ftp.inboundAdapter(sf())
                    .filter(new FtpPersistentAcceptOnceFileListFilter(new
 SimpleMetadataStore(), "rotate"))
                    .localDirectory(new File(tmpDir))
                    .localFilenameExpression("#remoteDirectory + T(java.io.File).separator + #root")
                    .remoteDirectory("."),
                e -> e.poller(Pollers.fixedDelay(1).advice(advice())))
            .channel(MessageChannels.queue("files"))
            .get();
}
```

Important

Do not configure a `TaskExecutor` on the poller when using this advice; see the section called “Conditional Pollers for Message Sources” for more information.

=== Inbound Channel Adapters: Controlling Remote File Fetching

There are two properties that should be considered when configuring inbound channel adapters. `max-messages-per-poll`, as with all pollers, can be used to limit the number of messages emitted on each poll (if more than the configured value are ready). `max-fetch-size` (since *version 5.0*) can limit the number of files retrieved from the remote server at a time.

The following scenarios assume the starting state is an empty local directory.

- `max-messages-per-poll=2` and `max-fetch-size=1`, the adapter will fetch one file, emit it, fetch the next file, emit it; then sleep until the next poll.
- `max-messages-per-poll=2` and `max-fetch-size=2`), the adapter will fetch both files, then emit each one.
- `max-messages-per-poll=2` and `max-fetch-size=4`, the adapter will fetch up to 4 files (if available) and emit the first two (if there are at least two); the next two files will be emitted on the next poll.
- `max-messages-per-poll=2` and `max-fetch-size` not specified, the adapter will fetch all remote files and emit the first two (if there are at least two); the subsequent files will be emitted on subsequent polls (2-at-a-time); when all are consumed, the remote fetch will be attempted again, to pick up any new files.

Important

When deploying multiple instances of an application, a small `max-fetch-size` is recommended to avoid one instance "grabbing" all the files and starving other instances.

Another use for `max-fetch-size` is if you want to stop fetching remote files, but continue to process files that have already been fetched. Setting the `maxFetchSize` property on the `MessageSource` (programmatically, via JMX, or via a control bus) effectively stops the adapter from fetching more files, but allows the poller to continue to emit messages for files that have previously been fetched. If the poller is active when the property is changed, the change will take effect on the next poll.

=== FTP Outbound Channel Adapter

The *FTP Outbound Channel Adapter* relies upon a `MessageHandler` implementation that will connect to the FTP server and initiate an FTP transfer for every file it receives in the payload of incoming Messages. It also supports several representations of the *File* so you are not limited only to java.io.File typed payloads. The *FTP Outbound Channel Adapter* supports the following payloads: 1) `java.io.File` - the actual file object; 2) `byte[]` - a byte array that represents the file contents; and 3) `java.lang.String` - text that represents the file contents.

```
<int-ftp:outbound-channel-adapter id="ftpOutbound"
    channel="ftpChannel"
    session-factory="ftpSessionFactory"
    charset="UTF-8"
    remote-file-separator="/"
    auto-create-directory="true"
    remote-directory-expression="headers['remote_dir']"
    temporary-remote-directory-expression="headers['temp_remote_dir']"
    filename-generator="fileNameGenerator"
    use-temporary-filename="true"
    mode="REPLACE"/>
```

As you can see from the configuration above you can configure an *FTP Outbound Channel Adapter* via the `outbound-channel-adapter` element while also providing values for various attributes such as `filename-generator` (an implementation of the `org.springframework.integration.file.FileNameGenerator` strategy interface), a reference to a `session-factory`, as well as other attributes. You can also see some examples of `*expression` attributes which allow you to use SpEL to configure things like `remote-directory-expression`, `temporary-remote-directory-expression` and `remote-filename-generator-expression` (a SpEL alternative to `filename-generator` shown above). As with any component that allows the usage of SpEL, access to Payload and Message Headers is available via *payload* and *headers* variables. Please refer to the schema for more details on the available attributes.

Note

By default Spring Integration will use `o.s.i.file.DefaultFileNameGenerator` if none is specified. `DefaultFileNameGenerator` will determine the file name based on the value of the `file_name` header (if it exists) in the MessageHeaders, or if the payload of the Message is already a `java.io.File`, then it will use the original name of that file.

Important

Defining certain values (e.g., remote-directory) might be platform/ftp server dependent. For example as it was reported on this forum https://forum.spring.io/showthread.php?p=333478&posted=1#post333478 on some platforms you must add slash to the end of the directory definition (e.g., remote-directory="/foo/bar/" instead of remote-directory="/foo/bar")

Starting with *version 4.1*, you can specify the `mode` when transferring the file. By default, an existing file will be overwritten; the modes are defined on `enum FileExistsMode`, having values `REPLACE` (default), `APPEND`, `IGNORE`, and `FAIL`. With `IGNORE` and `FAIL`, the file is not transferred; `FAIL` causes an exception to be thrown whereas `IGNORE` silently ignores the transfer (although a `DEBUG` log entry is produced).

Avoiding Partially Written Files

One of the common problems, when dealing with file transfers, is the possibility of processing a *partial file* - a file might appear in the file system before its transfer is actually complete.

To deal with this issue, Spring Integration FTP adapters use a very common algorithm where files are transferred under a temporary name and then renamed once they are fully transferred.

By default, every file that is in the process of being transferred will appear in the file system with an additional suffix which, by default, is `.writing`; this can be changed using the `temporary-file-suffix` attribute.

However, there may be situations where you don't want to use this technique (for example, if the server does not permit renaming files). For situations like this, you can disable this feature by setting `use-temporary-file-name` to `false` (default is `true`). When this attribute is `false`, the file is written with its final name and the consuming application will need some other mechanism to detect that the file is completely uploaded before accessing it.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the Outbound Adapter using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class FtpJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
                    new SpringApplicationBuilder(FtpJavaApplication.class)
                        .web(false)
                        .run(args);
        MyGateway gateway = context.getBean(MyGateway.class);
        gateway.sendToFtp(new File("/foo/bar.txt"));
    }

    @Bean
    public SessionFactory<FTPFile> ftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<FTPFile>(sf);
    }

    @Bean
    @ServiceActivator(inputChannel = "ftpChannel")
    public MessageHandler handler() {
        FtpMessageHandler handler = new FtpMessageHandler(ftpSessionFactory());
        handler.setRemoteDirectoryExpressionString("headers['remote-target-dir']");
        handler.setFileNameGenerator(new FileNameGenerator() {

            @Override
            public String generateFileName(Message<?> message) {
                 return "handlerContent.test";
            }

        });
        return handler;
    }

    @MessagingGateway
    public interface MyGateway {

         @Gateway(requestChannel = "toFtpChannel")
         void sendToFtp(File file);

    }
}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Outbound Adapter using the Java DSL:

```
@SpringBootApplication
@IntegrationComponentScan
public class FtpJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
            new SpringApplicationBuilder(FtpJavaApplication.class)
                .web(false)
                .run(args);
        MyGateway gateway = context.getBean(MyGateway.class);
        gateway.sendToFtp(new File("/foo/bar.txt"));
    }

    @Bean
    public SessionFactory<FTPFile> ftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<FTPFile>(sf);
    }

    @Bean
    public IntegrationFlow ftpOutboundFlow() {
        return IntegrationFlows.from("toFtpChannel")
                .handle(Ftp.outboundAdapter(ftpSessionFactory(), FileExistsMode.FAIL)
                        .useTemporaryFileName(false)
                        .fileNameExpression("headers['" + FileHeaders.FILENAME + "']")
                        .remoteDirectory(this.ftpServer.getTargetFtpDirectory().getName())
                ).get();
    }

    @MessagingGateway
    public interface MyGateway {

         @Gateway(requestChannel = "toFtpChannel")
         void sendToFtp(File file);

    }

}
```

=== FTP Outbound Gateway

The *FTP Outbound Gateway* provides a limited set of commands to interact with a remote FTP/FTPS server. Commands supported are:

- ls (list files)
- nlst (list file names)
- get (retrieve file)
- mget (retrieve file(s))
- rm (remove file(s))
- mv (move/rename file)
- put (send file)

- mput (send multiple files)

ls

ls lists remote file(s) and supports the following options:

- `-1` - just retrieve a list of file names, default is to retrieve a list of `FileInfo` objects.
- -a - include all files (including those starting with .)
- -f - do not sort the list
- -dirs - include directories (excluded by default)
- -links - include symbolic links (excluded by default)
- -R - list the remote directory recursively

In addition, filename filtering is provided, in the same manner as the `inbound-channel-adapter`.

The message payload resulting from an *ls* operation is a list of file names, or a list of `FileInfo` objects. These objects provide information such as modified time, permissions etc.

The remote directory that the *ls* command acted on is provided in the `file_remoteDirectory` header.

When using the recursive option (`-R`), the `fileName` includes any subdirectory elements, representing a relative path to the file (relative to the remote directory). If the `-dirs` option is included, each recursive directory is also returned as an element in the list. In this case, it is recommended that the `-1` is not used because you would not be able to determine files Vs. directories, which is achievable using the `FileInfo` objects.

Starting with *version 4.3*, the `FtpSession` supports `null` for the `list()` and `listNames()` methods, therefore the `expression` attribute can be omitted. For Java configuration, there are two constructors without an `expression` argument for convenience. `null` for `LS`, `NLST`, `PUT` and `MPUT` commands is treated as the Client working directory according to the FTP protocol. All other commands must be supplied with the `expression` to evaluate remote path against request message. The working directory can be set via the `FTPClient.changeWorkingDirectory()` function when you extend the `DefaultFtpSessionFactory` and implement `postProcessClientAfterConnect()` callback.

nlst

(Since *version 5.0*)

Lists remote file names and supports the following options:

- -f - do not sort the list

The message payload resulting from an *nlst* operation is a list of file names.

The remote directory that the *nlst* command acted on is provided in the `file_remoteDirectory` header.

Unlike the `-1` option for the *ls* command (see above), which uses the `LIST` command, the *nlst* command sends an `NLST` command to the target FTP server. This command is useful when the server doesn't support LIST, due to security restrictions, for example. The result of the *nlst* is just the names, therefore the framework can't determine if an entity is a directory, to perform filtering or recursive listing, for example.

get

get retrieves a remote file and supports the following option:

- -P - preserve the timestamp of the remote file.
- -stream - retrieve the remote file as a stream.
- -D - delete the remote file after successful transfer. The remote file is NOT deleted if the transfer is ignored because the FileExistsMode is IGNORE and the local file already exists.

The remote directory is provided in the file_remoteDirectory header, and the filename is provided in the file_remoteFile header.

The message payload resulting from a *get* operation is a File object representing the retrieved file, or an InputStream when the -stream option is provided. This option allows retrieving the file as a stream. For text files, a common use case is to combine this operation with a File Splitter or Stream Transformer. When consuming remote files as streams, the user is responsible for closing the Session after the stream is consumed. For convenience, the Session is provided in the closeableResource header, a convenience method is provided on the IntegrationMessageHeaderAccessor:

```
Closeable closeable = new IntegrationMessageHeaderAccessor(message).getCloseableResource();
if (closeable != null) {
    closeable.close();
}
```

Framework components such as the File Splitter and Stream Transformer will automatically close the session after the data is transferred.

The following shows an example of consuming a file as a stream:

```
<int-ftp:outbound-gateway session-factory="ftpSessionFactory"
                            request-channel="inboundGetStream"
                            command="get"
                            command-options="-stream"
                            expression="payload"
                            remote-directory="ftpTarget"
                            reply-channel="stream" />

<int-file:splitter input-channel="stream" output-channel="lines" />
```

Note: if you consume the input stream in a custom component, you **must** close the Session. You can either do that in your custom code, or route a copy of the message to a service-activator and use SpEL:

```
<int:service-activator input-channel="closeSession"
    expression="headers['closeableResource'].close()" />
```

mget

mget retrieves multiple remote files based on a pattern and supports the following options:

- -P - preserve the timestamps of the remote files.

- -R - retrieve the entire directory tree recursively.
- -x - Throw an exception if no files match the pattern (otherwise an empty list is returned).
- -D - delete each remote file after successful transfer. The remote file is NOT deleted if the transfer is ignored because the `FileExistsMode` is `IGNORE` and the local file already exists.

The message payload resulting from an *mget* operation is a `List<File>` object - a List of File objects, each representing a retrieved file.

> **Important**
>
> Starting with *version 5.0*, if the `FileExistsMode` is `IGNORE`, the payload of the output message will no longer contain files that were not fetched due to the file already existing. Previously, the array contained all files, including those that already existed.

The expression used to determine the remote path should produce a result that ends with `*` - e.g. `foo/*` will fetch the complete tree under `foo`.

Starting with *version 5.0*, a recursive `MGET`, combined with the new `FileExistsMode.REPLACE_IF_MODIFIED` mode, can be used to periodically synchronize an entire remote directory tree locally. This mode will set the local file last modified timestamp with the remote timestamp, regardless of the `-P` (preserve timestamp) option.

> **Notes for when using recursion (`-R`)**
>
> The pattern is ignored, and `*` is assumed. By default, the entire remote tree is retrieved. However, files in the tree can be filtered, by providing a `FileListFilter`; directories in the tree can also be filtered this way. A `FileListFilter` can be provided by reference or by `filename-pattern` or `filename-regex` attributes. For example, `filename-regex="(subDir|.*1.txt)"` will retrieve all files ending with `1.txt` in the remote directory and the subdirectory `subDir`. However, see below for an alternative available in *version 5.0*.
>
> If a subdirectory is filtered, no additional traversal of that subdirectory is performed.
>
> The `-dirs` option is not allowed (the recursive mget uses the recursive `ls` to obtain the directory tree and the directories themselves cannot be included in the list).
>
> Typically, you would use the `#remoteDirectory` variable in the `local-directory-expression` so that the remote directory structure is retained locally.

Starting with *version 5.0*, the `FtpSimplePatternFileListFilter` and `FtpRegexPatternFileListFilter` can be configured to always pass directories by setting the `alwaysAcceptDirectories` to `true`. This allows recursion for a simple pattern; examples follow:

```xml
<bean id="starDotTxtFilter"
        class="org.springframework.integration.ftp.filters.FtpSimplePatternFileListFilter">
    <constructor-arg value="*.txt" />
    <property name="alwaysAcceptDirectories" value="true" />
</bean>

<bean id="dotStarDotTxtFilter"
            class="org.springframework.integration.ftp.filters.FtpRegexPatternFileListFilter">
    <constructor-arg value="^.*\.txt$" />
    <property name="alwaysAcceptDirectories" value="true" />
</bean>
```

and provide one of these filters using `filter` property on the gateway.

See also the section called “CompletableFuture”.

put

put sends a file to the remote server; the payload of the message can be a `java.io.File`, a `byte[]` or a `String`. A `remote-filename-generator` (or expression) is used to name the remote file. Other available attributes include `remote-directory`, `temporary-remote-directory` (and their `*-expression`) equivalents, `use-temporary-file-name`, and `auto-create-directory`. Refer to the schema documentation for more information.

The message payload resulting from a *put* operation is a `String` representing the full path of the file on the server after transfer.

mput

mput sends multiple files to the server and supports the following option:

- -R - Recursive - send all files (possibly filtered) in the directory and subdirectories

The message payload must be a `java.io.File` representing a local directory.

The same attributes as the `put` command are supported. In addition, files in the local directory can be filtered with one of `mput-pattern`, `mput-regex`, `mput-filter` or `mput-filter-expression`. The filter works with recursion, as long as the subdirectories themselves pass the filter. Subdirectories that do not pass the filter are not recursed.

The message payload resulting from an *mget* operation is a `List<String>` object - a List of remote file paths resulting from the transfer.

See also the section called “CompletableFuture”.

rm

The *rm* command has no options.

The message payload resulting from an *rm* operation is Boolean.TRUE if the remove was successful, Boolean.FALSE otherwise. The remote directory is provided in the `file_remoteDirectory` header, and the filename is provided in the `file_remoteFile` header.

mv

The *mv* command has no options.

The *expression* attribute defines the "from" path and the *rename-expression* attribute defines the "to" path. By default, the *rename-expression* is `headers['file_renameTo']`. This expression must not evaluate to null, or an empty `String`. If necessary, any remote directories needed will be created. The payload of the result message is `Boolean.TRUE`. The original remote directory is provided in the `file_remoteDirectory` header, and the filename is provided in the `file_remoteFile` header. The new path is in the `file_renameTo` header.

Additional Information

The *get* and *mget* commands support the *local-filename-generator-expression* attribute. It defines a SpEL expression to generate the name of local file(s) during the transfer. The root object of the evaluation context is the request Message but, in addition, the `remoteFileName` variable is also available, which is particularly useful for *mget*, for example: `local-filename-generator-expression="#remoteFileName.toUpperCase() + headers.foo"`.

The *get* and *mget* commands support the *local-directory-expression* attribute. It defines a SpEL expression to generate the name of local directory(ies) during the transfer. The root object of the evaluation context is the request Message but, in addition, the `remoteDirectory` variable is also available, which is particularly useful for *mget*, for example: `local-directory-expression="'/tmp/local/' + #remoteDirectory.toUpperCase() + headers.foo"`. This attribute is mutually exclusive with *local-directory* attribute.

For all commands, the PATH that the command acts on is provided by the *expression* property of the gateway. For the mget command, the expression might evaluate to , *meaning retrieve all files, or* somedirectory/ etc.

Here is an example of a gateway configured for an ls command…

```xml
<int-ftp:outbound-gateway id="gateway1"
    session-factory="ftpSessionFactory"
    request-channel="inbound1"
    command="ls"
    command-options="-1"
    expression="payload"
    reply-channel="toSplitter"/>
```

The payload of the message sent to the `toSplitter` channel is a list of String objects containing the filename of each file. If the `command-options` was omitted, it would be a list of `FileInfo` objects. Options are provided space-delimited, e.g. `command-options="-1 -dirs -links"`.

Starting with *version 4.2*, the `GET`, `MGET`, `PUT` and `MPUT` commands support a `FileExistsMode` property (`mode` when using the namespace support). This affects the behavior when the local file exists (`GET` and `MGET`) or the remote file exists (`PUT` and `MPUT`). Supported modes are `REPLACE`, `APPEND`, `FAIL` and `IGNORE`. For backwards compatibility, the default mode for `PUT` and `MPUT` operations is `REPLACE` and for `GET` and `MGET` operations, the default is `FAIL`.

Starting with *version 5.0*, the `setWorkingDirExpression()` (`working-dir-expression`) option is provided on the `FtpOutboundGateway` (`<int-ftp:outbound-gateway>`) enabling the client working directory to be changed at runtime; the expression is evaluated against the request message. The previous working directory is restored after each gateway operation.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the Outbound Gateway using Java configuration:

```
@SpringBootApplication
public class FtpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FtpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public SessionFactory<FTPFile> ftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<FTPFile>(sf);
    }

    @Bean
    @ServiceActivator(inputChannel = "ftpChannel")
    public MessageHandler handler() {
        FtpOutboundGateway ftpOutboundGateway =
                          new FtpOutboundGateway(ftpSessionFactory(), "ls", "'my_remote_dir/'");
        ftpOutboundGateway.setOutputChannelName("lsReplyChannel");
        return ftpOutboundGateway;
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Outbound Gateway using the Java DSL:

```
@SpringBootApplication
public class FtpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(FtpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public SessionFactory<FTPFile> ftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<FTPFile>(sf);
    }

    @Bean
    public FtpOutboundGatewaySpec ftpOutboundGateway() {
        return Ftp.outboundGateway(ftpSessionFactory(),
            AbstractRemoteFileOutboundGateway.Command.MGET, "payload")
            .options(AbstractRemoteFileOutboundGateway.Option.RECURSIVE)
            .regexFileNameFilter("(subFtpSource|.*1.txt)")
            .localDirectoryExpression("'localDirectory/' + #remoteDirectory")
            .localFilenameExpression("#remoteFileName.replaceFirst('ftpSource', 'localTarget')");
    }

    @Bean
    public IntegrationFlow ftpMGetFlow(AbstractRemoteFileOutboundGateway<FTPFile> ftpOutboundGateway) {
        return f -> f
            .handle(ftpOutboundGateway)
            .channel(c -> c.queue("remoteFileOutputChannel"));
    }

}
```

==== Outbound Gateway Partial Success (mget and mput)

When performing operations on multiple files (`mget` and `mput`) it is possible that an exception occurs some time after one or more files have been transferred. In this case (starting with *version 4.2*), a `PartialSuccessException` is thrown. As well as the usual `MessagingException` properties (`failedMessage` and `cause`), this exception has two additional properties:

- `partialResults` - the successful transfer results.
- `derivedInput` - the list of files generated from the request message (e.g. local files to transfer for an `mput`).

This will enable you to determine which files were successfully transferred, and which were not.

In the case of a recursive `mput`, the `PartialSuccessException` may have nested `PartialSuccessException` s.

Consider:

```
root/
|- file1.txt
|- subdir/
   | - file2.txt
   | - file3.txt
|- zoo.txt
```

If the exception occurs on `file3.txt`, the `PartialSuccessException` thrown by the gateway will have `derivedInput` of `file1.txt`, `subdir`, `zoo.txt` and `partialResults` of `file1.txt`. It's `cause` will be another `PartialSuccessException` with `derivedInput` of `file2.txt`, `file3.txt` and `partialResults` of `file2.txt`.

=== FTP Session Caching

Important

Starting with *Spring Integration version 3.0*, sessions are no longer cached by default; the `cache-sessions` attribute is no longer supported on endpoints. You must use a `CachingSessionFactory` (see below) if you wish to cache sessions.

In versions prior to 3.0, the sessions were cached automatically by default. A `cache-sessions` attribute was available for disabling the auto caching, but that solution did not provide a way to configure other session caching attributes. For example, you could not limit on the number of sessions created. To support that requirement and other configuration options, a `CachingSessionFactory` was provided. It provides `sessionCacheSize` and `sessionWaitTimeout` properties. As its name suggests, the `sessionCacheSize` property controls how many active sessions the factory will maintain in its cache (the DEFAULT is unbounded). If the `sessionCacheSize` threshold has been reached, any attempt to acquire another session will block until either one of the cached sessions becomes available or until the wait time for a Session expires (the DEFAULT wait time is Integer.MAX_VALUE). The `sessionWaitTimeout` property enables configuration of that value.

If you want your Sessions to be cached, simply configure your default Session Factory as described above and then wrap it in an instance of `CachingSessionFactory` where you may provide those additional properties.

```xml
<bean id="ftpSessionFactory" class="o.s.i.ftp.session.DefaultFtpSessionFactory">
    <property name="host" value="localhost"/>
</bean>

<bean id="cachingSessionFactory" class="o.s.i.file.remote.session.CachingSessionFactory">
    <constructor-arg ref="ftpSessionFactory"/>
    <constructor-arg value="10"/>
    <property name="sessionWaitTimeout" value="1000"/>
</bean>
```

In the above example you see a `CachingSessionFactory` created with the `sessionCacheSize` set to 10 and the `sessionWaitTimeout` set to 1 second (its value is in milliseconds).

Starting with *Spring Integration version 3.0*, the `CachingConnectionFactory` provides a `resetCache()` method. When invoked, all idle sessions are immediately closed and in-use sessions are closed when they are returned to the cache. New requests for sessions will establish new sessions as necessary.

=== RemoteFileTemplate

Starting with *Spring Integration version 3.0* a new abstraction is provided over the `FtpSession` object. The template provides methods to send, retrieve (as an `InputStream`), remove, and rename files. In addition an `execute` method is provided allowing the caller to execute multiple operations on the session. In all cases, the template takes care of reliably closing the session. For more information, refer to the JavaDocs for `RemoteFileTemplate`. There is a subclass for FTP: `FtpRemoteFileTemplate`.

Additional methods were added in *version 4.1* including `getClientInstance()` which provides access to the underlying `FTPClient` enabling access to low-level APIs.

Not all FTP servers properly implement `STAT <path>` command, in that it can return a positive result for a non-existent path. The `NLST` command reliably returns the name, when the path is a file and it exists. However, this does not support checking that an empty directory exists since `NLST` always returns an empty list in this case, when the path is a directory. Since the template doesn't know if the path represents a directory or not, it has to perform additional checks when the path does not appear to exist, when using `NLST`. This adds overhead, requiring several requests to the server. Starting with *version 4.1.9* the `FtpRemoteFileTemplate` provides `FtpRemoteFileTemplate.ExistsMode` property with the following options:

- `STAT` - Perform the `STAT` FTP command (`FTPClient.getStatus(path)`) to check the path existence; this is the default and requires that your FTP server properly supports the `STAT` command (with a path).
- `NLST` - Perform the `NLST` FTP command - `FTPClient.listName(path)`; use this if you are testing for a path that is a full path to a file; it won't work for empty directories.
- `NLST_AND_DIRS` - Perform the `NLST` command first and if it returns no files, fall back to a technique which temporarily switches the working directory using `FTPClient.changeWorkingDirectory(path)`. See `FtpSession.exists()` for more information.

Since we know that the `FileExistsMode.FAIL` case is always only looking for a file (and not a directory), we safely use `NLST` mode for the `FtpMessageHandler` and `FtpOutboundGateway` components.

For any other cases the `FtpRemoteFileTemplate` can be extended for implementing a custom logic in the overridden `exist()` method.

Starting with *version 5.0*, the new `RemoteFileOperations.invoke(OperationsCallback<F, T> action)` method is available. This method allows several `RemoteFileOperations` calls to be called in the scope of the same, thread-bounded, `Session`. This is useful when you need to perform several high-level operations of the `RemoteFileTemplate` as one unit of work. For example `AbstractRemoteFileOutboundGateway` uses it with the *mput* command implementation, where we perform a *put* operation for each file in the provided directory and recursively for its sub-directories. See the JavaDocs for more information.

=== MessageSessionCallback

Starting with *Spring Integration version 4.2*, a `MessageSessionCallback<F, T>` implementation can be used with the `<int-ftp:outbound-gateway/>` (`FtpOutboundGateway`) to perform any operation(s) on the `Session<FTPFile>` with the `requestMessage` context. It can be used for any non-standard or low-level FTP operation (or several); for example, allowing access from an integration flow definition, and *functional* interface (Lambda) implementation injection:

```
@Bean
@ServiceActivator(inputChannel = "ftpChannel")
public MessageHandler ftpOutboundGateway(SessionFactory<FTPFile> sessionFactory) {
    return new FtpOutboundGateway(sessionFactory,
         (session, requestMessage) -> session.list(requestMessage.getPayload()));
}
```

Another example might be to pre- or post- process the file data being sent/retrieved.

When using XML configuration, the `<int-ftp:outbound-gateway/>` provides a `session-callback` attribute to allow you to specify the `MessageSessionCallback` bean name.

> **Note**
>
> The `session-callback` is mutually exclusive with the `command` and `expression` attributes. When configuring with Java, different constructors are available in the `FtpOutboundGateway` class.

== GemFire Support

Spring Integration provides support for VMWare vFabric GemFire

=== Introduction

VMWare vFabric GemFire (GemFire) is a distributed data management platform providing a key-value data grid along with advanced distributed system features such as event processing, continuous querying, and remote function execution. This guide assumes some familiarity with GemFire and its API.

Spring integration provides support for GemFire by providing inbound adapters for entry and continuous query events, an outbound adapter to write entries to the cache, and `MessageStore` and `MessageGroupStore` implementations. Spring integration leverages thehttp://www.springsource.org/spring-gemfire[Spring Gemfire] project, providing a thin wrapper over its components.

To configure the *int-gfe* namespace, include the following elements within the headers of your XML configuration file:

```
xmlns:int-gfe="http://www.springframework.org/schema/integration/gemfire"
xsi:schemaLocation="http://www.springframework.org/schema/integration/gemfire
 https://www.springframework.org/schema/integration/gemfire/spring-integration-gemfire.xsd"
```

=== Inbound Channel Adapter

The *inbound-channel-adapter* produces messages on a channel triggered by a GemFire `EntryEvent`. GemFire generates events whenever an entry is CREATED, UPDATED, DESTROYED, or INVALIDATED in the associated region. The inbound channel adapter allows you to filter on a subset of these events. For example, you may want to only produce messages in response to an entry being CREATED. In addition, the inbound channel adapter can evaluate a SpEL expression if, for example, you want your message payload to contain an event property such as the new entry value.

```
<gfe:cache/>
<gfe:replicated-region id="region"/>
<int-gfe:inbound-channel-adapter id="inputChannel" region="region"
    cache-events="CREATED" expression="newValue"/>
```

In the above configuration, we are creating a GemFire `Cache` and `Region` using Spring GemFire's *gfe* namespace. The inbound-channel-adapter requires a reference to the GemFire region for which the adapter will be listening for events. Optional attributes include `cache-events` which can contain a comma separated list of event types for which a message will be produced on the input channel. By default CREATED and UPDATED are enabled. Note that this adapter conforms to Spring integration conventions. If no `channel` attribute is provided, the channel will be created from the `id` attribute. This adapter also supports an `error-channel`. The GemFire EntryEvent is the `#root` object of the `expression` evaluation. Example:

```
expression="new foo.MyEvent(key, oldValue, newValue)"
```

If the `expression` attribute is not provided, the message payload will be the GemFire `EntryEvent` itself.

=== Continuous Query Inbound Channel Adapter

The *cq-inbound-channel-adapter* produces messages a channel triggered by a GemFire continuous query or `CqEvent` event. Spring GemFire introduced continuous query support in release 1.1, including a `ContinuousQueryListenerContainer` which provides a nice abstraction over the GemFire native API. This adapter requires a reference to a ContinuousQueryListenerContainer, and creates a listener for a given `query` and executes the query. The continuous query acts as an event source that will fire whenever its result set changes state.

Note

GemFire queries are written in OQL and are scoped to the entire cache (not just one region). Additionally, continuous queries require a remote (i.e., running in a separate process or remote host) cache server. Please consult the GemFire documentation for more information on implementing continuous queries.

```
<gfe:client-cache id="client-cache" pool-name="client-pool"/>

<gfe:pool id="client-pool" subscription-enabled="true" >
    <!--configure server or locator here required to address the cache server -->
</gfe:pool>

<gfe:client-region id="test" cache-ref="client-cache" pool-name="client-pool"/>

<gfe:cq-listener-container id="queryListenerContainer" cache="client-cache"
    pool-name="client-pool"/>

<int-gfe:cq-inbound-channel-adapter id="inputChannel"
    cq-listener-container="queryListenerContainer"
    query="select * from /test"/>
```

In the above configuration, we are creating a GemFire client cache (recall a remote cache server is required for this implementation and its address is configured as a sub-element of the pool), a client region and a `ContinuousQueryListenerContainer` using Spring GemFire. The continuous query inbound channel adapter requires a `cq-listener-container` attribute which contains a reference to the `ContinuousQueryListenerContainer`. Optionally, it accepts an `expression` attribute which uses SpEL to transform the `CqEvent` or extract an individual property as needed. The cq-inbound-channel-adapter provides a `query-events` attribute, containing a comma separated list of event types for which a message will be produced on the input channel. Available event types are CREATED, UPDATED, DESTROYED, REGION_DESTROYED, REGION_INVALIDATED. CREATED and UPDATED are enabled by default. Additional optional attributes include, `query-name` which provides an optional query name, and `expression` which works as described in the above section, and `durable` - a boolean value indicating if the query is durable (false by default). Note that this adapter conforms to Spring integration conventions. If no `channel` attribute is provided, the channel will be created from the `id` attribute. This adapter also supports an `error-channel`

=== Outbound Channel Adapter

The *outbound-channel-adapter* writes cache entries mapped from the message payload. In its simplest form, it expects a payload of type `java.util.Map` and puts the map entries into its configured region.

```
<int-gfe:outbound-channel-adapter id="cacheChannel" region="region"/>
```

Given the above configuration, an exception will be thrown if the payload is not a Map. Additionally, the outbound channel adapter can be configured to create a map of cache entries using SpEL of course.

```
<int-gfe:outbound-channel-adapter id="cacheChannel" region="region">
    <int-gfe:cache-entries>
        <entry key="payload.toUpperCase()" value="payload.toLowerCase()"/>
        <entry key="'foo'" value="'bar'"/>
    </int-gfe:cache-entries>
</int-gfe:outbound-channel-adapter>
```

In the above configuration, the inner element `cache-entries` is semantically equivalent to Spring *map* element. The adapter interprets the `key` and `value` attributes as SpEL expressions with the message as the evaluation context. Note that this contain arbitrary cache entries (not only those derived from the message) and that literal values must be enclosed in single quotes. In the above example, if the message sent to `cacheChannel` has a String payload with a value "Hello", two entries `[HELLO:hello, foo:bar]` will be written (created or updated) in the cache region. This adapter also supports the `order` attribute which may be useful if it is bound to a PublishSubscribeChannel.

=== Gemfire Message Store

As described in EIP, a Message Store allows you to persist Messages. This can be very useful when dealing with components that have a capability to buffer messages (*QueueChannel, Aggregator, Resequencer*, etc.) if reliability is a concern. In Spring Integration, the MessageStore strategy also provides the foundation for thehttp://www.eaipatterns.com/StoreInLibrary.html[ClaimCheck] pattern, which is described in EIP as well.

Spring Integration's Gemfire module provides the `GemfireMessageStore` which is an implementation of both the the `MessageStore` strategy (mainly used by the *QueueChannel* and *ClaimCheck* patterns) and the `MessageGroupStore` strategy (mainly used by the *Aggregator* and *Resequencer* patterns).

```
<bean id="gemfireMessageStore" class="o.s.i.gemfire.store.GemfireMessageStore">
    <constructor-arg ref="myRegion"/>
</bean>

<gfe:cache/>

<gfe:replicated-region id="myRegion"/>


<int:channel id="somePersistentQueueChannel">
    <int:queue message-store="gemfireMessageStore"/>
<int:channel>

<int:aggregator input-channel="inputChannel" output-channel="outputChannel"
    message-store="gemfireMessageStore"/>
```

In the above example, the cache and region are configured using the spring-gemfire namespace (not to be confused with the spring-integration-gemfire namespace). Often it is desirable for the message store to be maintained in one or more remote cache servers in a client-server configuration (See the GemFire product documentation for more details). In this case, you configure a client cache, client region, and client pool and inject the region into the MessageStore. Here is an example:

```
<bean id="gemfireMessageStore"
    class="org.springframework.integration.gemfire.store.GemfireMessageStore">
    <constructor-arg ref="myRegion"/>
</bean>

<gfe:client-cache/>

<gfe:client-region id="myRegion" shortcut="PROXY" pool-name="messageStorePool"/>

<gfe:pool id="messageStorePool">
    <gfe:server host="localhost" port="40404" />
</gfe:pool>
```

Note the *pool* element is configured with the address of a cache server (a locator may be substituted here). The region is configured as a *PROXY* so that no data will be stored locally. The region's id corresponds to a region with the same name configured in the cache server.

Starting with version *4.3.12*, the `GemfireMessageStore` supports the key `prefix` option to allow distinguishing between instances of the store on the same Gemfire region.

=== Gemfire Lock Registry

Starting with *version 4.0*, the `GemfireLockRegistry` is available. Certain components (for example aggregator and resequencer) use a lock obtained from a `LockRegistry` instance to ensure that only one thread is manipulating a group at a time. The `DefaultLockRegistry` performs this function within a single component; you can now configure an external lock registry on these components. When used with a shared `MessageGroupStore`, the `GemfireLockRegistry` can be use to provide this functionality across multiple application instances, such that only one instance can manipulate the group at a time.

Note

One of the `GemfireLockRegistry` constructors requires a `Region` as an argument; it is used to obtain a `Lock` via the `getDistributedLock()` method. This operation requires `GLOBAL` scope for the `Region`. Another constructor requires `Cache` and the `Region` will be created with `GLOBAL` scope and with the name `LockRegistry`.

=== Gemfire Metadata Store

As of *version 4.0*, a new Gemfire-based `MetadataStore` (the section called "CompletableFuture") implementation is available. The `GemfireMetadataStore` can be used to maintain metadata state across application restarts. This new `MetadataStore` implementation can be used with adapters such as:

- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"

In order to instruct these adapters to use the new `GemfireMetadataStore`, simply declare a Spring bean using the bean name **metadataStore**. The *Twitter Inbound Channel Adapter* and the *Feed Inbound Channel Adapter* will both automatically pick up and use the declared `GemfireMetadataStore`.

Note

The `GemfireMetadataStore` also implements `ConcurrentMetadataStore`, allowing it to be reliably shared across multiple application instances where only one instance will be allowed to store or modify a key’s value. These methods give various levels of concurrency guarantees based on the scope and data policy of the region. They are implemented in the peer cache and client/server cache but are disallowed in peer Regions having NORMAL or EMPTY data policies.

Note

Since *version 5.0*, the `GemfireMetadataStore` also implements `ListenableMetadataStore`, allowing users to listen to cache events by providing `MetadataStoreListener` instances to the store:

```
GemfireMetadataStore metadataStore = new GemfireMetadataStore(cache);
metadataStore.addListener(new MetadataStoreListenerAdapter() {

    @Override
    public void onAdd(String key, String value) {
         ...
    }

});
```

== HTTP Support

=== Introduction

The HTTP support allows for the execution of HTTP requests and the processing of inbound HTTP requests. The HTTP support consists of the following gateway implementations: `HttpInboundEndpoint`, `HttpRequestExecutingMessageHandler`. Also see the section called “CompletableFuture”.

=== Http Inbound Components

To receive messages over HTTP, you need to use an *HTTP Inbound Channel Adapter* or *Gateway*. To support the *HTTP Inbound Adapters*, they need to be deployed within a servlet container such as Apache Tomcat or Jetty. The easiest way to do this is to use Spring’s HttpRequestHandlerServlet, by providing the following servlet definition in the *web.xml* file:

```
<servlet>
    <servlet-name>inboundGateway</servlet-name>
    <servlet-class>o.s.web.context.support.HttpRequestHandlerServlet</servlet-class>
</servlet>
```

Notice that the servlet name matches the bean name. For more information on using the `HttpRequestHandlerServlet`, see chapter Remoting and web services using Spring, which is part of the Spring Framework Reference documentation.

If you are running within a Spring MVC application, then the aforementioned explicit servlet definition is not necessary. In that case, the bean name for your gateway can be matched against the URL path just like a Spring MVC Controller bean. For more information, please see the chapter Web MVC framework, which is part of the Spring Framework Reference documentation.

Tip

For a sample application and the corresponding configuration, please see the Spring Integration Samples repository. It contains the Http Sample application demonstrating Spring Integration's HTTP support.

Below is an example bean definition for a simple HTTP inbound endpoint.

```
<bean id="httpInbound"
  class="org.springframework.integration.http.inbound.HttpRequestHandlingMessagingGateway">
  <property name="requestChannel" ref="httpRequestChannel" />
  <property name="replyChannel" ref="httpReplyChannel" />
</bean>
```

The `HttpRequestHandlingMessagingGateway` accepts a list of `HttpMessageConverter` instances or else relies on a default list. The converters allow customization of the mapping from `HttpServletRequest` to `Message`. The default converters encapsulate simple strategies, which for example will create a String message for a *POST* request where the content type starts with "text", see the Javadoc for full details. An additional flag (`mergeWithDefaultConverters`) can be set along with the list of custom `HttpMessageConverter` to add the default converters after the custom converters. By default this flag is set to false, meaning that the custom converters replace the default list.

The message conversion process uses the (optional) `requestPayloadType` property and the incoming `Content-Type` header. Starting with *version 4.3*, if a request has no content type header, `application/octet-stream` is assumed, as recommended by `RFC 2616`. Previously, the body of such messages was ignored.

Starting with *Spring Integration 2.0*, MultiPart File support is implemented. If the request has been wrapped as a `MultipartHttpServletRequest`, when using the default converters, that request will be converted to a Message payload that is a `MultiValueMap` containing values that may be byte arrays, Strings, or instances of Spring's `MultipartFile` depending on the content type of the individual parts.

Note

The HTTP inbound Endpoint will locate a `MultipartResolver` in the context if one exists with the bean name "multipartResolver" (the same name expected by Spring's `DispatcherServlet`). If it does in fact locate that bean, then the support for MultipartFiles will be enabled on the inbound request mapper. Otherwise, it will fail when trying to map a multipart-file request to a Spring Integration Message. For more on Spring's support for `MultipartResolver`, refer to the Spring Reference Manual.

If you wish to proxy a `multipart/form-data` to another server, it may be better to keep it in raw form. To handle this situation, do not add the `multipartResolver` bean to the context; configure the endpoint to expect a `byte[]` request; customize the message converters to include a `ByteArrayHttpMessageConverter`, and disable the default multipart converter. You may need some other converter(s) for the replies:

```
<int-http:inbound-gateway
                  channel="receiveChannel"
                  path="/inboundAdapter.htm"
                  request-payload-type="byte[]"
                  message-converters="converters"
                  merge-with-default-converters="false"
                  supported-methods="POST" />

<util:list id="converters">
    <beans:bean class="org.springframework.http.converter.ByteArrayHttpMessageConverter" />
    <beans:bean class="org.springframework.http.converter.StringHttpMessageConverter" />
    <beans:bean class="org.springframework.http.converter.json.MappingJackson2HttpMessageConverter" />
</util:list>
```

In sending a response to the client there are a number of ways to customize the behavior of the gateway. By default the gateway will simply acknowledge that the request was received by sending a 200 status code back. It is possible to customize this response by providing a *viewName* to be resolved by the Spring MVC `ViewResolver`. In the case that the gateway should expect a reply to the `Message` then setting the `expectReply` flag (constructor argument) will cause the gateway to wait for a reply `Message` before creating an HTTP response. Below is an example of a gateway configured to serve as a Spring MVC Controller with a view name. Because of the constructor arg value of TRUE, it wait for a reply. This also shows how to customize the HTTP methods accepted by the gateway, which are *POST* and *GET* by default.

```
<bean id="httpInbound"
  class="org.springframework.integration.http.inbound.HttpRequestHandlingController">
  <constructor-arg value="true" /> <!-- indicates that a reply is expected -->
  <property name="requestChannel" ref="httpRequestChannel" />
  <property name="replyChannel" ref="httpReplyChannel" />
  <property name="viewName" value="jsonView" />
  <property name="supportedMethodNames" >
    <list>
      <value>GET</value>
      <value>DELETE</value>
    </list>
  </property>
</bean>
```

The reply message will be available in the Model map. The key that is used for that map entry by default is *reply*, but this can be overridden by setting the *replyKey* property on the endpoint’s configuration.

=== Http Outbound Components ==== HttpRequestExecutingMessageHandler

To configure the `HttpRequestExecutingMessageHandler` write a bean definition like this:

```
<bean id="httpOutbound"
  class="org.springframework.integration.http.outbound.HttpRequestExecutingMessageHandler">
  <constructor-arg value="http://localhost:8080/example" />
  <property name="outputChannel" ref="responseChannel" />
</bean>
```

This bean definition will execute HTTP requests by delegating to a `RestTemplate`. That template in turn delegates to a list of HttpMessageConverters to generate the HTTP request body from the Message payload. You can configure those converters as well as the ClientHttpRequestFactory instance to use:

```
<bean id="httpOutbound"
  class="org.springframework.integration.http.outbound.HttpRequestExecutingMessageHandler">
  <constructor-arg value="http://localhost:8080/example" />
  <property name="outputChannel" ref="responseChannel" />
  <property name="messageConverters" ref="messageConverterList" />
  <property name="requestFactory" ref="customRequestFactory" />
</bean>
```

By default the HTTP request will be generated using an instance of `SimpleClientHttpRequestFactory` which uses the JDK `HttpURLConnection`. Use of the Apache Commons HTTP Client is also supported through the provided `CommonsClientHttpRequestFactory` which can be injected as shown above.

> **Note**
>
> In the case of the Outbound Gateway, the reply message produced by the gateway will contain all Message Headers present in the request message.

Cookies

Basic cookie support is provided by the *transfer-cookies* attribute on the outbound gateway. When set to true (default is false), a *Set-Cookie* header received from the server in a response will be converted to *Cookie* in the reply message. This header will then be used on subsequent sends. This enables simple stateful interactions, such as…

```
...->logonGateway->...->doWorkGateway->...->logoffGateway->...
```

If *transfer-cookies* is false, any *Set-Cookie* header received will remain as *Set-Cookie* in the reply message, and will be dropped on subsequent sends.

> **Note: Empty Response Bodies**
>
> HTTP is a request/response protocol. However the response may not have a body, just headers. In this case, the `HttpRequestExecutingMessageHandler` produces a reply `Message` with the payload being an `org.springframework.http.ResponseEntity`, regardless of any provided `expected-response-type`. According to the HTTP RFC Status Code Definitions, there are many statuses which identify that a response MUST NOT contain a message-body (e.g. 204 No Content). There are also cases where calls to the same URL might, or might not, return a response body; for example, the first request to an HTTP resource returns content, but the second does not (e.g. 304 Not Modified). In all cases, however, the `http_statusCode` message header is populated. This can be used in some routing logic after the Http Outbound Gateway. You could also use a`<payload-type-router/>` to route messages with an `ResponseEntity` to a different flow than that used for responses with a body.

> **Note: expected-response-type**
>
> Further to the note above regarding **empty response bodies**, if a response **does** contain a body, you must provide an appropriate `expected-response-type` attribute or, again, you will simply receive a `ResponseEntity` with no body. The `expected-response-type` must be compatible with the (configured or default) `HttpMessageConverter` s and the `Content-Type` header in the response. Of course, this can be an abstract class, or even an interface (such as `java.io.Serializable` when using java serialization and `Content-Type: application/x-java-serialized-object`).

=== HTTP Namespace Support

==== Introduction

Spring Integration provides an *http* namespace and the corresponding schema definition. To include it in your configuration, simply provide the following namespace declaration in your application context configuration file:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-http="http://www.springframework.org/schema/integration/http"
  xsi:schemaLocation="
    http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/http
    https://www.springframework.org/schema/integration/http/spring-integration-http.xsd">
    ...
</beans>
```

==== Inbound

The XML Namespace provides two components for handling HTTP Inbound requests. In order to process requests without returning a dedicated response, use the *inbound-channel-adapter*:

```
<int-http:inbound-channel-adapter id="httpChannelAdapter" channel="requests"
    supported-methods="PUT, DELETE"/>
```

To process requests that do expect a response, use an *inbound-gateway*:

```
<int-http:inbound-gateway id="inboundGateway"
    request-channel="requests"
    reply-channel="responses"/>
```

==== Request Mapping Support

Note

Spring Integration 3.0 is improving the REST support by introducing the IntegrationRequestMappingHandlerMapping. The implementation relies on the enhanced REST support provided by Spring Framework 3.1 or higher.

The parsing of the *HTTP Inbound Gateway* or the *HTTP Inbound Channel Adapter* registers an `integrationRequestMappingHandlerMapping` bean of type IntegrationRequestMappingHandlerMapping, in case there is none registered, yet. This particular implementation of the `HandlerMapping` delegates its logic to the `RequestMappingInfoHandlerMapping`. The implementation provides similar functionality as the one provided by the `org.springframework.web.bind.annotation.RequestMapping` annotation in Spring MVC.

Note

For more information, please see Mapping Requests With `@RequestMapping`.

For this purpose, *Spring Integration 3.0* introduces the `<request-mapping>` sub-element. This optional sub-element can be added to the `<http:inbound-channel-adapter>` and the `<http:inbound-gateway>`. It works in conjunction with the `path` and `supported-methods` attributes:

```
<inbound-gateway id="inboundController"
    request-channel="requests"
    reply-channel="responses"
    path="/foo/{fooId}"
    supported-methods="GET"
    view-name="foo"
    error-code="oops">
   <request-mapping headers="User-Agent"
     params="myParam=myValue"
     consumes="application/json"
     produces="!text/plain"/>
</inbound-gateway>
```

Based on this configuration, the namespace parser creates an instance of the `IntegrationRequestMappingHandlerMapping` (if none exists, yet), a `HttpRequestHandlingController` bean and associated with it an instance of `RequestMapping`, which in turn, is converted to the Spring MVC `RequestMappingInfo`.

The `<request-mapping>` sub-element provides the following attributes:

- headers
- params
- consumes
- produces

With the `path` and `supported-methods` attributes of the `<http:inbound-channel-adapter>` or the `<http:inbound-gateway>`, `<request-mapping>` attributes translate directly into the respective options provided by the `org.springframework.web.bind.annotation.RequestMapping` annotation in Spring MVC.

The `<request-mapping>` sub-element allows you to configure several *Spring Integration* HTTP Inbound Endpoints to the same `path` (or even the same `supported-methods`) and to provide different downstream message flows based on incoming HTTP requests.

Alternatively, you can also declare just one HTTP Inbound Endpoint and apply routing and filtering logic within the *Spring Integration* flow to achieve the same result. This allows you to get the `Message` into the flow as early as possibly, e.g.:

```
<int-http:inbound-gateway request-channel="httpMethodRouter"
    supported-methods="GET,DELETE"
    path="/process/{entId}"
    payload-expression="#pathVariables.entId"/>

<int:router input-channel="httpMethodRouter" expression="headers.http_requestMethod">
    <int:mapping value="GET" channel="in1"/>
    <int:mapping value="DELETE" channel="in2"/>
</int:router>

<int:service-activator input-channel="in1" ref="service" method="getEntity"/>

<int:service-activator input-channel="in2" ref="service" method="delete"/>
```

For more information regarding *Handler Mappings*, please see: Handler Mappings.

==== Cross-Origin Resource Sharing (CORS) Support

Starting with *version 4.2* the `<http:inbound-channel-adapter>` and `<http:inbound-gateway>` can be configured with a `<cross-origin>` sub-element. It represents the same options as

Spring MVC's `@CrossOrigin` for `@Controller` methods and allows the configuration of Cross-origin resource sharing (CORS) for Spring Integration HTTP endpoints:

- `origin` - List of allowed origins. `*` means that all origins are allowed. These values are placed in the `Access-Control-Allow-Origin` header of both the pre-flight and actual responses. Default value is `*`.
- `allowed-headers` - Indicates which request headers can be used during the actual request. `*` means that all headers asked by the client are allowed. This property controls the value of the pre-flight response's `Access-Control-Allow-Headers` header. Default value is `*`.
- `exposed-headers` - List of response headers that the user-agent will allow the client to access. This property controls the value of the actual response's `Access-Control-Expose-Headers` header.
- `method` - The HTTP request methods to allow: GET, POST, HEAD, OPTIONS, PUT, PATCH, DELETE, TRACE. Methods specified here overrides those in `supported-methods`.
- `allow-credentials` - Set to `true` if the the browser should include any cookies associated to the domain of the request, or `false` if it should not. Empty string "" means undefined. If `true`, the pre-flight response will include the header `Access-Control-Allow-Credentials=true`. Default value is `true`.
- `max-age` - Controls the cache duration for pre-flight responses. Setting this to a reasonable value can reduce the number of pre-flight request/response interactions required by the browser. This property controls the value of the `Access-Control-Max-Age` header in the pre-flight response. A value of `-1` means undefined. Default value is 1800 seconds, or 30 minutes.

The CORS Java Configuration is represented by the `org.springframework.integration.http.inbound.CrossOrigin` class, instances of which can be injected to the `HttpRequestHandlingEndpointSupport` beans.

==== Response StatusCode

Starting with *version 4.1* the `<http:inbound-channel-adapter>` can be configured with a `status-code-expression` to override the default `200 OK` status. The expression must return an object which can be converted to an `org.springframework.http.HttpStatus` enum value. The `evaluationContext` has a `BeanResolver` but no variables, so the usage of this attribute is somewhat limited. An example might be to resolve, at runtime, some scoped Bean that returns a status code value but, most likely, it will be set to a fixed value such as `status-code=expression="204"` (No Content), or `status-code-expression="T(org.springframework.http.HttpStatus).NO_CONTENT"`. By default, `status-code-expression` is null meaning that the normal *200 OK* response status will be returned.

```
<http:inbound-channel-adapter id="inboundController"
       channel="requests" view-name="foo" error-code="oops"
       status-code-expression="T(org.springframework.http.HttpStatus).ACCEPTED">
   <request-mapping headers="BAR"/>
</http:inbound-channel-adapter>
```

The `<http:inbound-gateway>` resolves the *status code* from the `http_statusCode` header of the reply Message. Starting with *version 4.2*, the default response status code when no reply is received within the `reply-timeout` is `500 Internal Server Error`. There are two ways to modify this behavior:

- add a `reply-timeout-status-code-expression` - this has the same semantics as the `status-code-expression` on the inbound adapter.

- Add an `error-channel` and return an appropriate message with an http status code header, such as…

```
<int:chain input-channel="errors">
    <int:header-enricher>
        <int:header name="http_statusCode" value="504" />
    </int:header-enricher>
    <int:transformer expression="payload.failedMessage" />
</int:chain>
```

The payload of the `ErrorMessage` is a `MessageTimeoutException`; it must be transformed to something that can be converted by the gateway, such as a `String`; a good candidate is the exception's message property, which is the value used when using the expression technique.

If the error flow times out after a main flow timeout, `500 Internal Server Error` is returned, or the `reply-timeout-status-code-expression` is evaluated, if present.

Note

previously, the default status code for a timeout was `200 OK`; to restore that behavior, set `reply-timeout-status-code-expression="200"`.

==== URI Template Variables and Expressions

By Using the *path* attribute in conjunction with the *payload-expression* attribute as well as the *header* sub-element, you have a high degree of flexibility for mapping inbound request data.

In the following example configuration, an Inbound Channel Adapter is configured to accept requests using the following URI: `/first-name/{firstName}/last-name/{lastName}`

Using the *payload-expression* attribute, the URI template variable *{firstName}* is mapped to be the Message payload, while the *{lastName}* URI template variable will map to the *lname* Message header.

```
<int-http:inbound-channel-adapter id="inboundAdapterWithExpressions"
    path="/first-name/{firstName}/last-name/{lastName}"
    channel="requests"
    payload-expression="#pathVariables.firstName">
    <int-http:header name="lname" expression="#pathVariables.lastName"/>
</int-http:inbound-channel-adapter>
```

For more information about *URI template variables*, please see the Spring Reference Manual: uri template patterns.

Since *Spring Integration 3.0*, in addition to the existing `#pathVariables` and `#requestParams` variables being available in payload and header expressions, other useful variables have been added.

The entire list of available expression variables:

- *#requestParams* - the `MultiValueMap` from the `ServletRequest` `parameterMap`.
- *#pathVariables* - the `Map` from URI Template placeholders and their values;
- *#matrixVariables* - the `Map` of `MultiValueMap` according to Spring MVC Specification. Note, *#matrixVariables* require Spring MVC 3.2 or higher;
- *#requestAttributes* - the `org.springframework.web.context.request.RequestAttributes` associated with the current Request;

- *#requestHeaders* - the `org.springframework.http.HttpHeaders` object from the current Request;
- *#cookies* - the `Map<String, Cookie>` of `javax.servlet.http.Cookie` s from the current Request.

Note, all these values (and others) can be accessed within expressions in the downstream message flow via the `ThreadLocal` `org.springframework.web.context.request.RequestAttributes` variable, if that message flow is single-threaded and lives within the request thread:

```
<int-:transformer
    expression="T(org.springframework.web.context.request.RequestContextHolder).
                  requestAttributes.request.queryString"/>
```

==== Outbound

To configure the outbound gateway you can use the namespace support as well. The following code snippet shows the different configuration options for an outbound Http gateway. Most importantly, notice that the *http-method* and *expected-response-type* are provided. Those are two of the most commonly configured values. The default http-method is POST, and the default response type is *null*. With a null response type, the payload of the reply Message would contain the ResponseEntity as long as it's http status is a success (non-successful status codes will throw Exceptions). If you are expecting a different type, such as a `String`, then provide that fully-qualified class name as shown below. See also the note about empty response bodies in the section called "CompletableFuture".

Important

Beginning with Spring Integration 2.1 the *request-timeout* attribute of the HTTP Outbound Gateway was renamed to *reply-timeout* to better reflect the intent.

```
<int-http:outbound-gateway id="example"
    request-channel="requests"
    url="http://localhost/test"
    http-method="POST"
    extract-request-payload="false"
    expected-response-type="java.lang.String"
    charset="UTF-8"
    request-factory="requestFactory"
    reply-timeout="1234"
    reply-channel="replies"/>
```

Important

Since *Spring Integration 2.2*, Java serialization over HTTP is no longer enabled by default. Previously, when setting the `expected-response-type` attribute to a `Serializable` object, the `Accept` header was not properly set up. Since *Spring Integration 2.2*, the `SerializingHttpMessageConverter` has now been updated to set the `Accept` header to `application/x-java-serialized-object`.

However, because this could cause incompatibility with existing applications, it was decided to no longer automatically add this converter to the HTTP endpoints. If you wish to use Java serialization, you will need to add the `SerializingHttpMessageConverter` to the appropriate endpoints, using the `message-converters` attribute, when using XML configuration, or using the `setMessageConverters()` method. Alternatively, you may wish to consider using JSON instead which is enabled by simply having `Jackson` on the classpath.

Beginning with Spring Integration 2.2 you can also determine the HTTP Method dynamically using SpEL and the *http-method-expression* attribute. Note that this attribute is obviously mutually exclusive with *http-method* You can also use `expected-response-type-expression` attribute instead of `expected-response-type` and provide any valid SpEL expression that determines the type of the response.

```
<int-http:outbound-gateway id="example"
    request-channel="requests"
    url="http://localhost/test"
    http-method-expression="headers.httpMethod"
    extract-request-payload="false"
    expected-response-type-expression="payload"
    charset="UTF-8"
    request-factory="requestFactory"
    reply-timeout="1234"
    reply-channel="replies"/>
```

If your outbound adapter is to be used in a unidirectional way, then you can use an outbound-channel-adapter instead. This means that a successful response will simply execute without sending any Messages to a reply channel. In the case of any non-successful response status code, it will throw an exception. The configuration looks very similar to the gateway:

```
<int-http:outbound-channel-adapter id="example"
    url="http://localhost/example"
    http-method="GET"
    channel="requests"
    charset="UTF-8"
    extract-payload="false"
    expected-response-type="java.lang.String"
    request-factory="someRequestFactory"
    order="3"
    auto-startup="false"/>
```

Note

To specify the URL; you can use either the *url* attribute or the *url-expression* attribute. The *url* is a simple string (with placeholders for URI variables, as described below); the *url-expression* is a SpEL expression, with the Message as the root object, enabling dynamic urls. The url resulting from the expression evaluation can still have placeholders for URI variables.

In previous releases, some users used the place holders to replace the entire URL with a URI variable. Changes in Spring 3.1 can cause some issues with escaped characters, such as ?. For this reason, it is recommended that if you wish to generate the URL entirely at runtime, you use the *url-expression* attribute.

==== Mapping URI Variables

If your URL contains URI variables, you can map them using the `uri-variable` sub-element. This sub-element is available for the *Http Outbound Gateway* and the *Http Outbound Channel Adapter*.

```
<int-http:outbound-gateway id="trafficGateway"
    url="https://local.yahooapis.com/trafficData?appid=YdnDemo&amp;zip={zipCode}"
    request-channel="trafficChannel"
    http-method="GET"
    expected-response-type="java.lang.String">
    <int-http:uri-variable name="zipCode" expression="payload.getZip()"/>
</int-http:outbound-gateway>
```

The `uri-variable` sub-element defines two attributes: `name` and `expression`. The `name` attribute identifies the name of the URI variable, while the `expression` attribute is used to set the actual value.

Using the `expression` attribute, you can leverage the full power of the Spring Expression Language (SpEL) which gives you full dynamic access to the message payload and the message headers. For example, in the above configuration the `getZip()` method will be invoked on the payload object of the Message and the result of that method will be used as the value for the URI variable named *zipCode*.

Since *Spring Integration 3.0*, HTTP Outbound Endpoints support the `uri-variables-expression` attribute to specify an `Expression` which should be evaluated, resulting in a `Map` for all URI variable placeholders within the URL template. It provides a mechanism whereby different variable expressions can be used, based on the outbound message. This attribute is mutually exclusive with the `<uri-variable/>` sub-element:

```
<int-http:outbound-gateway
     url="https://foo.host/{foo}/bars/{bar}"
     request-channel="trafficChannel"
     http-method="GET"
     uri-variables-expression="@uriVariablesBean.populate(payload)"
     expected-response-type="java.lang.String"/>
```

where `uriVariablesBean` might be:

```
public class UriVariablesBean {
    private static final ExpressionParser EXPRESSION_PARSER = new SpelExpressionParser();

    public Map<String, ?> populate(Object payload) {
        Map<String, Object> variables = new HashMap<String, Object>();
        if (payload instanceOf String.class)) {
            variables.put("foo", "foo"));
        }
        else {
            variables.put("foo", EXPRESSION_PARSER.parseExpression("headers.bar"));
        }
        return variables;
    }

}
```

Note

The `uri-variables-expression` must evaluate to a `Map`. The values of the Map must be instances of `String` or `Expression`. This Map is provided to an `ExpressionEvalMap` for further resolution of URI variable placeholders using those expressions in the context of the outbound `Message`.

IMPORTANT

The `uriVariablesExpression` property provides a very powerful mechanism for evaluating URI variables. It is anticipated that simple expressions like the example above will be used. However, you could also configure something like this `"@uriVariablesBean.populate(#root)"` with an expression in the returned map being `variables.put("foo", EXPRESSION_PARSER.parseExpression(message.getHeaders().get("bar", String.class)));`, where the expression is dynamically provided in the message header `bar`. Since the header may come from an untrusted source, the HTTP outbound endpoints use a `SimpleEvaluationContext` when evaluating these expressions; allowing only a subset of SpEL features to be used. If you trust your message sources and wish to use the restricted SpEL constructs, set the `trustedSpel` property of the outbound endpoint to `true`.

Scenarios when we need to supply a dynamic set of URI variables on per message basis can be achieved with the custom `url-expression` and some utilities for building and encoding URL parameters:

```
url-expression="T(org.springframework.web.util.UriComponentsBuilder)
                           .fromHttpUrl('http://HOST:PORT/PATH')
                           .queryParams(payload)
                           .build()
                           .toUri()"
```

where `queryParams()` expects a `MultiValueMap<String, String>` as an argument, so a real set of URL query parameters can be build in advance, before performing request.

The whole `queryString` can also be presented as an uri variable:

```
<int-http:outbound-gateway id="proxyGateway" request-channel="testChannel"
              url="http://testServer/test?{queryString}">
    <int-http:uri-variable name="queryString" expression="'a=A&amp;b=B'"/>
</int-http:outbound-gateway>
```

In this case the URL encoding must be provided manually. For example the `org.apache.http.client.utils.URLEncodedUtils#format()` can be used for this purpose. A mentioned, manually built, `MultiValueMap<String, String>` can be converted to the the `List<NameValuePair>` `format()` method argument using this Java Streams snippet:

```
List<NameValuePair> nameValuePairs =
    params.entrySet()
            .stream()
            .flatMap(e -> e
                    .getValue()
                    .stream()
                    .map(v -> new BasicNameValuePair(e.getKey(), v)))
            .collect(Collectors.toList());
```

==== Controlling URI Encoding

By default, the URL string is encoded (see UriComponentsBuilder) to the URI object before sending the request. In some scenarios with a non-standard URI (e.g. the RabbitMQ Rest API) it is undesirable to perform the encoding. The `<http:outbound-gateway/>` and `<http:outbound-channel-adapter/>` provide an `encode-uri` attribute. To disable encoding the URL, this attribute should be set to `false` (by default it is `true`). If you wish to partially encode some of the URL, this can be achieved using an `expression` within a `<uri-variable/>`:

```
<http:outbound-gateway url="http://somehost/%2f/fooApps?bar={param}" encode-uri="false">
          <http:uri-variable name="param"
            expression="T(org.apache.commons.httpclient.util.URIUtil)
                                             .encodeWithinQuery('Hello World!')"/>
</http:outbound-gateway>
```

=== Configuring HTTP Endpoints with Java

Inbound Gateway Using Java Configuration.

```
@Bean
public HttpRequestHandlingMessagingGateway inbound() {
    HttpRequestHandlingMessagingGateway gateway =
        new HttpRequestHandlingMessagingGateway(true);
    gateway.setRequestMapping(mapping());
    gateway.setRequestPayloadType(String.class);
    gateway.setRequestChannelName("httpRequest");
    return gateway;
}

@Bean
public RequestMapping mapping() {
    RequestMapping requestMapping = new RequestMapping();
    requestMapping.setPathPatterns("/foo");
    requestMapping.setMethods(HttpMethod.POST);
    return requestMapping;
}
```

Inbound Gateway Using the Java DSL.

```
@Bean
public IntegrationFlow inbound() {
    return IntegrationFlows.from(Http.inboundGateway("/foo")
            .requestMapping(m -> m.methods(HttpMethod.POST))
            .requestPayloadType(String.class))
        .channel("httpRequest")
        .get();
}
```

Outbound Gateway Using Java Configuration.

```
@ServiceActivator(inputChannel = "httpOutRequest")
@Bean
public HttpRequestExecutingMessageHandler outbound() {
    HttpRequestExecutingMessageHandler handler =
        new HttpRequestExecutingMessageHandler("http://localhost:8080/foo");
    handler.setHttpMethod(HttpMethod.POST);
    handler.setExpectedResponseType(String.class);
    return handler;
}
```

Outbound Gateway Using the Java DSL.

```
@Bean
public IntegrationFlow outbound() {
    return IntegrationFlows.from("httpOutRequest")
        .handle(Http.outboundGateway("http://localhost:8080/foo")
            .httpMethod(HttpMethod.POST)
            .expectedResponseType(String.class))
        .get();
}
```

=== Timeout Handling

In the context of HTTP components, there are two timing areas that have to be considered.

Timeouts when interacting with Spring Integration Channels

Timeouts when interacting with a remote HTTP server

First, the components interact with Message Channels, for which timeouts can be specified. For example, an HTTP Inbound Gateway will forward messages received from connected HTTP Clients to a Message Channel (Request Timeout) and consequently the HTTP Inbound Gateway will receive a reply Message from the Reply Channel (Reply Timeout) that will be used to generate the HTTP Response. Please see the figure below for an illustration.

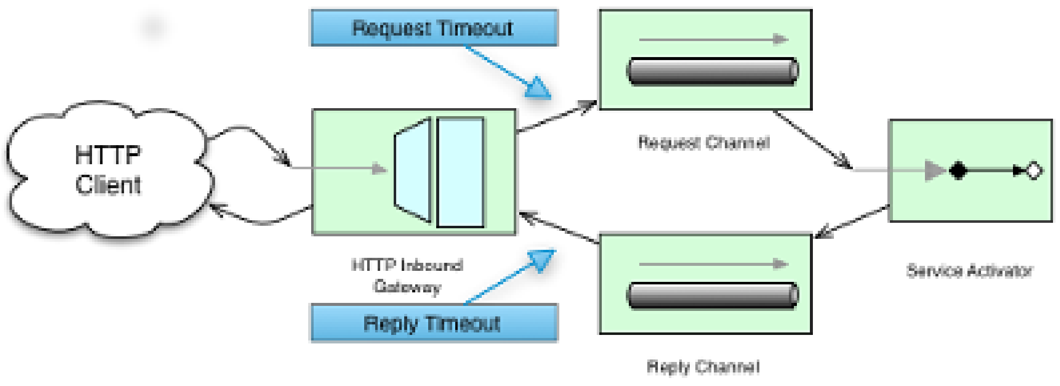


Figure 8.1. How timeout settings apply to an HTTP Inbound Gateway

For outbound endpoints, the second thing to consider is timing while interacting with the remote server.

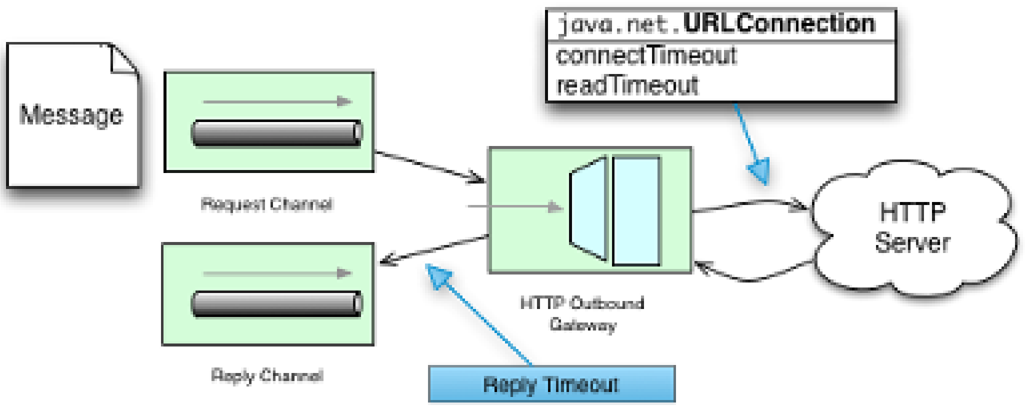


Figure 8.2. How timeout settings apply to an HTTP Outbound Gateway

You may want to configure the HTTP related timeout behavior, when making active HTTP requests using the *HTTP Outbound Gateway* or the *HTTP Outbound Channel Adapter*. In those instances, these two components use Spring's RestTemplate support to execute HTTP requests.

In order to configure timeouts for the *HTTP Outbound Gateway* and the *HTTP Outbound Channel Adapter*, you can either reference a `RestTemplate` bean directly, using the *rest-template* attribute, or you can provide a reference to a ClientHttpRequestFactory bean using the *request-factory* attribute. Spring provides the following implementations of the `ClientHttpRequestFactory` interface:

SimpleClientHttpRequestFactory - Uses standard J2SE facilities for making HTTP Requests

HttpComponentsClientHttpRequestFactory - Uses Apache HttpComponents HttpClient (Since Spring 3.1)

If you don't explicitly configure the *request-factory* or *rest-template* attribute respectively, then a default RestTemplate which uses a `SimpleClientHttpRequestFactory` will be instantiated.

Note

With some JVM implementations, the handling of timeouts using the *URLConnection* class may not be consistent.

> E.g. from the *Java™ Platform, Standard Edition 6 API Specification* on *setConnectTimeout*: [quote] Some non-standard implementation of this method may ignore the specified timeout. To see the connect timeout set, please call getConnectTimeout().
>
> Please test your timeouts if you have specific needs. Consider using the `HttpComponentsClientHttpRequestFactory` which, in turn, uses Apache HttpComponents HttpClient instead.

> **Important**
>
> When using the *Apache HttpComponents HttpClient* with a Pooling Connection Manager, be aware that, by default, the connection manager will create no more than 2 concurrent connections per given route and no more than 20 connections in total. For many real-world applications these limits may prove too constraining. Refer to the Apache documentation (link above) for information about configuring this important component.

Here is an example of how to configure an *HTTP Outbound Gateway* using a `SimpleClientHttpRequestFactory`, configured with connect and read timeouts of 5 seconds respectively:

```
<int-http:outbound-gateway url="https://www.google.com/ig/api?weather={city}"
                           http-method="GET"
                           expected-response-type="java.lang.String"
                           request-factory="requestFactory"
                           request-channel="requestChannel"
                           reply-channel="replyChannel">
    <int-http:uri-variable name="city" expression="payload"/>
</int-http:outbound-gateway>

<bean id="requestFactory"
      class="org.springframework.http.client.SimpleClientHttpRequestFactory">
    <property name="connectTimeout" value="5000"/>
    <property name="readTimeout"    value="5000"/>
</bean>
```

HTTP Outbound Gateway

For the *HTTP Outbound Gateway*, the XML Schema defines only the *reply-timeout*. The *reply-timeout* maps to the *sendTimeout* property of the *org.springframework.integration.http.outbound.HttpRequestExecutingMessageHandler* class. More precisely, the property is set on the extended `AbstractReplyProducingMessageHandler` class, which ultimately sets the property on the `MessagingTemplate`.

The value of the *sendTimeout* property defaults to "-1" and will be applied to the connected `MessageChannel`. This means, that depending on the implementation, the Message Channel's *send* method may block indefinitely. Furthermore, the *sendTimeout* property is only used, when the actual MessageChannel implementation has a blocking send (such as *full* bounded QueueChannel).

HTTP Inbound Gateway

For the *HTTP Inbound Gateway*, the XML Schema defines the *request-timeout* attribute, which will be used to set the *requestTimeout* property on the `HttpRequestHandlingMessagingGateway` class (on the extended MessagingGatewaySupport class). Secondly, the_reply-timeout_ attribute exists and it maps to the *replyTimeout* property on the same class.

The default for both timeout properties is "1000ms". Ultimately, the *request-timeout* property will be used to set the *sendTimeout* on the used `MessagingTemplate` instance. The *replyTimeout* property on the other hand, will be used to set the *receiveTimeout* property on the used `MessagingTemplate` instance.

> **Tip**
>
> In order to simulate connection timeouts, connect to a non-routable IP address, for example 10.255.255.10.

=== HTTP Proxy configuration

If you are behind a proxy and need to configure proxy settings for HTTP outbound adapters and/or gateways, you can apply one of two approaches. In most cases, you can rely on the standard Java System Properties that control the proxy settings. Otherwise, you can explicitly configure a Spring bean for the HTTP client request factory instance.

Standard Java Proxy configuration

There are 3 System Properties you can set to configure the proxy settings that will be used by the HTTP protocol handler:

- *http.proxyHost* - the host name of the proxy server.
- *http.proxyPort* - the port number, the default value being 80.
- *http.nonProxyHosts* - a list of hosts that should be reached directly, bypassing the proxy. This is a list of patterns separated by |. The patterns may start or end with a `*` for wildcards. Any host matching one of these patterns will be reached through a direct connection instead of through a proxy.

And for HTTPS:

- *https.proxyHost* - the host name of the proxy server.
- *https.proxyPort* - the port number, the default value being 80.

For more information please refer to this document: https://download.oracle.com/javase/6/docs/technotes/guides/net/proxies.html

Spring's SimpleClientHttpRequestFactory

If for any reason, you need more explicit control over the proxy configuration, you can use Spring's `SimpleClientHttpRequestFactory` and configure its *proxy* property as such:

```xml
<bean id="requestFactory"
    class="org.springframework.http.client.SimpleClientHttpRequestFactory">
    <property name="proxy">
        <bean id="proxy" class="java.net.Proxy">
            <constructor-arg>
                <util:constant static-field="java.net.Proxy.Type.HTTP"/>
            </constructor-arg>
            <constructor-arg>
                <bean class="java.net.InetSocketAddress">
                    <constructor-arg value="123.0.0.1"/>
                    <constructor-arg value="8080"/>
                </bean>
            </constructor-arg>
        </bean>
    </property>
</bean>
```

=== HTTP Header Mappings

Spring Integration provides support for Http Header mapping for both HTTP Request and HTTP Responses.

By default all standard Http Headers as defined here https://en.wikipedia.org/wiki/List_of_HTTP_header_fields will be mapped from the message to HTTP request/response headers without further configuration. However if you do need further customization you may provide additional configuration via convenient namespace support. You can provide a comma-separated list of header names, and you can also include simple patterns with the * character acting as a wildcard. If you do provide such values, it will override the default behavior. Basically, it assumes you are in complete control at that point. However, if you do want to include all of the standard HTTP headers, you can use the shortcut patterns: `HTTP_REQUEST_HEADERS` and `HTTP_RESPONSE_HEADERS`. Here are some examples:

```
<int-http:outbound-gateway id="httpGateway"
    url="http://localhost/test2"
    mapped-request-headers="foo, bar"
    mapped-response-headers="X-*, HTTP_RESPONSE_HEADERS"
    channel="someChannel"/>

<int-http:outbound-channel-adapter id="httpAdapter"
    url="http://localhost/test2"
    mapped-request-headers="foo, bar, HTTP_REQUEST_HEADERS"
    channel="someChannel"/>
```

The adapters and gateways will use the `DefaultHttpHeaderMapper` which now provides two static factory methods for "inbound" and "outbound" adapters so that the proper direction can be applied (mapping HTTP requests/responses IN/OUT as appropriate).

If further customization is required you can also configure a `DefaultHttpHeaderMapper` independently and inject it into the adapter via the `header-mapper` attribute.

Before *version 5.0*, the `DefaultHttpHeaderMapper` the default prefix for user-defined, non-standard HTTP headers was `X-`. In _version 5.0_ this has been changed to an empty string. According to RFC-6648, the use of such prefixes is now discouraged. This option can still be customized by setting the `DefaultHttpHeaderMapper.setUserDefinedHeaderPrefix()` property.

```
<int-http:outbound-gateway id="httpGateway"
    url="http://localhost/test2"
    header-mapper="headerMapper"
    channel="someChannel"/>

<bean id="headerMapper" class="o.s.i.http.support.DefaultHttpHeaderMapper">
    <property name="inboundHeaderNames" value="foo*, *bar, baz"/>
    <property name="outboundHeaderNames" value="a*b, d"/>
</bean>
```

Of course, you can even implement the HeaderMapper strategy interface directly and provide a reference to that if you need to do something other than what the `DefaultHttpHeaderMapper` supports.

=== Integration Graph Controller

Starting with *version 4.3*, the HTTP module provides an `@EnableIntegrationGraphController` `@Configuration` class annotation and `<int-http:graph-controller/>` XML element to expose the `IntegrationGraphServer` as a REST service. See the section called “CompletableFuture” for more information.

=== HTTP Samples

==== Multipart HTTP request - RestTemplate (client) and Http Inbound Gateway (server)

This example demonstrates how simple it is to send a Multipart HTTP request via Spring's RestTemplate and receive it with a Spring Integration HTTP Inbound Adapter. All we are doing is creating a `MultiValueMap` and populating it with multi-part data. The `RestTemplate` will take care of the rest (no pun intended) by converting it to a `MultipartHttpServletRequest` . This particular client will send a multipart HTTP Request which contains the name of the company as well as an image file with the company logo.

```
RestTemplate template = new RestTemplate();
String uri = "http://localhost:8080/multipart-http/inboundAdapter.htm";
Resource s2logo =
   new ClassPathResource("org/springframework/samples/multipart/spring09_logo.png");
MultiValueMap map = new LinkedMultiValueMap();
map.add("company", "SpringSource");
map.add("company-logo", s2logo);
HttpHeaders headers = new HttpHeaders();
headers.setContentType(new MediaType("multipart", "form-data"));
HttpEntity request = new HttpEntity(map, headers);
ResponseEntity<?> httpResponse = template.exchange(uri, HttpMethod.POST, request, null);
```

That is all for the client.

On the server side we have the following configuration:

```
<int-http:inbound-channel-adapter id="httpInboundAdapter"
    channel="receiveChannel"
    path="/inboundAdapter.htm"
    supported-methods="GET, POST"/>

<int:channel id="receiveChannel"/>

<int:service-activator input-channel="receiveChannel">
    <bean class="org.springframework.integration.samples.multipart.MultipartReceiver"/>
</int:service-activator>

<bean id="multipartResolver"
    class="org.springframework.web.multipart.commons.CommonsMultipartResolver"/>
```

The *httpInboundAdapter* will receive the request, convert it to a `Message` with a payload that is a `LinkedMultiValueMap`. We then are parsing that in the *multipartReceiver* service-activator;

```
public void receive(LinkedMultiValueMap<String, Object> multipartRequest){
    System.out.println("### Successfully received multipart request ###");
    for (String elementName : multipartRequest.keySet()) {
        if (elementName.equals("company")){
            System.out.println("\t" + elementName + " - " +
                ((String[]) multipartRequest.getFirst("company"))[0]);
        }
        else if (elementName.equals("company-logo")){
            System.out.println("\t" + elementName + " - as UploadedMultipartFile: " +
                ((UploadedMultipartFile) multipartRequest
                    .getFirst("company-logo")).getOriginalFilename());
        }
    }
}
```

You should see the following output:

```
### Successfully received multipart request ###
   company - SpringSource
   company-logo - as UploadedMultipartFile: spring09_logo.png
```

== JDBC Support

Spring Integration provides Channel Adapters for receiving and sending messages via database queries. Through those adapters Spring Integration supports not only plain JDBC SQL Queries, but also Stored Procedure and Stored Function calls.

The following JDBC components are available by default:

- *Inbound Channel Adapter*
- *Outbound Channel Adapter*
- *Outbound Gateway*
- *Stored Procedure Inbound Channel Adapter*
- *Stored Procedure Outbound Channel Adapter*
- *Stored Procedure Outbound Gateway*

Furthermore, the Spring Integration JDBC Module also provides a *JDBC Message Store*

=== Inbound Channel Adapter

The main function of an inbound Channel Adapter is to execute a SQL `SELECT` query and turn the result set as a message. The message payload is the whole result set, expressed as a `List`, and the types of the items in the list depend on the row-mapping strategy that is used. The default strategy is a generic mapper that just returns a `Map` for each row in the query result. Optionally, this can be changed by adding a reference to a `RowMapper` instance (see the Spring JDBC documentation for more detailed information about row mapping).

> **Note**
>
> If you want to convert rows in the SELECT query result to individual messages you can use a downstream splitter.

The inbound adapter also requires a reference to either a `JdbcTemplate` instance or a `DataSource`.

As well as the `SELECT` statement to generate the messages, the adapter above also has an `UPDATE` statement that is being used to mark the records as processed so that they don't show up in the next poll. The update can be parameterized by the list of ids from the original select. This is done through a naming convention by default (a column in the input result set called "id" is translated into a list in the parameter map for the update called "id"). The following example defines an inbound Channel Adapter with an update query and a `DataSource` reference.

```
<int-jdbc:inbound-channel-adapter query="select * from item where status=2"
    channel="target" data-source="dataSource"
    update="update item set status=10 where id in (:id)" />
```

> **Note**
>
> The parameters in the update query are specified with a colon (:) prefix to the name of a parameter (which in this case is an expression to be applied to each of the rows in the polled result set). This is a standard feature of the named parameter JDBC support in Spring JDBC combined with a convention (projection onto the polled result list) adopted in Spring Integration. The underlying

> Spring JDBC features limit the available expressions (e.g. most special characters other than period are disallowed), but since the target is usually a list of or an individual object addressable by simple bean paths this isn't unduly restrictive.

To change the parameter generation strategy you can inject a `SqlParameterSourceFactory` into the adapter to override the default behavior (the adapter has a `sql-parameter-source-factory` attribute). Spring Integration provides a `ExpressionEvaluatingSqlParameterSourceFactory` which will create a SpEL-based parameter source, with the results of the query as the `#root` object. (If `update-per-row` is true, the root object is the row). If the same parameter name appears multiple times in the update query, it is evaluated only one time, and its result is cached.

You can also use a parameter source for the select query. In this case, since there is no "result" object to evaluate against, a single parameter source is used each time (rather than using a parameter source factory). Starting with *version 4.0*, you can use Spring to create a SpEL based parameter source as follows:

```
<int-jdbc:inbound-channel-adapter query="select * from item where status=:status"
 channel="target" data-source="dataSource"
 select-sql-parameter-source="parameterSource" />

<bean id="parameterSource" factory-bean="parameterSourceFactory"
   factory-method="createParameterSourceNoCache">
 <constructor-arg value="" />
</bean>

<bean id="parameterSourceFactory"
  class="o.s.integration.jdbc.ExpressionEvaluatingSqlParameterSourceFactory">
 <property name="parameterExpressions">
  <map>
   <entry key="status" value="@statusBean.which()" />
  </map>
 </property>
</bean>

<bean id="statusBean" class="foo.StatusDetermination" />
```

The `value` in each parameter expression can be any valid SpEL expression. The `#root` object for the expression evaluation is the constructor argument defined on the `parameterSource` bean. It is static for all evaluations (in this case, an empty String).

Starting with *version 5.0*, the `ExpressionEvaluatingSqlParameterSourceFactory` can be supplied with the `sqlParameterTypes` to specify the target SQL type for the particular parameter.

Below example provides sql type for the parameters being used in the query.

```
<int-jdbc:inbound-channel-adapter query="select * from item where status=:status"
    channel="target" data-source="dataSource"
    select-sql-parameter-source="parameterSource" />

<bean id="parameterSource" factory-bean="parameterSourceFactory"
            factory-method="createParameterSourceNoCache">
    <constructor-arg value="" />
</bean>

<bean id="parameterSourceFactory"
        class="o.s.integration.jdbc.ExpressionEvaluatingSqlParameterSourceFactory">
    <property name="sqlParameterTypes">
        <map>
            <entry key="status" value="#{ T(java.sql.Types).BINARY}" />
        </map>
    </property>
</bean>
```

Important

Use the `createParameterSourceNoCache` factory method; otherwise the parameter source will cache the result of the evaluation. Also note that, because caching is disabled, if the same parameter name appears in the select query multiple times, it will be re-evaluated for each occurrence.

==== Polling and Transactions

The inbound adapter accepts a regular Spring Integration poller as a sub element, so for instance the frequency of the polling can be controlled. A very important feature of the poller for JDBC usage is the option to wrap the poll operation in a transaction, for example:

```
<int-jdbc:inbound-channel-adapter query="..."
        channel="target" data-source="dataSource" update="...">
    <int:poller fixed-rate="1000">
        <int:transactional/>
    </int:poller>
</int-jdbc:inbound-channel-adapter>
```

Note

If a poller is not explicitly specified, a default value will be used (and as per normal with Spring Integration can be defined as a top level bean).

In this example the database is polled every 1000 milliseconds, and the update and select queries are both executed in the same transaction. The transaction manager configuration is not shown, but as long as it is aware of the data source then the poll is transactional. A common use case is for the downstream channels to be direct channels (the default), so that the endpoints are invoked in the same thread, and hence the same transaction. Then if any of them fail, the transaction rolls back and the input data is reverted to its original state.

==== Max-rows-per-poll versus Max-messages-per-poll

The *JDBC Inbound Channel Adapter* defines an attribute `max-rows-per-poll`. When you specify the adapter's *Poller*, you can also define a property called `max-messages-per-poll`. While these two attributes look similar, their meaning is quite different.

`max-messages-per-poll` specifies the number of times the query is executed per polling interval, whereas `max-rows-per-poll` specifies the number of rows returned for each execution.

Under normal circumstances, you would likely not want to set the Poller's `max-messages-per-poll` property when using the *JDBC Inbound Channel Adapter*. Its default value is *1*, which means that the *JDBC Inbound Channel Adapter*'s [`receive()`] method is executed exactly once for each poll interval.

Setting the `max-messages-per-poll` attribute to a larger value means that the query is executed that many times back to back. For more information regarding the `max-messages-per-poll` attribute, please see the section called "Configuring An Inbound Channel Adapter".

In contrast, the `max-rows-per-poll` attribute, if greater than *0*, specifies the maximum number of rows that will be used from the query result set, per execution of the `receive()` method. If the attribute is set to *0*, then all rows will be included in the resulting message. If not explicitly set, the attribute defaults to *0*.

=== Outbound Channel Adapter

The outbound channel adapter is the inverse of the inbound: its role is to handle a message and use it to execute a SQL query. By default, the message payload and headers are available as input parameters to the query, as the following example shows:

```
<int-jdbc:outbound-channel-adapter
    query="insert into foos (id, status, name) values (:headers[id], 0, :payload[foo])"
    data-source="dataSource"
    channel="input"/>
```

In the example above, messages arriving on the channel labelled *input* have a payload of a map with key *foo*, so the `[]` operator dereferences that value from the map. The headers are also accessed as a map.

Note

The parameters in the query above are bean property expressions on the incoming message (not Spring EL expressions). This behavior is part of the `SqlParameterSource` which is the default source created by the outbound adapter. Other behavior is possible in the adapter, and requires the user to inject a different `SqlParameterSourceFactory`.

The outbound adapter requires a reference to either a `DataSource` or a `JdbcTemplate`. It can also have a `SqlParameterSourceFactory` injected to control the binding of each incoming message to a query.

If the input channel is a direct channel, then the outbound adapter runs its query in the same thread, and therefore the same transaction (if there is one) as the sender of the message.

Passing Parameters using SpEL Expressions

A common requirement for most JDBC Channel Adapters is to pass parameters as part of Sql queries or Stored Procedures/Functions. As mentioned above, these parameters are by default bean property expressions, not SpEL expressions. However, if you need to pass SpEL expression as parameters, you must inject a `SqlParameterSourceFactory` explicitly.

The following example uses a `ExpressionEvaluatingSqlParameterSourceFactory` to achieve that requirement.

```
<jdbc:outbound-channel-adapter data-source="dataSource" channel="input"
    query="insert into MESSAGES (MESSAGE_ID,PAYLOAD,CREATED_DATE)     \
    values (:id, :payload, :createdDate)"
    sql-parameter-source-factory="spelSource"/>

<bean id="spelSource"
      class="o.s.integration.jdbc.ExpressionEvaluatingSqlParameterSourceFactory">
    <property name="parameterExpressions">
        <map>
            <entry key="id"          value="headers['id'].toString()"/>
            <entry key="createdDate" value="new java.util.Date()"/>
            <entry key="payload"     value="payload"/>
        </map>
    </property>
</bean>
```

For further information, please also see the section called “CompletableFuture”

PreparedStatement Callback

There are some cases when the flexibility and loose-coupling of `SqlParameterSourceFactory` isn’t enough for the target `PreparedStatement` or we need to do some low-level JDBC work. The Spring

JDBC module provides APIs to configure the execution environment (e.g. `ConnectionCallback` or `PreparedStatementCreator`) and manipulation of parameter values (e.g. `SqlParameterSource`). Or even APIs for low level operations, for example `StatementCallback`.

Starting with *Spring Integration 4.2*, the `MessagePreparedStatementSetter` is available to allow the specification of parameters on the `PreparedStatement` manually, in the `requestMessage` context. This class plays exactly the same role as `PreparedStatementSetter` in the standard Spring JDBC API. Actually it is invoked directly from an inline `PreparedStatementSetter` implementation, when the `JdbcMessageHandler` invokes `execute` on the `JdbcTemplate`.

This functional interface option is mutually exclusive with `sqlParameterSourceFactory` and can be used as a more powerful alternative to populate parameters of the `PreparedStatement` from the `requestMessage`. For example it is useful when we need to store `File` data to the DataBase `BLOB` column in a stream manner:

```
@Bean
@ServiceActivator(inputChannel = "storeFileChannel")
public MessageHandler jdbcMessageHandler(DataSource dataSource) {
    JdbcMessageHandler jdbcMessageHandler = new JdbcMessageHandler(dataSource,
            "INSERT INTO imagedb (image_name, content, description) VALUES (?, ?, ?)");
    jdbcMessageHandler.setPreparedStatementSetter((ps, m) -> {
        ps.setString(1, m.getHeaders().get(FileHeaders.FILENAME));
        try (FileInputStream inputStream = new FileInputStream((File) m.getPayload()); ) {
            ps.setBlob(2, inputStream);
        }
        catch (Exception e) {
            throw new MessageHandlingException(m, e);
        }
        ps.setClob(3, new StringReader(m.getHeaders().get("description", String.class)));
    });
    return jdbcMessageHandler;
}
```

From the XML configuration perspective, the `prepared-statement-setter` attribute is available on the `<int-jdbc:outbound-channel-adapter>` component, to specify a `MessagePreparedStatementSetter` bean reference.

=== Outbound Gateway

The outbound Gateway is like a combination of the outbound and inbound adapters: its role is to handle a message and use it to execute a SQL query and then respond with the result sending it to a reply channel. The message payload and headers are available by default as input parameters to the query, for instance:

```
<int-jdbc:outbound-gateway
    update="insert into foos (id, status, name) values (:headers[id], 0, :payload[foo])"
    request-channel="input" reply-channel="output" data-source="dataSource" />
```

The result of the above would be to insert a record into the "foos" table and return a message to the output channel indicating the number of rows affected (the payload is a map: `{UPDATED=1}`).

If the update query is an insert with auto-generated keys, the reply message can be populated with the generated keys by adding `keys-generated="true"` to the above example (this is not the default because it is not supported by some database platforms). For example:

```
<int-jdbc:outbound-gateway
    update="insert into mythings (status, name) values (0, :payload[thing])"
    request-channel="input" reply-channel="output" data-source="dataSource"
    keys-generated="true"/>
```

Instead of the update count or the generated keys, you can also provide a select query to execute and generate a reply message from the result (like the inbound adapter), e.g:

```
<int-jdbc:outbound-gateway
    update="insert into foos (id, status, name) values (:headers[id], 0, :payload[foo])"
    query="select * from foos where id=:headers[$id]"
    request-channel="input" reply-channel="output" data-source="dataSource"/>
```

Since *Spring Integration 2.2* the update SQL query is no longer mandatory. You can now solely provide a select query, using either the *query attribute* or the *query sub-element*. This is extremely useful if you need to actively retrieve data using e.g. a generic Gateway or a Payload Enricher. The reply message is then generated from the result, like the inbound adapter, and passed to the reply channel.

```
<int-jdbc:outbound-gateway
    query="select * from foos where id=:headers[id]"
    request-channel="input"
    reply-channel="output"
    data-source="dataSource"/>
```

By default the component for the SELECT query returns only one, first row from the cursor. This can be adjusted with the `max-rows-per-poll` option. Consider to specify `max-rows-per-poll="0"` if you need to return all the rows from the SELECT.

As with the channel adapters, you can also provide `SqlParameterSourceFactory` instances for request and reply. The default is the same as for the outbound adapter, so the request message is available as the root of an expression. If `keys-generated="true"` then the root of the expression is the generated keys (a map if there is only one or a list of maps if multi-valued).

The outbound gateway requires a reference to either a DataSource or a JdbcTemplate. It can also have a `SqlParameterSourceFactory` injected to control the binding of the incoming message to the query.

Starting with the *version 4.2* the `request-prepared-statement-setter` attribute is available on the `<int-jdbc:outbound-gateway>` as an alternative to the `request-sql-parameter-source-factory`. It allows you to specify a `MessagePreparedStatementSetter` bean reference, which implements more sophisticated `PreparedStatement` preparation before its execution.

See the section called “CompletableFuture” for more information about `MessagePreparedStatementSetter`.

=== JDBC Message Store

Spring Integration provides 2 JDBC specific Message Store implementations. The first one, is the `JdbcMessageStore` which is suitable to be used in conjunction with *Aggregators* and the *Claim-Check* pattern. While it can be used for backing *Message Channels* as well, you may want to consider using the `JdbcChannelMessageStore` implementation instead, as it provides a more targeted and scalable implementation.

Important

Starting with versions 5.0.11, 5.1.2, the indexes for the `JdbcChannelMessageStore` have been optimized. If you have large message groups in such a store, you may wish to alter the indexes. Furthermore, the index for `PriorityChannel` is commented out because it is not needed unless you are using such channels backed by JDBC.

> **Note**
>
> When using the `OracleChannelMessageStoreQueryProvider`, the priority channel index **must** be added because it is included in a hint in the query.

==== Initializing the Database

Before starting to use JDBC Message Store components, it is important to provision target data base with the appropriate objects.

Spring Integration ships with some sample scripts that can be used to initialize a database. In the `spring-integration-jdbc` JAR file you can find scripts in the `org.springframework.integration.jdbc` package: there is a create and a drop script example for a range of common database platforms. A common way to use these scripts is to reference them in a Spring JDBC data source initializer. Note that the scripts are provided as samples or specifications of the the required table and column names. You may find that you need to enhance them for production use (e.g. with index declarations).

==== The Generic JDBC Message Store

The JDBC module provides an implementation of the Spring Integration `MessageStore` (important in the Claim Check pattern) and `MessageGroupStore` (important in stateful patterns like Aggregator) backed by a database. Both interfaces are implemented by the `JdbcMessageStore`, and there is also support for configuring store instances in XML. For example:

```
<int-jdbc:message-store id="messageStore" data-source="dataSource"/>
```

A `JdbcTemplate` can be specified instead of a `DataSource`.

Other optional attributes are show in the next example:

```
<int-jdbc:message-store id="messageStore" data-source="dataSource"
    lob-handler="lobHandler" table-prefix="MY_INT_"/>
```

Here we have specified a `LobHandler` for dealing with messages as large objects (e.g. often necessary if using Oracle) and a prefix for the table names in the queries generated by the store. The table name prefix defaults to `INT_`.

==== Backing Message Channels

If you intend backing *Message Channels* using JDBC, it is recommended to use the provided `JdbcChannelMessageStore` implementation instead. It can only be used in conjunction with *Message Channels*.

Supported Databases

The `JdbcChannelMessageStore` uses database specific SQL queries to retrieve messages from the database. Therefore, users must set the `ChannelMessageStoreQueryProvider` property on the `JdbcChannelMessageStore`. This `channelMessageStoreQueryProvider` provides the SQL queries and Spring Integration provides support for the following relational databases:

- PostgreSQL
- HSQLDB

- MySQL
- Oracle
- Derby
- H2
- SqlServer
- Sybase
- DB2

If your database is not listed, you can easily extend the `AbstractChannelMessageStoreQueryProvider` class and provide your own custom queries.

Since *version 4.0*, the `MESSAGE_SEQUENCE` column has been added to the table to ensure first-in-first-out (FIFO) queueing even when messages are stored in the same millisecond.

Since *version 5.0*, by overloading `ChannelMessageStorePreparedStatementSetter` class you can provide custom implementation for message insertion in the `JdbcChannelMessageStore`. It might be different columns or table structure or serialization strategy. For example, instead of default serialization to `byte[]`, we can store its structure in JSON string.

Below example uses the default implementation of `setValues` to store common columns and overrides the behavior just to store the message payload as varchar.

```
public class JsonPreparedStatementSetter extends ChannelMessageStorePreparedStatementSetter {

    public JsonPreparedStatementSetter() {
        super();
    }

    @Override
    public void setValues(PreparedStatement preparedStatement, Message<?> requestMessage,
        Object groupId, String region,  boolean priorityEnabled) throws SQLException {
        // Populate common columns
        super.setValues(preparedStatement, requestMessage, groupId, region, priorityEnabled);
        // Store message payload as varchar
        preparedStatement.setString(6, requestMessage.getPayload().toString());
    }
}
```

Important

Generally it is not recommended to use a relational database for the purpose of queuing. Instead, if possible, consider using either JMS or AMQP backed channels instead. For further reference please see the following resources:

- 5 subtle ways you're using MySQL as a queue, and why it'll bite you.
- The Database As Queue Anti-Pattern.

Concurrent Polling

When polling a *Message Channel*, you have the option to configure the associated `Poller` with a `TaskExecutor` reference.

Important

Keep in mind, though, that if you use a JDBC backed *Message Channel* and you are planning on polling the channel and consequently the message store transactionally with multiple threads, you should ensure that you use a relational database that supports Multiversion Concurrency Control (MVCC). Otherwise, locking may be an issue and the performance, when using multiple threads, may not materialize as expected. For example Apache Derby is problematic in that regard.

To achieve better JDBC queue throughput, and avoid issues when different threads may poll the same `Message` from the queue, it is **important** to set the `usingIdCache` property of `JdbcChannelMessageStore` to `true` when using databases that do not support MVCC:

```
<bean id="queryProvider"
    class="o.s.i.jdbc.store.channel.PostgresChannelMessageStoreQueryProvider"/>

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-commit expression="@store.removeFromIdCache(headers.id.toString())" />
    <int:after-rollback expression="@store.removeFromIdCache(headers.id.toString())"/>
</int:transaction-synchronization-factory>

<task:executor id="pool" pool-size="10"
    queue-capacity="10" rejection-policy="CALLER_RUNS" />

<bean id="store" class="o.s.i.jdbc.store.JdbcChannelMessageStore">
    <property name="dataSource" ref="dataSource"/>
    <property name="channelMessageStoreQueryProvider" ref="queryProvider"/>
    <property name="region" value="TX_TIMEOUT"/>
    <property name="usingIdCache" value="true"/>
</bean>

<int:channel id="inputChannel">
    <int:queue message-store="store"/>
</int:channel>

<int:bridge input-channel="inputChannel" output-channel="outputChannel">
    <int:poller fixed-delay="500" receive-timeout="500"
        max-messages-per-poll="1" task-executor="pool">
        <int:transactional propagation="REQUIRED" synchronization-factory="syncFactory"
        isolation="READ_COMMITTED" transaction-manager="transactionManager" />
    </int:poller>
</int:bridge>

<int:channel id="outputChannel" />
```

Priority Channel

Starting with *version 4.0*, the `JdbcChannelMessageStore` implements `PriorityCapableChannelMessageStore` and provides the `priorityEnabled` option allowing it to be used as a `message-store` reference for `priority-queue` s. For this purpose, the `INT_CHANNEL_MESSAGE` has a `MESSAGE_PRIORITY` column to store the value of `PRIORITY` Message header. In addition, a new `MESSAGE_SEQUENCE` column is also provided to achieve a robust first-in-first-out (FIFO) polling mechanism, even when multiple messages are stored with the same priority in the same millisecond. Messages are polled (selected) from the database with `order by MESSAGE_PRIORITY DESC NULLS LAST, CREATED_DATE, MESSAGE_SEQUENCE`.

Note

It's not recommended to use the same `JdbcChannelMessageStore` bean for priority and non-priority queue channel, because `priorityEnabled` option applies to the entire store and proper FIFO queue semantics will not be retained for the queue channel.

> However the same `INT_CHANNEL_MESSAGE` table, and even `region`, can be used for both `JdbcChannelMessageStore` types. To configure that scenario, simply extend one message store bean from the other:

```
<bean id="channelStore" class="o.s.i.jdbc.store.JdbcChannelMessageStore">
    <property name="dataSource" ref="dataSource"/>
    <property name="channelMessageStoreQueryProvider" ref="queryProvider"/>
</bean>

<int:channel id="queueChannel">
    <int:queue message-store="channelStore"/>
</int:channel>

<bean id="priorityStore" parent="channelStore">
    <property name="priorityEnabled" value="true"/>
</bean>

<int:channel id="priorityChannel">
    <int:priority-queue message-store="priorityStore"/>
</int:channel>
```

==== Partitioning a Message Store

It is common to use a `JdbcMessageStore` as a global store for a group of applications, or nodes in the same application. To provide some protection against name clashes, and to give control over the database meta-data configuration, the message store allows the tables to be partitioned in two ways. One is to use separate table names, by changing the prefix as described above, and the other is to specify a "region" name for partitioning data within a single table. An important use case for this is when the MessageStore is managing persistent queues backing a Spring Integration Message Channel. The message data for a persistent channel is keyed in the store on the channel name, so if the channel names are not globally unique then there is the danger of channels picking up data that was not intended for them. To avoid this, the message store *region* can be used to keep data separate for different physical channels that happen to have the same logical name.

=== Stored Procedures

In certain situations plain JDBC support is not sufficient. Maybe you deal with legacy relational database schemas or you have complex data processing needs, but ultimately you have to use Stored Procedures or Stored Functions. Since Spring Integration 2.1, we provide three components in order to execute Stored Procedures or Stored Functions:

- Stored Procedures Inbound Channel Adapter
- Stored Procedures Outbound Channel Adapter
- Stored Procedures Outbound Gateway

==== Supported Databases

In order to enable calls to *Stored Procedures* and *Stored Functions*, the Stored Procedure components use the `org.springframework.jdbc.core.simple.SimpleJdbcCall` class. Consequently, the following databases are fully supported for executing Stored Procedures:

- Apache Derby
- DB2
- MySQL

- Microsoft SQL Server
- Oracle
- PostgreSQL
- Sybase

If you want to execute Stored Functions instead, the following databases are fully supported:

- MySQL
- Microsoft SQL Server
- Oracle
- PostgreSQL

> **Note**
>
> Even though your particular database may not be fully supported, chances are, that you can use the Stored Procedure Spring Integration components quite successfully anyway, provided your RDBMS supports Stored Procedures or Functions.
>
> As a matter of fact, some of the provided integration tests use the H2 database. Nevertheless, it is very important to thoroughly test those usage scenarios.

==== Configuration

The Stored Procedure components provide full XML Namespace support and configuring the components is similar as for the general purpose JDBC components discussed earlier.

==== Common Configuration Attributes

Certain configuration parameters are shared among all Stored Procedure components and are described below:

auto-startup

Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to `true`. *Optional*.

data-source

Reference to a `javax.sql.DataSource`, which is used to access the database. *Required*.

id

Identifies the underlying Spring bean definition, which is an instance of either `EventDrivenConsumer` or `PollingConsumer`, depending on whether the Outbound Channel Adapter's `channel` attribute references a `SubscribableChannel` or a `PollableChannel`. *Optional*.

ignore-column-meta-data

For fully supported databases, the underlying `SimpleJdbcCall` class can automatically retrieve the parameter information for the to be invoked Stored Procedure or Function from the JDBC Meta-data.

However, if the used database does not support meta data lookups or if you like to provide customized parameter definitions, this flag can be set to `true`. It defaults to `false`. *Optional*.

is-function

If `true`, a SQL Function is called. In that case the `stored-procedure-name` or `stored-procedure-name-expression` attributes define the name of the called function. Defaults to `false`. *Optional*.

stored-procedure-name

The attribute specifies the name of the stored procedure. If the `is-function` attribute is set to `true`, this attribute specifies the function name instead. Either this property or `stored-procedure-name-expression` must be specified.

stored-procedure-name-expression

This attribute specifies the name of the stored procedure using a SpEL expression. Using SpEL you have access to the full message (if available), including its headers and payload. You can use this attribute to invoke different Stored Procedures at runtime. For example, you can provide Stored Procedure names that you would like to execute as a Message Header. The expression must resolve to a String.

If the `is-function` attribute is set to `true`, this attribute specifies a Stored Function. Either this property or *stored-procedure-name* must be specified.

jdbc-call-operations-cache-size

Defines the maximum number of cached `SimpleJdbcCallOperations` instances. Basically, for each Stored Procedure Name a new `SimpleJdbcCallOperations` instance is created that in return is being cached.

> **Note**
>
> The `stored-procedure-name-expression` attribute and the `jdbc-call-operations-cache-size` were added with Spring Integration 2.2.

The default cache size is *10*. A value of *0* disables caching. Negative values are not permitted.

If you enable JMX, statistical information about the `jdbc-call-operations-cache` is exposed as MBean. Please see the section called “CompletableFuture” for more information.

sql-parameter-source-factory (Not available for the Stored Procedure Inbound Channel Adapter.)

Reference to a `SqlParameterSourceFactory`. By default bean properties of the passed in `Message` payload will be used as a source for the Stored Procedure’s input parameters using a `BeanPropertySqlParameterSourceFactory`.

This may be sufficient for basic use cases. For more sophisticated options, consider passing in one or more `ProcedureParameter`. Please also refer to the section called “CompletableFuture”. *Optional*.

use-payload-as-parameter-source (Not available for the Stored Procedure Inbound Channel Adapter.)

If set to `true`, the payload of the Message will be used as a source for providing parameters. If false, however, the entire Message will be available as a source for parameters.

If no Procedure Parameters are passed in, this property will default to `true`. This means that using a default `BeanPropertySqlParameterSourceFactory` the bean properties of the payload will be used as a source for parameter values for the to-be-executed Stored Procedure or Stored Function.

However, if Procedure Parameters are passed in, then this property will by default evaluate to `false`. `ProcedureParameter` allow for SpEL Expressions to be provided and therefore it is highly beneficial to have access to the entire Message. The property is set on the underlying `StoredProcExecutor`. *Optional*.

==== Common Configuration Sub-Elements

The Stored Procedure components share a common set of sub-elements to define and pass parameters to Stored Procedures or Functions. The following elements are available:

- `parameter`
- `returning-resultset`
- `sql-parameter-definition`
- `poller`

parameter

Provides a mechanism to provide Stored Procedure parameters. Parameters can be either static or provided using a SpEL Expressions. *Optional*.

```
<int-jdbc:parameter name=""     ❶
                    type=""     ❷
                    value=""/>  ❸

<int-jdbc:parameter name=""
                    expression=""/> ❹
```

❶ The name of the parameter to be passed into the Stored Procedure or Stored Function. *Required*.

❷ This attribute specifies the type of the value. If nothing is provided this attribute will default to `java.lang.String`. This attribute is only used when the `value` attribute is used. *Optional*.

❸ The value of the parameter. You have to provider either this attribute or the `expression` attribute must be provided instead. *Optional*.

❹ Instead of the `value` attribute, you can also specify a SpEL expression for passing the value of the parameter. If you specify the `expression` the `value` attribute is not allowed. *Optional*.

returning-resultset

Stored Procedures may return multiple result sets. By setting one or more `returning-resultset` elements, you can specify `RowMappers` in order to convert each returned `ResultSet` to meaningful objects. *Optional*.

```
<int-jdbc:returning-resultset name="" row-mapper="" />
```

sql-parameter-definition

If you are using a database that is fully supported, you typically don’t have to specify the Stored Procedure parameter definitions. Instead, those parameters can be automatically derived from the JDBC Meta-data. However, if you are using databases that are not fully supported, you must set those parameters explicitly using the `sql-parameter-definition` sub-element.

You can also choose to turn off any processing of parameter meta data information obtained via JDBC using the `ignore-column-meta-data` attribute.

```
<int-jdbc:sql-parameter-definition
                                    name=""                              ❶
                                    direction="IN"                       ❷
                                    type="STRING"                        ❸
                                    scale="5"                            ❹
                                    type-name="FOO_STRUCT"               ❺
                                    return-type="fooSqlReturnType"/>     ❻
```

❶ Specifies the name of the SQL parameter. *Required*.

❷ Specifies the direction of the SQL parameter definition. Defaults to `IN`. Valid values are: `IN`, `OUT` and `INOUT`. If your procedure is returning ResultSets, please use the `returning-resultset` element. *Optional*.

❸ The SQL type used for this SQL parameter definition. Will translate into the integer value as defined by java.sql.Types. Alternatively you can provide the integer value as well. If this attribute is not explicitly set, then it will default to *VARCHAR*. *Optional*.

❹ The scale of the SQL parameter. Only used for numeric and decimal parameters. *Optional*.

❺ The typeName for types that are user-named like: `STRUCT`, `DISTINCT`, `JAVA_OBJECT`, named array types. This attribute is mutually exclusive with the *scale* attribute. *Optional*.

❻ The reference to a custom value handler for complex types. An implementation of SqlReturnType. This attribute is mutually exclusive with the *scale* attribute and is applicable for OUT(INOUT)-parameters only. *Optional*.

poller

Allows you to configure a Message Poller if this endpoint is a `PollingConsumer`. *Optional*.

==== Defining Parameter Sources

Parameter Sources govern the techniques of retrieving and mapping the Spring Integration Message properties to the relevant Stored Procedure input parameters. The Stored Procedure components follow certain rules.

By default bean properties of the passed in `Message` payload will be used as a source for the Stored Procedure's input parameters. In that case a `BeanPropertySqlParameterSourceFactory` will be used. This may be sufficient for basic use cases. The following example illustrates that default behavior.

> **Important**
>
> Please be aware that for the "automatic" lookup of bean properties using the `BeanPropertySqlParameterSourceFactory` to work, your bean properties must be defined in lower case. This is due to the fact that in `org.springframework.jdbc.core.metadata.CallMetaDataContext` (method `matchInParameterValuesWithCallParameters()`), the retrieved Stored Procedure parameter declarations are converted to lower case. As a result, if you have camel-case bean properties such as "lastName", the lookup will fail. In that case, please provide an explicit `ProcedureParameter`.

Let's assume we have a payload that consists of a simple bean with the following three properties: *id*, *name* and *description*. Furthermore, we have a simplistic Stored Procedure called *INSERT_COFFEE* that accepts three input parameters: *id*, *name* and *description*. We also use a fully supported database. In that case the following configuration for a Stored Procedure Outbound Adapter will be sufficient:

```
<int-jdbc:stored-proc-outbound-channel-adapter data-source="dataSource"
    channel="insertCoffeeProcedureRequestChannel"
    stored-procedure-name="INSERT_COFFEE"/>
```

For more sophisticated options consider passing in one or more `ProcedureParameter`.

If you do provide `ProcedureParameter` explicitly, then as default an `ExpressionEvaluatingSqlParameterSourceFactory` will be used for parameter processing in order to enable the full power of SpEL expressions.

Furthermore, if you need even more control over how parameters are retrieved, consider passing in a custom implementation of a `SqlParameterSourceFactory` using the `sql-parameter-source-factory` attribute.

==== Stored Procedure Inbound Channel Adapter

```
<int-jdbc:stored-proc-inbound-channel-adapter
                                   channel=""                                  ❶
                                   stored-procedure-name=""
                                   data-source=""
                                   auto-startup="true"
                                   id=""
                                   ignore-column-meta-data="false"
                                   is-function="false"
                                   skip-undeclared-results=""                  ❷
                                   return-value-required="false"               ❸
    <int:poller/>
    <int-jdbc:sql-parameter-definition name="" direction="IN"
                                               type="STRING"
                                               scale=""/>
    <int-jdbc:parameter name="" type="" value=""/>
    <int-jdbc:parameter name="" expression=""/>
    <int-jdbc:returning-resultset name="" row-mapper="" />
</int-jdbc:stored-proc-inbound-channel-adapter>
```

❶ Channel to which polled messages will be sent. If the stored procedure or function does not return any data, the payload of the Message will be Null. *Required*.

❷ If this attribute is set to `true`, all results from a stored procedure call that do not have a corresponding `SqlOutParameter` declaration are bypassed. For example, stored procedures can return an update count value, even though your stored procedure declared only a single result parameter. The exact behavior depends on the database implementation. The value is set on the underlying `JdbcTemplate`. Few developers will probably ever want to process update counts, thus the value defaults to `true`. *Optional*.

❸ Indicates whether this procedure's return value should be included. Since *Spring Integration 3.0*. *Optional*.

==== Stored Procedure Outbound Channel Adapter

```
<int-jdbc:stored-proc-outbound-channel-adapter channel=""                      ❶
                                               stored-procedure-name=""
                                               data-source=""
                                               auto-startup="true"
                                               id=""
                                               ignore-column-meta-data="false"
                                               order=""                        ❷
                                               sql-parameter-source-factory=""
                                               use-payload-as-parameter-source="">
    <int:poller fixed-rate=""/>
    <int-jdbc:sql-parameter-definition name=""/>
    <int-jdbc:parameter name=""/>

</int-jdbc:stored-proc-outbound-channel-adapter>
```

❶ The receiving Message Channel of this endpoint. *Required*.

❷ Specifies the order for invocation when this endpoint is connected as a subscriber to a channel. This is particularly relevant when that channel is using a *failover* dispatching strategy. It has no effect when this endpoint itself is a Polling Consumer for a channel with a queue. *Optional*.

==== Stored Procedure Outbound Gateway

```
<int-jdbc:stored-proc-outbound-gateway request-channel=""                    ❶
                                           stored-procedure-name=""
                                           data-source=""
                                       auto-startup="true"
                                       id=""
                                       ignore-column-meta-data="false"
                                       is-function="false"
                                       order=""
                                       reply-channel=""                      ❷
                                       reply-timeout=""                      ❸
                                       return-value-required="false"         ❹
                                       skip-undeclared-results=""            ❺
                                       sql-parameter-source-factory=""
                                       use-payload-as-parameter-source="">
<int-jdbc:sql-parameter-definition name="" direction="IN"
                                       type=""
                                       scale="10"/>
<int-jdbc:sql-parameter-definition name=""/>
<int-jdbc:parameter name="" type="" value=""/>
<int-jdbc:parameter name="" expression=""/>
<int-jdbc:returning-resultset name="" row-mapper="" />
```

❶ The receiving Message Channel of this endpoint. *Required*.

❷ Message Channel to which replies should be sent, after receiving the database response. *Optional*.

❸ Allows you to specify how long this gateway will wait for the reply message to be sent successfully before throwing an exception. Keep in mind that when sending to a `DirectChannel`, the invocation will occur in the sender's thread so the failing of the send operation may be caused by other components further downstream. By default the Gateway will wait indefinitely. The value is specified in milliseconds. *Optional*.

❹ Indicates whether this procedure's return value should be included. *Optional*.

❺ If the `skip-undeclared-results` attribute is set to `true`, then all results from a stored procedure call that don't have a corresponding `SqlOutParameter` declaration will be bypassed. E.g. Stored Procedures may return an update count value, even though your Stored Procedure only declared a single result parameter. The exact behavior depends on the used database. The value is set on the underlying `JdbcTemplate`. Few developers will probably ever want to process update counts, thus the value defaults to `true`. *Optional*.

==== Examples

In the following two examples we call Apache Derby Stored Procedures. The first procedure will call a Stored Procedure that returns a `ResultSet`, and using a `RowMapper` the data is converted into a domain object, which then becomes the Spring Integration message payload.

In the second sample we call a Stored Procedure that uses Output Parameters instead, in order to return data.

Note

Please have a look at the *Spring Integration Samples* project, located at null

> The project contains the Apache Derby example referenced here, as well as instruction on how to run it. The *Spring Integration Samples* project also provides an example using Oracle Stored Procedures.

In the first example, we call a Stored Procedure named *FIND_ALL_COFFEE_BEVERAGES* that does not define any input parameters but which returns a `ResultSet`.

In Apache Derby, Stored Procedures are implemented using Java. Here is the method signature followed by the corresponding Sql:

```
public static void findAllCoffeeBeverages(ResultSet[] coffeeBeverages)
            throws SQLException {
    ...
}
```

```
CREATE PROCEDURE FIND_ALL_COFFEE_BEVERAGES() \
PARAMETER STYLE JAVA LANGUAGE JAVA MODIFIES SQL DATA DYNAMIC RESULT SETS 1 \
EXTERNAL NAME
 'org.springframework.integration.jdbc.storedproc.derby.DerbyStoredProcedures.findAllCoffeeBeverages';
```

In Spring Integration, you can now call this Stored Procedure using e.g. a `stored-proc-outbound-gateway`

```
<int-jdbc:stored-proc-outbound-gateway id="outbound-gateway-storedproc-find-all"
                                       data-source="dataSource"
                                       request-channel="findAllProcedureRequestChannel"
                                       expect-single-result="true"
                                       stored-procedure-name="FIND_ALL_COFFEE_BEVERAGES">
<int-jdbc:returning-resultset name="coffeeBeverages"
    row-mapper="org.springframework.integration.support.CoffeBeverageMapper"/>
</int-jdbc:stored-proc-outbound-gateway>
```

In the second example, we call a Stored Procedure named *FIND_COFFEE* that has one input parameter. Instead of returning a ResultSet, an output parameter is used:

```
public static void findCoffee(int coffeeId, String[] coffeeDescription)
            throws SQLException {
    ...
}
```

```
CREATE PROCEDURE FIND_COFFEE(IN ID INTEGER, OUT COFFEE_DESCRIPTION VARCHAR(200)) \
PARAMETER STYLE JAVA LANGUAGE JAVA EXTERNAL NAME \
'org.springframework.integration.jdbc.storedproc.derby.DerbyStoredProcedures.findCoffee';
```

In Spring Integration, you can now call this Stored Procedure using e.g. a `stored-proc-outbound-gateway`

```
<int-jdbc:stored-proc-outbound-gateway id="outbound-gateway-storedproc-find-coffee"
                                       data-source="dataSource"
                                       request-channel="findCoffeeProcedureRequestChannel"
                                       skip-undeclared-results="true"
                                       stored-procedure-name="FIND_COFFEE"
                                       expect-single-result="true">
    <int-jdbc:parameter name="ID" expression="payload" />
</int-jdbc:stored-proc-outbound-gateway>
```

=== JDBC Lock Registry

Starting with *version 4.3*, the `JdbcLockRegistry` is available. Certain components (for example aggregator and resequencer) use a lock obtained from a `LockRegistry` instance to ensure that only one thread is manipulating a group at a time. The `DefaultLockRegistry` performs this function within a single component; you can now configure an external lock registry on these components. When used with a shared `MessageGroupStore`, the `JdbcLockRegistry` can be use to provide this functionality across multiple application instances, such that only one instance can manipulate the group at a time.

When a lock is released by a local thread, another local thread will generally be able to acquire the lock immediately. If a lock is released by a thread using a different registry instance, it can take up to 100ms to acquire the lock.

The `JdbcLockRegistry` is based on the `LockRepository` abstraction, where a `DefaultLockRepository` implementation is present. The data base schema scripts are located in the `org.springframework.integration.jdbc` package divided to the particular RDBMS vendors. For example the H2 DDL for lock table looks like:

```
CREATE TABLE INT_LOCK  (
    LOCK_KEY CHAR(36),
    REGION VARCHAR(100),
    CLIENT_ID CHAR(36),
    CREATED_DATE TIMESTAMP NOT NULL,
    constraint LOCK_PK primary key (LOCK_KEY, REGION)
);
```

The `INT_` can be changed according to the target data base design requirements. Therefore `prefix` property must be used on the `DefaultLockRepository` bean definition.

Sometimes it happens that one application has moved to the state when it can't release distributed lock - remove the particular record in the data base. For this purpose such dead locks can be expired by the other application on the next locking invocation. The `timeToLive` (TTL) option on the `DefaultLockRepository` is provided for this purpose. The user may also want to specify `CLIENT_ID` for the locks stored for a given `DefaultLockRepository` instance. In this case you can specify the `id` to be associated with the `DefaultLockRepository` as a constructor parameter.

=== JDBC Metadata Store

Starting with *version 5.0*, the JDBC `MetadataStore` (the section called "CompletableFuture") implementation is available. The `JdbcMetadataStore` can be used to maintain metadata state across application restarts. This `MetadataStore` implementation can be used with adapters such as:

- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"
- the section called "CompletableFuture"

In order to configure these adapters to use the `JdbcMetadataStore`, simply declare a Spring bean using the bean name **metadataStore**. The *Twitter Inbound Channel Adapter* and the *Feed Inbound Channel Adapter* will both automatically pick up and use the declared `JdbcMetadataStore`:

```
@Bean
public MetadataStore metadataStore(DataSource dataSource) {
    return new JdbcMetadataStore(dataSource);
}
```

Data base schema scripts for several RDMBS vendors are located in the `org.springframework.integration.jdbc` package. For example the H2 DDL for metadata table looks like:

```
CREATE TABLE INT_METADATA_STORE  (
 METADATA_KEY VARCHAR(255) NOT NULL,
 METADATA_VALUE VARCHAR(4000),
 REGION VARCHAR(100) NOT NULL,
 constraint METADATA_STORE primary key (METADATA_KEY, REGION)
);
```

The `INT_` prefix can be changed according to the target data base design requirements and the `JdbcMetadataStore` can be configured to use the custom prefix.

The `JdbcMetadataStore` implements `ConcurrentMetadataStore`, allowing it to be reliably shared across multiple application instances where only one instance will be allowed to store or modify a key's value. All of these operations are *atomic* via transaction guarantees.

Transaction management is required to use `JdbcMetadataStore`. Inbound Channel Adapters can be supplied with a reference to the `TransactionManager` in the poller configuration. Unlike non-transactional `MetadataStore` implementations, with `JdbcMetadataStore`, the entry appears in the target table only after the transaction commits. When a rollback occurs, no entries are added to the `INT_METADATA_STORE` table.

Since version 5.0.7, the `JdbcMetadataStore` can be configured with the RDBMS vendor-specific `lockHint` option for lock-based queries on metadata store entries. It is `FOR UPDATE` by default and can be configured with an empty string, if the target data base doesn't support row locking functionality. Please, consult with your vendor for particular possible hint in the `SELECT` expression for locking rows before updates.

== JPA Support

Spring Integration's JPA (Java Persistence API) module provides components for performing various database operations using JPA. The following components are provided:

- *Inbound Channel Adapter*
- *Outbound Channel Adapter*
- *Updating Outbound Gateway*
- *Retrieving Outbound Gateway*

These components can be used to perform *select*, *create*, *update* and *delete* operations on the target databases by sending/receiving messages to them.

The JPA *Inbound Channel Adapter* lets you poll and retrieve (select) data from the database using JPA whereas the JPA *Outbound Channel Adapter* lets you create, update and delete entities.

Outbound Gateways for JPA can be used to persist entities to the database, yet allowing you to continue with the flow and execute further components downstream. Similarly, you can use an Outbound Gateway to retrieve entities from the database.

For example, you may use the Outbound Gateway, which receives a Message with a `userId` as payload on its request channel, to query the database and retrieve the User entity and pass it downstream for further processing.

Recognizing these semantic differences, Spring Integration provides 2 separate JPA Outbound Gateways:

- *Retrieving Outbound Gateway*
- *Updating Outbound Gateway*

Functionality

All JPA components perform their respective JPA operations by using either one of the following:

- *Entity classes*
- *Java Persistence Query Language (JPQL) for update, select and delete (inserts are not supported by JPQL)*
- *Native Query*
- *Named Query*

In the following sections we will describe each of these components in more detail.

=== Supported Persistence Providers

The Spring Integration JPA support has been tested using the following persistence providers:

- *Hibernate*
- *EclipseLink*

When using a persistence provider, please ensure that the provider is compatible with JPA 2.1.

=== Java Implementation

Each of the provided components uses the `o.s.i.jpa.core.JpaExecutor` class which, in turn, uses an implementation of the `o.s.i.jpa.core.JpaOperations` interface. `JpaOperations` operates like a typical Data Access Object (DAO) and provides methods such as *find*, *persist*, *executeUpdate* etc. For most use cases the provided default implementation `o.s.i.jpa.core.DefaultJpaOperations` should be sufficient. Nevertheless, you have the option to specify your own implementation in case you require custom behavior.

For initializing a `JpaExecutor` you have to use one of 3 available constructors that accept one of:

- *EntityManagerFactory*
- *EntityManager* or
- *JpaOperations*

```
@Bean
public JpaExecutor jpaExecutor() {
    JpaExecutor executor = new JpaExecutor(this.entityManagerFactory);
    executor.setJpaParameters(Collections.singletonList(new JpaParameter("firstName", null, "#this")));
    executor.setUsePayloadAsParameterSource(true);
    executor.setExpectSingleResult(true);
    return executor;
}

@ServiceActivator(inputChannel = "getEntityChannel")
@Bean
public MessageHandler retrievingJpaGateway() {
    JpaOutboundGateway gateway = new JpaOutboundGateway(jpaExecutor());
    gateway.setGatewayType(OutboundGatewayType.RETRIEVING);
    gateway.setOutputChannelName("resultsChannel");
    return gateway;
}
```

=== Namespace Support

When using XML namespace support, the underlying parser classes will instantiate the relevant Java classes for you. Thus, you typically don't have to deal with the inner workings of the JPA adapter. This section will document the XML Namespace Support provided by the Spring Integration and will show you how to use the XML Namespace Support to configure the Jpa components.

==== Common XML Namespace Configuration Attributes

Certain configuration parameters are shared amongst all JPA components and are described below:

auto-startup

Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to `true`. *Optional*.

id

Identifies the underlying Spring bean definition, which is an instance of either `EventDrivenConsumer` or `PollingConsumer`. *Optional*.

entity-manager-factory

The reference to the JPA Entity Manager Factory that will be used by the adapter to create the `EntityManager`. Either this attribute or the *entity-manager* attribute or the *jpa-operations* attribute must be provided.

entity-manager

The reference to the JPA Entity Manager that will be used by the component. Either this attribute or the *entity-manager-factory* attribute or the *jpa-operations* attribute must be provided.

Note

Usually your Spring Application Context only defines a JPA Entity Manager Factory and the `EntityManager` is injected using the `@PersistenceContext` annotation. This, however, is not applicable for the Spring Integration JPA components. Usually, injecting the JPA Entity Manager Factory will be best but in case you want to inject an `EntityManager` explicitly, you have to define a `SharedEntityManagerBean`. For more information, please see the relevant JavaDoc.

```
<bean id="entityManager"
      class="org.springframework.orm.jpa.support.SharedEntityManagerBean">
    <property name="entityManagerFactory" ref="entityManagerFactoryBean" />
</bean>
```

jpa-operations

Reference to a bean implementing the `JpaOperations` interface. In rare cases it might be advisable to provide your own implementation of the `JpaOperations` interface, instead of relying on the default implementation `org.springframework.integration.jpa.core.DefaultJpaOperations`. As `JpaOperations` wraps the necessary datasource; the JPA Entity Manager or JPA Entity Manager Factory must not be provided, if the *jpa-operations* attribute is used.

entity-class

The fully qualified name of the entity class. The exact semantics of this attribute vary, depending on whether we are performing a persist/update operation or whether we are retrieving objects from the database.

When retrieving data, you can specify the *entity-class* attribute to indicate that you would like to retrieve objects of this type from the database. In that case you must not define any of the query attributes (*jpa-query*, *native-query* or *named-query*)

When persisting data, the *entity-class* attribute will indicate the type of object to persist. If not specified (for persist operations) the entity class will be automatically retrieved from the Message's payload.

jpa-query

Defines the JPA query (Java Persistence Query Language) to be used.

native-query

Defines the native SQL query to be used.

named-query

This attribute refers to a named query. A named query can either be defined in Native SQL or JPAQL but the underlying JPA persistence provider handles that distinction internally.

==== Providing JPA Query Parameters

For providing parameters, the *parameter* XML sub-element can be used. It provides a mechanism to provide parameters for the queries that are either based on the Java Persistence Query Language (JPQL) or native SQL queries. Parameters can also be provided for Named Queries.

Expression based Parameters

```
<int-jpa:parameter expression="payload.name" name="firstName"/>
```

Value based Parameters

```
<int-jpa:parameter name="name" type="java.lang.String" value="myName"/>
```

Positional Parameters

```
<int-jpa:parameter expression="payload.name"/>
<int-jpa:parameter type="java.lang.Integer" value="21"/>
```

==== Transaction Handling

All JPA operations like `INSERT`, `UPDATE` and `DELETE` require a transaction to be active whenever they are performed. For Inbound Channel Adapters there is nothing special to be done, it is similar to the way we configure transaction managers with pollers used with other inbound channel adapters. The xml snippet below shows a sample where a transaction manager is configured with the poller used with an *Inbound Channel Adapter*.

```
<int-jpa:inbound-channel-adapter
    channel="inboundChannelAdapterOne"
    entity-manager="em"
    auto-startup="true"
    jpa-query="select s from Student s"
    expect-single-result="true"
    delete-after-poll="true">
    <int:poller fixed-rate="2000" >
        <int:transactional propagation="REQUIRED"
            transaction-manager="transactionManager"/>
    </int:poller>
</int-jpa:inbound-channel-adapter>
```

However, it may be necessary to specifically start a transaction when using an *Outbound Channel Adapter/Gateway*. If a *DirectChannel* is an input channel for the outbound adapter/gateway, and if transaction is active in the current thread of execution, the JPA operation will be performed in the same transaction context. We can also configure to execute this JPA operation in a new transaction as below.

```
<int-jpa:outbound-gateway
    request-channel="namedQueryRequestChannel"
    reply-channel="namedQueryResponseChannel"
    named-query="updateStudentByRollNumber"
    entity-manager="em"
    gateway-type="UPDATING">
    <int-jpa:parameter name="lastName" expression="payload"/>
    <int-jpa:parameter name="rollNumber" expression="headers['rollNumber']"/>
  <int-jpa:transactional propagation="REQUIRES_NEW"
        transaction-manager="transactionManager"/>
</int-jpa:outbound-gateway>
```

As we can see above, the *transactional* sub element of the outbound gateway/adapter will be used to specify the transaction attributes. It is optional to define this child element if you have *DirectChannel* as an input channel to the adapter and you want the adapter to execute the operations in the same transaction context as the caller. If, however, you are using an *ExecutorChannel*, it is required to have the *transactional* sub element as the invoking client's transaction context is not propagated.

Note

Unlike the *transactional* sub element of the poller which is defined in the spring integration's namespace, the *transactional* sub element for the outbound gateway/adapter is defined in the jpa namespace.

=== Inbound Channel Adapter

An *Inbound Channel Adapter* is used to execute a *select* query over the database using JPA QL and return the result. The message payload will be either a single entity or a `List` of entities. Below is a sample xml snippet that shows a sample usage of *inbound-channel-adapter*.

```
<int-jpa:inbound-channel-adapter channel="inboundChannelAdapterOne"  ❶
                    entity-manager="em"  ❷
                    auto-startup="true"  ❸
                    query="select s from Student s"  ❹
                    expect-single-result="true"  ❺
                    max-results=""  ❻
                    max-results-expression=""  ❼
                    delete-after-poll="true"  ❽
                    flush-after-delete="true">  ❾
    <int:poller fixed-rate="2000" >
      <int:transactional propagation="REQUIRED" transaction-manager="transactionManager"/>
    </int:poller>
</int-jpa:inbound-channel-adapter>
```

❶ The channel over which the *inbound-channel-adapter* will put the messages with the payload received after executing the provided JPA QL in the *query* attribute.

❷ The `EntityManager` instance that will be used to perform the required JPA operations.

❸ Attribute signalling if the component should be automatically started on startup of the Application Context. The value defaults to `true`

❹ The JPA QL that needs to be executed and whose result needs to be sent out as the payload of the message

❺ The attribute that tells if the executed JPQL query gives a single entity in the result or a `List` of entities. If the value is set to `true`, the single entity retrieved is sent as the payload of the message. If, however, multiple results are returned after setting this to `true`, a `MessagingException` is thrown. The value defaults to `false`.

❻ This non zero, non negative integer value tells the adapter not to select more than given number of rows on execution of the select operation. By default, if this attribute is not set, all the possible records are selected by given query. This attribute is mutually exclusive with `max-results-expression`. *Optional*.

❼ An expression, mutually exclusive with `max-results`, that can be used to provide an expression that will be evaluated to find the maximum number of results in a result set. *Optional*.

❽ Set this value to `true` if you want to delete the rows received after execution of the query. Please ensure that the component is operating as part of a transaction. Otherwise, you may encounter an Exception such as: *java.lang.IllegalArgumentException: Removing a detached instance …*

❾ Set this value to `true` if you want to the persistence context immediately after deleting received entities and if you don't want rely on the `EntityManager`'s flushMode. The default value is set to `false`.

==== Configuration Parameter Reference

```
<int-jpa:inbound-channel-adapter
  auto-startup="true"  ❶
  channel=""  ❷
  delete-after-poll="false"   ❸
  delete-per-row="false"   ❹
  entity-class=""   ❺
  entity-manager=""  ❻
  entity-manager-factory=""  ❼
  expect-single-result="false"  ❽
  id=""
  jpa-operations=""  ❾
  jpa-query=""  ❿
  named-query=""  11
  native-query=""  12
  parameter-source=""  13
  send-timeout="">  14
  <int:poller ref="myPoller"/>
 </int-jpa:inbound-channel-adapter>
```

❶ This *Lifecycle* attribute signaled if this component should be started during startup of the Application Context. This attribute defaults to true.*Optional*.

❷ The channel to which the adapter will send a message with the payload that was received after performing the desired JPA operation.

❸ A boolean flag that indicates whether the records selected are to be deleted after they are being polled by the adapter. By default the value is `false`, that is, the records will not be deleted. Please ensure that the component is operating as part of a transaction. Otherwise, you may encounter an Exception such as: *java.lang.IllegalArgumentException: Removing a detached instance …* .*Optional*.

❹ A boolean flag that indicates whether the records can be deleted in bulk or are deleted one record at a time. By default the value is `false`, that is, the records are bulk deleted.*Optional*.

❺ The fully qualified name of the entity class that would be queried from the database. The adapter will automatically build a JPA Query to be executed based on the entity class name provided.*Optional*.

❻ An instance of `javax.persistence.EntityManager` that will be used to perform the JPA operations. *Optional*.

❼ An instance of `javax.persistence.EntityManagerFactory` that will be used to obtain an instance of `javax.persistence.EntityManager` that will perform the JPA operations. *Optional*.

❽ A boolean flag indicating whether the select operation is expected to return a single result or a `List` of results. If this flag is set to `true`, the single entity selected is sent as the payload of the message. If multiple entities are returned, an exception is thrown. If `false`, the `List` of entities is being sent as the payload of the message. By default the value is `false`.*Optional*.

❾ An implementation of `org.springframework.integration.jpa.core.JpaOperations` that would be used to perform the JPA operations. It is recommended not to provide an implementation of your own but use the default `org.springframework.integration.jpa.core.DefaultJpaOperations` implementation. Either of the *entity-manager*, *entity-manager-factory* or *jpa-operations* attributes is to be used. *Optional*.

❿ The JPA QL that needs to be executed by this adapter.*Optional*.

11 The named query that needs to be executed by this adapter.*Optional*.

12 The native query that will be executed by this adapter. Either of the *jpa-query*, *named-query*,*entity-class* or *native-query* attributes are to be used. *Optional*.

13 An implementation of `o.s.i.jpa.support.parametersource.ParameterSource` which will be used to resolve the values of the parameters provided in the query. Ignored if *entity-class* attribute is provided.*Optional*.

14 Maximum amount of time in milliseconds to wait when sending a message to the channel.*Optional*.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @Bean
    public JpaExecutor jpaExecutor() {
        JpaExecutor executor = new JpaExecutor(this.entityManagerFactory);
        jpaExecutor.setJpaQuery("from Student");
        return executor;
    }

    @Bean
    @InboundChannelAdapter(channel = "jpaInputChannel",
                     poller = @Poller(fixedDelay = "${poller.interval}"))
    public MessageSource<?> jpaInbound() {
        return new JpaPollingChannelAdapter(jpaExecutor());
    }

    @Bean
    @ServiceActivator(inputChannel = "jpaInputChannel")
    public MessageHandler handler() {
        return message -> System.out.println(message.getPayload());
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Inbound Adapter using the Java DSL:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @Bean
    public IntegrationFlow pollingAdapterFlow() {
        return IntegrationFlows
            .from(Jpa.inboundAdapter(this.entityManagerFactory)
                        .entityClass(StudentDomain.class)
                        .maxResults(1)
                        .expectSingleResult(true),
                e -> e.poller(p -> p.trigger(new OnlyOnceTrigger())))
            .channel(c -> c.queue("pollingResults"))
            .get();
    }

}
```

=== Outbound Channel Adapter

The JPA Outbound channel adapter allows you to accept messages over a request channel. The payload can either be used as the entity to be persisted, or used along with the headers in parameter expressions for a defined JPQL query to be executed. In the following sub sections we shall see what those possible ways of performing these operations are.

==== Using an Entity Class

The XML snippet below shows how we can use the Outbound Channel Adapter to persist an entity to the database.

```
<int-jpa:outbound-channel-adapter channel="entityTypeChannel"   ❶
    entity-class="org.springframework.integration.jpa.test.entity.Student"  ❷
    persist-mode="PERSIST"  ❸
    entity-manager="em"/ > ❹
```

❶ The channel over which a valid JPA entity will be sent to the JPA Outbound Channel Adapter.

❷ The fully qualified name of the entity class that would be accepted by the adapter to be persisted in the database. You can actually leave off this attribute in most cases as the adapter can determine the entity class automatically from the Spring Integration Message payload.

❸ The operation that needs to be done by the adapter, valid values are *PERSIST*, *MERGE* and *DELETE*. The default value is *MERGE*.

❹ The JPA entity manager to be used.

As we can see above these 4 attributes of the *outbound-channel-adapter* are all we need to configure it to accept entities over the input channel and process them to *PERSIST*,*MERGE* or *DELETE* it from the underlying data source.

Note

As of *Spring Integration 3.0*, payloads to *PERSIST* or *MERGE* can also be of type `https://docs.oracle.com/javase/7/docs/api/java/lang/`

> `Iterable.html[java.lang.Iterable]`. In that case, each object returned by the `Iterable` is treated as an entity and persisted or merged using the underlying `EntityManager`. *NULL* values returned by the iterator are ignored.

==== Using JPA Query Language (JPA QL)

We have seen in the above sub section how to perform a *PERSIST* action using an entity We will now see how to use the outbound channel adapter which uses JPA QL (Java Persistence API Query Language)

```
<int-jpa:outbound-channel-adapter channel="jpaQlChannel"  ❶
  jpa-query="update Student s set s.firstName = :firstName where s.rollNumber = :rollNumber"  ❷
  entity-manager="em">  ❸
    <int-jpa:parameter name="firstName"  expression="payload['firstName']"/>  ❹
    <int-jpa:parameter name="rollNumber" expression="payload['rollNumber']"/>
</int-jpa:outbound-channel-adapter>
```

❶ The input channel over which the message is being sent to the outbound channel adapter

❷ The JPA QL that needs to be executed.This query may contain parameters that will be evaluated using the *parameter* child tag.

❸ The entity manager used by the adapter to perform the JPA operations

❹ This sub element, one for each parameter will be used to evaluate the value of the parameter names specified in the JPA QL specified in the *query* attribute

The *parameter* sub element accepts an attribute *name* which corresponds to the named parameter specified in the provided JPA QL (point 2 in the above mentioned sample). The value of the parameter can either be static or can be derived using an expression. The static value and the expression to derive the value is specified using the *value* and the *expression* attributes respectively. These attributes are mutually exclusive.

If the *value* attribute is specified we can provide an optional *type* attribute. The value of this attribute is the fully qualified name of the class whose value is represented by the *value* attribute. By default the type is assumed to be a `java.lang.String`.

```
<int-jpa:outbound-channel-adapter ...
>
    <int-jpa:parameter name="level" value="2" type="java.lang.Integer"/>
    <int-jpa:parameter name="name" expression="payload['name']"/>
</int-jpa:outbound-channel-adapter>
```

As seen in the above snippet, it is perfectly valid to use multiple *parameter* sub elements within an outbound channel adapter tag and derive some parameters using expressions and some with static value. However, care should be taken not to specify the same parameter name multiple times, and, provide one *parameter* sub element for each named parameter specified in the JPA query. For example, we are specifying two parameters *level* and *name* where *level* attribute is a static value of type `java.lang.Integer`, where as the *name* attribute is derived from the payload of the message

> **Note**
>
> Though specifying *select* is valid for JPA QL, it makes no sense as outbound channel adapters will not be returning any result. If you want to select some values, consider using the outbound gateway instead.

==== Using Native Queries

In this section we will see how to use native queries to perform the operations using JPA outbound channel adapter. Using native queries is similar to using JPA QL, except that the query specified here is a native database query. By choosing native queries we lose the database vendor independence which we get using JPA QL.

One of the things we can achieve using native queries is to perform database inserts, which is not possible using JPA QL (To perform inserts we send JPA entities to the channel adapter as we have seen earlier). Below is a small xml fragment that demonstrates the use of native query to insert values in a table. Please note that we have only mentioned the important attributes below. All other attributes like *channel*, *entity-manager* and the *parameter* sub element has the same semantics as when we use JPA QL.

Important

Please be aware that named parameters may not be supported by your JPA provider in conjunction with native SQL queries. While they work fine using Hibernate, OpenJPA and EclipseLink do NOT support them: https://issues.apache.org/jira/browse/OPENJPA-111 Section 3.8.12 of the JPA 2.0 spec states: "Only positional parameter binding and positional access to result items may be portably used for native queries."

```
<int-jpa:outbound-channel-adapter channel="nativeQlChannel"
  native-query="insert into STUDENT_TABLE(FIRST_NAME,LAST_UPDATED) values (:lastName,:lastUpdated)"  ❶
  entity-manager="em">
    <int-jpa:parameter name="lastName" expression="payload['updatedLastName']"/>
    <int-jpa:parameter name="lastUpdated" expression="new java.util.Date()"/>
</int-jpa:outbound-channel-adapter>
```

❶ The native query that will be executed by this outbound channel adapter

==== Using Named Queries

We will now see how to use named queries after seeing using entity, JPA QL and native query in previous sub sections. Using named query is also very similar to using JPA QL or a native query, except that we specify a named query instead of a query. Before we go further and see the xml fragment for the declaration of the *outbound-channel-adapter*, we will see how named JPA named queries are defined.

In our case, if we have an entity called `Student`, then we have the following in the class to define two named queries *selectStudent* and *updateStudent*. Below is a way to define named queries using annotations

```
@Entity
@Table(name="Student")
@NamedQueries({
    @NamedQuery(name="selectStudent",
        query="select s from Student s where s.lastName = 'Last One'"),
    @NamedQuery(name="updateStudent",
        query="update Student s set s.lastName = :lastName,
               lastUpdated = :lastUpdated where s.id in (select max(a.id) from Student a)")
})
public class Student {

...
```

You can alternatively use the *orm.xml* to define named queries as seen below

```
<entity-mappings ...>
    ...
    <named-query name="selectStudent">
        <query>select s from Student s where s.lastName = 'Last One'</query>
    </named-query>
</entity-mappings>
```

Now that we have seen how we can define named queries using annotations or using *orm.xml*, we will now see a small xml fragment for defining an *outbound-channel-adapter* using named query

```
<int-jpa:outbound-channel-adapter channel="namedQueryChannel"
            named-query="updateStudent"  ❶
            entity-manager="em">
        <int-jpa:parameter name="lastName" expression="payload['updatedLastName']"/>
        <int-jpa:parameter name="lastUpdated" expression="new java.util.Date()"/>
</int-jpa:outbound-channel-adapter>
```

❶ The named query that we want the adapter to execute when it receives a message over the channel

==== Configuration Parameter Reference

```
<int-jpa:outbound-channel-adapter
  auto-startup="true"  ❶
  channel=""  ❷
  entity-class=""  ❸
  entity-manager=""  ❹
  entity-manager-factory=""  ❺
  id=""
  jpa-operations=""  ❻
  jpa-query=""  ❼
  named-query=""  ❽
  native-query=""  ❾
  order=""  ❿
  parameter-source-factory=""   11
  persist-mode="MERGE"   12
  flush="true"   13
  flush-size="10"   14
  clear-on-flush="true"   15
  use-payload-as-parameter-source="true"   16
 <int:poller/>
 <int-jpa:transactional/>    17
 <int-jpa:parameter/>    18
</int-jpa:outbound-channel-adapter>
```

❶ Lifecycle attribute signaling if this component should be started during Application Context startup. Defaults to `true`. *Optional*.

❷ The channel from which the outbound adapter will receive messages for performing the desired operation.

❸ The fully qualified name of the entity class for the JPA Operation. The attributes *entity-class*, *query* and *named-query* are mutually exclusive. *Optional*.

❹ An instance of `javax.persistence.EntityManager` that will be used to perform the JPA operations. *Optional*.

❺ An instance of `javax.persistence.EntityManagerFactory` that will be used to obtain an instance of `javax.persistence.EntityManager` that will perform the JPA operations. *Optional*.

❻ An implementation of `org.springframework.integration.jpa.core.JpaOperations` that would be used to perform the JPA operations. It is recommended not to provide an implementation of your own but use the default `org.springframework.integration.jpa.core.DefaultJpaOperations` implementation. Either of the *entity-manager*, *entity-manager-factory* or *jpa-operations* attributes is to be used. *Optional*.

7 The JPA QL that needs to be executed by this adapter.*Optional*.

8 The named query that needs to be executed by this adapter.*Optional*.

9 The native query that will be executed by this adapter. Either of the *jpa-query*, *named-query* or *native-query* attributes are to be used. *Optional*.

10 The order for this consumer when multiple consumers are registered thereby managing load-balancing and/or failover. Optional (Defaults to *Ordered.LOWEST_PRECEDENCE*).

11 An instance of `o.s.i.jpa.support.parametersource.ParameterSourceFactory` that will be used to get an instance of `o.s.i.jpa.support.parametersource.ParameterSource` which will be used to resolve the values of the parameters provided in the query. Ignored if operations are performed using a JPA entity. If a parameter sub element is used, the factory must be of type `ExpressionEvaluatingParameterSourceFactory` located in package `o.s.i.jpa.support.parametersource`. *Optional*.

12 Accepts one of the following: *PERSIST*, *MERGE* or *DELETE*. Indicates the operation that the adapter needs to perform. Relevant only if an entity is being used for JPA operations. Ignored if JPA QL, named query or native query is provided. Defaults to *MERGE*. *Optional*. As of **Spring Integration 3.0**, payloads to *persist* or *merge* can also be of type `https://docs.oracle.com/javase/7/docs/api/java/lang/Iterable.html[java.lang.Iterable]`. In that case, each object returned by the `Iterable` is treated as an entity and persisted or merged using the underlying `EntityManager`. *NULL* values returned by the iterator are ignored.

13 Set this value to `true` if you want to flush the persistence context immediately after persist, merge or delete operations and don't want to rely on the `EntityManager`'s flushMode. The default value is set to `false`. Applies only if the `flush-size` attribute isn't specified. If this attribute is set to `true`, then `flush-size` will be implicitly set to `1`, if it wasn't configured to any other value.

14 Set this attribute to a value greater than *0* if you want to flush the persistence context immediately after persist, merge or delete operations and don't want to rely on the `EntityManager`*s flushMode. The default value is set to `0` which means 'no flush*. This attribute is geared towards messages with `Iterable` payloads. For instance, if `flush-size` is set to `3`, then `entityManager.flush()` is called after every third entity. Furthermore, `entityManager.flush()` will be called once more after the entire loop. There is no reason to configure the `flush` attribute, if the *flush-size* attribute is specified with a value greater than *0*.

15 Set this value to *true* if you want to clear persistence context immediately after each flush operation. The attribute's value is applied only if the `flush` attribute is set to `true` or if the `flush-size` attribute is set to a value greater than `0`.

16 If set to true, the payload of the Message will be used as a source for providing parameters. If false, however, the entire Message will be available as a source for parameters.*Optional*.

17 Defines the transaction management attributes and the reference to transaction manager to be used by the JPA adapter.*Optional*.

18 One or more *parameter* attributes, one for each parameter used in the query. The value or expression provided will be evaluated to compute the value of the parameter.*Optional*.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
@IntegrationComponentScan
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @MessagingGateway
    interface JpaGateway {

       @Gateway(requestChannel = "jpaPersistChannel")
       @Transactional
       void persistStudent(StudentDomain payload);

    }

    @Bean
    public JpaExecutor jpaExecutor() {
        JpaExecutor executor = new JpaExecutor(this.entityManagerFactory);
        jpaExecutor.setEntityClass(StudentDomain.class);
        jpaExecutor.setPersistMode(PersistMode.PERSIST);
        return executor;
    }

    @Bean
    @ServiceActivator(channel = "jpaPersistChannel")
    public MessageHandler jpaOutbound() {
        JpaOutboundGateway adapter = new JpaOutboundGateway(jpaExecutor());
        adapter.setProducesReply(false);
        return adapter;
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Inbound Adapter using the Java DSL:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @Bean
    public IntegrationFlow outboundAdapterFlow() {
        return f -> f
                .handle(Jpa.outboundAdapter(this.entityManagerFactory)
                                .entityClass(StudentDomain.class)
                                .persistMode(PersistMode.PERSIST),
                        e -> e.transactional());
    }

}
```

=== Outbound Gateways

The JPA *Inbound Channel Adapter* allows you to poll a database in order to retrieve one or more JPA entities and the retrieved data is consequently used to start a Spring Integration flow using the retrieved data as message payload.

Additionally, you may use JPA *Outbound Channel Adapters* at the end of your flow in order to persist data, essentially terminating the flow at the end of the persistence operation.

However, how can you execute JPA persistence operation in the middle of a flow? For example, you may have business data that you are processing in your Spring Integration message flow, that you would like to persist, yet you still need to execute other components further downstream. Or instead of polling the database using a poller, you rather have the need to execute JPQL queries and retrieve data actively which then is used to being processed in subsequent components within your flow.

This is where JPA Outbound Gateways come into play. They give you the ability to persist data as well as retrieving data. To facilitate these uses, Spring Integration provides two types of JPA Outbound Gateways:

- *Updating Outbound Gateway*
- *Retrieving Outbound Gateway*

Whenever the Outbound Gateway is used to perform an action that saves, updates or solely deletes some records in the database, you need to use an *Updating Outbound Gateway* gateway. If for example an *entity* is used to persist it, then a merged/persisted entity is returned as a result. In other cases the number of records affected (updated or deleted) is returned instead.

When retrieving (selecting) data from the database, we use a *Retrieving Outbound Gateway*. With a *Retrieving Outbound Gateway* gateway, we can use either JPQL, Named Queries (native or JPQL-based) or Native Queries (SQL) for selecting the data and retrieving the results.

An *Updating Outbound Gateway* is functionally very similar to an *Outbound Channel Adapter*, except that an *Updating Outbound Gateway* is used to send a result to the Gateway's *reply channel* after performing the given JPA operation.

A *Retrieving Outbound Gateway* is quite similar to an *Inbound Channel Adapter*.

> **Note**
>
> We recommend you to first refer to the JPA Outbound Channel Adapter section and the JPA Inbound Channel Adapter sections above, as most of the common concepts are being explained there.

This similarity was the main factor to use the central `JpaExecutor` class to unify common functionality as much as possible.

Common for all JPA Outbound Gateways and simlar to the *outbound-channel-adapter*, we can use

- *Entity classes*
- *JPA Query Language (JPQL)*
- *Native query*

- *Named query*

for performing various JPA operations. For configuration examples please see the section called “CompletableFuture”.

==== Common Configuration Parameters

JPA Outbound Gateways always have access to the Spring Integration Message as input. As such the following parameters are available:

parameter-source-factory

An instance of `o.s.i.jpa.support.parametersource.ParameterSourceFactory` that will be used to get an instance of `o.s.i.jpa.support.parametersource.ParameterSource`. The *ParameterSource* is used to resolve the values of the parameters provided in the query. The_parameter-source-factory_ attribute is ignored, if operations are performed using a JPA entity. If a *parameter* sub-element is used, the factory must be of type `ExpressionEvaluatingParameterSourceFactory`, located in package *o.s.i.jpa.support.parametersource*. *Optional*.

use-payload-as-parameter-source

If set to *true*, the payload of the Message will be used as a source for providing parameters. If set to *false*, the entire Message will be available as a source for parameters. If no JPA Parameters are passed in, this property will default to *true*. This means that using a default `BeanPropertyParameterSourceFactory`, the bean properties of the payload will be used as a source for parameter values for the to-be-executed JPA query. However, if JPA Parameters are passed in, then this property will by default evaluate to *false*. The reason is that JPA Parameters allow for SpEL Expressions to be provided and therefore it is highly beneficial to have access to the entire Message, including the Headers.

==== Updating Outbound Gateway

```
<int-jpa:updating-outbound-gateway request-channel=""  ❶
    auto-startup="true"
    entity-class=""
    entity-manager=""
    entity-manager-factory=""
    id=""
    jpa-operations=""
    jpa-query=""
    named-query=""
    native-query=""
    order=""
    parameter-source-factory=""
    persist-mode="MERGE"
    reply-channel=""  ❷
    reply-timeout=""  ❸
    use-payload-as-parameter-source="true">

    <int:poller/>
    <int-jpa:transactional/>

    <int-jpa:parameter name="" type="" value=""/>
    <int-jpa:parameter name="" expression=""/>
</int-jpa:updating-outbound-gateway>
```

❶ The channel from which the outbound gateway will receive messages for performing the desired operation. This attribute is similar to *channel* attribute of the outbound-channel-adapter.*Optional*.

❷ The channel to which the gateway will send the response after performing the required JPA operation. If this attribute is not defined, the request message must have a replyChannel header. *Optional*.

❸ Specifies the time the gateway will wait to send the result to the reply channel. Only applies when the reply channel itself might block the send (for example a bounded QueueChannel that is currently full). By default the Gateway will wait indefinitely. The value is specified in milliseconds. *Optional*.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
@IntegrationComponentScan
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @MessagingGateway
    interface JpaGateway {

       @Gateway(requestChannel = "jpaUpdateChannel")
       @Transactional
       void updateStudent(StudentDomain payload);

    }

    @Bean
    @ServiceActivator(channel = "jpaUpdateChannel")
    public MessageHandler jpaOutbound() {
        JpaOutboundGateway adapter =
               new JpaOutboundGateway(new JpaExecutor(this.entityManagerFactory));
        adapter.setOutputChannelName("updateResults");
        return adapter;
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Inbound Adapter using the Java DSL:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @Bean
    public IntegrationFlow updatingGatewayFlow() {
        return f -> f
                .handle(Jpa.updatingGateway(this.entityManagerFactory),
                        e -> e.transactional(true))
                .channel(c -> c.queue("updateResults"));
    }

}
```

==== Retrieving Outbound Gateway

```
<int-jpa:retrieving-outbound-gateway request-channel=""
    auto-startup="true"
    delete-after-poll="false"
    delete-in-batch="false"
    entity-class=""
    id-expression=""  ❶
    entity-manager=""
    entity-manager-factory=""
    expect-single-result="false"  ❷
    id=""
    jpa-operations=""
    jpa-query=""
    max-results=""  ❸
    max-results-expression=""  ❹
    first-result=""  ❺
    first-result-expression=""  ❻
    named-query=""
    native-query=""
    order=""
    parameter-source-factory=""
    reply-channel=""
    reply-timeout=""
    use-payload-as-parameter-source="true">
    <int:poller></int:poller>
    <int-jpa:transactional/>

    <int-jpa:parameter name="" type="" value=""/>
    <int-jpa:parameter name="" expression=""/>
</int-jpa:retrieving-outbound-gateway>
```

❶ (Since *Spring Integration 4.0*) The SpEL expression to determine the `primaryKey` value for `EntityManager.find(Class entityClass, Object primaryKey)` method against the `requestMessage` as root object of evaluation context. The `entityClass` argument is determined from `entity-class` attribute, if presented, otherwise from `payload` class. All other attributed are disallowed in case of `id-expression`. *Optional*.

❷ A boolean flag indicating whether the select operation is expected to return a single result or a `List` of results. If this flag is set to `true`, the single entity selected is sent as the payload of the message. If multiple entities are returned, an exception is thrown. If `false`, the `List` of entities is being sent as the payload of the message. By default the value is `false`. *Optional*.

❸ This non zero, non negative integer value tells the adapter not to select more than given number of rows on execution of the select operation. By default, if this attribute is not set, all the possible records are selected by given query. This attribute is mutually exclusive with `max-results-expression`. *Optional*.

❹ An expression, mutually exclusive with `max-results`, that can be used to provide an expression that will be evaluated to find the maximum number of results in a result set. *Optional*.

❺ This non zero, non negative integer value tells the adapter the first record from which the results are to be retrieved This attribute is mutually exclusive to `first-result-expression`. This attribute is introduced since version 3.0. *Optional*.

❻ This expression is evaluated against the message to find the position of first record in the result set to be retrieved This attribute is mutually exclusive to `first-result`. This attribute is introduced since version 3.0. *Optional*.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;


    @Bean
    public JpaExecutor jpaExecutor() {
        JpaExecutor executor = new JpaExecutor(this.entityManagerFactory);
        jpaExecutor.setJpaQuery("from Student s where s.id = :id");
        executor.setJpaParameters(Collections.singletonList(new JpaParameter("id", null, "payload")));
        jpaExecutor.setExpectSingleResult(true);
        return executor;
    }

    @Bean
    @ServiceActivator(channel = "jpaRetrievingChannel")
    public MessageHandler jpaOutbound() {
        JpaOutboundGateway adapter = new JpaOutboundGateway(jpaExecutor());
        adapter.setOutputChannelName("retrieveResults");
        adapter.setGatewayType(OutboundGatewayType.RETRIEVING);
        return adapter;
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Inbound Adapter using the Java DSL:

```
@SpringBootApplication
@EntityScan(basePackageClasses = StudentDomain.class)
public class JpaJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(JpaJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private EntityManagerFactory entityManagerFactory;

    @Bean
    public IntegrationFlow retrievingGatewayFlow() {
        return f -> f
                .handle(Jpa.retrievingGateway(this.entityManagerFactory)
                        .jpaQuery("from Student s where s.id = :id")
                        .expectSingleResult(true)
                        .parameterExpression("id", "payload"))
                .channel(c -> c.queue("retrieveResults"));
    }

}
```

Important

When choosing to delete entities upon retrieval and you have retrieved a collection of entities, please be aware that by default entities are deleted on a per entity basis. This may cause performance issues.

Alternatively, you can set attribute *deleteInBatch* to *true*, which will perform a batch delete. However, please be aware of the limitation that in that case cascading deletes are not supported.

JSR 317: Java™ Persistence 2.0 states in chapter Chapter 4.10, Bulk Update and Delete Operations that:

"A delete operation only applies to entities of the specified class and its subclasses. It does not cascade to related entities."

For more information please see JSR 317: Java™ Persistence 2.0

==== JPA Outbound Gateway Samples

This section contains various examples of the *Updating Outbound Gateway* and *Retrieving Outbound Gateway*

Update using an Entity Class

In this example an *Updating Outbound Gateway* is persisted using solely the entity class `org.springframework.integration.jpa.test.entity.Student` as JPA defining parameter.

```
<int-jpa:updating-outbound-gateway request-channel="entityRequestChannel"   ❶
    reply-channel="entityResponseChannel"  ❷
    entity-class="org.springframework.integration.jpa.test.entity.Student"
    entity-manager="em"/>
```

❶ This is the request channel for the outbound gateway, this is similar to the *channel* attribute of the *outbound-channel-adapter*

❷ This is where a gateway differs from an outbound adapter, this is the channel over which the reply of the performed JPA operation is received. If,however, you are not interested in the reply received and just want to perform the operation, then using a JPA *outbound-channel-adapter* is the appropriate choice. In above case, where we are using entity class, the reply will be the entity object that was created/merged as a result of the JPA operation.

Update using JPQL

In this example, we will see how we can update an entity using the Java Persistence Query Language (JPQL). For this we use an_Updating Outbound Gateway_.

```
<int-jpa:updating-outbound-gateway request-channel="jpaqlRequestChannel"
  reply-channel="jpaqlResponseChannel"
  jpa-query="update Student s set s.lastName = :lastName where s.rollNumber = :rollNumber"  ❶
  entity-manager="em">
    <int-jpa:parameter name="lastName" expression="payload"/>
    <int-jpa:parameter name="rollNumber" expression="headers['rollNumber']"/>
</int-jpa:updating-outbound-gateway>
```

❶ The JPQL query that will be executed by the gateway. Since an *Updating Outbound Gateway* is used, only *update* and *delete* JPQL queries would be sensible choices.

When sending a message with a String payload and containing a header *rollNumber* with a *long* value, the last name of the student with the provided roll number is updated to the value provided in the message payload. When using an *UPDATING* gateway, the return value is *always* an integer value which denotes the number of records affected by execution of the JPA QL.

Retrieving an Entity using JPQL

The following examples uses a *Retrieving Outbound Gateway* together with JPQL to retrieve (select) one or more entities from the database.

```
<int-jpa:retrieving-outbound-gateway request-channel="retrievingGatewayReqChannel"
    reply-channel="retrievingGatewayReplyChannel"
    jpa-query="select s from Student s where s.firstName = :firstName and s.lastName = :lastName"
    entity-manager="em">
    <int-jpa:parameter name="firstName" expression="payload"/>
    <int-jpa:parameter name="lastName" expression="headers['lastName']"/>
</int-jpa:outbound-gateway>
```

Retrieving an Entity using id-expression

The following examples uses a *Retrieving Outbound Gateway* together with `id-expression` to retrieve (find) one and only one entity from the database. The `primaryKey` is the result of `id-expression` evaluation. The `entityClass` is a class of Message `payload`.

```
<int-jpa:retrieving-outbound-gateway
 request-channel="retrievingGatewayReqChannel"
    reply-channel="retrievingGatewayReplyChannel"
    id-expression="payload.id"
    entity-manager="em"/>
```

Update using a Named Query

Using a Named Query is basically the same as using a JPQL query directly. The difference is that the *named-query* attribute is used instead, as seen in the xml snippet below.

```
<int-jpa:updating-outbound-gateway request-channel="namedQueryRequestChannel"
    reply-channel="namedQueryResponseChannel"
    named-query="updateStudentByRollNumber"
    entity-manager="em">
    <int-jpa:parameter name="lastName" expression="payload"/>
    <int-jpa:parameter name="rollNumber" expression="headers['rollNumber']"/>
</int-jpa:outbound-gateway>
```

Note

You can find a complete Sample application for using Spring Integration's JPA adapter at jpa sample.

== JMS Support

Spring Integration provides Channel Adapters for receiving and sending JMS messages. There are actually two JMS-based inbound Channel Adapters. The first uses Spring's `JmsTemplate` to receive based on a polling period. The second is "message-driven" and relies upon a Spring MessageListener container. There is also an outbound Channel Adapter which uses the `JmsTemplate` to convert and send a JMS Message on demand.

As you can see from above by using `JmsTemplate` and `MessageListener` container Spring Integration relies on Spring's JMS support. This is important to understand since most of the attributes exposed on these adapters will configure the underlying Spring's `JmsTemplate` and/or `MessageListener` container. For more details about `JmsTemplate` and `MessageListener` container please refer to Spring JMS documentation.

Whereas the JMS Channel Adapters are intended for unidirectional Messaging (send-only or receive-only), Spring Integration also provides inbound and outbound JMS Gateways for request/reply operations. The inbound gateway relies on one of Spring's `MessageListener` container implementations for Message-driven reception that is also capable of sending a return value to the `reply-to` Destination as provided by the received Message. The outbound Gateway sends a JMS Message to a `request-destination` (or `request-destination-name` or `request-destination-expression`) and then receives a reply Message. The `reply-destination` reference (or `reply-destination-name` or `reply-destination-expression`) can be configured explicitly or else the outbound gateway will use a JMS TemporaryQueue.

Prior to *Spring Integration 2.2*, if necessary, a `TemporaryQueue` was created (and removed) for each request/reply. Beginning with *Spring Integration 2.2*, the outbound gateway can be configured to use a `MessageListener` container to receive replies instead of directly using a new (or cached) `Consumer` to receive the reply for each request. When so configured, and no explicit reply destination is provided, a single `TemporaryQueue` is used for each gateway instead of one for each request.

=== Inbound Channel Adapter

The inbound Channel Adapter requires a reference to either a single `JmsTemplate` instance or both `ConnectionFactory` and `Destination` (a *destinationName* can be provided in place of the *destination* reference). The following example defines an inbound Channel Adapter with a `Destination` reference.

```
<int-jms:inbound-channel-adapter id="jmsIn" destination="inQueue" channel="exampleChannel">
    <int:poller fixed-rate="30000"/>
</int-jms:inbound-channel-adapter>
```

> **Tip**
>
> Notice from the configuration that the inbound-channel-adapter is a Polling Consumer. That means that it invokes `receive()` when triggered. This should only be used in situations where polling is done relatively infrequently and timeliness is not important. For all other situations (a vast majority of JMS-based use-cases), the *message-driven-channel-adapter* described below is a better option.

> **Note**
>
> All of the JMS adapters that require a reference to the `ConnectionFactory` will automatically look for a bean named `jmsConnectionFactory` by default. That is why you don't see a "connection-factory" attribute in many of the examples. However, if your JMS `ConnectionFactory` has a different bean name, then you will need to provide that attribute.

If `extract-payload` is set to true (which is the default), the received JMS Message will be passed through the `MessageConverter`. When relying on the default `SimpleMessageConverter`, this means that the resulting Spring Integration Message will have the JMS Message's body as its payload. A JMS `TextMessage` will produce a String-based payload, a JMS `BytesMessage` will produce a byte array payload, and a JMS `ObjectMessage` 's Serializable instance will become the Spring Integration Message's payload. If instead you prefer to have the raw JMS Message as the Spring Integration Message's payload, then set `extract-payload` to `false`.

```
<int-jms:inbound-channel-adapter id="jmsIn"
    destination="inQueue"
    channel="exampleChannel"
    extract-payload="false"/>
    <int:poller fixed-rate="30000"/>
</int-jms:inbound-channel-adapter>
```

Starting with version 5.0.8, a default value of the `receive-timeout` is `-1` (no wait) for the `org.springframework.jms.connection.CachingConnectionFactory` and `cacheConsumers`, otherwise it is 1 second.

==== Transactions

Starting with *version 4.0*, the inbound channel adapter supports the `session-transacted` attribute. In earlier versions, you had to inject a `JmsTemplate` with `sessionTransacted` set to `true`. (The adapter did allow the `acknowledge` attribute to be set to `transacted` but this was incorrect and did not work).

Note, however, that setting `session-transacted` to `true` has little value because the transaction is committed immediately after the `receive()` and before the message is sent to the `channel`.

If you want the entire flow to be transactional (for example if there is a downstream outbound channel adapter), you must use a `transactional` poller, with a `JmsTransactionManager`. Or, consider using a `jms-message-driven-channel-adapter` with `acknowledge` set to `transacted` (the default).

=== Message-Driven Channel Adapter

The "message-driven-channel-adapter" requires a reference to either an instance of a Spring MessageListener container (any subclass of `AbstractMessageListenerContainer`) or both

`ConnectionFactory` and `Destination` (a *destinationName* can be provided in place of the *destination* reference). The following example defines a message-driven Channel Adapter with a `Destination` reference.

```
<int-jms:message-driven-channel-adapter id="jmsIn" destination="inQueue" channel="exampleChannel"/>
```

Note

The Message-Driven adapter also accepts several properties that pertain to the MessageListener container. These values are only considered if you do not provide a `container` reference. In that case, an instance of DefaultMessageListenerContainer will be created and configured based on these properties. For example, you can specify the "transaction-manager" reference, the "concurrent-consumers" value, and several other property references and values. Refer to the JavaDoc and Spring Integration's JMS Schema (*spring-integration-jms.xsd*) for more details.

If you have a custom listener container implementation (usually a subclass of `DefaultMessageListenerContainer`), you can either provide a reference to an instance of it using the `container` attribute, or simply provide its fully qualified class name using the `container-class` attribute. In that case, the attributes on the adapter are transferred to an instance of your custom container.

Important

Starting with *version 4.2*, the default `acknowledge` mode is `transacted`, unless an external container is provided, in which case the container should be configured as needed. It is recommended to use `transacted` with the `DefaultMessageListenerContainer` to avoid message loss.

The *extract-payload* property has the same effect as described above, and once again its default value is *true*. The poller sub-element is not applicable for a message-driven Channel Adapter, as it will be actively invoked. For most usage scenarios, the message-driven approach is better since the Messages will be passed along to the `MessageChannel` as soon as they are received from the underlying JMS consumer.

Finally, the `<message-driven-channel-adapter>` also accepts the *error-channel* attribute. This provides the same basic functionality as described in the section called "Enter the GatewayProxyFactoryBean".

```
<int-jms:message-driven-channel-adapter id="jmsIn" destination="inQueue"
    channel="exampleChannel"
    error-channel="exampleErrorChannel"/>
```

When comparing this to the generic gateway configuration, or the JMS *inbound-gateway* that will be discussed below, the key difference here is that we are in a one-way flow since this is a *channel-adapter*, not a gateway. Therefore, the flow downstream from the *error-channel* should also be one-way. For example, it could simply send to a logging handler, or it could be connected to a different JMS `<outbound-channel-adapter>` element.

When consuming from topics, set the `pub-sub-domain` attribute to true; set `subscription-durable` to true for a durable subscription, `subscription-shared` for a shared subscription (requires a JMS 2.0 broker and has been available since *version 4.2*). Use `subscription-name` to name the subscription.

==== Inbound Conversion Errors

> **Note**
>
> Starting with *version 4.2* the *error-channel* is used for the conversion errors, too. Previously, if a JMS `<message-driven-channel-adapter/>` or `<inbound-gateway/>` could not deliver a message due to a conversion error, an exception would be thrown back to the container. If the container was configured to use transactions, the message would be rolled back and redelivered repeatedly. The conversion process occurs before and during message construction so such errors were not sent to the *error-channel*. Now such conversion exceptions result in an `ErrorMessage` being sent to the *error-channel*, with the exception as the `payload`. If you wish the transaction to be rolled back, and you have an *error-channel* defined, the integration flow on the *error-channel* must re-throw the exception (or another). If the error flow does not throw an exception, the transaction will be committed and the message removed. If no *error-channel* is defined, the exception is thrown back to the container, as before.

=== Outbound Channel Adapter

The `JmsSendingMessageHandler` implements the `MessageHandler` interface and is capable of converting Spring Integration `Messages` to JMS messages and then sending to a JMS destination. It requires either a `jmsTemplate` reference or both `jmsConnectionFactory` and `destination` references (again, the `destinationName` may be provided in place of the `destination`). As with the inbound Channel Adapter, the easiest way to configure this adapter is with the namespace support. The following configuration will produce an adapter that receives Spring Integration Messages from the "exampleChannel" and then converts those into JMS Messages and sends them to the JMS Destination reference whose bean name is "outQueue".

```
<int-jms:outbound-channel-adapter id="jmsOut" destination="outQueue" channel="exampleChannel"/>
```

As with the inbound Channel Adapters, there is an *extract-payload* property. However, the meaning is reversed for the outbound adapter. Rather than applying to the JMS Message, the boolean property applies to the Spring Integration Message payload. In other words, the decision is whether to pass the Spring Integration Message *itself* as the JMS Message body or whether to pass the Spring Integration Message's payload as the JMS Message body. The default value is once again *true*. Therefore, if you pass a Spring Integration Message whose payload is a String, a JMS TextMessage will be created. If on the other hand you want to send the actual Spring Integration Message to another system via JMS, then simply set this to *false*.

> **Note**
>
> Regardless of the boolean value for payload extraction, the Spring Integration MessageHeaders will map to JMS properties as long as you are relying on the default converter or provide a reference to another instance of HeaderMappingMessageConverter (the same holds true for *inbound* adapters except that in those cases, it's the JMS properties mapping *to* Spring Integration MessageHeaders).

==== Transactions

Starting with *version 4.0*, the outbound channel adapter supports the `session-transacted` attribute. In earlier versions, you had to inject a `JmsTemplate` with `sessionTransacted` set to `true`. The attribute now sets the property on the built-in default `JmsTemplate`. If a transaction exists (perhaps from an upstream `message-driven-channel-adapter`) the send will be performed within the same transaction. Otherwise a new transaction will be started.

=== Inbound Gateway

Spring Integration's message-driven JMS inbound-gateway delegates to a `MessageListener` container, supports dynamically adjusting concurrent consumers, and can also handle replies. The inbound gateway requires references to a `ConnectionFactory`, and a request `Destination` (or *requestDestinationName*). The following example defines a JMS "inbound-gateway" that receives from the JMS queue referenced by the bean id "inQueue" and sends to the Spring Integration channel named "exampleChannel".

```
<int-jms:inbound-gateway id="jmsInGateway"
    request-destination="inQueue"
    request-channel="exampleChannel"/>
```

Since the gateways provide request/reply behavior instead of unidirectional send *or* receive, they also have two distinct properties for the "payload extraction" (as discussed above for the Channel Adapters' *extract-payload* setting). For an inbound-gateway, the *extract-request-payload* property determines whether the received JMS Message body will be extracted. If *false*, the JMS Message itself will become the Spring Integration Message payload. The default is *true*.

Similarly, for an inbound-gateway the *extract-reply-payload* property applies to the Spring Integration Message that is going to be converted into a reply JMS Message. If you want to pass the whole Spring Integration Message (as the body of a JMS ObjectMessage) then set this to *false*. By default, it is also *true* such that the Spring Integration Message *payload* will be converted into a JMS Message (e.g. String payload becomes a JMS TextMessage).

As with anything else, Gateway invocation might result in error. By default Producer will not be notified of the errors that might have occurred on the consumer side and will time out waiting for the reply. However there might be times when you want to communicate an error condition back to the consumer, in other words treat the Exception as a valid reply by mapping it to a Message. To accomplish this JMS Inbound Gateway provides support for a Message Channel to which errors can be sent for processing, potentially resulting in a reply Message payload that conforms to some contract defining what a caller may expect as an "error" reply. Such a channel can be configured via the *error-channel* attribute.

```
<int-jms:inbound-gateway request-destination="requestQueue"
          request-channel="jmsinputchannel"
          error-channel="errorTransformationChannel"/>

<int:transformer input-channel="exceptionTransformationChannel"
        ref="exceptionTransformer" method="createErrorResponse"/>
```

You might notice that this example looks very similar to that included within the section called "Enter the GatewayProxyFactoryBean". The same idea applies here: The *exceptionTransformer* could be a simple POJO that creates error response objects, you could reference the "nullChannel" to suppress the errors, or you could leave *error-channel* out to let the Exception propagate.

> **Note**
>
> See the section called "CompletableFuture".

When consuming from topics, set the `pub-sub-domain` attribute to true; set `subscription-durable` to true for a durable subscription, `subscription-shared` for a shared subscription (requires a JMS 2.0 broker and has been available since *version 4.2*). Use `subscription-name` to name the subscription.

> **Important**
>
> Starting with *version 4.2*, the default `acknowledge` mode is `transacted`, unless an external container is provided, in which case the container should be configured as needed. It is recommended to use `transacted` with the `DefaultMessageListenerContainer` to avoid message loss.

=== Outbound Gateway

The outbound Gateway creates JMS Messages from Spring Integration Messages and then sends to a *request-destination*. It will then handle the JMS reply Message either by using a selector to receive from the *reply-destination* that you configure, or if no *reply-destination* is provided, it will create JMS `TemporaryQueue` s.

> **Warning**
>
> Using a reply-destination (or reply-destination-name), together with a `CachingConnectionFactory` with *cacheConsumers* set to *true*, can cause Out of Memory conditions. This is because each request gets a new consumer with a new selector (selecting on the correlation-key value, or on the sent JMSMessageID when there is no correlation-key). Given that these selectors are unique, they will remain in the cache unused after the current request completes.
>
> If you specify a reply destination, you are advised to NOT use cached consumers. Alternatively, consider using a `<reply-listener/>` as described below.

```
<int-jms:outbound-gateway id="jmsOutGateway"
    request-destination="outQueue"
    request-channel="outboundJmsRequests"
    reply-channel="jmsReplies"/>
```

The *outbound-gateway* payload extraction properties are inversely related to those of the *inbound-gateway* (see the discussion above). That means that the *extract-request-payload* property value applies to the Spring Integration Message that is being converted into a JMS Message to be *sent as a request*, and the *extract-reply-payload* property value applies to the JMS Message that is *received as a reply* and then converted into a Spring Integration Message to be subsequently sent to the *reply-channel* as shown in the example configuration above.

<reply-listener/>

Spring Integration 2.2 introduced an alternative technique for handling replies. If you add a `<reply-listener/>` child element to the gateway, instead of creating a consumer for each reply, a `MessageListener` container is used to receive the replies and hand them over to the requesting thread. This provides a number of performance benefits as well as alleviating the cached consumer memory utilization problem described in the caution above.

When using a `<reply-listener/>` with an outbound gateway with no `reply-destination`, instead of creating a `TemporaryQueue` for each request, a single `TemporaryQueue` is used (the gateway will create an additional `TemporaryQueue`, as necessary, if the connection to the broker is lost and recovered).

When using a `correlation-key`, multiple gateways can share the same reply destination because the listener container uses a selector that is unique to each gateway.

> **Warning**
>
> If you specify a reply listener, and specify a reply destination (or reply destination name), but provide NO correlation key, the gateway will log a warning and fall back to pre-2.2 behavior. This is because there is no way to configure a selector in this case, thus there is no way to avoid a reply going to a different gateway that might be configured with the same reply destination.
>
> Note that, in this situation, a new consumer is used for each request, and consumers can build up in memory as described in the caution above; therefore cached consumers should not be used in this case.

```
<int-jms:outbound-gateway id="jmsOutGateway"
        request-destination="outQueue"
        request-channel="outboundJmsRequests"
        reply-channel="jmsReplies">
    <int-jms:reply-listener />
</int-jms-outbound-gateway>
```

In the above example, a reply listener with default attributes is used. The listener is very lightweight and it is anticipated that, in most cases, only a single consumer will be needed. However, attributes such as *concurrent-consumers*, *max-concurrent-consumers* etc., can be added. Refer to the schema for a complete list of supported attributes, together with the Spring JMS documentation for their meanings.

Idle Reply Listeners

Starting with *version 4.2*, the reply listener can be started as needed (and stopped after an idle time) instead of running for the duration of the gateway's lifecycle. This might be useful if you have many gateways in the application context where they are mostly idle. One such situation is a context with many (inactive) partitioned Spring Batch jobs using Spring Integration and JMS for partition distribution. If all the reply listeners were active, the JMS broker would have an active consumer for each gateway. By enabling the idle timeout, each consumer would exist only while the corresponding batch job is running (and for a short time after it finishes).

See `idle-reply-listener-timeout` in the section called "CompletableFuture".

==== Gateway Reply Correlation

The following describes the mechanisms used for reply correlation (ensuring the originating gateway receives replies to only its requests), depending on how the gateway is configured. See the next section for complete description of the attributes discussed here.

1. No `reply-destination*` properties; no `<reply-listener>`

A `TemporaryQueue` is created for each request, and deleted when the request is complete (successfully or otherwise). `correlation-key` is irrelevant.

2. A `reply-destination*` property is provided; no `<reply-listener/>`; no `correlation-key`

The `JMSCorrelationID` equal to the outgoing message id is used as a message selector for the consumer:

```
messageSelector = "JMSCorrelationID = '" + messageId + "'"
```

The responding system is expected to return the inbound `JMSMessageID` in the reply `JMSCorrelationID` - this is a common pattern and is implemented by the Spring Integration inbound gateway as well as Spring's `MessageListenerAdapter` for message-driven POJOs.

> **Note**
>
> When using this configuration, you should not use a topic for replies; the reply may be lost.

3. A `reply-destination*` property is provided; no `<reply-listener/>`; `correlation-key="JMSCorrelationID"`

The gateway generates a unique correlation id and inserts it in the `JMSCorrelationID` header. The message selector is:

```
messageSelector = "JMSCorrelationID = '" + uniqueId + "'"
```

The responding system is expected to return the inbound `JMSCorrelationID` in the reply `JMSCorrelationID` - this is a common pattern and is implemented by the Spring Integration inbound gateway as well as Spring's `MessageListenerAdapter` for message-driven POJOs.

4. A `reply-destination*` property is provided; no `<reply-listener/>`; `correlation-key="myCorrelationHeader"`

The gateway generates a unique correlation id and inserts it in the `myCorrelationHeader` message property. The `correlation-key` can be any user-defined value; the message selector is:

```
messageSelector = "myCorrelationHeader = '" + uniqueId + "'"
```

The responding system is expected to return the inbound `myCorrelationHeader` in the reply `myCorrelationHeader`.

5. A `reply-destination*` property is provided; no `<reply-listener/>`; `correlation-key="JMSCorrelationID*"`

(Note the `*` in the correlation key)

The gateway uses the value in the `jms_correlationId` header (if present) from the request message, and inserts it in the `JMSCorrelationID` header. The message selector is:

```
messageSelector = "JMSCorrelationID = '" + headers['jms_correlationId'] + "'"
```

The user must ensure this value is unique.

If the header does not exist, the gateway behaves as in `3.` above.

The responding system is expected to return the inbound `JMSCorrelationID` in the reply `JMSCorrelationID` - this is a common pattern and is implemented by the Spring Integration inbound gateway as well as Spring's `MessageListenerAdapter` for message-driven POJOs.

6. No `reply-destination*` properties; with `<reply-listener>`

A temporary queue is created and used for all replies from this gateway instance. No correlation data is needed in the message but the outgoing `JMSMessageID` is used internally in the gateway to direct the reply to the correct requesting thread.

7. A `reply-destination*` property is provided; with `<reply-listener>`, no `correlation-key`

NOT ALLOWED

The `<reply-listener/>` configuration is ignored and the gateway behaves as in `2.` above. A warning log message is written indicating this situation.

8. A `reply-destination*` property is provided; with `<reply-listener>`, `correlation-key="JMSCorrelationID"`

The gateway has a unique correlation id and inserts it, together with an incrementing value in the `JMSCorrelationID` header (`gatewayId + "_" + ++seq`). The message selector is:

```
messageSelector = "JMSCorrelationID LIKE '" + gatewayId%'"
```

The responding system is expected to return the inbound `JMSCorrelationID` in the reply `JMSCorrelationID` - this is a common pattern and is implemented by the Spring Integration inbound gateway as well as Spring's `MessageListenerAdapter` for message-driven POJOs. Since each gateway has a unique id, each instance only gets its own replies; the complete correlation data is used to route the reply to the correct requesting thread.

9. A `reply-destination*` property is provided; with `<reply-listener/>`; `correlation-key="myCorrelationHeader"`

The gateway has a unique correlation id and inserts it, together with an incrementing value in the `myCorrelationHeader` property (`gatewayId + "_" + ++seq`). The `correlation-key` can be any user-defined value; and the message selector is:

```
messageSelector = "myCorrelationHeader LIKE '" + gatewayId%'"
```

The responding system is expected to return the inbound `myCorrelationHeader` in the reply `myCorrelationHeader`. Since each gateway has a unique id, each instance only gets its own replies; the complete correlation data is used to route the reply to the correct requesting thread.

10. A `reply-destination*` property is provided; with `<reply-listener/>`; `correlation-key="JMSCorrelationID*"`

(Note the `*` in the correlation key)

NOT ALLOWED

User-supplied correlation ids are not permitted with a reply listener; the gateway will not initialize with this configuration.

==== Async Gateway

Starting with *version 4.3*, you can now specify `async="true"` (or `setAsync(true)`) when configuring the outbound gateway.

By default, when a request is sent to the gateway, the requesting thread is suspended until the reply is received and the flow then continues on that thread. If `async` is true, the requesting thread is released immediately after the send completes, and the reply is returned (and the flow continues) on the listener container thread. This can be useful when the gateway is invoked on a poller thread; the thread is released and is available for other tasks within the framework.

async requires a <reply-listener/> (or setUseReplyContainer(true) when using Java configuration); it also requires a correlationKey (usually JMSCorrelationID) to be specified. If either of these conditions are not met, async is ignored.

==== Attribute Reference

```
<int-jms:outbound-gateway
    connection-factory="connectionFactory" ❶
    correlation-key="" ❷
    delivery-persistent="" ❸
    destination-resolver="" ❹
    explicit-qos-enabled="" ❺
    extract-reply-payload="true" ❻
    extract-request-payload="true" ❼
    header-mapper="" ❽
    message-converter="" ❾
    priority="" ❿
    receive-timeout="" 11
    reply-channel="" 12
    reply-destination="" 13
    reply-destination-expression="" 14
    reply-destination-name="" 15
    reply-pub-sub-domain="" 16
    reply-timeout="" 17
    request-channel="" 18
    request-destination="" 19
    request-destination-expression="" 20
    request-destination-name="" 21
    request-pub-sub-domain="" 22
    time-to-live="" 23
    requires-reply="" 24
    idle-reply-listener-timeout="" 25
    async=""> 26
  <int-jms:reply-listener /> 27
</int-jms:outbound-gateway>
```

❶ Reference to a javax.jms.ConnectionFactory; default jmsConnectionFactory.

❷ The name of a property that will contain correlation data to correlate responses with replies. If omitted, the gateway will expect the responding system to return the value of the outbound JMSMessageID header in the JMSCorrelationID header. If specified, the gateway will generate a correlation id and populate the specified property with it; the responding system must echo back that value in the same property. Can be set to JMSCorrelationID, in which case the standard header is used instead of a simple String property to hold the correlation data. When a <reply-container/> is used, the correlation-key MUST be specified if an explicit reply-destination is provided. Starting with *version 4.0.1* this attribute also supports the value JMSCorrelationID*, which means that if the outbound message already has a JMSCorrelationID (mapped from the jms_correlationId) header, it will be used, instead of generating a new one. Note, the JMSCorrelationID* key is not allowed when using a <reply-container/> because the container needs to set up a message selector during initialization.IMPORTANT: You should understand that the gateway has no means to ensure uniqueness and unexpected side effects can occur if the provided correlation id is not unique.

❸ A boolean value indicating whether the delivery mode should be DeliveryMode.PERSISTENT (true) or DeliveryMode.NON_PERSISTENT (false). This setting will only take effect if explicit-qos-enabled is true.

❹ A DestinationResolver; default is a DynamicDestinationResolver which simply maps the destination name to a queue or topic of that name.

❺ When set to true, enables the use of quality of service attributes - priority, delivery-mode, time-to-live.

❻ When set to `true` (default), the payload of the Spring Integration reply Message will be created from the JMS Reply Message's body (using the `MessageConverter`). When set to `false`, the entire JMS Message will become the payload of the Spring Integration Message.

❼ When set to `true` (default), the payload of the Spring Integration Message will be converted to a JMSMessage (using the `MessageConverter`). When set to `false`, the entire Spring Integration Message will be converted to the the JMSMessage. In both cases, the Spring Integration Message Headers are mapped to JMS headers and properties using the HeaderMapper.

❽ A `HeaderMapper` used to map Spring Integration Message Headers to/from JMS Message Headers/Properties.

❾ A reference to a `MessageConverter` for converting between JMS Messages and the Spring Integration Message payloads (or messages if `extract-request-payload` is `false`). Default is a `SimpleMessageConverter`.

❿ The default priority of request messages. Overridden by the message priority header, if present; range 0-9. This setting will only take effect if `explicit-qos-enabled` is `true`.

11 The time (in millseconds) to wait for a reply. Default 5 seconds.

12 The channel to which the reply message will be sent.

13 A reference to a `Destination` which will be set as the JMSReplyTo header. At most, only one of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is allowed. If none is provided, a `TemporaryQueue` is used for replies to this gateway.

14 A SpEL expression evaluating to a `Destination` which will be set as the JMSReplyTo header. The expression can result in a `Destination` object, or a `String`, which will be used by the `DestinationResolver` to resolve the actual `Destination`. At most, only one of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is allowed. If none is provided, a `TemporaryQueue` is used for replies to this gateway.

15 The name of the destination which will be set as the JMSReplyTo header; used by the `DestinationResolver` to resolve the actual `Destination`. At most, only one of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is allowed. If none is provided, a `TemporaryQueue` is used for replies to this gateway.

16 When set to `true`, indicates that any reply `Destination` resolved by the `DestinationResolver` should be a `Topic` rather then a `Queue`.

17 The time the gateway will wait when sending the reply message to the `reply-channel`. This only has an effect if the `reply-channel` can block - such as a `QueueChannel` with a capacity limit that is currently full. Default: infinity.

18 The channel on which this gateway receives request messages.

19 A reference to a `Destination` to which request messages will be sent. One, and only one, of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is required.

20 A SpEL expression evaluating to a `Destination` to which request messages will be sent. The expression can result in a `Destination` object, or a `String`, which will be used by the `DestinationResolver` to resolve the actual `Destination`. One, and only one, of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is required.

21 The name of the destination to which request messages will be sent; used by the `DestinationResolver` to resolve the actual `Destination`. One, and only one, of `reply-destination`, `reply-destination-expression`, or `reply-destination-name` is required.

22 When set to `true`, indicates that any request `Destination` resolved by the `DestinationResolver` should be a `Topic` rather then a `Queue`.

23 Specify the message time to live. This setting will only take effect if `explicit-qos-enabled` is `true`.

24 Specify whether this outbound gateway must return a non-null value. This value is `true` by default, and a `MessageTimeoutException` will be thrown when the underlying service does not return a value after the `receive-timeout`. Note, it is important to keep in mind that, if the service is never expected to return a reply, it would be better to use a `<int-jms:outbound-channel-adapter/>` instead of a `<int-jms:outbound-gateway/>` with `requires-reply="false"`. With the latter, the sending thread is blocked, waiting for a reply for the `receive-timeout` period.

25 When a `<reply-listener />` is used, it's lifecycle (start/stop) matches that of the gateway by default. When this value is greater than `0`, the container is started on demand (when a request is sent). The container continues to run until at least this time elapses with no requests being received (and no replies are outstanding). The container will be started again on the next request. The stop time is a minimum and may actually be up to 1.5x this value.

26 See the section called "CompletableFuture".

27 When this element is included, replies are received by an asynchronous `MessageListenerContainer` rather than creating a consumer for each reply. This can be more efficient in many cases.

=== Mapping Message Headers to/from JMS Message

JMS Message can contain meta-information such as JMS API headers as well as simple properties. You can map those to/from Spring Integration Message Headers using `JmsHeaderMapper`. The JMS API headers are passed to the appropriate setter methods (e.g. setJMSReplyTo) whereas other headers will be copied to the general properties of the JMS Message. JMS Outbound Gateway is bootstrapped with the default implementation of `JmsHeaderMapper` which will map standard JMS API Headers as well as primitive/String Message Headers. Custom header mapper could also be provided via `header-mapper` attribute of inbound and outbound gateways.

Important

Since *version 4.0*, the `JMSPriority` header is mapped to the standard `priority` header for inbound messages (previously, the `priority` header was only used for outbound messages). To revert to the previous behavior (do not map inbound priority), use the `mapInboundPriority` property of `DefaultJmsHeaderMapper` with argument set to `false`.

Important

Since *version 4.3*, the `DefaultJmsHeaderMapper` now maps the standard `correlationId` header as a message property by invoking its `toString()` method (`correlationId` is often a `UUID`, which is not a type that is supported by JMS). On the inbound side, it is mapped as a `String`. This is independent of the `jms_correlationId` header which is mapped to/from the `JMSCorrelationID` header. The `JMSCorrelationID` is generally used to correlate requests and replies whereas the `correlationId` is often used to combine related messages into a group (such as with an aggregator or resequencer).

=== Message Conversion, Marshalling and Unmarshalling

If you need to convert the message, all JMS adapters and gateways, allow you to provide a `MessageConverter` via *message-converter* attribute. Simply provide the bean name of an instance of `MessageConverter` that is available within the same ApplicationContext. Also, to provide some consistency with Marshaller and Unmarshaller interfaces Spring provides `MarshallingMessageConverter` which you can configure with your own custom Marshallers and Unmarshallers

```
<int-jms:inbound-gateway request-destination="requestQueue"
    request-channel="inbound-gateway-channel"
    message-converter="marshallingMessageConverter"/>

<bean id="marshallingMessageConverter"
    class="org.springframework.jms.support.converter.MarshallingMessageConverter">
    <constructor-arg>
        <bean class="org.bar.SampleMarshaller"/>
    </constructor-arg>
    <constructor-arg>
        <bean class="org.bar.SampleUnmarshaller"/>
    </constructor-arg>
</bean>
```

Note

Note, however, that when you provide your own MessageConverter instance, it will still be wrapped within the HeaderMappingMessageConverter. This means that the *extract-request-payload* and *extract-reply-payload* properties may affect what actual objects are passed to your converter. The HeaderMappingMessageConverter itself simply delegates to a target MessageConverter while also mapping the Spring Integration MessageHeaders to JMS Message properties and vice-versa.

=== JMS Backed Message Channels

The Channel Adapters and Gateways featured above are all intended for applications that are integrating with other external systems. The inbound options assume that some other system is sending JMS Messages to the JMS Destination and the outbound options assume that some other system is receiving from the Destination. The other system may or may not be a Spring Integration application. Of course, when sending the Spring Integration Message instance as the body of the JMS Message itself (with the *extract-payload* value set to false), it is assumed that the other system is based on Spring Integration. However, that is by no means a requirement. That flexibility is one of the benefits of using a Message-based integration option with the abstraction of "channels" or Destinations in the case of JMS.

There are cases where both the producer and consumer for a given JMS Destination are intended to be part of the same application, running within the same process. This could be accomplished by using a pair of inbound and outbound Channel Adapters. The problem with that approach is that two adapters are required even though conceptually the goal is to have a single Message Channel. A better option is supported as of Spring Integration version 2.0. Now it is possible to define a single "channel" when using the JMS namespace.

```
<int-jms:channel id="jmsChannel" queue="exampleQueue"/>
```

The channel in the above example will behave much like a normal <channel/> element from the main Spring Integration namespace. It can be referenced by both "input-channel" and "output-channel" attributes of any endpoint. The difference is that this channel is backed by a JMS Queue instance named "exampleQueue". This means that asynchronous messaging is possible between the producing and consuming endpoints, but unlike the simpler asynchronous Message Channels created by adding a <queue/> sub-element within a non-JMS <channel/> element, the Messages are not just stored in an in-memory queue. Instead those Messages are passed within a JMS Message body, and the full power of the underlying JMS provider is then available for that channel. Probably the most common rationale for using this alternative would be to take advantage of the persistence made available by the *store and forward* approach of JMS messaging. If configured properly, the JMS-backed Message Channel also supports transactions. In other words, a producer would not actually write to a transactional JMS-backed channel if its send operation is part of a transaction that rolls back. Likewise, a consumer would not physically remove a JMS Message from the channel if the reception of that Message is part of a transaction that rolls back. Note that the producer and consumer transactions are separate in such a scenario. This is significantly different than the propagation of a transactional context across the simple, synchronous <channel/> element that has no <queue/> sub-element.

Since the example above is referencing a JMS Queue instance, it will act as a point-to-point channel. If on the other hand, publish/subscribe behavior is needed, then a separate element can be used, and a JMS Topic can be referenced instead.

```
<int-jms:publish-subscribe-channel id="jmsChannel" topic="exampleTopic"/>
```

For either type of JMS-backed channel, the name of the destination may be provided instead of a reference.

```
<int-jms:channel id="jmsQueueChannel" queue-name="exampleQueueName"/>

<jms:publish-subscribe-channel id="jmsTopicChannel" topic-name="exampleTopicName"/>
```

In the examples above, the Destination names would be resolved by Spring's default `DynamicDestinationResolver` implementation, but any implementation of the `DestinationResolver` interface could be provided. Also, the JMS `ConnectionFactory` is a required property of the channel, but by default the expected bean name would be `jmsConnectionFactory`. The example below provides both a custom instance for resolution of the JMS Destination names and a different name for the ConnectionFactory.

```
<int-jms:channel id="jmsChannel" queue-name="exampleQueueName"
    destination-resolver="customDestinationResolver"
    connection-factory="customConnectionFactory"/>
```

For the `<publish-subscribe-channel />`; set the `durable` attribute to true for a durable subscription, `subscription-shared` for a shared subscription (requires a JMS 2.0 broker and has been available since *version 4.2*). Use `subscription` to name the subscription.

=== Using JMS Message Selectors

With JMS message selectors you can filter JMS Messages based on JMS headers as well as JMS properties. For example, if you want to listen to messages whose custom JMS header property *fooHeaderProperty* equals *bar*, you can specify the following expression:

```
fooHeaderProperty = 'bar'
```

Message selector expressions are a subset of the SQL-92 conditional expression syntax, and are defined as part of the *Java Message Service* specification (Version 1.1 April 12, 2002). Specifically, please see chapter "3.8 Message Selection". It contains a detailed explanation of the expressions syntax.

You can specify the JMS message *selector* attribute using XML Namespace configuration for the following Spring Integration JMS components:

- JMS Channel
- JMS Publish Subscribe Channel
- JMS Inbound Channel Adapter

- JMS Inbound Gateway
- JMS Message-driven Channel Adapter

Important

It is important to remember that you cannot reference message body values using JMS Message selectors.

=== JMS Samples

To experiment with these JMS adapters, check out the JMS samples available in the *Spring Integration Samples* Git repository:

- https://github.com/SpringSource/spring-integration-samples/tree/master/basic/jms

There are two samples included. One provides *Inbound* and *Outbound Channel Adapters*, and the other provides *Inbound* and *Outbound Gateways*. They are configured to run with an embedded_http://activemq.apache.org/[ActiveMQ]_ process, but the samples' *common.xml* *Spring Application Context* file can easily be modified to support either a different JMS provider or a standalone *ActiveMQ* process.

In other words, you can split the configuration, so that the Inbound and Outbound Adapters are running in separate JVMs. If you have *ActiveMQ* installed, simply modify the *brokerURL* property within the *common.xml* file to use *tcp://localhost:61616* (instead of *vm://localhost*). Both of the samples accept input via stdin and then echo back to stdout. Look at the configuration to see how these messages are routed over JMS.

== Mail Support

=== Mail-Sending Channel Adapter

Spring Integration provides support for outbound email with the `MailSendingMessageHandler`. It delegates to a configured instance of Spring's `JavaMailSender`:

```
JavaMailSender mailSender = context.getBean("mailSender", JavaMailSender.class);

MailSendingMessageHandler mailSendingHandler = new MailSendingMessageHandler(mailSender);
```

`MailSendingMessageHandler` has various mapping strategies that use Spring's `MailMessage` abstraction. If the received Message's payload is already a `MailMessage` instance, it will be sent directly. Therefore, it is generally recommended to precede this consumer with a Transformer for non-trivial `MailMessage` construction requirements. However, a few simple Message mapping strategies are supported out-of-the-box. For example, if the message payload is a byte array, then that will be mapped to an attachment. For simple text-based emails, you can provide a String-based Message payload. In that case, a MailMessage will be created with that String as the text content. If you are working with a Message payload type whose `toString()` method returns appropriate mail text content, then consider adding Spring Integration's *ObjectToStringTransformer* prior to the outbound Mail adapter (see the example within the section called "Configuring Transformer with XML" for more detail).

The outbound MailMessage may also be configured with certain values from the `MessageHeaders`. If available, values will be mapped to the outbound mail's properties, such as the recipients (TO, CC, and BCC), the from/reply-to, and the subject. The header names are defined by the following constants:

```
MailHeaders.SUBJECT
MailHeaders.TO
MailHeaders.CC
MailHeaders.BCC
MailHeaders.FROM
MailHeaders.REPLY_TO
```

Note

`MailHeaders` also allows you to override corresponding `MailMessage` values. For example: If `MailMessage.to` is set to *foo@bar.com* and `MailHeaders.TO` Message header is provided it will take precedence and override the corresponding value in `MailMessage`.

=== Mail-Receiving Channel Adapter

Spring Integration also provides support for inbound email with the `MailReceivingMessageSource`. It delegates to a configured instance of Spring Integration's own `MailReceiver` interface, and there are two implementations: `Pop3MailReceiver` and `ImapMailReceiver`. The easiest way to instantiate either of these is by passing the *uri* for a Mail store to the receiver's constructor. For example:

```
MailReceiver receiver = new Pop3MailReceiver("pop3://usr:pwd@localhost/INBOX");
```

Another option for receiving mail is the IMAP "idle" command (if supported by the mail server you are using). Spring Integration provides the `ImapIdleChannelAdapter` which is itself a Message-producing endpoint. It delegates to an instance of the `ImapMailReceiver` but enables asynchronous reception of Mail Messages. There are examples in the next section of configuring both types of inbound Channel Adapter with Spring Integration's namespace support in the *mail* schema.

Normally, when `IMAPMessage.getContent()` method is called, certain headers as well as the body are rendered (for a simple text email):

```
To: foo@bar
From: bar@baz
Subject: Test Email

foo
```

With a simple `MimeMessage`, `getContent()` just returns the mail body (`foo` in this case).

Starting with *version 2.2*, the framework eagerly fetches IMAP messages and exposes them as an internal subclass of `MimeMessage`. This had the undesired side effect of changing the `getContent()` behavior. This inconsistency was further exacerbated by the Mail Mapping enhancement in *version 4.3* in that, when a header mapper was provided, the payload was rendered by the `IMAPMessage.getContent()` method. This meant that IMAP content differed depending on whether or not a header mapper was provided. Starting with *version 5.0*, messages originating from an IMAP source will now render the content in accordance with `IMAPMessage.getContent()` behavior, regardless of whether a header mapper is provided. If you are not using a header mapper, and you wish to revert to the previous behavior of just rendering the body, set the `simpleContent` boolean property on the mail receiver to `true`. This property now controls the rendering regardless of whether a header mapper is used; it now allows the simple body-only rendering when a header mapper is provided.

=== Inbound Mail Message Mapping

By default, the payload of messages produced by the inbound adapters is the raw `MimeMessage`; you can interrogate the headers and content using that object. Starting with *version 4.3*, you can provide a `HeaderMapper<MimeMessage>` to map the headers to `MessageHeaders`; for convenience, a `DefaultMailHeaderMapper` is provided for this purpose. This maps the following headers:

- `mail_from` - A String representation of the `from` address.
- `mail_bcc` - A String array containing the `bcc` addresses.
- `mail_cc` - A String array containing the `cc` addresses.
- `mail_to` - A String array containing the `to` addresses.
- `mail_replyTo` - A String representation of the `replyTo` address.
- `mail_subject` - The mail subject.
- `mail_lineCount` - A line count (if available).
- `mail_receivedDate` - The received date (if available).
- `mail_size` - The mail size (if available).
- `mail_expunged` - A boolean indicating if the message is expunged.
- `mail_raw` - A `MultiValueMap` containing all the mail headers and their values.
- `mail_contentType` - The content type of the original mail message.
- `contentType` - The payload content type (see below).

When message mapping is enabled, the payload depends on the mail message and its implementation. Email contents are usually rendered by a `DataHandler` within the `MimeMessage`.

- For a simple `text/*` email, the payload will be a String and the `contentType` header will be the same as `mail_contentType`.
- For a messages with embedded `javax.mail.Part` s, the `DataHandler` usually renders a `Part` object - these objects are not `Serializable`, and are not suitable for serialization using alternative technologies such as `Kryo`. For this reason, by default, when mapping is enabled, such payloads are rendered as a raw `byte[]` containing the `Part` data. Examples of `Part` are `Message` and `Multipart`. The `contentType` header is `application/octet-stream` in this case. To change this behavior, and receive a `Multipart` object payload, set `embeddedPartsAsBytes` to `false` on the `MailReceiver`. For content types that are unknown to the `DataHandler`, the contents are rendered as a `byte[]` with a `contentType` header of `application/octet-stream`.

When you do not provide a header mapper, the message payload is the `MimeMessage` presented by `javax.mail`. The framework provides a `MailToStringTransformer` which can be used to convert the message using a simple strategy to convert the mail contents to a String. This is also available using the XML namespace:

```
<int-mail:mail-to-string-transformer ... >
```

and with Java configuration:

```
@Bean
@Transformer(inputChannel="...", outputChannel="...")
public Transformer transformer() {
    return new MailToStringTransformer();
}
```

and with the Java DSL:

```
...
.transform(Mail.toStringTransformer())
...
```

Starting with *version 4.3*, the transformer will handle embedded `Part` as well as `Multipart` which was handled previously. The transformer is a subclass of `AbstractMailTransformer` which maps the address and subject headers from the list above. If you wish to perform some other transformation on the message, consider subclassing `AbstractMailTransformer`.

=== Mail Namespace Support

Spring Integration provides a namespace for mail-related configuration. To use it, configure the following schema locations.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int-mail="http://www.springframework.org/schema/integration/mail"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration/mail
    https://www.springframework.org/schema/integration/mail/spring-integration-mail.xsd">
```

To configure an outbound Channel Adapter, provide the channel to receive from, and the MailSender:

```
<int-mail:outbound-channel-adapter channel="outboundMail"
    mail-sender="mailSender"/>
```

Alternatively, provide the host, username, and password:

```
<int-mail:outbound-channel-adapter channel="outboundMail"
    host="somehost" username="someuser" password="somepassword"/>
```

Note

Keep in mind, as with any outbound Channel Adapter, if the referenced channel is a `PollableChannel`, a `<poller>` sub-element should be provided (see the section called “Endpoint Namespace Support”).

When using the namespace support, a *header-enricher* Message Transformer is also available. This simplifies the application of the headers mentioned above to any Message prior to sending to the Mail Outbound Channel Adapter.

```
<int-mail:header-enricher input-channel="expressionsInput" default-overwrite="false">
 <int-mail:to expression="payload.to"/>
 <int-mail:cc expression="payload.cc"/>
 <int-mail:bcc expression="payload.bcc"/>
 <int-mail:from expression="payload.from"/>
 <int-mail:reply-to expression="payload.replyTo"/>
 <int-mail:subject expression="payload.subject" overwrite="true"/>
</int-mail:header-enricher>
```

This example assumes the payload is a JavaBean with appropriate getters for the specified properties, but any SpEL expression can be used. Alternatively, use the `value` attribute to specify a literal. Notice also that you can specify `default-overwrite` and individual `overwrite` attributes to control the behavior with existing headers.

To configure an Inbound Channel Adapter, you have the choice between polling or event-driven (assuming your mail server supports IMAP IDLE - if not, then polling is the only option). A polling Channel Adapter simply requires the store URI and the channel to send inbound Messages to. The URI may begin with "pop3" or "imap":

```
<int-mail:inbound-channel-adapter id="imapAdapter"
      store-uri="imaps://[username]:[password]@imap.gmail.com/INBOX"
      java-mail-properties="javaMailProperties"
      channel="receiveChannel"
      should-delete-messages="true"
      should-mark-messages-as-read="true"
      auto-startup="true">
      <int:poller max-messages-per-poll="1" fixed-rate="5000"/>
</int-mail:inbound-channel-adapter>
```

If you do have IMAP idle support, then you may want to configure the "imap-idle-channel-adapter" element instead. Since the "idle" command enables event-driven notifications, no poller is necessary for this adapter. It will send a Message to the specified channel as soon as it receives the notification that new mail is available:

```
<int-mail:imap-idle-channel-adapter id="customAdapter"
      store-uri="imaps://[username]:[password]@imap.gmail.com/INBOX"
      channel="receiveChannel"
      auto-startup="true"
      should-delete-messages="false"
      should-mark-messages-as-read="true"
      java-mail-properties="javaMailProperties"/>
```

...where *javaMailProperties* could be provided by creating and populating a regular `java.utils.Properties` object. For example via *util* namespace provided by Spring.

Important

If your username contains the @ character use *%40* instead of @ to avoid parsing errors from the underlying JavaMail API.

```
<util:properties id="javaMailProperties">
  <prop key="mail.imap.socketFactory.class">javax.net.ssl.SSLSocketFactory</prop>
  <prop key="mail.imap.socketFactory.fallback">false</prop>
  <prop key="mail.store.protocol">imaps</prop>
  <prop key="mail.debug">false</prop>
</util:properties>
```

By default, the `ImapMailReceiver` will search for Messages based on the default `SearchTerm` which is *All mails that are RECENT (if supported), that are NOT ANSWERED, that are NOT DELETED, that are NOT SEEN and have not been processed by this mail receiver (enabled by the use of the custom USER flag or simply NOT FLAGGED if not supported)*. The custom user flag is `spring-integration-mail-adapter` but can be configured. Since version 2.2, the `SearchTerm` used by the `ImapMailReceiver` is fully configurable via the `SearchTermStrategy` which you can inject via the `search-term-strategy` attribute. `SearchTermStrategy` is a simple strategy interface with a single method that allows you to create an instance of the `SearchTerm` that will be used by the `ImapMailReceiver`.

See the section called “CompletableFuture” regarding message flagging.

```
public interface SearchTermStrategy {

    SearchTerm generateSearchTerm(Flags supportedFlags, Folder folder);

}
```

For example:

```
<mail:imap-idle-channel-adapter id="customAdapter"
   store-uri="imap:foo"
   …
   search-term-strategy="searchTermStrategy"/>

<bean id="searchTermStrategy"
  class="o.s.i.mail.config.ImapIdleChannelAdapterParserTests.TestSearchTermStrategy"/>
```

In the above example instead of relying on the default `SearchTermStrategy` the `TestSearchTermStrategy` will be used instead

> **Important: IMAP PEEK**
>
> Starting with *version 4.1.1*, the IMAP mail receiver will use the `mail.imap.peek` or `mail.imaps.peek` javamail property, if specified. Previously, the receiver ignored the property and always set the PEEK flag. Now, if you explicitly set this property to `false`, the message will be marked as `\Seen` regardless of the setting of `shouldMarkMessagesRead`. If not specified, the previous behavior is retained (peek is `true`).

IMAP IDLE and lost connection

When using IMAP IDLE channel adapter there might be situations where connection to the server may be lost (e.g., network failure) and since Java Mail documentation explicitly states that the actual IMAP API is EXPERIMENTAL it is important to understand the differences in the API and how to deal with them when configuring IMAP IDLE adapters. Currently Spring Integration Mail adapters was tested with Java Mail 1.4.1 and Java Mail 1.4.3 and depending on which one is used special attention must be payed to some of the java mail properties that needs to be set with regard to auto-reconnect.

> **Note**
>
> The following behavior was observed with GMAIL but should provide you with some tips on how to solve re-connect issue with other providers, however feedback is always welcome. Again, below notes are based on GMAIL.

With Java Mail 1.4.1 if `mail.imaps.timeout` property is set for a relatively short period of time (e.g., ~ 5 min) then `IMAPFolder.idle()` will throw `FolderClosedException` after this timeout. However if this property is not set (should be indefinite) the behavior that was observed is that `IMAPFolder.idle()` method never returns nor it throws an exception. It will however reconnect automatically if connection was lost for a short period of time (e.g., under 10 min), but if connection was lost for a long period of time (e.g., over 10 min), then `IMAPFolder.idle()` will not throw `FolderClosedException` nor it will re-establish connection and will remain in the blocked state indefinitely, thus leaving you no possibility to reconnect without restarting the adapter. So the only way to make re-connect to work with Java Mail 1.4.1 is to set `mail.imaps.timeout` property explicitly to some value, but it also means that such value should be relatively short (under 10 min) and the connection should be re-established relatively quickly. Again, it may be different with other providers. With Java Mail 1.4.3 there was significant improvements to the API ensuring that there will always be a condition which will force `IMAPFolder.idle()` method to return via `StoreClosedException` or `FolderClosedException` or simply return, thus allowing us to proceed with auto-reconnect. Currently auto-reconnect will run infinitely making attempts to reconnect every 10 sec.

> **Important**
>
> In both configurations `channel` and `should-delete-messages` are the *REQUIRED* attributes. The important thing to understand is why `should-delete-messages` is required. The issue is with the POP3 protocol, which does NOT have any knowledge of messages that were READ. It can only know what's been read within a single session. This means that when your POP3 mail adapter is running, emails are successfully consumed as as they become available during each poll and no single email message will be delivered more then once. However, as soon as you restart your adapter and begin a new session all the email messages that might have been retrieved in the previous session will be retrieved again. That is the nature of POP3. Some might argue that `should-delete-messages` should be TRUE by default. In other words, there are two valid and mutually exclusive use cases which make it very hard to pick a single "best" default. You may want to configure your adapter as the only email receiver in which case you want to be able to restart such adapter without fear that messages that were delivered before will not be redelivered again. In this case setting `should-delete-messages` to TRUE would make most sense. However, you may have another use case where you may want to have multiple adapters that simply monitor email servers and their content. In other words you just want to *peek but not touch*. Then setting `should-delete-messages` to FALSE would be much more appropriate. So since it is hard to choose what should be the right default value for the `should-delete-messages` attribute, we simply made it a required attribute, to be set by the user. Leaving it up to the user also means, you will be less likely to end up with unintended behavior.

> **Note**
>
> When configuring a polling email adapter's *should-mark-messages-as-read* attribute, be aware of the protocol you are configuring to retrieve messages. For example POP3 does not support this flag which means setting it to either value will have no effect as messages will NOT be marked as read.

> **Important**
>
> It is important to understand that that these actions (marking messages read, and deleting messages) are performed after the messages are received, but before they are processed. This can cause messages to be lost.
>
> You may wish to consider using transaction synchronization instead - see the section called “CompletableFuture”

The `<imap-idle-channel-adapter/>` also accepts the *error-channel* attribute. If a downstream exception is thrown and an *error-channel* is specified, a MessagingException message containing the failed message and original exception, will be sent to this channel. Otherwise, if the downstream channels are synchronous, any such exception will simply be logged as a warning by the channel adapter.

> **Note**
>
> Beginning with the 3.0 release, the IMAP idle adapter emits application events (specifically `ImapIdleExceptionEvent` s) when exceptions occur. This allows applications to detect and act on those exceptions. The events can be obtained using an `<int-event:inbound-channel-adapter>` or any `ApplicationListener` configured to receive an `ImapIdleExceptionEvent` or one of its super classes.

=== Marking IMAP Messages When \Recent is Not Supported

If `shouldMarkMessagesAsRead` is true, the IMAP adapters set the `\Seen` flag.

In addition, when an email server does not support the `\Recent` flag, the IMAP adapters mark messages with a user flag (`spring-integration-mail-adapter` by default) as long as the server supports user flags. If not, `Flag.FLAGGED` is set to `true`. These flags are applied regardless of the `shouldMarkMessagesRead` setting.

As discussed in the section called “CompletableFuture”, the default `SearchTermStrategy` will ignore messages so flagged.

Starting with *version 4.2.2*, the name of the user flag can be set using `setUserFlag` on the `MailReceiver` - this allows multiple receivers to use a different flag (as long as the mail server supports user flags). The attribute `user-flag` is available when configuring the adapter with the namespace.

=== Email Message Filtering

Very often you may encounter a requirement to filter incoming messages (e.g., You want to only read emails that have *Spring Integration* in the *Subject* line). This could be easily accomplished by connecting Inbound Mail adapter with an expression-based *Filter*. Although it would work, there is a downside to this approach. Since messages would be filtered after going through inbound mail adapter all such messages would be marked as read (SEEN) or Un-read (depending on the value of `should-mark-messages-as-read` attribute). However in reality what would be more useful is to mark messages as SEEN only if they passed the filtering criteria. This is very similar to looking at your email client while scrolling through all the messages in the preview pane, but only flagging messages as SEEN that were actually opened and read.

In Spring Integration 2.0.4 we've introduced `mail-filter-expression` attribute on `inbound-channel-adapter` and `imap-idle-channel-adapter`. This attribute allows you to provide an expression which is a combination of SpEL and Regular Expression. For example if you would like to read only emails that contain *Spring Integration* in the Subject line, you would configure `mail-filter-expression` attribute like this this: `mail-filter-expression="subject matches '(?i).*Spring Integration.*"`

Since `javax.mail.internet.MimeMessage` is the root context of SpEL Evaluation Context, you can filter on any value available through MimeMessage including the actual body of the message. This one is particularly important since reading the body of the message would typically result in such message to be marked as SEEN by default, but since we now setting PEAK flag of every incomming message to *true*, only messages that were explicitly marked as SEEN will be seen as read.

So in the below example only messages that match the filter expression will be output by this adapter and only those messages will be marked as SEEN. In this case based on the `mail-filter-expression` only messages that contain *Spring Integration* in the subject line will be produced by this adapter.

```
<int-mail:imap-idle-channel-adapter id="customAdapter"
 store-uri="imaps://some_google_address:${password}@imap.gmail.com/INBOX"
 channel="receiveChannel"
 should-mark-messages-as-read="true"
 java-mail-properties="javaMailProperties"
 mail-filter-expression="subject matches '(?i).*Spring Integration.*'"/>
```

Another reasonable question is what happens on the next poll, or idle event, or what happens when such adapter is restarted. Will there be a potential duplication of massages to be filtered? In other words if on the last retrieval where you had 5 new messages and only 1 passed the filter what would happen with the other 4. Would they go through the filtering logic again on the next poll or idle? After all they were not marked as SEEN. The actual answer is no. They would not be subject of duplicate processing due to another flag (RECENT) that is set by the Email server and is used by Spring Integration mail search filter. Folder implementations set this flag to indicate that this message is new to this folder, that is, it has arrived since the last time this folder was opened. In other while our adapter may peek at the email it also lets the email server know that such email was touched and therefore will be marked as RECENT by the email server.

=== Transaction Synchronization

Transaction synchronization for inbound adapters allows you to take different actions after a transaction commits, or rolls back. Transaction synchronization is enabled by adding a `<transactional/>` element to the poller for the polled `<inbound-adapter/>`, or to the `<imap-idle-inbound-adapter/>`. Even if there is no *real* transaction involved, you can still enable this feature by using a `PseudoTransactionManager` with the `<transactional/>` element. For more information, see the section called “CompletableFuture”.

Because of the many different mail servers, and specifically the limitations that some have, at this time we only provide a strategy for these transaction synchronizations. You can send the messages to some other Spring Integration components, or invoke a custom bean to perform some action. For example, to move an IMAP message to a different folder after the transaction commits, you might use something similar to the following:

```
<int-mail:imap-idle-channel-adapter id="customAdapter"
    store-uri="imaps://foo.com:password@imap.foo.com/INBOX"
    channel="receiveChannel"
    auto-startup="true"
    should-delete-messages="false"
    java-mail-properties="javaMailProperties">
    <int:transactional synchronization-factory="syncFactory"/>
</int-mail:imap-idle-channel-adapter>

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-commit expression="@syncProcessor.process(payload)"/>
</int:transaction-synchronization-factory>

<bean id="syncProcessor" class="foo.bar.Mover"/>
```

```
public class Mover {

    public void process(MimeMessage message) throws Exception{
        Folder folder = message.getFolder();
        folder.open(Folder.READ_WRITE);
        String messageId = message.getMessageID();
        Message[] messages = folder.getMessages();
        FetchProfile contentsProfile = new FetchProfile();
        contentsProfile.add(FetchProfile.Item.ENVELOPE);
        contentsProfile.add(FetchProfile.Item.CONTENT_INFO);
        contentsProfile.add(FetchProfile.Item.FLAGS);
        folder.fetch(messages, contentsProfile);
        // find this message and mark for deletion
        for (int i = 0; i < messages.length; i++) {
            if (((MimeMessage) messages[i]).getMessageID().equals(messageId)) {
                messages[i].setFlag(Flags.Flag.DELETED, true);
                break;
            }
        }

        Folder fooFolder = store.getFolder("FOO"));
        fooFolder.appendMessages(new MimeMessage[]{message});
        folder.expunge();
        folder.close(true);
        fooFolder.close(false);
    }
}
```

Important

For the message to be still available for manipulation after the transaction, *should-delete-messages* must be set to *false*.

== MongoDb Support

As of version 2.1 Spring Integration introduces support for MongoDB: a *"high-performance, open source, document-oriented database"*. This support comes in the form of a MongoDB-based MessageStore.

=== Introduction

To download, install, and run MongoDB please refer to the MongoDB documentation.

=== Connecting to MongoDb

To begin interacting with MongoDB you first need to connect to it. Spring Integration builds on the support provided by another Spring project, Spring Data MongoDB, which provides a factory class called `MongoDbFactory` that simplifies integration with the MongoDB Client API.

MongoDbFactory

To connect to MongoDB you can use an implementation of the `MongoDbFactory` interface:

```
public interface MongoDbFactory {

    /**
     * Creates a default {@link DB} instance.
     *
     * @return the DB instance
     * @throws DataAccessException
     */
    DB getDb() throws DataAccessException;

    /**
     * Creates a {@link DB} instance to access the database with the given name.
     *
     * @param dbName must not be {@literal null} or empty.
     *
     * @return the DB instance
     * @throws DataAccessException
     */
    DB getDb(String dbName) throws DataAccessException;
}
```

The example below shows `SimpleMongoDbFactory`, the out-of-the-box implementation:

In Java:

```
MongoDbFactory mongoDbFactory = new SimpleMongoDbFactory(new Mongo(), "test");
```

Or in Spring's XML configuration:

```
<bean id="mongoDbFactory" class="o.s.data.mongodb.core.SimpleMongoDbFactory">
    <constructor-arg>
        <bean class="com.mongodb.Mongo"/>
    </constructor-arg>
    <constructor-arg value="test"/>
</bean>
```

As you can see `SimpleMongoDbFactory` takes two arguments: 1) a `Mongo` instance and 2) a String specifying the name of the database. If you need to configure properties such as `host`, `port`, etc, you can pass those using one of the constructors provided by the underlying `Mongo` class. For more information on how to configure MongoDB, please refer to the Spring-Data-MongoDB reference.

=== MongoDB Message Store

As described in EIP, a Message Store allows you to persist Messages. This can be very useful when dealing with components that have a capability to buffer messages (*QueueChannel, Aggregator, Resequencer*, etc.) if reliability is a concern. In Spring Integration, the `MessageStore` strategy also provides the foundation for the ClaimCheck pattern, which is described in EIP as well.

Spring Integration's MongoDB module provides the `MongoDbMessageStore` which is an implementation of both the `MessageStore` strategy (mainly used by the *ClaimCheck* pattern) and the `MessageGroupStore` strategy (mainly used by the *Aggregator* and *Resequencer* patterns).

```
<bean id="mongoDbMessageStore" class="o.s.i.mongodb.store.MongoDbMessageStore">
    <constructor-arg ref="mongoDbFactory"/>
</bean>

<int:channel id="somePersistentQueueChannel">
    <int:queue message-store="mongoDbMessageStore"/>
<int:channel>

<int:aggregator input-channel="inputChannel" output-channel="outputChannel"
         message-store="mongoDbMessageStore"/>
```

Above is a sample `MongoDbMessageStore` configuration that shows its usage by a *QueueChannel* and an *Aggregator*. As you can see it is a simple bean configuration, and it expects a `MongoDbFactory` as a constructor argument.

The `MongoDbMessageStore` expands the `Message` as a Mongo document with all nested properties using the Spring Data Mongo Mapping mechanism. It is useful when you need to have access to the `payload` or `headers` for auditing or analytics, for example, against stored messages.

> **Important**
>
> The `MongoDbMessageStore` uses a custom `MappingMongoConverter` implementation to store `Message` s as MongoDB documents and there are some limitations for the properties (`payload` and `header` values) of the `Message`. For example, there is no ability to configure custom converters for complex domain `payload` s or `header` values. Or to provide a custom `MongoTemplate` (or `MappingMongoConverter`). To achieve these capabilities, an alternative MongoDB `MessageStore` implementation has been introduced; see next paragraph.

Spring Integration 3.0 introduced the `ConfigurableMongoDbMessageStore` - `MessageStore` and `MessageGroupStore` implementation. This class can receive, as a constructor argument, a `MongoTemplate`, with which you can configure with a custom `WriteConcern`, for example. Another constructor requires a `MappingMongoConverter`, and a `MongoDbFactory`, which allows you to provide some custom conversions for `Message` s and their properties. Note, by default, the `ConfigurableMongoDbMessageStore` uses standard Java serialization to write/ read `Message` s to/from MongoDB (see `MongoDbMessageBytesConverter`) and relies on default values for other properties from `MongoTemplate`, which is built from the provided `MongoDbFactory` and `MappingMongoConverter`. The default name for the collection stored by the `ConfigurableMongoDbMessageStore` is `configurableStoreMessages`. It is recommended to use this implementation for robust and flexible solutions when messages contain complex data types.

==== MongoDB Channel Message Store

Starting with *version 4.0*, the new `MongoDbChannelMessageStore` has been introduced; it is an optimized `MessageGroupStore` for use in `QueueChannel` s. With `priorityEnabled = true`, it can be used in `<int:priority-queue>` s to achieve *priority* order polling for persisted messages. The *priority* MongoDB document field is populated from the `IntegrationMessageHeaderAccessor.PRIORITY` (`priority`) message header.

In addition, all MongoDB `MessageStore` s now have a `sequence` field for MessageGroup documents. The `sequence` value is the result of an `$inc` operation for a simple `sequence` document from the same collection, which is created on demand. The `sequence` field is used in `poll` operations to provide first-in-first-out (FIFO) message order (within priority if configured) when messages are stored within the same millisecond.

> **Note**
>
> It is not recommended to use the same `MongoDbChannelMessageStore` bean for priority and non-priority, because the `priorityEnabled` option applies to the entire store. However, the same `collection` can be used for both `MongoDbChannelMessageStore` types, because message polling from the store is sorted and uses indexes. To configure that scenario, simply extend one message store bean from the other:

```
<bean id="channelStore" class="o.s.i.mongodb.store.MongoDbChannelMessageStore">
    <constructor-arg name="mongoDbFactory" ref="mongoDbFactory"/>
</bean>

<int:channel id="queueChannel">
    <int:queue message-store="store"/>
</int:channel>

<bean id="priorityStore" parent="channelStore">
    <property name="priorityEnabled" value="true"/>
</bean>

<int:channel id="priorityChannel">
    <int:priority-queue message-store="priorityStore"/>
</int:channel>
```

==== MongoDB Metadata Store

As of *Spring Integration 4.2*, a new MongoDB-based `MetadataStore` (the section called “CompletableFuture”) implementation is available. The `MongoDbMetadataStore` can be used to maintain metadata state across application restarts. This new `MetadataStore` implementation can be used with adapters such as:

- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”
- the section called “CompletableFuture”

In order to instruct these adapters to use the new `MongoDbMetadataStore`, simply declare a Spring bean using the bean name **metadataStore**. The *Twitter Inbound Channel Adapter* and the *Feed Inbound Channel Adapter* will both automatically pick up and use the declared `MongoDbMetadataStore`:

```
@Bean
public MetadataStore metadataStore(MongoDbFactory factory) {
    return new MongoDbMetadataStore(factory, "integrationMetadataStore");
}
```

The `MongoDbMetadataStore` also implements `ConcurrentMetadataStore`, allowing it to be reliably shared across multiple application instances where only one instance will be allowed to store or modify a key’s value. All these operations are *atomic* via MongoDB guarantees.

=== MongoDB Inbound Channel Adapter

The *MongoDb Inbound Channel Adapter* is a polling consumer that reads data from MongoDb and sends it as a Message payload.

```
<int-mongodb:inbound-channel-adapter id="mongoInboundAdapter"
       channel="replyChannel"
       query="{'name' : 'Bob'}"
       entity-class="java.lang.Object"
       auto-startup="false">
  <int:poller fixed-rate="100"/>
</int-mongodb:inbound-channel-adapter>
```

As you can see from the configuration above, you configure a *MongoDb Inbound Channel Adapter* using the `inbound-channel-adapter` element, providing values for various attributes such as:

- `query`: A JSON query (see MongoDB Querying)
- `query-expression`: A SpEL expression that is evaluated to a JSON query string (as the `query` attribute above) or to an instance of `o.s.data.mongodb.core.query.Query`. Mutually exclusive with the `query` attribute.
- `entity-class`: The type of the payload object. If not supplied, a `com.mongodb.DBObject` is returned.
- `collection-name` or `collection-name-expression`: Identifies the name of the MongoDB collection to use.
- `mongodb-factory`: Reference to an instance of `o.s.data.mongodb.MongoDbFactory`
- `mongo-template`: Reference to an instance of `o.s.data.mongodb.core.MongoTemplate`
- Other attributes that are common across all other inbound adapters (such as *channel*).

```
and other attributes that are common across all other inbound adapters (e.g., 'channel').
```

Note

You cannot set both `mongo-template` and `mongodb-factory`.

The example above is relatively simple and static since it has a literal value for the `query` and uses the default name for a `collection`. Sometimes you may need to change those values at runtime, based on some condition. To do that, simply use their `-expression` equivalents (`query-expression` and `collection-name-expression`) where the provided expression can be any valid SpEL expression.

Also, you may wish to do some post-processing to the successfully processed data that was read from the MongoDb. For example; you may want to move or remove a document after its been processed. You can do this using Transaction Synchronization feature that was added with Spring Integration 2.2.

```
<int-mongodb:inbound-channel-adapter id="mongoInboundAdapter"
    channel="replyChannel"
    query-expression="new BasicQuery('{''name'' : ''Bob''}').limit(100)"
    entity-class="java.lang.Object"
    auto-startup="false">
        <int:poller fixed-rate="200" max-messages-per-poll="1">
            <int:transactional synchronization-factory="syncFactory"/>
        </int:poller>
</int-mongodb:inbound-channel-adapter>

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-commit
        expression="@documentCleaner.remove(#mongoTemplate, payload, headers.mongo_collectionName)"
        channe="someChannel"/>
</int:transaction-synchronization-factory>

<bean id="documentCleaner" class="foo.bar.DocumentCleaner"/>

<bean id="transactionManager" class="o.s.i.transaction.PseudoTransactionManager"/>
```

```
public class DocumentCleaner {
    public void remove(MongoOperations mongoOperations, Object target, String collectionName) {
        if (target instanceof List<?>){
            List<?> documents = (List<?>) target;
            for (Object document : documents) {
                mongoOperations.remove(new BasicQuery(JSON.serialize(document)), collectionName);
            }
        }
    }
}
```

As you can see from the above, all you need to do is declare your poller to be transactional with a `transactional` element. This element can reference a real transaction manager (for example if some other part of your flow invokes JDBC). If you don't have a *real* transaction, you can use a `org.springframework.integration.transaction.PseudoTransactionManager` which is an implementation of Spring's `PlatformTransactionManager` and enables the use of the transaction synchronization features of the mongo adapter when there is no actual transaction.

> **Important**
>
> This does NOT make MongoDB itself transactional, it simply allows the synchronization of actions to be taken before/after success (commit) or after failure (rollback).

Once your poller is transactional all you need to do is set an instance of the `o.s.i.transaction.TransactionSynchronizationFactory` on the `transactional` element. `TransactionSynchronizationFactory` will create an instance of the `TransactionSynchronization`. For your convenience, we've exposed a default SpEL-based `TransactionSynchronizationFactory` which allows you to configure SpEL expressions, with their execution being coordinated (synchronized) with a transaction. Expressions for before-commit, after-commit, and after-rollback are supported, together with a channel for each where the evaluation result (if any) will be sent. For each sub-element you can specify `expression` and/or `channel` attributes. If only the `channel` attribute is present the received Message will be sent there as part of the particular synchronization scenario. If only the `expression` attribute is present and the result of an expression is a non-Null value, a Message with the result as the payload will be generated and sent to a default channel (NullChannel) and will appear in the logs (DEBUG). If you want the evaluation result to go to a specific channel add a `channel` attribute. If the result of an expression is null or void, no Message will be generated.

For more information about transaction synchronization, see the section called “CompletableFuture”.

=== MongoDB Outbound Channel Adapter

The *MongoDb Outbound Channel Adapter* allows you to write the Message payload to a MongoDb document store

```
<int-mongodb:outbound-channel-adapter id="fullConfigWithCollectionExpression"
 collection-name="myCollection"
 mongo-converter="mongoConverter"
 mongodb-factory="mongoDbFactory" />
```

As you can see from the configuration above, you configure a *MongoDb Outbound Channel Adapter* using the `outbound-channel-adapter` element, providing values for various attributes such as:

- `collection-name` or `collection-name-expression` - Identifies the name of the MongoDb collection to use.

- `mongo-converter` - reference to an instance of `o.s.data.mongodb.core.convert.MongoConverter` to assist with converting a raw java object to a JSON document representation
- `mongodb-factory` - reference to an instance of `o.s.data.mongodb.MongoDbFactory`
- `mongo-template` - reference to an instance of `o.s.data.mongodb.core.MongoTemplate` (NOTE: you can not have both mongo-template and mongodb-factory set)

and other attributes that are common across all other inbound adapters (e.g., *channel*).

The example above is relatively simple and static since it has a literal value for the `collection-name`. Sometimes you may need to change this value at runtime based on some condition. To do that, simply use `collection-name-expression` where the provided expression can be any valid SpEL expression.

=== MongoDB Outbound Gateway

Starting with *version 5.0*, the MongoDb Outbound Gateway is provided and it allows you to query a database by sending a Message to its request channel. The gateway will then send the response to the reply channel. The Message payload and headers can be used to specify the query, as well as collection name.

```
<int-mongodb:outbound-gateway id="gatewayQuery"
    mongodb-factory="mongoDbFactory"
    mongo-converter="mongoConverter"
    query="{firstName: 'Bob'}"
    collection-name="foo"
    request-channel="in"
    reply-channel="out"
    entity-class="org.springframework.integration.mongodb.test.entity$Person"/>
```

- `collection-name` or `collection-name-expression` - identifies the name of the MongoDb collection to use;
- `mongo-converter` - reference to an instance of `o.s.data.mongodb.core.convert.MongoConverter` to assist with converting a raw java object to a JSON document representation
- `mongodb-factory` - reference to an instance of `o.s.data.mongodb.MongoDbFactory`
- `mongo-template` - reference to an instance of `o.s.data.mongodb.core.MongoTemplate` (NOTE: you can not have both mongo-template and mongodb-factory set)
- `entity-class` - the fully qualified name of the entity class to be passed to `find(..)` or `findOne(..)` method in MongoTemplate. If this attribute is not provided the default value is `org.bson.Document`;
- `query` or `query-expression` - specifies the MongoDb query. Please refer to [MongoDB documentation]() for more query samples.
- `collection-callback` - reference to an instance of `org.springframework.data.mongodb.core.CollectionCallback` (NOTE: you can not have both collection-callback and any of the query attributes).
- `collection-name` or `collection-name-expression`: Identifies the name of the MongoDB collection to use.

- `mongo-converter`: Reference to an instance of `o.s.data.mongodb.core.convert.MongoConverter` that assists with converting a raw Java object to a JSON document representation.
- `mongodb-factory`: Reference to an instance of `o.s.data.mongodb.MongoDbFactory`.
- `mongo-template`: Reference to an instance of `o.s.data.mongodb.core.MongoTemplate`. NOTE: you can not set both `mongo-template` and `mongodb-factory`.
- `entity-class`: The fully qualified name of the entity class to be passed to the `find(..)` and `findOne(..)` methods in MongoTemplate. If this attribute is not provided, the default value is `org.bson.Document`.
- `query` or `query-expression`: Specifies the MongoDB query. See the MongoDB documentation for more query samples.
- `collection-callback`: Reference to an instance of `org.springframework.data.mongodb.core.CollectionCallback`. Preferable an instance of `org.springframework.integration.mongodb.outbound.MessageCollectionCallback` since 5.0.11 with the request message context. See its Javadocs for more information. NOTE: You can not have both `collection-callback` and any of the query attributes.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the outbound gateway using Java configuration:

```
@SpringBootApplication
public class MongoDbJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(MongoDbJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private MongoDbFactory mongoDbFactory;

    @Bean
    @ServiceActivator(inputChannel = "requestChannel")
    public MessageHandler mongoDbOutboundGateway() {
        MongoDbOutboundGateway gateway = new MongoDbOutboundGateway(this.mongoDbFactory);
        gateway.setCollectionNameExpressionString("'foo'");
        gateway.setQueryExpressionString("'{''name'' : ''Bob''}'");
        gateway.setExpectSingleResult(true);
        gateway.setEntityClass(Person.class);
        gateway.setOutputChannelName("replyChannel");
        return gateway;
    }

    @Bean
    @ServiceActivator(inputChannel = "replyChannel")
    public MessageHandler handler() {
        return message -> System.out.println(message.getPayload());
    }
}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Outbound Gateway using the Java DSL:

```
@SpringBootApplication
public class MongoDbJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(MongoDbJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Autowired
    private MongoDbFactory;

    @Autowired
    private MongoConverter;


    @Bean
    public IntegrationFlow gatewaySingleQueryFlow() {
        return f -> f
                .handle(queryOutboundGateway())
                .channel(c -> c.queue("retrieveResults"));
    }

    private MongoDbOutboundGatewaySpec queryOutboundGateway() {
        return MongoDb.outboundGateway(this.mongoDbFactory, this.mongoConverter)
                .query("{name : 'Bob'}")
                .collectionNameFunction(m -> m.getHeaders().get("collection"))
                .expectSingleResult(true)
                .entityClass(Person.class);
    }

}
```

As an alternate to the `query` and `query-expression` properties, you can specify other database operations by using the `collectionCallback` property as a reference to the `MessageCollectionCallback` functional interface implementation. The following example specifies a count operation:

```
private MongoDbOutboundGatewaySpec collectionCallbackOutboundGateway() {
    return MongoDb.outboundGateway(this.mongoDbFactory, this.mongoConverter)
            .collectionCallback((collection, requestMessage) -> collection.count())
            .collectionName("foo");
    }
```

== MQTT Support

=== Introduction

Spring Integration provides inbound and outbound channel adapters supporting the MQ Telemetry Transport (MQTT) protocol. The current implementation uses the Eclipse Paho MQTT Client library.

Configuration of both adapters is achieved using the `DefaultMqttPahoClientFactory`. Refer to the Paho documentation for more information about configuration options.

> **Note**
>
> It is preferred to configure an `MqttConnectOptions` object and inject it into the factory, instead of setting the (deprecated) options on the factory itself.

=== Inbound (message-driven) Channel Adapter

The inbound channel adapter is implemented by the `MqttPahoMessageDrivenChannelAdapter`. For convenience, it can be configured using the namespace. A minimal configuration might be:

```
<bean id="clientFactory"
        class="org.springframework.integration.mqtt.core.DefaultMqttPahoClientFactory">
    <property name="connectionOptions">
        <bean class="org.eclipse.paho.client.mqttv3.MqttConnectOptions">
            <property name="userName" value="${mqtt.username}"/>
            <property name="password" value="${mqtt.password}"/>
        </bean>
    </property>
</bean>

<int-mqtt:message-driven-channel-adapter id="mqttInbound"
    client-id="${mqtt.default.client.id}.src"
    url="${mqtt.url}"
    topics="sometopic"
    client-factory="clientFactory"
    channel="output"/>
```

Attributes:

```
<int-mqtt:message-driven-channel-adapter id="oneTopicAdapter"
    client-id="foo"  ❶
    url="tcp://localhost:1883"  ❷
    topics="bar,baz"  ❸
    qos="1,2"  ❹
    converter="myConverter"  ❺
    client-factory="clientFactory"  ❻
    send-timeout="123"  ❼
    error-channel="errors"  ❽
    recovery-interval="10000"  ❾
    channel="out" />
```

❶ The client id.

❷ The broker URL.

❸ A comma delimited list of topics from which this adapter will receive messages.

❹ A comma delimited list of QoS values. Can be a single value that is applied to all topics, or a value for each topic (in which case the lists must the same length).

❺ An `MqttMessageConverter` (optional). The default `DefaultPahoMessageConverter` produces a message with a `String` payload (by default) with the following headers:
`mqtt_topic` - the topic from which the message was received
`mqtt_duplicate` - true if the message is a duplicate
`mqtt_qos` - the quality of service
The `DefaultPahoMessageConverter` can be configured to return the raw `byte[]` in the payload by declaring it as a `<bean/>` and setting the `payloadAsBytes` property.

❻ The client factory.

❼ The send timeout - only applies if the channel might block (such as a bounded `QueueChannel` that is currently full).

❽ The error channel - downstream exceptions will be sent to this channel, if supplied, in an `ErrorMessage`; the payload is a `MessagingException` containing the failed message and cause.

❾ The recovery interval - controls the interval at which the adapter will attempt to reconnect after a failure; it defaults to `10000ms` (ten seconds).

> **Note**
>
> Starting with *version 4.1* the url can be omitted and, instead, the server URIs can be provided in the `serverURIs` property of the `DefaultMqttPahoClientFactory`. This enables, for example, connection to a highly available (HA) cluster.

Starting with *version 4.2.2*, an `MqttSubscribedEvent` is published when the adapter successfully subscribes to the topic(s). `MqttConnectionFailedEvent` s are published when the connection/ subscription fails. These events can be received by a bean that implements `ApplicationListener`.

Also, a new property `recoveryInterval` controls the interval at which the adapter will attempt to reconnect after a failure; it defaults to `10000ms` (ten seconds).

Prior to *version 4.2.3*, the client always unsubscribed when the adapter was stopped. This was incorrect because if the client QOS is > 0, we need to keep the subscription active so that messages arriving while the adapter is stopped will be delivered on the next start. This also requires setting the `cleanSession` property on the client factory to `false` - it defaults to `true`.

Starting with *version 4.2.3*, the adapter will not unsubscribe (by default) if the `cleanSession` property is `false`.

This behavior can be overridden by setting the `consumerCloseAction` property on the factory. It can have values: `UNSUBSCRIBE_ALWAYS`, `UNSUBSCRIBE_NEVER`, and `UNSUBSCRIBE_CLEAN`. The latter (the default) will unsubscribe only if the `cleanSession` property is `true`.

To revert to the pre-4.2.3 behavior, use `UNSUBSCRIBE_ALWAYS`.

Starting with *version 5.0*, the `topic`, `qos` and `retained` properties are mapped to `.RECEIVED_...` headers (`MqttHeaders.RECEIVED_TOPIC`, `MqttHeaders.RECEIVED_QOS`, and `MqttHeaders.RECEIVED_RETAINED`), to avoid inadvertent propagation to an outbound message which (by default) uses the `MqttHeaders.TOPIC`, `MqttHeaders.QOS`, and `MqttHeaders.RETAINED` headers.

==== Adding/Removing Topics at Runtime

Starting with *version 4.1*, it is possible to programmatically change the topics to which the adapter is subscribed. Methods `addTopic()` and `removeTopic()` are provided. When adding topics, you can optionally specify the `QoS` (default: 1). You can also modify the topics by sending an appropriate message to a `<control-bus/>` with an appropriate payload: `"myMqttAdapter.addTopic('foo', 1)"`.

Stopping/starting the adapter has no effect on the topic list (it does **not** revert to the original settings in the configuration). The changes are not retained beyond the life cycle of the application context; a new application context will revert to the configured settings.

Changing the topics while the adapter is stopped (or disconnected from the broker) will take effect the next time a connection is established.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class MqttJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(MqttJavaApplication.class)
                .web(false)
                .run(args);
    }

    @Bean
    public MessageChannel mqttInputChannel() {
        return new DirectChannel();
    }

    @Bean
    public MessageProducer inbound() {
        MqttPahoMessageDrivenChannelAdapter adapter =
                new MqttPahoMessageDrivenChannelAdapter("tcp://localhost:1883", "testClient",
                                                 "topic1", "topic2");
        adapter.setCompletionTimeout(5000);
        adapter.setConverter(new DefaultPahoMessageConverter());
        adapter.setQos(1);
        adapter.setOutputChannel(mqttInputChannel());
        return adapter;
    }

    @Bean
    @ServiceActivator(inputChannel = "mqttInputChannel")
    public MessageHandler handler() {
        return new MessageHandler() {

            @Override
            public void handleMessage(Message<?> message) throws MessagingException {
                System.out.println(message.getPayload());
            }

        };
    }

}
```

=== Outbound Channel Adapter

The outbound channel adapter is implemented by the `MqttPahoMessageHandler` which is wrapped in a `ConsumerEndpoint`. For convenience, it can be configured using the namespace.

Starting with *version 4.1*, the adapter supports asynchronous sends, avoiding blocking until the delivery is confirmed; application events can be emitted to enable applications to confirm delivery if desired.

Attributes:

```
<int-mqtt:outbound-channel-adapter id="withConverter"
    client-id="foo"  ❶
    url="tcp://localhost:1883"  ❷
    converter="myConverter"  ❸
    client-factory="clientFactory"  ❹
    default-qos="1"  ❺
    qos-expression="" ❻
    default-retained="true"  ❼
    retained-expression="" ❽
    default-topic="bar"  ❾
    topic-expression="" ❿
    async="false"  11
    async-events="false"  12
    channel="target" />
```

❶ The client id.

❷ The broker URL.

❸ An `MqttMessageConverter` (optional). The default `DefaultPahoMessageConverter` recognizes the following headers:
`mqtt_topic` - the topic to which the message will be sent
`mqtt_retained` - true if the message is to be retained
`mqtt_qos` - the quality of service

❹ The client factory.

❺ The default quality of service (used if no `mqtt_qos` header is found or the `qos-expression` returns `null`. Not used if a custom `converter` is supplied.

❻ An expression to evaluate to determine the qos; default `headers[mqtt_qos]`.

❼ The default value of the retained flag (used if no `mqtt_retained` header is found). Not used if a custom `converter` is supplied.

❽ An expression to evaluate to determine the retained boolean; default `headers[mqtt_retained]`.

❾ The default topic to which the message will be sent (used if no `mqtt_topic` header is found).

❿ An expression to evaluate to determine the destination topic; default `headers['topic']`.

11 When `true`, the caller will not block waiting for delivery confirmation when a message is sent. Default:false (the send blocks until delivery is confirmed).

12 When `async` and `async-events` are both `true`, an `MqttMessageSentEvent` is emitted, containing the message, the topic, the `messageId` generated by the client library, the `clientId` and the `clientInstance` (incremented each time the client is connected). When the delivery is confirmed by the client library, an `MqttMessageDeliveredEvent` is emitted, containing the the `messageId`, `clientId` and the `clientInstance`, enabling delivery to be correlated with the send. These events can be received by any `ApplicationListener`, or by an event inbound channel adapter. Note that it is possible that the `MqttMessageDeliveredEvent` might be received before the `MqttMessageSentEvent`. Default: `false`.

> **Note**
>
> Starting with *version 4.1* the url can be omitted and, instead, the server URIs can be provided in the `serverURIs` property of the `DefaultMqttPahoClientFactory`. This enables, for example, connection to a highly available (HA) cluster.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the outbound adapter using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class MqttJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
                new SpringApplicationBuilder(MqttJavaApplication.class)
                        .web(false)
                        .run(args);
        MyGateway gateway = context.getBean(MyGateway.class);
        gateway.sendToMqtt("foo");
    }

    @Bean
    public MqttPahoClientFactory mqttClientFactory() {
        DefaultMqttPahoClientFactory factory = new DefaultMqttPahoClientFactory();
        MqttConnectOptions options = new MqttConnectOptions();
        options.setServerURIs(new String[] { "tcp://host1:1883", "tcp://host2:1883" });
        options.setUserName("username");
        options.setPassword("password".toCharArray());
        factory.setConnectionOptions(options);
        return factory;
    }

    @Bean
    @ServiceActivator(inputChannel = "mqttOutboundChannel")
    public MessageHandler mqttOutbound() {
        MqttPahoMessageHandler messageHandler =
                       new MqttPahoMessageHandler("testClient", mqttClientFactory());
        messageHandler.setAsync(true);
        messageHandler.setDefaultTopic("testTopic");
        return messageHandler;
    }

    @Bean
    public MessageChannel mqttOutboundChannel() {
        return new DirectChannel();
    }

    @MessagingGateway(defaultRequestChannel = "mqttOutboundChannel")
    public interface MyGateway {

        void sendToMqtt(String data);

    }

}
```

== Redis Support

Since version 2.1 Spring Integration introduces support for Redis: _"an open source advanced key-value store". _ This support comes in the form of a Redis-based MessageStore as well as Publish-Subscribe Messaging adapters that are supported by Redis via its PUBLISH, SUBSCRIBE and UNSUBSCRIBE commands.

=== Introduction

To download, install and run Redis please refer to the Redis documentation.

=== Connecting to Redis

To begin interacting with Redis you first need to connect to it. Spring Integration uses support provided by another Spring project, Spring Data Redis, which provides typical Spring constructs: `ConnectionFactory` and `Template`. Those abstractions simplify integration with several Redis-client Java APIs. Currently Spring-Data-Redis supportshttps://github.com/xetorthio/jedis[jedis], jredis and rjc

RedisConnectionFactory

To connect to Redis you would use one of the implementations of the `RedisConnectionFactory` interface:

```
public interface RedisConnectionFactory extends PersistenceExceptionTranslator {

    /**
     * Provides a suitable connection for interacting with Redis.
     *
     * @return connection for interacting with Redis.
     */
    RedisConnection getConnection();
}
```

The example below shows how to create a `JedisConnectionFactory`.

In Java:

```
JedisConnectionFactory jcf = new JedisConnectionFactory();
jcf.afterPropertiesSet();
```

Or in Spring's XML configuration:

```
<bean id="redisConnectionFactory"
    class="o.s.data.redis.connection.jedis.JedisConnectionFactory">
    <property name="port" value="7379" />
</bean>
```

The implementations of RedisConnectionFactory provide a set of properties such as port and host that can be set if needed. Once an instance of RedisConnectionFactory is created, you can create an instance of RedisTemplate and inject it with the RedisConnectionFactory.

RedisTemplate

As with other template classes in Spring (e.g., `JdbcTemplate`, `JmsTemplate`) `RedisTemplate` is a helper class that simplifies Redis data access code. For more information about `RedisTemplate` and its variations (e.g., `StringRedisTemplate`) please refer to the Spring-Data-Redis documentation

The code below shows how to create an instance of `RedisTemplate`:

In Java:

```
RedisTemplate rt = new RedisTemplate<String, Object>();
rt.setConnectionFactory(redisConnectionFactory);
```

Or in Spring's XML configuration

```
<bean id="redisTemplate" class="org.springframework.data.redis.core.RedisTemplate">
    <property name="connectionFactory" ref="redisConnectionFactory"/>
</bean>
```

=== Messaging with Redis

As mentioned in the introduction Redis provides support for Publish-Subscribe messaging via its PUBLISH, SUBSCRIBE and UNSUBSCRIBE commands. As with JMS and AMQP, Spring Integration provides Message Channels and adapters for sending and receiving messages via Redis.

==== Redis Publish/Subscribe channel

Similar to the JMS there are cases where both the producer and consumer are intended to be part of the same application, running within the same process. This could be accomplished by using a pair of inbound and outbound Channel Adapters, however just like with Spring Integration's JMS support, there is a simpler approach to address this use case.

```
<int-redis:publish-subscribe-channel id="redisChannel" topic-name="si.test.topic"/>
```

The publish-subscribe-channel (above) will behave much like a normal `<publish-subscribe-channel/>` element from the main Spring Integration namespace. It can be referenced by both `input-channel` and `output-channel` attributes of any endpoint. The difference is that this channel is backed by a Redis topic name - a String value specified by the `topic-name` attribute. However unlike JMS this topic doesn't have to be created in advance or even auto-created by Redis. In Redis topics are simple String values that play the role of an address, and all the producer and consumer need to do to communicate is use the same String value as their topic name. A simple subscription to this channel means that asynchronous pub-sub messaging is possible between the producing and consuming endpoints, but unlike the asynchronous Message Channels created by adding a `<queue/>` sub-element within a simple Spring Integration `<channel/>` element, the Messages are not just stored in an in-memory queue. Instead those Messages are passed through Redis allowing you to rely on its support for persistence and clustering as well as its interoperability with other non-java platforms.

==== Redis Inbound Channel Adapter

The Redis-based Inbound Channel Adapter (`RedisInboundChannelAdapter`) adapts incoming Redis messages into Spring Messages in the same way as other inbound adapters. It receives platform-specific messages (Redis in this case) and converts them to Spring Messages using a `MessageConverter` strategy.

```
<int-redis:inbound-channel-adapter id="redisAdapter"
       topics="foo, bar"
       channel="receiveChannel"
       error-channel="testErrorChannel"
       message-converter="testConverter" />

<bean id="redisConnectionFactory"
    class="o.s.data.redis.connection.jedis.JedisConnectionFactory">
    <property name="port" value="7379" />
</bean>

<bean id="testConverter" class="foo.bar.SampleMessageConverter" />
```

Above is a simple but complete configuration of a Redis Inbound Channel Adapter. Note that the above configuration relies on the familiar Spring paradigm of auto-discovering certain beans. In this case the `redisConnectionFactory` is implicitly injected into the adapter. You can of course specify it explicitly using the `connection-factory` attribute instead.

Also, note that the above configuration injects the adapter with a custom `MessageConverter`. The approach is similar to JMS where `MessageConverters` are used to convert between Redis Messages and the Spring Integration Message payloads. The default is a `SimpleMessageConverter`.

Inbound adapters can subscribe to multiple topic names hence the comma-delimited set of values in the `topics` attribute.

Since *version 3.0*, the Inbound Adapter, in addition to the existing `topics` attribute, now has the `topic-patterns` attribute. This attribute contains a comma-delimited set of Redis topic patterns. For more information regarding Redis publish/subscribe, see Redis Pub/Sub.

Inbound adapters can use a `RedisSerializer` to deserialize the body of Redis Messages. The `serializer` attribute of the `<int-redis:inbound-channel-adapter>` can be set to an empty string, which results in a `null` value for the `RedisSerializer` property. In this case the raw `byte[]` bodies of Redis Messages are provided as the message payloads.

Since *version 5.0*, an `Executor` instance can be provided to the Inbound Adapter via the `task-executor` attribute of the `<int-redis:inbound-channel-adapter>`. Also the received Spring Integration Messages have now `RedisHeaders.MESSAGE_SOURCE` header to indicate the source of the published message - topic or pattern. This can be used downstream for routing logic.

==== Redis Outbound Channel Adapter

The Redis-based Outbound Channel Adapter adapts outgoing Spring Integration messages into Redis messages in the same way as other outbound adapters. It receives Spring Integration messages and converts them to platform-specific messages (Redis in this case) using a `MessageConverter` strategy.

```
<int-redis:outbound-channel-adapter id="outboundAdapter"
    channel="sendChannel"
    topic="foo"
    message-converter="testConverter"/>

<bean id="redisConnectionFactory"
    class="o.s.data.redis.connection.jedis.JedisConnectionFactory">
    <property name="port" value="7379"/>
</bean>

<bean id="testConverter" class="foo.bar.SampleMessageConverter" />
```

As you can see the configuration is similar to the Redis Inbound Channel Adapter. The adapter is implicitly injected with a `RedisConnectionFactory` which was defined with `redisConnectionFactory` as its bean name. This example also includes the optional, custom `MessageConverter` (the `testConverter` bean).

Since *Spring Integration 3.0*, the `<int-redis:outbound-channel-adapter>`, as an alternative to the `topic` attribute, has the `topic-expression` attribute to determine the Redis topic against the Message at runtime. These attributes are mutually exclusive.

==== Redis Queue Inbound Channel Adapter

Since *Spring Integration 3.0*, a Queue Inbound Channel Adapter is available to *pop* messages from a Redis List. By default it uses *right pop*, but it can be configured to use *left pop* instead. The adapter is message-driven using an internal listener thread and does not use a poller.

```
<int-redis:queue-inbound-channel-adapter id=""  ❶
                    channel=""  ❷
                    auto-startup=""  ❸
                    phase=""  ❹
                    connection-factory=""  ❺
                    queue=""  ❻
                    error-channel=""  ❼
                    serializer=""  ❽
                    receive-timeout=""  ❾
                    recovery-interval=""  ❿
                    expect-message=""  11
                    task-executor=""  12
                    right-pop=""/>  13
```

❶ The component bean name. If the `channel` attribute isn't provided a `DirectChannel` is created and registered with application context with this `id` attribute as the bean name. In this case, the endpoint itself is registered with the bean name `id + '.adapter'`.

❷ The `MessageChannel` to which to send `Message` s from this Endpoint.

❸ A `SmartLifecycle` attribute to specify whether this Endpoint should start automatically after the application context start or not. Default is `true`.

❹ A `SmartLifecycle` attribute to specify the *phase* in which this Endpoint will be started. Default is `0`.

❺ A reference to a `RedisConnectionFactory` bean. Defaults to `redisConnectionFactory`.

❻ The name of the Redis List on which the queue-based *pop* operation is performed to get Redis messages.

❼ The `MessageChannel` to which to send `ErrorMessage` s with `Exception` s from the listening task of the Endpoint. By default the underlying `MessagePublishingErrorHandler` uses the default `errorChannel` from the application context.

❽ The `RedisSerializer` bean reference. Can be an empty string, which means *no serializer*. In this case the raw `byte[]` from the inbound Redis message is sent to the `channel` as the `Message` payload. By default it is a `JdkSerializationRedisSerializer`.

❾ The timeout in milliseconds for *pop* operation to wait for a Redis message from the queue. Default is 1 second.

❿ The time in milliseconds for which the listener task should sleep after exceptions on the *pop* operation, before restarting the listener task.

11 Specify if this Endpoint expects data from the Redis queue to contain entire `Message` s. If this attribute is set to `true`, the `serializer` can't be an empty string because messages require some form of deserialization (JDK serialization by default). Default is `false`.

12 A reference to a Spring `TaskExecutor` (or standard JDK 1.5+ `Executor`) bean. It is used for the underlying listening task. By default a `SimpleAsyncTaskExecutor` is used.

13 Specify whether this Endpoint should use *right pop* (when `true`) or *left pop* (when `false`) to read messages from the Redis List. If `true`, the Redis List acts as a `FIFO` queue when used with a default *Redis Queue Outbound Channel Adapter*. Set to `false` to use with software that writes to the list with *right push*, or to achieve a stack-like message order. Default is `true`. Since *version 4.3*.

==== Redis Queue Outbound Channel Adapter

Since *Spring Integration 3.0*, a Queue Outbound Channel Adapter is available to *push* to a Redis List from Spring Integration messages. By default, it uses *left push*, but it can be configured to use *right push* instead.

```
<int-redis:queue-outbound-channel-adapter id=""  ❶
                        channel=""  ❷
                        connection-factory=""  ❸
                        queue=""  ❹
                        queue-expression=""  ❺
                        serializer=""  ❻
                        extract-payload=""  ❼
                        left-push=""/>  ❽
```

❶ The component bean name. If the `channel` attribute isn't provided, a `DirectChannel` is created and registered with the application context with this `id` attribute as the bean name. In this case, the endpoint is registered with the bean name `id + '.adapter'`.

❷ The `MessageChannel` from which this Endpoint receives `Message` s.

❸ A reference to a `RedisConnectionFactory` bean. Defaults to `redisConnectionFactory`.

❹ The name of the Redis List on which the queue-based *push* operation is performed to send Redis messages. This attribute is mutually exclusive with `queue-expression`.

❺ A SpEL `Expression` to determine the name of the Redis List using the incoming `Message` at runtime as the `#root` variable. This attribute is mutually exclusive with `queue`.

❻ A `RedisSerializer` bean reference. By default it is a `JdkSerializationRedisSerializer`. However, for `String` payloads, a `StringRedisSerializer` is used, if a `serializer` reference isn't provided.

❼ Specify if this Endpoint should send just the *payload* to the Redis queue, or the entire `Message`. Default is `true`.

❽ Specify whether this Endpoint should use *left push* (when `true`) or *right push* (when `false`) to write messages to the Redis List. If `true`, the Redis List acts as a `FIFO` queue when used with a default *Redis Queue Inbound Channel Adapter*. Set to `false` to use with software that reads from the list with *left pop*, or to achieve a stack-like message order. Default is `true`. Since *version 4.3*.

==== Redis Application Events

Since *Spring Integration 3.0*, the Redis module provides an implementation of `IntegrationEvent` - which, in turn, is a `org.springframework.context.ApplicationEvent`. The `RedisExceptionEvent` encapsulates an `Exception` s from Redis operations (with the Endpoint being the `source` of the event). For example, the `<int-redis:queue-inbound-channel-adapter/>` emits those events after catching `Exception` s from the `BoundListOperations.rightPop` operation. The exception may be any generic `org.springframework.data.redis.RedisSystemException` or a `org.springframework.data.redis.RedisConnectionFailureException`. Handling these events using an `<int-event:inbound-channel-adapter/>` can be useful to determine problems with background Redis tasks and to take administrative actions.

=== Redis Message Store

As described in EIP, a Message Store allows you to persist Messages. This can be very useful when dealing with components that have a capability to buffer messages (*Aggregator, Resequencer*, etc.) if reliability is a concern. In Spring Integration, the MessageStore strategy also provides the foundation for the ClaimCheck pattern, which is described in EIP as well.

Spring Integration's Redis module provides the `RedisMessageStore`.

```
<bean id="redisMessageStore" class="o.s.i.redis.store.RedisMessageStore">
    <constructor-arg ref="redisConnectionFactory"/>
</bean>

<int:aggregator input-channel="inputChannel" output-channel="outputChannel"
         message-store="redisMessageStore"/>
```

Above is a sample `RedisMessageStore` configuration that shows its usage by an *Aggregator*. As you can see it is a simple bean configuration, and it expects a `RedisConnectionFactory` as a constructor argument.

By default the `RedisMessageStore` will use Java serialization to serialize the Message. However if you want to use a different serialization technique (e.g., JSON), you can provide your own serializer via the `valueSerializer` property of the `RedisMessageStore`.

Starting with *version 4.3.10*, the Framework provides Jackson Serializer and Deserializer implementations for `Message` s and `MessageHeaders` - `MessageHeadersJacksonSerializer` and `MessageJacksonDeserializer`, respectively. They have to be configured via the

SimpleModule options for the ObjectMapper. In addition, enableDefaultTyping should be configured on the ObjectMapper to add type information for each serialized complex object. That type information is then used during deserialization. The Framework provides a utility method JacksonJsonUtils.messagingAwareMapper(), which is already supplied with all the above-mentioned properties and serializers. To manage JSON serialization in the RedisMessageStore, it must be configured like so:

```
RedisMessageStore store = new RedisMessageStore(jedisConnectionFactory);
ObjectMapper mapper = JacksonJsonUtils.messagingAwareMapper();
RedisSerializer<Object> serializer = new GenericJackson2JsonRedisSerializer(mapper);
store.setValueSerializer(serializer);
```

Starting with version *4.3.12*, the RedisMessageStore supports the key prefix option to allow distinguishing between instances of the store on the same Redis server.

==== Redis Channel Message Stores

The RedisMessageStore above maintains each group as a value under a single key (the group id). While this can be used to back a QueueChannel for persistence, a specialized RedisChannelMessageStore is provided for that purpose (since *version 4.0*). This store uses a LIST for each channel and LPUSH when sending and RPOP when receiving messages. This store also uses JDK serialization by default, but the value serializer can be modified as described above.

It is recommended that this store is used for backing channels, instead of the general RedisMessageStore.

```
<bean id="redisMessageStore" class="o.s.i.redis.store.RedisChannelMessageStore">
 <constructor-arg ref="redisConnectionFactory"/>
</bean>

<int:channel id="somePersistentQueueChannel">
    <int:queue message-store="redisMessageStore"/>
<int:channel>
```

The keys that are used to store the data have the form <storeBeanName>:<channelId> (in the above example, redisMessageStore:somePersistentQueueChannel).

In addition, a subclass RedisChannelPriorityMessageStore is also provided. When this is used with a QueueChannel, the messages are received in (FIFO within) priority order. It uses the standard IntegrationMessageHeaderAccessor.PRIORITY header and supports priority values 0 - 9; messages with other priorities (and messages with no priority) are retrieved in FIFO order after any messages with priority.

Important

These stores implement only BasicMessageGroupStore and do not implement MessageGroupStore; they can only be used for situations such as backing a QueueChannel.

=== Redis Metadata Store

As of *Spring Integration 3.0* a new Redis-based MetadataStore (the section called “CompletableFuture”) implementation is available. The RedisMetadataStore can be used to maintain state of a MetadataStore across application restarts. This new MetadataStore implementation can be used with adapters such as:

- the section called “CompletableFuture”

- the section called “CompletableFuture”
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- the section called “CompletableFuture”

In order to instruct these adapters to use the new `RedisMetadataStore` simply declare a Spring bean using the bean name **metadataStore**. The *Twitter Inbound Channel Adapter* and the *Feed Inbound Channel Adapter* will both automatically pick up and use the declared `RedisMetadataStore`.

```
<bean name="metadataStore" class="o.s.i.redis.store.metadata.RedisMetadataStore">
    <constructor-arg name="connectionFactory" ref="redisConnectionFactory"/>
</bean>
```

The `RedisMetadataStore` is backed by `RedisProperties` and interaction with it uses `BoundHashOperations`, which, in turn, requires a `key` for the entire `Properties` store. In the case of the `MetadataStore`, this `key` plays the role of a *region*, which is useful in distributed environment, when several applications use the same Redis server. By default this `key` has the value `MetaData`.

Starting with *version 4.0*, this store now implements `ConcurrentMetadataStore`, allowing it to be reliably shared across multiple application instances where only one instance will be allowed to store or modify a key’s value.

Important

The `RedisMetadataStore.replace()` (for example in the `AbstractPersistentAcceptOnceFileListFilter`) can’t be used with a Redis cluster since the `WATCH` command for atomicity is not currently supported.

=== RedisStore Inbound Channel Adapter

The *RedisStore Inbound Channel Adapter* is a polling consumer that reads data from a Redis collection and sends it as a Message payload.

```
<int-redis:store-inbound-channel-adapter id="listAdapter"
    connection-factory="redisConnectionFactory"
    key="myCollection"
    channel="redisChannel"
    collection-type="LIST" >
    <int:poller fixed-rate="2000" max-messages-per-poll="10"/>
</int-redis:store-inbound-channel-adapter>
```

As you can see from the configuration above you configure a *Redis Store Inbound Channel Adapter* using the `store-inbound-channel-adapter` element, providing values for various attributes such as:

- `key` or `key-expression` - The name of the key for the collection being used.
- `collection-type` - enumeration of the Collection types supported by this adapter. Supported Collections are: LIST, SET, ZSET, PROPERTIES, MAP
- `connection-factory` - reference to an instance of `o.s.data.redis.connection.RedisConnectionFactory`
- `redis-template` - reference to an instance of `o.s.data.redis.core.RedisTemplate`

and other attributes that are common across all other inbound adapters (e.g., *channel*).

> **Note**
>
> You cannot set both `redis-template` and `connection-factory`.

> **Important**
>
> By default, the adapter uses a `StringRedisTemplate`; this uses `StringRedisSerializer` s for keys, values, hash keys and hash values. If your Redis store contains objects that are serialized with other techniques, you must supply a `RedisTemplate` configured with appropriate serializers. For example, if the store is written to using a RedisStore Outbound Adapter that has its `extract-payload-elements` set to false, you must provide a `RedisTemplate` configured thus:
>
> ```
> <bean id="redisTemplate" class="org.springframework.data.redis.core.RedisTemplate">
>     <property name="connectionFactory" ref="redisConnectionFactory"/>
>     <property name="keySerializer">
>         <bean class="org.springframework.data.redis.serializer.StringRedisSerializer"/>
>     </property>
>     <property name="hashKeySerializer">
>         <bean class="org.springframework.data.redis.serializer.StringRedisSerializer"/>
>     </property>
> </bean>
> ```
>
> This uses String serializers for keys and hash keys and the default JDK Serialization serializers for values and hash values.

The example above is relatively simple and static since it has a literal value for the `key`. Sometimes, you may need to change the value of the key at runtime based on some condition. To do that, simply use `key-expression` instead, where the provided expression can be any valid SpEL expression.

Also, you may wish to perform some post-processing to the successfully processed data that was read from the Redis collection. For example; you may want to move or remove the value after its been processed. You can do this using the Transaction Synchronization feature that was added with Spring Integration 2.2.

```
<int-redis:store-inbound-channel-adapter id="zsetAdapterWithSingleScoreAndSynchronization"
        connection-factory="redisConnectionFactory"
        key-expression="'presidents'"
        channel="otherRedisChannel"
        auto-startup="false"
        collection-type="ZSET">
            <int:poller fixed-rate="1000" max-messages-per-poll="2">
                <int:transactional synchronization-factory="syncFactory"/>
            </int:poller>
</int-redis:store-inbound-channel-adapter>

<int:transaction-synchronization-factory id="syncFactory">
 <int:after-commit expression="payload.removeByScore(18, 18)"/>
</int:transaction-synchronization-factory>

<bean id="transactionManager" class="o.s.i.transaction.PseudoTransactionManager"/>
```

As you can see from the above all, you need to do is declare your poller to be transactional with a `transactional` element. This element can reference a real transaction manager (for example if some other part of your flow invokes JDBC). If you don't have a *real* transaction, you can use a `o.s.i.transaction.PseudoTransactionManager` which is an implementation of Spring's

`PlatformTransactionManager` and enables the use of the transaction synchronization features of the redis adapter when there is no actual transaction.

> **Important**
>
> This does NOT make the Redis activities themselves transactional, it simply allows the synchronization of actions to be taken before/after success (commit) or after failure (rollback).

Once your poller is transactional all you need to do is set an instance of the `o.s.i.transaction.TransactionSynchronizationFactory` on the `transactional` element. `TransactionSynchronizationFactory` will create an instance of the `TransactionSynchronization`. For your convenience we've exposed a default SpEL-based `TransactionSynchronizationFactory` which allows you to configure SpEL expressions, with their execution being coordinated (synchronized) with a transaction. Expressions for before-commit, after-commit, and after-rollback are supported, together with a channel for each where the evaluation result (if any) will be sent. For each sub-element you can specify `expression` and/or `channel` attributes. If only the `channel` attribute is present the received Message will be sent there as part of the particular synchronization scenario. If only the `expression` attribute is present and the result of an expression is a non-Null value, a Message with the result as the payload will be generated and sent to a default channel (NullChannel) and will appear in the logs (DEBUG). If you want the evaluation result to go to a specific channel add a `channel` attribute. If the result of an expression is null or void, no Message will be generated.

For more information about transaction synchronization, see the section called “CompletableFuture”.

=== RedisStore Outbound Channel Adapter

The *RedisStore Outbound Channel Adapter* allows you to write a Message payload to a Redis collection

```
<int-redis:store-outbound-channel-adapter id="redisListAdapter"
          collection-type="LIST"
          channel="requestChannel"
          key="myCollection" />
```

As you can see from the configuration above, you configure a *Redis Store Outbound Channel Adapter* using the `store-inbound-channel-adapter` element, providing values for various attributes such as:

- `key` or `key-expression` - The name of the key for the collection being used.
- `extract-payload-elements` - If set to `true` (Default) and the payload is an instance of a "multi-value" object (i.e., Collection or Map) it will be stored using addAll/ putAll semantics. Otherwise, if set to `false` the payload will be stored as a single entry regardless of its type. If the payload is not an instance of a "multi-value" object, the value of this attribute is ignored and the payload will always be stored as a single entry.
- `collection-type` - enumeration of the Collection types supported by this adapter. Supported Collections are: LIST, SET, ZSET, PROPERTIES, MAP
- `map-key-expression` - SpEL expression that returns the name of the key for entry being stored. Only applies if the `collection-type` is MAP or PROPERTIES and *extract-payload-elements* is false.
- `connection-factory` - reference to an instance of `o.s.data.redis.connection.RedisConnectionFactory`

- `redis-template` - reference to an instance of `o.s.data.redis.core.RedisTemplate`

and other attributes that are common across all other inbound adapters (e.g., *channel*).

Note

You cannot set both `redis-template` and `connection-factory`.

Important

By default, the adapter uses a `StringRedisTemplate`; this uses `StringRedisSerializer` s for keys, values, hash keys and hash values. However, if `extract-payload-elements` is set to false, a `RedisTemplate` using `StringRedisSerializer` s for keys and hash keys, and `JdkSerializationRedisSerializer` s for values and hash values will be used. With the JDK serializer, it is important to understand that java serialization is used for all values, regardless of whether the value is actually a collection or not. If you need more control over the serialization of values, you may want to consider providing your own `RedisTemplate` rather than relying upon these defaults.

The example above is relatively simple and static since it has a literal values for the `key` and other attributes. Sometimes you may need to change the values dynamically at runtime based on some condition. To do that simply use their `-expression` equivalents (`key-expression`, `map-key-expression` etc.) where the provided expression can be any valid SpEL expression.

=== Redis Outbound Command Gateway

Since *Spring Integration 4.0*, the Redis Command Gateway is available to perform any standard Redis command using generic `RedisConnection#execute` method:

```
<int-redis:outbound-gateway
        request-channel=""  ❶
        reply-channel=""  ❷
        requires-reply=""  ❸
        reply-timeout=""  ❹
        connection-factory=""  ❺
        redis-template=""  ❻
        arguments-serializer=""  ❼
        command-expression=""  ❽
        argument-expressions=""  ❾
        use-command-variable=""  ❿
        arguments-strategy="" /> 11
```

❶ The `MessageChannel` from which this Endpoint receives `Message` s.

❷ The `MessageChannel` where this Endpoint sends reply `Message` s.

❸ Specify whether this outbound gateway must return a non-null value. This value is `true` by default. A ReplyRequiredException will be thrown when the Redis returns a `null` value.

❹ The timeout in milliseconds to wait until the reply message will be sent or not. Typically is applied for queue-based limited reply-channels.

❺ A reference to a `RedisConnectionFactory` bean. Defaults to `redisConnectionFactory`. Mutually exclusive with *redis-template* attribute.

❻ A reference to a `RedisTemplate` bean. Mutually exclusive with *connection-factory* attribute.

❼ Reference to an instance of `org.springframework.data.redis.serializer.RedisSerializer`. Used to serialize each command argument to byte[] if necessary.

❽ The SpEL expression that returns the command key. Default is the `redis_command` message header. Must not evaluate to `null`.

❾ Comma-separate SpEL expressions that will be evaluated as command arguments. Mutually exclusive with the `arguments-strategy` attribute. If neither of them is provided the `payload` is used as the command argument(s). Argument expressions may evaluate to *null*, to support a variable number of arguments.

❿ A `boolean` flag to specify if the evaluated Redis command string will be made available as the `#cmd` variable in the expression evaluation context in the `o.s.i.redis.outbound.ExpressionArgumentsStrategy` when `argument-expressions` is configured, otherwise this attribute is ignored.

11 Reference to an instance of `o.s.i.redis.outbound.ArgumentsStrategy`. Mutually exclusive with `argument-expressions` attribute. If neither of them is provided the `payload` is used as the command argument(s).

The `<int-redis:outbound-gateway>` can be used as a common component to perform any desired Redis operation. For example to get incremented value from Redis Atomic Number:

```
<int-redis:outbound-gateway request-channel="requestChannel"
    reply-channel="replyChannel"
    command-expression="'INCR'"/>
```

where the Message `payload` should be a name of `redisCounter`, which may be provided by `org.springframework.data.redis.support.atomic.RedisAtomicInteger` bean definition.

The `RedisConnection#execute` has a generic `Object` as return type and real result depends on command type, for example `MGET` returns a `List<byte[]>`. For more information about commands, their arguments and result type seehttp://redis.io/commands[Redis Specification].

=== Redis Queue Outbound Gateway

Since *Spring Integration 4.1*, the Redis Queue Outbound Gateway is available to perform request and reply scenarios. It pushes a *conversation*`UUID` to the provided `queue`, then pushes the value to a Redis List with that `UUID` as its key and waits for the reply from a Redis List with a key of `UUID + '.reply'`. A different UUID is used for each interaction.

```
<int-redis:queue-outbound-gateway
        request-channel=""  ❶
        reply-channel=""  ❷
        requires-reply=""  ❸
        reply-timeout=""  ❹
        connection-factory=""  ❺
        queue=""  ❻
        order=""  ❼
        serializer=""  ❽
        extract-payload=""/>  ❾
```

❶ The `MessageChannel` from which this Endpoint receives `Message` s.

❷ The `MessageChannel` where this Endpoint sends reply `Message` s.

❸ Specify whether this outbound gateway must return a non-null value. This value is `false` by default, otherwise a ReplyRequiredException will be thrown when the Redis returns a `null` value.

❹ The timeout in milliseconds to wait until the reply message will be sent or not. Typically is applied for queue-based limited reply-channels.

❺ A reference to a `RedisConnectionFactory` bean. Defaults to `redisConnectionFactory`. Mutually exclusive with *redis-template* attribute.

❻ The name of the Redis List to which outbound gateway will send a *conversation*`UUID`.

❼ The order for this outbound gateway when multiple gateway are registered thereby

❽ The `RedisSerializer` bean reference. Can be an empty string, which means *no serializer*. In this case the raw `byte[]` from the inbound Redis message is sent to the `channel` as the `Message` payload. By default it is a `JdkSerializationRedisSerializer`.

❾ Specify if this Endpoint expects data from the Redis queue to contain entire `Message` s. If this attribute is set to `true`, the `serializer` can't be an empty string because messages require some form of deserialization (JDK serialization by default).

=== Redis Queue Inbound Gateway

Since *Spring Integration 4.1*, the Redis Queue Inbound Gateway is available to perform request and reply scenarios. It pops a *conversation* `UUID` from the provided `queue`, then pops the value from the Redis List with that `UUID` as its key and pushes the reply to the Redis List with a key of `UUID + '.reply'`:

```
<int-redis:queue-inbound-gateway
        request-channel=""  ❶
        reply-channel=""  ❷
        executor=""  ❸
        reply-timeout=""  ❹
        connection-factory=""  ❺
        queue=""  ❻
        order=""  ❼
        serializer=""  ❽
        receive-timeout=""  ❾
        expect-message=""  ❿
        recovery-interval=""/>  11
```

❶ The `MessageChannel` from which this Endpoint receives `Message` s.

❷ The `MessageChannel` where this Endpoint sends reply `Message` s.

❸ A reference to a Spring `TaskExecutor` (or standard JDK 1.5+ `Executor`) bean. It is used for the underlying listening task. By default a `SimpleAsyncTaskExecutor` is used.

❹ The timeout in milliseconds to wait until the reply message will be sent or not. Typically is applied for queue-based limited reply-channels.

❺ A reference to a `RedisConnectionFactory` bean. Defaults to `redisConnectionFactory`. Mutually exclusive with *redis-template* attribute.

❻ The name of the Redis List for the *conversation* `UUID` s.

❼ The order for this inbound gateway when multiple gateway are registered thereby

❽ The `RedisSerializer` bean reference. Can be an empty string, which means *no serializer*. In this case the raw `byte[]` from the inbound Redis message is sent to the `channel` as the `Message` payload. By default it is a `JdkSerializationRedisSerializer`. (Note that in releases before *version 4.3*, it was a `StringRedisSerializer` by default; to restore that behavior provide a reference to a `StringRedisSerializer`).

❾ The timeout in milliseconds to wait until the receive message will be get or not. Typically is applied for queue-based limited request-channels.

❿ Specify if this Endpoint expects data from the Redis queue to contain entire `Message` s. If this attribute is set to `true`, the `serializer` can't be an empty string because messages require some form of deserialization (JDK serialization by default).

11 The time in milliseconds for which the listener task should sleep after exceptions on the *right pop* operation, before restarting the listener task.

=== Redis Lock Registry

Starting with *version 4.0*, the `RedisLockRegistry` is available. Certain components (for example aggregator and resequencer) use a lock obtained from a `LockRegistry` instance to ensure that only one thread is manipulating a group at a time. The `DefaultLockRegistry` performs this function within a single component; you can now configure an external lock registry on these components. When used with a shared `MessageGroupStore`, the `RedisLockRegistry` can be use to provide this functionality across multiple application instances, such that only one instance can manipulate the group at a time.

When a lock is released by a local thread, another local thread will generally be able to acquire the lock immediately. If a lock is released by a thread using a different registry instance, it can take up to 100ms to acquire the lock.

To avoid "hung" locks (when a server fails), the locks in this registry are expired after a default 60 seconds, but this can be configured on the registry. Locks are normally held for a much smaller time.

> **Important**
>
> Because the keys can expire, an attempt to unlock an expired lock will result in an exception being thrown. However, be aware that the resources protected by such a lock may have been compromised so such exceptions should be considered severe. The expiry should be set at a large enough value to prevent this condition, while small enough that the lock can be recovered after a server failure in a reasonable amount of time.

Starting with *version 5.0*, the `RedisLockRegistry` implements `ExpirableLockRegistry` providing functionality to remove locks last acquired more than `age` ago that are not currently locked.

== Resource Support

=== Introduction

The *Resource Inbound Channel Adapter* builds upon Spring's `Resource` abstraction to support greater flexibility across a variety of actual types of underlying resources, such as a file, a URL, or a class path resource. Therefore, it's similar to but more generic than the *File Inbound Channel Adapter*.

=== Resource Inbound Channel Adapter

The *Resource Inbound Channel Adapter* is a polling adapter that creates a `Message` whose payload is a collection of `Resource` objects.

`Resource` objects are resolved based on the pattern specified using the `pattern` attribute. The collection of resolved `Resource` objects is then sent as a payload within a `Message` to the adapter's channel. That is one major difference between *Resource Inbound Channel Adapter* and *File Inbound Channel Adapter*; the latter buffers File objects and sends a single `File` object per `Message`.

Below is an example of a very simple configuration which will find all files ending with the *properties* extension in the `foo.bar` package available on the classpath and will send them as the payload of a Message to the channel named *`resultChannel`*:

```
<int:resource-inbound-channel-adapter id="resourceAdapter"
               channel="resultChannel"
               pattern="classpath:foo/bar/*.properties">
    <int:poller fixed-rate="1000"/>
</int:resource-inbound-channel-adapter>
```

The *Resource Inbound Channel Adapter* relies on the `org.springframework.core.io.support.ResourcePatternResolver` strategy interface to resolve the provided pattern. It defaults to an instance of the current `ApplicationContext`. However you may provide a reference to an instance of your own implementation of `ResourcePatternResolver` using the `pattern-resolver` attribute:

```
<int:resource-inbound-channel-adapter id="resourceAdapter"
               channel="resultChannel"
               pattern="classpath:foo/bar/*.properties"
               pattern-resolver="myPatternResolver">
    <int:poller fixed-rate="1000"/>
</int:resource-inbound-channel-adapter>

<bean id="myPatternResolver" class="org.example.MyPatternResolver"/>
```

You may have a use case where you need to further filter the collection of resources resolved by the `ResourcePatternResolver`. For example, you may want to prevent resources that were resolved already from appearing in a collection of resolved resources ever again. On the other hand your resources might be updated rather often and you *do* want them to be picked up again. In other words there is a valid use case for defining an additional filter as well as disabling filtering altogether. You can provide your own implementation of the `org.springframework.integration.util.CollectionFilter` strategy interface:

```
public interface CollectionFilter<T> {

    Collection<T> filter(Collection<T> unfilteredElements);

}
```

As you can see the `CollectionFilter` receives a collection of un-filtered elements (which would be `Resource` objects in this case), and it returns a collection of filtered elements of that same type.

If you are defining the adapter via XML but you do not specify a filter reference, a default implementation of `CollectionFilter` will be used by the *Resource Inbound Channel Adapter*. The implementation class of that default filter is `org.springframework.integration.util.AcceptOnceCollectionFilter`. It remembers the elements passed in the previous invocation in order to avoid returning those elements more than once.

To inject your own implementation of `CollectionFilter` instead, use the `filter` attribute.

```
<int:resource-inbound-channel-adapter id="resourceAdapter"
               channel="resultChannel"
               pattern="classpath:foo/bar/*.properties"
               filter="myFilter">
    <int:poller fixed-rate="1000"/>
</int:resource-inbound-channel-adapter>

<bean id="myFilter" class="org.example.MyFilter"/>
```

If you don't need any filtering and want to disable even the default `CollectionFilter` strategy, simply provide an empty value for the filter attribute (e.g., `filter=""`)

== RMI Support

=== Introduction

This Chapter explains how to use RMI specific channel adapters to distribute a system over multiple JVMs. The first section will deal with sending messages over RMI. The second section shows how to receive messages over RMI. The last section shows how to define rmi channel adapters through the namespace support.

=== Outbound RMI

To send messages from a channel over RMI, simply define an `RmiOutboundGateway`. This gateway will use Spring's RmiProxyFactoryBean internally to create a proxy for a remote gateway. Note that to invoke a remote interface that doesn't use Spring Integration you should use a service activator in combination with Spring's RmiProxyFactoryBean.

To configure the outbound gateway write a bean definition like this:

```
<bean id="rmiOutGateway" class=org.spf.integration.rmi.RmiOutboundGateway>
    <constructor-arg value="rmi://host"/>
    <property name="replyChannel" value="replies"/>
</bean>
```

=== Inbound RMI

To receive messages over RMI you need to use a `RmiInboundGateway`. This gateway can be configured like this

```
<bean id="rmiInGateway" class=org.spf.integration.rmi.RmiInboundGateway>
    <property name="requestChannel" value="requests"/>
</bean>
```

Important

If you use an `errorChannel` on an inbound gateway, it would be normal for the error flow to return a result (or throw an exception). This is because it is likely that there is a corresponding outbound gateway waiting for a response of some kind. Consuming a message on the error flow, and not replying, will result in no reply at the inbound gateway. Exceptions (on the main flow when there is no errorChannel, or on the error flow) will be propagated to the corresponding inbound gateway.

=== RMI namespace support

To configure the inbound gateway you can choose to use the namespace support for it. The following code snippet shows the different configuration options that are supported.

```
<int-rmi:inbound-gateway id="gatewayWithDefaults" request-channel="testChannel"/>

<int-rmi:inbound-gateway id="gatewayWithCustomProperties" request-channel="testChannel"
    expect-reply="false" request-timeout="123" reply-timeout="456"/>

<int-rmi:inbound-gateway id="gatewayWithHost" request-channel="testChannel"
    registry-host="localhost"/>

<int-rmi:inbound-gateway id="gatewayWithPort" request-channel="testChannel"
    registry-port="1234" error-channel="rmiErrorChannel"/>

<int-rmi:inbound-gateway id="gatewayWithExecutorRef" request-channel="testChannel"
    remote-invocation-executor="invocationExecutor"/>
```

To configure the outbound gateway you can use the namespace support as well. The following code snippet shows the different configuration for an outbound rmi gateway.

```
<int-rmi:outbound-gateway id="gateway"
    request-channel="localChannel"
    remote-channel="testChannel"
    host="localhost"/>
```

=== Configuring with Java Configuration

```
@Bean
public RmiInboundGateway inbound() {
    RmiInboundGateway gateway = new RmiInboundGateway();
    gateway.setRequestChannel(requestChannel());
    gateway.setRegistryHost("host");
    gateway.setRegistryPort(port);
    return gateway;
}

@Bean
@ServiceActivator(inputChannel="inChannel")
public RmiOutboundGateway outbound() {
    RmiOutboundGateway gateway = new RmiOutboundGateway("rmi://host:port/"
        + RmiInboundGateway.SERVICE_NAME_PREFIX + "remoteChannelName");
    return gateway;
}
```

Starting with *version 4.3*, the outbound gateway has a second constructor that takes a RmiProxyFactoryBeanConfigurer instance along with the service url argument. This allows further configuration before the proxy is created; for example, to inject a Spring Security `ContextPropagatingRemoteInvocationFactory`:

```
@Bean
@ServiceActivator(inputChannel="inChannel")
public RmiOutboundGateway outbound() {
    RmiOutboundGateway gateway = new RmiOutboundGateway("rmi://host:port/"
                + RmiInboundGateway.SERVICE_NAME_PREFIX + "remoteChannelName",
        pfb -> {
            pfb.setRemoteInvocationFactory(new ContextPropagatingRemoteInvocationFactory());
        });
    return gateway;
}
```

Starting with *version 5.0*, this can be set using the XML namespace, using the `configurer` attribute.

== SFTP Adapters

Spring Integration provides support for file transfer operations via SFTP.

=== Introduction

The Secure File Transfer Protocol (SFTP) is a network protocol which allows you to transfer files between two computers on the Internet over any reliable stream.

The SFTP protocol requires a secure channel, such as SSH, as well as visibility to a client's identity throughout the SFTP session.

Spring Integration supports sending and receiving files over SFTP by providing three *client* side endpoints: *Inbound Channel Adapter*, *Outbound Channel Adapter*, and *Outbound Gateway* It also provides convenient namespace configuration to define these *client* components.

```
xmlns:int-sftp="http://www.springframework.org/schema/integration/sftp"
xsi:schemaLocation="http://www.springframework.org/schema/integration/sftp
    https://www.springframework.org/schema/integration/sftp/spring-integration-sftp.xsd"
```

=== SFTP Session Factory

Important

Starting with version 3.0, sessions are no longer cached by default. See the section called “CompletableFuture”.

Before configuring SFTP adapters, you must configure an *SFTP Session Factory*. You can configure the *SFTP Session Factory* via a regular bean definition:

```
<beans:bean id="sftpSessionFactory"
    class="org.springframework.integration.sftp.session.DefaultSftpSessionFactory">
    <beans:property name="host" value="localhost"/>
    <beans:property name="privateKey" value="classpath:META-INF/keys/sftpTest"/>
    <beans:property name="privateKeyPassphrase" value="springIntegration"/>
    <beans:property name="port" value="22"/>
    <beans:property name="user" value="kermit"/>
</beans:bean>
```

Every time an adapter requests a session object from its `SessionFactory`, a new SFTP session is being created. Under the covers, the SFTP Session Factory relies on the JSch library to provide the SFTP capabilities.

However, Spring Integration also supports the caching of SFTP sessions, please see the section called “CompletableFuture” for more information.

Important

JSch supports multiple channels (operations) over a connection to the server. By default, the Spring Integration session factory uses a separate physical connection for each channel. Since *Spring Integration 3.0*, you can configure the session factory (using a boolean constructor arg - default `false`) to use a single connection to the server and create multiple `JSch` channels on that single connection.

When using this feature, you must wrap the session factory in a caching session factory, as described below, so that the connection is not physically closed when an operation completes.

If the cache is reset, the session is disconnected only when the last channel is closed.

The connection will be refreshed if it is found to be disconnected when a new operation obtains a session.

Note

If you experience connectivity problems and would like to trace Session creation as well as see which Sessions are polled you may enable it by setting the logger to TRACE level (e.g., log4j.category.org.springframework.integration.sftp=TRACE). Please also see the section called “CompletableFuture”.

Now all you need to do is inject this *SFTP Session Factory* into your adapters.

Note

A more practical way to provide values for the *SFTP Session Factory* would be via Spring’s property placeholder support.

==== Configuration Properties

Below you will find all properties that are exposed by the DefaultSftpSessionFactory.

isSharedSession (constructor argument)

When true, a single connection will be used and `JSch Channels` will be multiplexed. Defaults to false.

clientVersion

Allows you to set the client version property. It's default depends on the underlying JSch version but it will look like:_SSH-2.0-JSCH-0.1.45_

enableDaemonThread

If `true`, all threads will be daemon threads. If set to `false`, normal non-daemon threads will be used instead. This property will be set on the underlying Session. There, this property will default to `false`, if not explicitly set.

host

The url of the host you want connect to. *Mandatory*.

hostKeyAlias

Sets the host key alias, used when comparing the host key to the known hosts list.

knownHosts

Specifies the filename that will be used for a host key repository. The file has the same format as OpenSSH's *known_hosts* file and is required and must be pre-populated if `allowUnknownKeys` is false.

password

The password to authenticate against the remote host. If a *password* is not provided, then the *privateKey* property is mandatory. Not allowed if `userInfo` is set; the password is obtained from that object.

port

The port over which the SFTP connection shall be established. If not specified, this value defaults to `22`. If specified, this properties must be a positive number.

privateKey

Allows you to set a Resource, which represents the location of the private key used for authenticating against the remote host. If the *privateKey* is not provided, then the *password* property is mandatory.

privateKeyPassphrase

The password for the private key. Not allowed if `userInfo` is set; the passphrase is obtained from that object. Optional.

proxy

Allows for specifying a JSch-based Proxy. If set, then the proxy object is used to create the connection to the remote host via the proxy. See the section called "CompletableFuture" for a convenient way to configure the proxy.

serverAliveCountMax

Specifies the number of server-alive messages, which will be sent without any reply from the server before disconnecting. If not set, this property defaults to `1`.

serverAliveInterval

Sets the timeout interval (milliseconds) before a server alive message is sent, in case no message is received from the server.

sessionConfig

Using `Properties`, you can set additional configuration setting on the underlying JSch Session.

socketFactory

Allows you to pass in a SocketFactory. The socket factory is used to create a socket to the target host. When a proxy is used, the socket factory is passed to the proxy. By default plain TCP sockets are used.

timeout

The timeout property is used as the socket timeout parameter, as well as the default connection timeout. Defaults to `0`, which means, that no timeout will occur.

user

The remote user to use. *Mandatory*.

allowUnknownKeys

Set to `true` to allow connections to hosts with unknown (or changed) keys. Default *false* (since 4.2 - defaults to `true` in 4.1.7 and was not configurable before that version). Only applied if no `userInfo` is provided. If false, a pre-populated knownHosts file is required.

userInfo

Set a custom `UserInfo` used during authentication. In particular, be aware that `promptYesNo()` is invoked when an unknown (or changed) host key is received. Also see `allowUnknownHosts`. When a `UserInfo` is provided, the `password` and private key `passphrase` is obtained from it, and discrete `password` and `privateKeyPassprase` properties cannot be set.

=== Proxy Factory Bean

`Jsch` provides a mechanism to connect to the server via an HTTP or SOCKS proxy. To use this feature, configure the `Proxy` and provide a reference to the `DefaultSftpSessionFactory` as discussed above. Three implementations are provided by `Jsch`, `HTTP`, `SOCKS4` and `SOCKS5`. *Spring Integration 4.3* provides a `FactoryBean` making configuration of these proxies easier, allowing property injection:

```
<bean id="proxySocks5" class="org.springframework.integration.sftp.session.JschProxyFactoryBean">
    <constructor-arg value="SOCKS5" />
    <constructor-arg value="${sftp.proxy.address}" />
    <constructor-arg value="${sftp.proxy.port}" />
    <constructor-arg value="${sftp.proxy.user}" />
    <constructor-arg value="${sftp.proxy.pw}" />
</bean>

<bean id="sessionFactory"
          class="org.springframework.integration.sftp.session.DefaultSftpSessionFactory" >
    ...
    <property name="proxy" ref="proxySocks5" />
    ...
</bean>
```

=== Delegating Session Factory

Version 4.2 introduced the `DelegatingSessionFactory` which allows the selection of the actual session factory at runtime. Prior to invoking the ftp endpoint, call `setThreadKey()` on the factory to associate a key with the current thread. That key is then used to lookup the actual session factory to be used. The key can be cleared by calling `clearThreadKey()` after use.

Convenience methods have been added so this can easily be done from a message flow:

```
<bean id="dsf" class="org.springframework.integration.file.remote.session.DelegatingSessionFactory">
    <constructor-arg>
        <bean class="o.s.i.file.remote.session.DefaultSessionFactoryLocator">
            <!-- delegate factories here -->
        </bean>
    </constructor-arg>
</bean>

<int:service-activator input-channel="in" output-channel="c1"
        expression="@dsf.setThreadKey(#root, headers['factoryToUse'])" />

<int-sftp:outbound-gateway request-channel="c1" reply-channel="c2" ... />

<int:service-activator input-channel="c2" output-channel="out"
        expression="@dsf.clearThreadKey(#root)" />
```

Important

When using session caching (see the section called “CompletableFuture”), each of the delegates should be cached; you cannot cache the `DelegatingSessionFactory` itself.

Starting with *version 5.0.7*, the `DelegatingSessionFactory` can be used in conjunction with a `RotatingServerAdvice` to poll multiple servers; see the section called “CompletableFuture”.

=== SFTP Session Caching

Important

Starting with *Spring Integration version 3.0*, sessions are no longer cached by default; the `cache-sessions` attribute is no longer supported on endpoints. You must use a `CachingSessionFactory` (see below) if you wish to cache sessions.

In versions prior to 3.0, the sessions were cached automatically by default. A `cache-sessions` attribute was available for disabling the auto caching, but that solution did not provide a way to configure other session caching attributes. For example, you could not limit on the number of sessions created. To support that requirement and other configuration options, a `CachingSessionFactory` was provided. It provides `sessionCacheSize` and `sessionWaitTimeout` properties. As its name suggests, the `sessionCacheSize` property controls how many active sessions the factory will maintain in its cache (the DEFAULT is unbounded). If the `sessionCacheSize` threshold has been reached, any attempt to acquire another session will block until either one of the cached sessions becomes available or until the wait time for a Session expires (the DEFAULT wait time is Integer.MAX_VALUE). The `sessionWaitTimeout` property enables configuration of that value.

If you want your Sessions to be cached, simply configure your default Session Factory as described above and then wrap it in an instance of `CachingSessionFactory` where you may provide those additional properties.

```
<bean id="sftpSessionFactory"
    class="org.springframework.integration.sftp.session.DefaultSftpSessionFactory">
    <property name="host" value="localhost"/>
</bean>

<bean id="cachingSessionFactory"
    class="org.springframework.integration.file.remote.session.CachingSessionFactory">
    <constructor-arg ref="sftpSessionFactory"/>
    <constructor-arg value="10"/>
    <property name="sessionWaitTimeout" value="1000"/>
</bean>
```

In the above example you see a `CachingSessionFactory` created with the `sessionCacheSize` set to 10 and the `sessionWaitTimeout` set to 1 second (its value is in milliseconds).

Starting with *Spring Integration version 3.0*, the `CachingConnectionFactory` provides a `resetCache()` method. When invoked, all idle sessions are immediately closed and in-use sessions are closed when they are returned to the cache. When using `isSharedSession=true`, the channel is closed, and the shared session is closed only when the last channel is closed. New requests for sessions will establish new sessions as necessary.

=== RemoteFileTemplate

Starting with *Spring Integration version 3.0*, a new abstraction is provided over the `SftpSession` object. The template provides methods to send, retrieve (as an `InputStream`), remove, and rename files. In addition an `execute` method is provided allowing the caller to execute multiple operations on the session. In all cases, the template takes care of reliably closing the session. For more information, refer to the javadocs for `RemoteFileTemplate` There is a subclass for SFTP: `SftpRemoteFileTemplate`.

Additional methods were added in *version 4.1* including `getClientInstance()` which provides access to the underlying `ChannelSftp` enabling access to low-level APIs.

Starting with *version 5.0*, the new `RemoteFileOperations.invoke(OperationsCallback<F, T> action)` method is available. This method allows several `RemoteFileOperations` calls to be called in the scope of the same, thread-bounded, `Session`. This is useful when you need to perform several high-level operations of the `RemoteFileTemplate` as one unit of work. For example `AbstractRemoteFileOutboundGateway` uses it with the *mput* command implementation, where we perform a *put* operation for each file in the provided directory and recursively for its sub-directories. See the JavaDocs for more information.

=== SFTP Inbound Channel Adapter

The *SFTP Inbound Channel Adapter* is a special listener that will connect to the server and listen for the remote directory events (e.g., new file created) at which point it will initiate a file transfer.

```
<int-sftp:inbound-channel-adapter id="sftpAdapterAutoCreate"
              session-factory="sftpSessionFactory"
            channel="requestChannel"
            filename-pattern="*.txt"
            remote-directory="/foo/bar"
            preserve-timestamp="true"
            local-directory="file:target/foo"
            auto-create-local-directory="true"
            local-filename-generator-expression="#this.toUpperCase() + '.a'"
            scanner="myDirScanner"
            local-filter="myFilter"
            temporary-file-suffix=".writing"
            max-fetch-size="-1"
            delete-remote-files="false">
        <int:poller fixed-rate="1000"/>
</int-sftp:inbound-channel-adapter>
```

As you can see from the configuration above you can configure the *SFTP Inbound Channel Adapter* via the `inbound-channel-adapter` element while also providing values for various attributes such as `local-directory` - where files are going to be transferred TO and `remote-directory` - the remote source directory where files are going to be transferred FROM - as well as other attributes including a `session-factory` reference to the bean we configured earlier.

By default the transferred file will carry the same name as the original file. If you want to override this behavior you can set the `local-filename-generator-expression` attribute which allows you to provide a SpEL Expression to generate the name of the local file. Unlike outbound gateways and adapters where the root object of the SpEL Evaluation Context is a `Message`, this inbound adapter does not yet have the Message at the time of evaluation since that's what it ultimately generates with the transferred file as its payload. So, the root object of the SpEL Evaluation Context is the original name of the remote file (String).

The inbound channel adapter first retrieves the file to a local directory and then emits each file according to the poller configuration. Starting with *version 5.0* you can now limit the number of files fetched from the FTP server when new file retrievals are needed. This can be beneficial when the target files are very large and/or when running in a clustered system with a persistent file list filter discussed below. Use `max-fetch-size` for this purpose; a negative value (default) means no limit and all matching files will be retrieved; see the section called “CompletableFuture” for more information. Since *version 5.0*, you can also provide a custom `DirectoryScanner` implementation to the `inbound-channel-adapter` via the `scanner` attribute.

Starting with *Spring Integration 3.0*, you can specify the `preserve-timestamp` attribute (default `false`); when `true`, the local file's modified timestamp will be set to the value retrieved from the server; otherwise it will be set to the current time.

Starting with *version 4.2*, you can specify `remote-directory-expression` instead of `remote-directory`, allowing you to dynamically determine the directory on each poll. e.g `remote-directory-expression="@myBean.determineRemoteDir()"`.

Sometimes file filtering based on the simple pattern specified via `filename-pattern` attribute might not be sufficient. If this is the case, you can use the `filename-regex` attribute to specify a Regular Expression (e.g. `filename-regex=".*\.test$"`). And of course if you need complete control you can use the `filter` attribute to provide a reference to a custom implementation of the `org.springframework.integration.file.filters.FileListFilter` - a strategy interface for filtering a list of files. This filter determines which remote files are retrieved. You can also combine a pattern based filter with other filters, such as an `AcceptOnceFileListFilter` to avoid synchronizing files that have previously been fetched, by using a `CompositeFileListFilter`.

The `AcceptOnceFileListFilter` stores its state in memory. If you wish the state to survive a system restart, consider using the `SftpPersistentAcceptOnceFileListFilter` instead. This filter stores the accepted file names in an instance of the `MetadataStore` strategy (the section called “CompletableFuture”). This filter matches on the filename and the remote modified time.

Since *version 4.0*, this filter requires a `ConcurrentMetadataStore`. When used with a shared data store (such as `Redis` with the `RedisMetadataStore`) this allows filter keys to be shared across multiple application or server instances.

Starting with *version 5.0*, the `SftpPersistentAcceptOnceFileListFilter` with in-memory `SimpleMetadataStore` is applied by default for the `SftpInboundFileSynchronizer`. This filter is also applied together with the `regex` or `pattern` option in the XML configuration as well as via `FtpInboundChannelAdapterSpec` in Java DSL. Any other use-cases can be reached via `CompositeFileListFilter` (or `ChainFileListFilter`).

The above discussion refers to filtering the files before retrieving them. Once the files have been retrieved, an additional filter is applied to the files on the file system. By default, this is an`AcceptOnceFileListFilter` which, as discussed, retains state in memory and does not consider the file’s modified time. Unless your application removes files after processing, the adapter will re-process the files on disk by default after an application restart.

Also, if you configure the `filter` to use a `FtpPersistentAcceptOnceFileListFilter`, and the remote file timestamp changes (causing it to be re-fetched), the default local filter will not allow this new file to be processed.

Use the `local-filter` attribute to configure the behavior of the local file system filter. Starting with *version 4.3.8*, a `FileSystemPersistentAcceptOnceFileListFilter` is configured by default. This filter stores the accepted file names and modified timestamp in an instance of the `MetadataStore` strategy (the section called “CompletableFuture”), and will detect changes to the local file modified time. The default `MetadataStore` is a `SimpleMetadataStore` which stores state in memory.

Since *version 4.1.5*, these filters have a new property `flushOnUpdate` which will cause them to flush the metadata store on every update (if the store implements `Flushable`).

Important

Further, if you use a distributed `MetadataStore` (such as the section called “CompletableFuture” or the section called “CompletableFuture”) you can have multiple instances of the same adapter/ application and be sure that one and only one will process a file.

The actual local filter is a `CompositeFileListFilter` containing the supplied filter and a pattern filter that prevents processing files that are in the process of being downloaded (based on the `temporary-file-suffix`); files are downloaded with this suffix (default: `.writing`) and the file is renamed to its final name when the transfer is complete, making it *visible* to the filter.

Please refer to the schema for more detail on these attributes.

It is also important to understand that *SFTP Inbound Channel Adapter* is a Polling Consumer and therefore you must configure a poller (either a global default or a local sub-element). Once the file has been transferred to a local directory, a Message with `java.io.File` as its payload type will be generated and sent to the channel identified by the `channel` attribute.

More on File Filtering and Large Files

Sometimes a file that just appeared in the monitored (remote) directory is not complete. Typically such a file will be written with some temporary extension (e.g., foo.txt.writing) and then renamed after the writing process completes. As a user in most cases you are only interested in files that are complete and would like to filter only those files. To handle these scenarios, use filtering support provided via the `filename-pattern`, `filename-regex` and `filter` attributes. If you need a custom filter implementation simply include a reference in your adapter via the `filter` attribute.

```
<int-sftp:inbound-channel-adapter id="sftpInbondAdapter"
            channel="receiveChannel"
            session-factory="sftpSessionFactory"
            filter="customFilter"
            local-directory="file:/local-test-dir"
            remote-directory="/remote-test-dir">
        <int:poller fixed-rate="1000" max-messages-per-poll="10" task-executor="executor"/>
</int-sftp:inbound-channel-adapter>

<bean id="customFilter" class="org.foo.CustomFilter"/>
```

==== Recovering from Failures

It is important to understand the architecture of the adapter. There is a file synchronizer which fetches the files, and a `FileReadingMessageSource` to emit a message for each synchronized file. As discussed above, there are two filters involved. The `filter` attribute (and patterns) refers to the remote (SFTP) file list - to avoid fetching files that have already been fetched. The `local-filter` is used by the `FileReadingMessageSource` to determine which files are to be sent as messages.

The synchronizer lists the remote files and consults its filter; the files are then transferred. If an IO error occurs during file transfer, any files that have already been added to the filter are removed so they are eligible to be re-fetched on the next poll. This only applies if the filter implements `ReversibleFileListFilter` (such as the `AcceptOnceFileListFilter`).

If, after synchronizing the files, an error occurs on the downstream flow processing a file, there is *no* automatic rollback of the filter so the failed file will *not* be reprocessed by default.

If you wish to reprocess such files after a failure, you can use configuration similar to the following to facilitate the removal of the failed file from the filter. This will work for any `ResettableFileListFilter`.

```
<int-sftp:inbound-channel-adapter id="sftpAdapter"
        session-factory="sftpSessionFactory"
        channel="requestChannel"
        remote-directory-expression="'/sftpSource'"
        local-directory="file:myLocalDir"
        auto-create-local-directory="true"
        filename-pattern="*.txt">
    <int:poller fixed-rate="1000">
        <int:transactional synchronization-factory="syncFactory" />
    </int:poller>
</int-sftp:inbound-channel-adapter>

<bean id="acceptOnceFilter"
    class="org.springframework.integration.file.filters.AcceptOnceFileListFilter" />

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-rollback expression="payload.delete()" />
</int:transaction-synchronization-factory>

<bean id="transactionManager"
    class="org.springframework.integration.transaction.PseudoTransactionManager" />
```

Starting with *version 5.0*, the Inbound Channel Adapter can build sub-directories locally according the generated local file name. That can be a remote sub-path as well. To be able to read local directory recursively for modification according the hierarchy support, an internal `FileReadingMessageSource` now can bve supplied with a new `RecursiveDirectoryScanner` based on the `Files.walk()` algorithm. See `AbstractInboundFileSynchronizingMessageSource.setScanner()` for more information. Also the `AbstractInboundFileSynchronizingMessageSource` can now be switched to the `WatchService` -based `DirectoryScanner` via `setUseWatchService()` option. It is also configured for all the `WatchEventType` s to react for any modifications in local directory. The reprocessing sample above is based on the build-in functionality of the `FileReadingMessageSource.WatchServiceDirectoryScanner` to perform `ResettableFileListFilter.remove()` when the file is deleted (`StandardWatchEventKinds.ENTRY_DELETE`) from the local directory. See the section called “CompletableFuture” for more information.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public SessionFactory<LsEntry> sftpSessionFactory() {
        DefaultSftpSessionFactory factory = new DefaultSftpSessionFactory(true);
        factory.setHost("localhost");
        factory.setPort(port);
        factory.setUser("foo");
        factory.setPassword("foo");
        factory.setAllowUnknownKeys(true);
        return new CachingSessionFactory<LsEntry>(factory);
    }

    @Bean
    public SftpInboundFileSynchronizer sftpInboundFileSynchronizer() {
        SftpInboundFileSynchronizer fileSynchronizer = new
 SftpInboundFileSynchronizer(sftpSessionFactory());
        fileSynchronizer.setDeleteRemoteFiles(false);
        fileSynchronizer.setRemoteDirectory("foo");
        fileSynchronizer.setFilter(new SftpSimplePatternFileListFilter("*.xml"));
        return fileSynchronizer;
    }

    @Bean
    @InboundChannelAdapter(channel = "sftpChannel", poller = @Poller(fixedDelay = "5000"))
    public MessageSource<File> sftpMessageSource() {
        SftpInboundFileSynchronizingMessageSource source =
                new SftpInboundFileSynchronizingMessageSource(sftpInboundFileSynchronizer());
        source.setLocalDirectory(new File("sftp-inbound"));
        source.setAutoCreateLocalDirectory(true);
        source.setLocalFilter(new AcceptOnceFileListFilter<File>());
        source.setMaxFetchSize(1);
        return source;
    }

    @Bean
    @ServiceActivator(inputChannel = "sftpChannel")
    public MessageHandler handler() {
        return new MessageHandler() {

            @Override
            public void handleMessage(Message<?> message) throws MessagingException {
                System.out.println(message.getPayload());
            }

        };
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the inbound adapter using the Java DSL:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow sftpInboundFlow() {
        return IntegrationFlows
            .from(s -> s.sftp(this.sftpSessionFactory)
                    .preserveTimestamp(true)
                    .remoteDirectory("foo")
                    .regexFilter(".*\\.txt$")
                    .localFilenameExpression("#this.toUpperCase() + '.a'")
                    .localDirectory(new File("sftp-inbound")),
                 e -> e.id("sftpInboundAdapter")
                    .autoStartup(true)
                    .poller(Pollers.fixedDelay(5000)))
            .handle(m -> System.out.println(m.getPayload()))
            .get();
    }
}
```

==== Dealing With Incomplete Data

See the section called “CompletableFuture”.

The `SftpSystemMarkerFilePresentFileListFilter` is provided to filter remote files that don’t have the corresponding marker file on the remote system. See the javadocs for configuration information.

=== SFTP Streaming Inbound Channel Adapter

The streaming inbound channel adapter was introduced in *version 4.3*. This adapter produces message with payloads of type `InputStream`, allowing files to be fetched without writing to the local file system. Since the session remains open, the consuming application is responsible for closing the session when the file has been consumed. The session is provided in the `closeableResource` header (`IntegrationMessageHeaderAccessor.CLOSEABLE_RESOURCE`). Standard framework components, such as the `FileSplitter` and `StreamTransformer` will automatically close the session. See the section called “CompletableFuture” and the section called “Stream Transformer” for more information about these components.

```
<int-sftp:inbound-streaming-channel-adapter id="ftpInbound"
            channel="ftpChannel"
            session-factory="sessionFactory"
            filename-pattern="*.txt"
            filename-regex=".*\.txt"
            filter="filter"
            filter-expression="@myFilterBean.check(#root)"
            remote-file-separator="/"
            comparator="comparator"
            max-fetch-size="1"
            remote-directory-expression="'foo/bar'">
        <int:poller fixed-rate="1000" />
</int-sftp:inbound-streaming-channel-adapter>
```

Only one of `filename-pattern`, `filename-regex`, `filter` or `filter-expression` is allowed.

Important

Starting with *version 5.0*, by default, the `SftpStreamingMessageSource` adapter prevents duplicates for remote files via `SftpPersistentAcceptOnceFileListFilter` based on the in-memory `SimpleMetadataStore`. This filter is also applied by default together with the filename pattern (or regex) as well. If there is a requirement to allow duplicates, the `AcceptAllFileListFilter` can be used. Any other use-cases can be reached via `CompositeFileListFilter` (or `ChainFileListFilter`). The java configuration below shows one technique to remove the remote file after processing, avoiding duplicates.

Use the `max-fetch-size` attribute to limit the number of files fetched on each poll when a fetch is necessary; set to 1 and use a persistent filter when running in a clustered environment; see the section called "CompletableFuture" for more information.

The adapter puts the remote directory and file name in headers `FileHeaders.REMOTE_DIRECTORY` and `FileHeaders.REMOTE_FILE` respectively. Starting with *version 5.0*, additional remote file information, in JSON, is provided in the `FileHeaders.REMOTE_FILE_INFO` header. If you set the `fileInfoJson` property on the `SftpStreamingMessageSource` to `false`, the header will contain an `SftpFileInfo` object. The `LsEntry` object provided by the underlying Jsch library can be accessed using the `SftpFileInfo.getFileInfo()` method. The `fileInfoJson` property is not available when using XML configuration but you can set it by injecting the `SftpStreamingMessageSource` into one of your configuration classes.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the inbound adapter using Java configuration:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    @InboundChannelAdapter(channel = "stream")
    public MessageSource<InputStream> ftpMessageSource() {
        SftpStreamingMessageSource messageSource = new SftpStreamingMessageSource(template());
        messageSource.setRemoteDirectory("sftpSource/");
        messageSource.setFilter(new AcceptAllFileListFilter<>());
        messageSource.setMaxFetchSize(1);
        return messageSource;
    }

    @Bean
    @Transformer(inputChannel = "stream", outputChannel = "data")
    public org.springframework.integration.transformer.Transformer transformer() {
        return new StreamTransformer("UTF-8");
    }

    @Bean
    public SftpRemoteFileTemplate template() {
        return new SftpRemoteFileTemplate(sftpSessionFactory());
    }

    @ServiceActivator(inputChannel = "data", adviceChain = "after")
    @Bean
    public MessageHandler handle() {
        return System.out::println;
    }

    @Bean
    public ExpressionEvaluatingRequestHandlerAdvice after() {
        ExpressionEvaluatingRequestHandlerAdvice advice = new
 ExpressionEvaluatingRequestHandlerAdvice();
        advice.setOnSuccessExpression(
                "@template.remove(headers['file_remoteDirectory'] + headers['file_remoteFile'])");
        advice.setPropagateEvaluationFailures(true);
        return advice;
    }

}
```

Notice that, in this example, the message handler downstream of the transformer has an advice that removes the remote file after processing.

=== Inbound Channel Adapters: Polling Multiple Servers and Directories

Starting with *version 5.0.7*, the `RotatingServerAdvice` is available; when configured as a poller advice, the inbound adapters can poll multiple servers and directories. Configure the advice and add it to the poller's advice chain as normal. A `DelegatingSessionFactory` is used to select the server see the section called "CompletableFuture" for more information. The advice configuration consists of a list of `RotatingServerAdvice.KeyDirectory` objects.

Example.

```
@Bean
public RotatingServerAdvice advice() {
    List<KeyDirectory> keyDirectories = new ArrayList<>();
    keyDirectories.add(new KeyDirectory("one", "foo"));
    keyDirectories.add(new KeyDirectory("one", "bar"));
    keyDirectories.add(new KeyDirectory("two", "baz"));
    keyDirectories.add(new KeyDirectory("two", "qux"));
    keyDirectories.add(new KeyDirectory("three", "fiz"));
    keyDirectories.add(new KeyDirectory("three", "buz"));
    return new RotatingServerAdvice(delegatingSf(), keyDirectories);
}
```

This advice will poll directory `foo` on server `one` until no new files exist then move to directory `bar` and then directory `baz` on server `two`, etc.

This default behavior can be modified with the `fair` constructor arg:

fair.

```
@Bean
public RotatingServerAdvice advice() {
    ...
    return new RotatingServerAdvice(delegatingSf(), keyDirectories, true);
}
```

In this case, the advice will move to the next server/directory regardless of whether the previous poll returned a file.

Alternatively, you can provide your own `RotatingServerAdvice.RotationPolicy` to reconfigure the message source as needed:

policy.

```
public interface RotationPolicy {

    void beforeReceive(MessageSource<?> source);

    void afterReceive(boolean messageReceived, MessageSource<?> source);

}
```

and

custom.

```
@Bean
public RotatingServerAdvice advice() {
    return new RotatingServerAdvice(myRotationPolicy());
}
```

The `local-filename-generator-expression` attribute (`localFilenameGeneratorExpression` on the synchronizer) can now contain the `#remoteDirectory` variable. This allows files retrieved from different directories to be downloaded to similar directories locally:

```
@Bean
public IntegrationFlow flow() {
    return IntegrationFlows.from(Ftp.inboundAdapter(sf())
                    .filter(new FtpPersistentAcceptOnceFileListFilter(new
 SimpleMetadataStore(), "rotate"))
                    .localDirectory(new File(tmpDir))
                    .localFilenameExpression("#remoteDirectory + T(java.io.File).separator + #root")
                    .remoteDirectory("."),
                e -> e.poller(Pollers.fixedDelay(1).advice(advice())))
            .channel(MessageChannels.queue("files"))
            .get();
}
```

Important

Do not configure a `TaskExecutor` on the poller when using this advice; see the section called "Conditional Pollers for Message Sources" for more information.

=== Inbound Channel Adapters: Controlling Remote File Fetching

There are two properties that should be considered when configuring inbound channel adapters. `max-messages-per-poll`, as with all pollers, can be used to limit the number of messages emitted on each poll (if more than the configured value are ready). `max-fetch-size` (since *version 5.0*) can limit the number of files retrieved from the remote server at a time.

The following scenarios assume the starting state is an empty local directory.

- `max-messages-per-poll=2` and `max-fetch-size=1`, the adapter will fetch one file, emit it, fetch the next file, emit it; then sleep until the next poll.
- `max-messages-per-poll=2` and `max-fetch-size=2`), the adapter will fetch both files, then emit each one.
- `max-messages-per-poll=2` and `max-fetch-size=4`, the adapter will fetch up to 4 files (if available) and emit the first two (if there are at least two); the next two files will be emitted on the next poll.
- `max-messages-per-poll=2` and `max-fetch-size` not specified, the adapter will fetch all remote files and emit the first two (if there are at least two); the subsequent files will be emitted on subsequent polls (2-at-a-time); when all are consumed, the remote fetch will be attempted again, to pick up any new files.

Important

When deploying multiple instances of an application, a small `max-fetch-size` is recommended to avoid one instance "grabbing" all the files and starving other instances.

Another use for `max-fetch-size` is if you want to stop fetching remote files, but continue to process files that have already been fetched. Setting the `maxFetchSize` property on the `MessageSource` (programmatically, via JMX, or via a control bus) effectively stops the adapter from fetching more files, but allows the poller to continue to emit messages for files that have previously been fetched. If the poller is active when the property is changed, the change will take effect on the next poll.

=== SFTP Outbound Channel Adapter

The *SFTP Outbound Channel Adapter* is a special `MessageHandler` that will connect to the remote directory and will initiate a file transfer for every file it will receive as the payload of an incoming `Message`.

It also supports several representations of the File so you are not limited to the File object. Similar to the FTP outbound adapter, the *SFTP Outbound Channel Adapter* supports the following payloads: 1) `java.io.File` - the actual file object; 2) `byte[]` - byte array that represents the file contents; 3) `java.lang.String` - text that represents the file contents.

```
<int-sftp:outbound-channel-adapter id="sftpOutboundAdapter"
    session-factory="sftpSessionFactory"
    channel="inputChannel"
    charset="UTF-8"
    remote-file-separator="/"
    remote-directory="foo/bar"
    remote-filename-generator-expression="payload.getName() + '-foo'"
    filename-generator="fileNameGenerator"
    use-temporary-filename="true"
    chmod="600"
    mode="REPLACE"/>
```

As you can see from the configuration above you can configure the *SFTP Outbound Channel Adapter* via the `outbound-channel-adapter` element. Please refer to the schema for more detail on these attributes.

SpEL and the SFTP Outbound Adapter

As with many other components in Spring Integration, you can benefit from the Spring Expression Language (SpEL) support when configuring an *SFTP Outbound Channel Adapter*, by specifying two attributes `remote-directory-expression` and `remote-filename-generator-expression` (see above). The expression evaluation context will have the Message as its root object, thus allowing you to provide expressions which can dynamically compute the *file name* or the existing *directory path* based on the data in the Message (either from *payload* or *headers*). In the example above we are defining the `remote-filename-generator-expression` attribute with an expression value that computes the *file name* based on its original name while also appending a suffix: *-foo*.

Starting with *version 4.1*, you can specify the `mode` when transferring the file. By default, an existing file will be overwritten; the modes are defined on `enum FileExistsMode`, having values `REPLACE` (default), `APPEND`, `IGNORE`, and `FAIL`. With `IGNORE` and `FAIL`, the file is not transferred; `FAIL` causes an exception to be thrown whereas `IGNORE` silently ignores the transfer (although a `DEBUG` log entry is produced).

Avoiding Partially Written Files

One of the common problems, when dealing with file transfers, is the possibility of processing a *partial file* - a file might appear in the file system before its transfer is actually complete.

To deal with this issue, Spring Integration SFTP adapters use a very common algorithm where files are transferred under a temporary name and than renamed once they are fully transferred.

By default, every file that is in the process of being transferred will appear in the file system with an additional suffix which, by default, is `.writing`; this can be changed using the `temporary-file-suffix` attribute.

However, there may be situations where you don't want to use this technique (for example, if the server does not permit renaming files). For situations like this, you can disable this feature by setting `use-temporary-file-name` to `false` (default is `true`). When this attribute is `false`, the file is written with its final name and the consuming application will need some other mechanism to detect that the file is completely uploaded before accessing it.

Version 4.3 introduced the `chmod` attribute which changes the remote file permissions after upload. Use the conventional Unix octal format, e.g. `600` allows read-write for the file owner only. When configuring the adapter using java, you can use `setChmodOctal("600")` or `setChmodDecimal(384)`.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the Outbound Adapter using Java configuration:

```
@SpringBootApplication
@IntegrationComponentScan
public class SftpJavaApplication {

    public static void main(String[] args) {
        ConfigurableApplicationContext context =
                    new SpringApplicationBuilder(SftpJavaApplication.class)
                        .web(false)
                        .run(args);
        MyGateway gateway = context.getBean(MyGateway.class);
        gateway.sendToSftp(new File("/foo/bar.txt"));
    }

    @Bean
    public SessionFactory<LsEntry> sftpSessionFactory() {
        DefaultSftpSessionFactory factory = new DefaultSftpSessionFactory(true);
        factory.setHost("localhost");
        factory.setPort(port);
        factory.setUser("foo");
        factory.setPassword("foo");
        factory.setAllowUnknownKeys(true);
        return new CachingSessionFactory<LsEntry>(factory);
    }

    @Bean
    @ServiceActivator(inputChannel = "toSftpChannel")
    public MessageHandler handler() {
        SftpMessageHandler handler = new SftpMessageHandler(sftpSessionFactory());
        handler.setRemoteDirectoryExpressionString("headers['remote-target-dir']");
        handler.setFileNameGenerator(new FileNameGenerator() {

            @Override
            public String generateFileName(Message<?> message) {
                 return "handlerContent.test";
            }

        });
        return handler;
    }

    @MessagingGateway
    public interface MyGateway {

         @Gateway(requestChannel = "toSftpChannel")
         void sendToSftp(File file);

    }
}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Outbound Adapter using the Java DSL:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public IntegrationFlow sftpOutboundFlow() {
        return IntegrationFlows.from("toSftpChannel")
            .handle(Sftp.outboundAdapter(this.sftpSessionFactory, FileExistsMode.FAIL)
                         .useTemporaryFileName(false)
                         .remoteDirectory("/foo")
            ).get();
    }

}
```

=== SFTP Outbound Gateway

The *SFTP Outbound Gateway* provides a limited set of commands to interact with a remote SFTP server. Commands supported are:

- ls (list files)
- nlst (list file names)
- get (retrieve file)
- mget (retrieve file(s))
- rm (remove file(s))
- mv (move/rename file)
- put (send file)
- mput (send multiple files)

ls

ls lists remote file(s) and supports the following options:

- -1 - just retrieve a list of filenames, default is to retrieve a list of `FileInfo` objects.
- -a - include all files (including those starting with .)
- -f - do not sort the list
- -dirs - include directories (excluded by default)
- -links - include symbolic links (excluded by default)
- -R - list the remote directory recursively

In addition, filename filtering is provided, in the same manner as the `inbound-channel-adapter`.

The message payload resulting from an *ls* operation is a list of file names, or a list of `FileInfo` objects. These objects provide information such as modified time, permissions etc.

The remote directory that the *ls* command acted on is provided in the `file_remoteDirectory` header.

When using the recursive option (`-R`), the `fileName` includes any subdirectory elements, representing a relative path to the file (relative to the remote directory). If the `-dirs` option is included, each recursive directory is also returned as an element in the list. In this case, it is recommended that the `-1` is not used because you would not be able to determine files Vs. directories, which is achievable using the `FileInfo` objects.

nlst

(Since *version 5.0*)

Lists remote file names and supports the following options:

- -f - do not sort the list

The message payload resulting from an *nlst* operation is a list of file names.

The remote directory that the *nlst* command acted on is provided in the `file_remoteDirectory` header.

The SFTP protocol doesn't provide *list names* functionality, s this command is fully equivalent of the *ls* command with `-1` option and added here for convenience.

get

get retrieves a remote file and supports the following option:

- -P - preserve the timestamp of the remote file.
- -stream - retrieve the remote file as a stream.
- -D - delete the remote file after successful transfer. The remote file is NOT deleted if the transfer is ignored because the `FileExistsMode` is `IGNORE` and the local file already exists.

The remote directory is provided in the `file_remoteDirectory` header, and the filename is provided in the `file_remoteFile` header.

The message payload resulting from a *get* operation is a `File` object representing the retrieved file, or an `InputStream` when the `-stream` option is provided. This option allows retrieving the file as a stream. For text files, a common use case is to combine this operation with a File Splitter or Stream Transformer. When consuming remote files as streams, the user is responsible for closing the `Session` after the stream is consumed. For convenience, the `Session` is provided in the `closeableResource` header, a convenience method is provided on the `IntegrationMessageHeaderAccessor`:

```
Closeable closeable = new IntegrationMessageHeaderAccessor(message).getCloseableResource();
if (closeable != null) {
    closeable.close();
}
```

Framework components such as the File Splitter and Stream Transformer will automatically close the session after the data is transferred.

The following shows an example of consuming a file as a stream:

```
<int-sftp:outbound-gateway session-factory="ftpSessionFactory"
                            request-channel="inboundGetStream"
                            command="get"
                            command-options="-stream"
                            expression="payload"
                            remote-directory="ftpTarget"
                            reply-channel="stream" />

<int-file:splitter input-channel="stream" output-channel="lines" />
```

Note: if you consume the input stream in a custom component, you **must** close the `Session`. You can either do that in your custom code, or route a copy of the message to a `service-activator` and use SpEL:

```
<int:service-activator input-channel="closeSession"
    expression="headers['closeableResource'].close()" />
```

mget

mget retrieves multiple remote files based on a pattern and supports the following options:

- -P - preserve the timestamps of the remote files.
- -R - retrieve the entire directory tree recursively.
- -x - Throw an exception if no files match the pattern (otherwise an empty list is returned).
- -D - delete each remote file after successful transfer. The remote file is NOT deleted if the transfer is ignored because the `FileExistsMode` is `IGNORE` and the local file already exists.

The message payload resulting from an *mget* operation is a `List<File>` object - a List of File objects, each representing a retrieved file.

> **Important**
>
> Starting with *version 5.0*, if the `FileExistsMode` is `IGNORE`, the payload of the output message will no longer contain files that were not fetched due to the file already existing. Previously, the array contained all files, including those that already existed.

The expression used to determine the remote path should produce a result that ends with `*` - e.g. `foo/*` will fetch the complete tree under `foo`.

Starting with *version 5.0*, a recursive `MGET`, combined with the new `FileExistsMode.REPLACE_IF_MODIFIED` mode, can be used to periodically synchronize an entire remote directory tree locally. This mode will set the local file last modified timestamp to the remote file timestamp, regardless of the `-P` (preserve timestamp) option.

> **Notes for when using recursion (`-R`)**
>
> The pattern is ignored, and `*` is assumed. By default, the entire remote tree is retrieved. However, files in the tree can be filtered, by providing a `FileListFilter`; directories in the tree can also be filtered this way. A `FileListFilter` can be provided by reference or by `filename-pattern` or `filename-regex` attributes. For example, `filename-regex="(subDir|.*1.txt)"` will retrieve all files ending with `1.txt` in the remote directory and the subdirectory `subDir`. However, see below for an alternative available in *version 5.0*.
>
> If a subdirectory is filtered, no additional traversal of that subdirectory is performed.

> The `-dirs` option is not allowed (the recursive mget uses the recursive `ls` to obtain the directory tree and the directories themselves cannot be included in the list).
>
> Typically, you would use the `#remoteDirectory` variable in the `local-directory-expression` so that the remote directory structure is retained locally.

Starting with *version 5.0*, the `SftpSimplePatternFileListFilter` and `SftpRegexPatternFileListFilter` can be configured to always pass directories by setting the `alwaysAcceptDirectorties` to `true`. This allows recursion for a simple pattern; examples follow:

```xml
<bean id="starDotTxtFilter"
            class="org.springframework.integration.sftp.filters.SftpSimplePatternFileListFilter">
    <constructor-arg value="*.txt" />
    <property name="alwaysAcceptDirectories" value="true" />
</bean>

<bean id="dotStarDotTxtFilter"
            class="org.springframework.integration.sftp.filters.SftpRegexPatternFileListFilter">
    <constructor-arg value="^.*\.txt$" />
    <property name="alwaysAcceptDirectories" value="true" />
</bean>
```

and provide one of these filters using `filter` property on the gateway.

See also the section called "CompletableFuture"

put

put sends a file to the remote server; the payload of the message can be a `java.io.File`, a `byte[]` or a `String`. A `remote-filename-generator` (or expression) is used to name the remote file. Other available attributes include `remote-directory`, `temporary-remote-directory` (and their `*-expression`) equivalents, `use-temporary-file-name`, and `auto-create-directory`. Refer to the schema documentation for more information.

The message payload resulting from a *put* operation is a `String` representing the full path of the file on the server after transfer.

Version 4.3 introduced the `chmod` attribute which changes the remote file permissions after upload. Use the conventional Unix octal format, e.g. `600` allows read-write for the file owner only. When configuring the adapter using java, you can use `setChmod(0600)`.

mput

mput sends multiple files to the server and supports the following option:

- -R - Recursive - send all files (possibly filtered) in the directory and subdirectories

The message payload must be a `java.io.File` representing a local directory.

The same attributes as the `put` command are supported. In addition, files in the local directory can be filtered with one of `mput-pattern`, `mput-regex`, `mput-filter` or `mput-filter-expression`. The filter works with recursion, as long as the subdirectories themselves pass the filter. Subdirectories that do not pass the filter are not recursed.

The message payload resulting from an *mget* operation is a `List<String>` object - a List of remote file paths resulting from the transfer.

See also the section called "CompletableFuture"

Version 4.3 introduced the `chmod` attribute which changes the remote file permissions after upload. Use the conventional Unix octal format, e.g. `600` allows read-write for the file owner only. When configuring the adapter using java, you can use `setChmodOctal("600")` or `setChmodDecimal(384)`.

rm

The *rm* command has no options.

The message payload resulting from an *rm* operation is Boolean.TRUE if the remove was successful, Boolean.FALSE otherwise. The remote directory is provided in the `file_remoteDirectory` header, and the filename is provided in the `file_remoteFile` header.

mv

The *mv* command has no options.

The *expression* attribute defines the "from" path and the *rename-expression* attribute defines the "to" path. By default, the *rename-expression* is `headers['file_renameTo']`. This expression must not evaluate to null, or an empty `String`. If necessary, any remote directories needed will be created. The payload of the result message is `Boolean.TRUE`. The original remote directory is provided in the `file_remoteDirectory` header, and the filename is provided in the `file_remoteFile` header. The new path is in the `file_renameTo` header.

Additional Information

The *get* and *mget* commands support the *local-filename-generator-expression* attribute. It defines a SpEL expression to generate the name of local file(s) during the transfer. The root object of the evaluation context is the request Message but, in addition, the `remoteFileName` variable is also available, which is particularly useful for *mget*, for example: `local-filename-generator-expression="#remoteFileName.toUpperCase() + headers.foo"`

The *get* and *mget* commands support the *local-directory-expression* attribute. It defines a SpEL expression to generate the name of local directory(ies) during the transfer. The root object of the evaluation context is the request Message but, in addition, the `remoteDirectory` variable is also available, which is particularly useful for *mget*, for example: `local-directory-expression="'/tmp/local/' + #remoteDirectory.toUpperCase() + headers.foo"`. This attribute is mutually exclusive with *local-directory* attribute.

For all commands, the PATH that the command acts on is provided by the *expression* property of the gateway. For the mget command, the expression might evaluate to *, meaning retrieve all files, or* somedirectory/ etc.

Here is an example of a gateway configured for an ls command…

```xml
<int-ftp:outbound-gateway id="gateway1"
        session-factory="ftpSessionFactory"
        request-channel="inbound1"
        command="ls"
        command-options="-1"
        expression="payload"
        reply-channel="toSplitter"/>
```

The payload of the message sent to the toSplitter channel is a list of String objects containing the filename of each file. If the `command-options` was omitted, it would be a list of `FileInfo` objects. Options are provided space-delimited, e.g. `command-options="-1 -dirs -links"`.

Starting with *version 4.2*, the `GET`, `MGET`, `PUT` and `MPUT` commands support a `FileExistsMode` property (`mode` when using the namespace support). This affects the behavior when the local file exists (`GET` and `MGET`) or the remote file exists (`PUT` and `MPUT`). Supported modes are `REPLACE`, `APPEND`, `FAIL` and `IGNORE`. For backwards compatibility, the default mode for `PUT` and `MPUT` operations is `REPLACE` and for `GET` and `MGET` operations, the default is `FAIL`.

==== Configuring with Java Configuration

The following Spring Boot application provides an example of configuring the Outbound Gateway using Java configuration:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    @ServiceActivator(inputChannel = "sftpChannel")
    public MessageHandler handler() {
        return new SftpOutboundGateway(ftpSessionFactory(), "ls", "'my_remote_dir/'");
    }

}
```

==== Configuring with the Java DSL

The following Spring Boot application provides an example of configuring the Outbound Gateway using the Java DSL:

```
@SpringBootApplication
public class SftpJavaApplication {

    public static void main(String[] args) {
        new SpringApplicationBuilder(SftpJavaApplication.class)
            .web(false)
            .run(args);
    }

    @Bean
    public SessionFactory<LsEntry> sftpSessionFactory() {
        DefaultFtpSessionFactory sf = new DefaultFtpSessionFactory();
        sf.setHost("localhost");
        sf.setPort(port);
        sf.setUsername("foo");
        sf.setPassword("foo");
        return new CachingSessionFactory<LsEntry>(sf);
    }

    @Bean
    public QueueChannelSpec remoteFileOutputChannel() {
        return MessageChannels.queue();
    }

    @Bean
    public IntegrationFlow sftpMGetFlow() {
        return IntegrationFlows.from("sftpMgetInputChannel")
            .handleWithAdapter(h ->
                h.sftpGateway(sftpSessionFactory(), AbstractRemoteFileOutboundGateway.Command.MGET,
                    "payload")
                    .options(AbstractRemoteFileOutboundGateway.Option.RECURSIVE)
                    .regexFileNameFilter("(subSftpSource|.*1.txt)")
                    .localDirectoryExpression("'myDir/' + #remoteDirectory")
                    .localFilenameExpression("#remoteFileName.replaceFirst('sftpSource',
 'localTarget')"))
            .channel("remoteFileOutputChannel")
            .get();
    }

}
```

==== Outbound Gateway Partial Success (mget and mput)

When performing operations on multiple files (`mget` and `mput`) it is possible that an exception occurs some time after one or more files have been transferred. In this case (starting with *version 4.2*), a `PartialSuccessException` is thrown. As well as the usual `MessagingException` properties (`failedMessage` and `cause`), this exception has two additional properties:

- `partialResults` - the successful transfer results.
- `derivedInput` - the list of files generated from the request message (e.g. local files to transfer for an `mput`).

This will enable you to determine which files were successfully transferred, and which were not.

In the case of a recursive `mput`, the `PartialSuccessException` may have nested `PartialSuccessException` s.

Consider:

```
root/
|- file1.txt
|- subdir/
   | - file2.txt
   | - file3.txt
|- zoo.txt
```

If the exception occurs on `file3.txt`, the `PartialSuccessException` thrown by the gateway will have `derivedInput` of `file1.txt`, `subdir`, `zoo.txt` and `partialResults` of `file1.txt`. It's `cause` will be another `PartialSuccessException` with `derivedInput` of `file2.txt`, `file3.txt` and `partialResults` of `file2.txt`.

=== SFTP/JSCH Logging

Since we use JSch libraries (http://www.jcraft.com/jsch/) to provide SFTP support, at times you may require more information from the JSch API itself, especially if something is not working properly (e.g., Authentication exceptions). Unfortunately JSch does not use commons-logging but instead relies on custom implementations of their `com.jcraft.jsch.Logger` interface. As of Spring Integration 2.0.1, we have implemented this interface. So, now all you need to do to enable JSch logging is to configure your logger the way you usually do. For example, here is valid configuration of a logger using Log4J.

```
log4j.category.com.jcraft.jsch=DEBUG
```

=== MessageSessionCallback

Starting with *Spring Integration version 4.2*, a `MessageSessionCallback<F, T>` implementation can be used with the `<int-sftp:outbound-gateway/>` (`SftpOutboundGateway`) to perform any operation(s) on the `Session<LsEntry>` with the `requestMessage` context. It can be used for any non-standard or low-level FTP operation (or several); for example, allowing access from an integration flow definition, and *functional* interface (Lambda) implementation injection:

```
@Bean
@ServiceActivator(inputChannel = "sftpChannel")
public MessageHandler sftpOutboundGateway(SessionFactory<ChannelSftp.LsEntry> sessionFactory) {
    return new SftpOutboundGateway(sessionFactory,
         (session, requestMessage) -> session.list(requestMessage.getPayload()));
}
```

Another example might be to pre- or post- process the file data being sent/retrieved.

When using XML configuration, the `<int-sftp:outbound-gateway/>` provides a `session-callback` attribute to allow you to specify the `MessageSessionCallback` bean name.

Note

The `session-callback` is mutually exclusive with the `command` and `expression` attributes. When configuring with Java, different constructors are available in the `SftpOutboundGateway` class.

== STOMP Support

=== Introduction

Spring Integration *version 4.2* introduced *STOMP Client* support. It is based on the architecture, infrastructure and API from the Spring Framework's *messaging* module, *stomp* package. Many of Spring STOMP components (e.g. `StompSession` or `StompClientSupport`) are used within Spring Integration. For more information, please, refer to the Spring Framework STOMP Support chapter in the Spring Framework reference manual.

=== Overview

To configure STOMP (Simple [or Streaming] Text Orientated Messaging Protocol) let's start with the *STOMP Client* object. The Spring Framework provides these implementations:

- `WebSocketStompClient` - built on the Spring WebSocket API with support for standard JSR-356 WebSocket, Jetty 9, as well as SockJS for HTTP-based WebSocket emulation with SockJS Client.
- `ReactorNettyTcpStompClient` - built on `ReactorNettyTcpClient` from the `reactor-netty` project.

Any other `StompClientSupport` implementation can be provided. See the JavaDocs of those classes for more information.

The `StompClientSupport` class is designed as a *factory* to produce a `StompSession` for the provided `StompSessionHandler` and all the remaining work is done through the *callbacks* to that `StompSessionHandler` and `StompSession` abstraction. With the Spring Integration *adapter* abstraction, we need to provide some managed shared object to represent our application as a STOMP client with its unique session. For this purpose, Spring Integration provides the `StompSessionManager` abstraction to manage the *single* `StompSession` between any provided `StompSessionHandler`. This allows the use of *inbound* or *outbound* channel adapters (or both) for the particular STOMP Broker. See `StompSessionManager` (and its implementations) JavaDocs for more information.

=== STOMP Inbound Channel Adapter

The `StompInboundChannelAdapter` is a one-stop `MessageProducer` component to subscribe our Spring Integration application to the provided STOMP destinations and receive messages from them, converted from the STOMP frames using the provided `MessageConverter` on the connected `StompSession`. The destinations (and therefore STOMP subscriptions) can be changed at runtime using appropriate `@ManagedOperation` s on the `StompInboundChannelAdapter`.

For more configuration options see the section called “CompletableFuture” and the `StompInboundChannelAdapter` JavaDocs.

=== STOMP Outbound Channel Adapter

The `StompMessageHandler` is the `MessageHandler` for the `<int-stomp:outbound-channel-adapter>` to send the outgoing `Message<?>` s to the STOMP `destination` (pre-configured or determined at runtime via a SpEL expression) STOMP through the `StompSession`, provided by the shared `StompSessionManager`.

For more configuration option see the section called “CompletableFuture” and the `StompMessageHandler` JavaDocs.

=== STOMP Headers Mapping

The STOMP protocol provides *headers* as part of frame; the entire structure of the STOMP frame has this format:

```
COMMAND
header1:value1
header2:value2

Body^@
```

Spring Framework provides `StompHeaders`, to represent these headers. See the JavaDocs for more details. STOMP frames are converted to/from `Message<?>` and these headers are mapped to/from `MessageHeaders`. Spring Integration provides a default `HeaderMapper` implementation for the

STOMP adapters. The implementation is `StompHeaderMapper` which provides `fromHeaders()` and `toHeaders()` operations for the *inbound* and *outbound* adapters respectively.

As with many other Spring Integration modules, the `IntegrationStompHeaders` class has been introduced to map standard STOMP headers to `MessageHeaders` with `stomp_` as the header name prefix. In addition, all `MessageHeaders` with that prefix are mapped to the `StompHeaders` when sending to a destination.

For more information, see the JavaDocs of those classes and the `mapped-headers` attribute description in the the section called “CompletableFuture”.

=== STOMP Integration Events

Many STOMP operations are asynchronous, including error handling. For example, STOMP has a `RECEIPT` server frame that is returned when a client frame has requested one by adding the `RECEIPT` header. To provide access to these asynchronous events, Spring Integration emits `StompIntegrationEvent` s which can be obtained by implementing an `ApplicationListener` or using an `<int-event:inbound-channel-adapter>` (see the section called “CompletableFuture”).

Specifically, a `StompExceptionEvent` is emitted from the `AbstractStompSessionManager`, when a `stompSessionListenableFuture` receives `onFailure()` in case of failure to connect to STOMP Broker. Another example is the `StompMessageHandler` which processes `ERROR` STOMP frames, which are server responses to improper, unaccepted, messages sent by this `StompMessageHandler`.

The `StompReceiptEvent s` are emitted from the `StompMessageHandler` as a part of `StompSession.Receiptable` callbacks in the asynchronous answers for the sent messages to the `StompSession`. The `StompReceiptEvent` can be positive and negative depending on whether or not the `RECEIPT` frame was received from the server within the `receiptTimeLimit` period, which can be configured on the `StompClientSupport` instance. Defaults to `15 * 1000`.

> **Note**
>
> The `StompSession.Receiptable` callbacks are added only if the `RECEIPT` STOMP header of the message to send is not `null`. Automatic `RECEIPT` header generation can be enabled on the `StompSession` through its `autoReceipt` option and on the `StompSessionManager` respectively.

See the next paragraph for more information how to configure Spring Integration to accept those `ApplicationEvent` s.

=== STOMP Adapters Java Configuration

A comprehensive Java & Annotation Configuration for STOMP Adapters may look like this:

```
@Configuration
@EnableIntegration
public class StompConfiguration {

    @Bean
    public ReactorNettyTcpStompClient stompClient() {
        ReactorNettyTcpStompClient stompClient = new ReactorNettyTcpStompClient("127.0.0.1", 61613);
        stompClient.setMessageConverter(new PassThruMessageConverter());
        ThreadPoolTaskScheduler taskScheduler = new ThreadPoolTaskScheduler();
        taskScheduler.afterPropertiesSet();
        stompClient.setTaskScheduler(taskScheduler);
        stompClient.setReceiptTimeLimit(5000);
        return stompClient;
    }

    @Bean
    public StompSessionManager stompSessionManager() {
        ReactorNettyTcpStompSessionManager stompSessionManager = new
 ReactorNettyTcpStompSessionManager(stompClient());
        stompSessionManager.setAutoReceipt(true);
        return stompSessionManager;
    }

    @Bean
    public PollableChannel stompInputChannel() {
        return new QueueChannel();
    }

    @Bean
    public StompInboundChannelAdapter stompInboundChannelAdapter() {
        StompInboundChannelAdapter adapter =
          new StompInboundChannelAdapter(stompSessionManager(), "/topic/myTopic");
        adapter.setOutputChannel(stompInputChannel());
        return adapter;
    }

    @Bean
    @ServiceActivator(inputChannel = "stompOutputChannel")
    public MessageHandler stompMessageHandler() {
        StompMessageHandler handler = new StompMessageHandler(stompSessionManager());
        handler.setDestination("/topic/myTopic");
        return handler;
    }

    @Bean
    public PollableChannel stompEvents() {
        return new QueueChannel();
    }

    @Bean
    public ApplicationListener<ApplicationEvent> stompEventListener() {
        ApplicationEventListeningMessageProducer producer = new
 ApplicationEventListeningMessageProducer();
        producer.setEventTypes(StompIntegrationEvent.class);
        producer.setOutputChannel(stompEvents());
        return producer;
    }

}
```

=== STOMP Namespace Support

Spring Integration *STOMP* namespace implements the *inbound* and *outbound* channel adapter components described below. To include it in your configuration, simply provide the following namespace declaration in your application context configuration file:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-stomp="http://www.springframework.org/schema/integration/stomp"
  xsi:schemaLocation="
    http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/stomp
    https://www.springframework.org/schema/integration/stomp/spring-integration-stomp.xsd">
    ...
</beans>
```

<int-stomp:outbound-channel-adapter>

```
<int-stomp:outbound-channel-adapter
                           id=""  ❶
                           channel=""  ❷
                           stomp-session-manager=""  ❸
                           header-mapper=""  ❹
                           mapped-headers=""  ❺
                           destination=""  ❻
                           destination-expression=""  ❼
                           auto-startup=""  ❽
                           phase=""/>  ❾
```

❶ The component bean name. The `MessageHandler` is registered with the bean alias `id + '.handler'`. If the `channel` attribute isn't provided, a `DirectChannel` is created and registered with the application context with this `id` attribute as the bean name. In this case, the endpoint is registered with the bean name `id + '.adapter'`.

❷ Identifies the channel attached to this adapter. *Optional* - if `id` is present - see `id`.

❸ Reference to a `StompSessionManager` bean, which encapsulates the low-level connection and `StompSession` handling operations. *Required*.

❹ Reference to a bean implementing `HeaderMapper<StompHeaders>` that maps Spring Integration MessageHeaders to/from STOMP frame headers. This is mutually exclusive with `mapped-headers`. Defaults to `StompHeaderMapper`.

❺ Comma-separated list of names of STOMP Headers to be mapped to the STOMP frame headers. This can only be provided if the `header-mapper` reference is not set. The values in this list can also be simple patterns to be matched against the header names (e.g. "foo*" or "*foo"). A special token `STOMP_OUTBOUND_HEADERS` represents all the standard STOMP headers (content-length, receipt, heart-beat etc); they are included by default. If you wish to add your own headers, you must also include this token if you wish the standard headers to also be mapped or provide your own `HeaderMapper` implementation using `header-mapper`.

❻ Name of the destination to which STOMP Messages will be sent. Mutually exclusive with the `destination-expression`.

❼ A SpEL expression to be evaluated at runtime against each Spring Integration `Message` as the root object. Mutually exclusive with the `destination`.

❽ Boolean value indicating whether this endpoint should start automatically. Default to `true`.

❾ The lifecycle phase within which this endpoint should start and stop. The lower the value the earlier this endpoint will start and the later it will stop. The default is `Integer.MIN_VALUE`. Values can be negative. See `SmartLifeCycle`.

<int-stomp:inbound-channel-adapter>

```
<int-stomp:inbound-channel-adapter
                            id=""  ❶
                            channel=""  ❷
                            error-channel=""  ❸
                            stomp-session-manager=""  ❹
                            header-mapper=""  ❺
                            mapped-headers=""  ❻
                            destinations=""  ❼
                            send-timeout=""  ❽
                            payload-type=""  ❾
                            auto-startup=""  ❿
                            phase=""/>  11
```

❶ The component bean name. If the `channel` attribute isn't provided, a `DirectChannel` is created and registered with the application context with this `id` attribute as the bean name. In this case, the endpoint is registered with the bean name `id + '.adapter'`.

❷ Identifies the channel attached to this adapter.

❸ The `MessageChannel` bean reference to which the `ErrorMessages` should be sent.

❹ See the same option on the `<int-stomp:outbound-channel-adapter>`.

❺ Comma-separated list of names of STOMP Headers to be mapped from the STOMP frame headers. This can only be provided if the `header-mapper` reference is not set. The values in this list can also be simple patterns to be matched against the header names (e.g. "foo*" or "*foo"). A special token `STOMP_INBOUND_HEADERS` represents all the standard STOMP headers (content-length, receipt, heart-beat etc); they are included by default. If you wish to add your own headers, you must also include this token if you wish the standard headers to also be mapped or provide your own `HeaderMapper` implementation using `header-mapper`.

❻ See the same option on the `<int-stomp:outbound-channel-adapter>`.

❼ Comma-separated list of STOMP destination names to subscribe. The list of destinations (and therefore subscriptions) can be modified at runtime through the `addDestination()` and `removeDestination()` `@ManagedOperation` s.

❽ Maximum amount of time in milliseconds to wait when sending a message to the channel if the channel may block. For example, a `QueueChannel` can block until space is available if its maximum capacity has been reached.

❾ Fully qualified name of the java type for the target `payload` to convert from the incoming STOMP Frame. Default to `String.class`.

❿ See the same option on the `<int-stomp:outbound-channel-adapter>`.

11 See the same option on the `<int-stomp:outbound-channel-adapter>`.

== Stream Support

=== Introduction

In many cases application data is obtained from a stream. It is *not* recommended to send a reference to a Stream as a message payload to a consumer. Instead messages are created from data that is read from an input stream and message payloads are written to an output stream one by one.

=== Reading from streams

Spring Integration provides two adapters for streams. Both `ByteStreamReadingMessageSource` and `CharacterStreamReadingMessageSource` implement `MessageSource`. By configuring one of these within a channel-adapter element, the polling period can be configured, and the Message Bus can automatically detect and schedule them. The byte stream version requires an `InputStream`, and the character stream version requires a `Reader` as the single constructor argument. The

`ByteStreamReadingMessageSource` also accepts the *bytesPerMessage* property to determine how many bytes it will attempt to read into each `Message`. The default value is 1024.

```
<bean class="org.springframework.integration.stream.ByteStreamReadingMessageSource">
  <constructor-arg ref="someInputStream"/>
  <property name="bytesPerMessage" value="2048"/>
</bean>

<bean class="org.springframework.integration.stream.CharacterStreamReadingMessageSource">
  <constructor-arg ref="someReader"/>
</bean>
```

The `CharacterStreamReadingMessageSource` wraps the reader in a `BufferedReader` (if it's not one already). You can set the buffer size used by the buffered reader in the second constructor argument. Starting with *version 5.0*, a third constructor argument (`blockToDetectEOF`) controls the behavior of the `CharacterStreamReadingMessageSource`. When `false` (default), the `receive()` method checks if the reader is `ready()` and returns null if not. EOF is not detected in this case. When `true`, the `receive()` method blocks until data is available, or EOF is detected on the underlying stream. When EOF is detected, a `StreamClosedEvent` (application event) is published; you can consume this event with a bean implementing `ApplicationListener<StreamClosedEvent>`.

Note

To facilitate EOF detection, the poller thread will block in the `receive()` method until either data arrives or EOF is detected.

Important

The poller will continue to publish an event on each poll once EOF has been detected; the application listener can stop the adapter to prevent this. The event is published on the poller thread and stopping the adapter will cause the thread to be interrupted. If you intend to perform some interruptible task after stopping the adapter, you must either perform the `stop()` on a different thread, or use a different thread for those downstream activities. Note that sending to a `QueueChannel` is interruptible so if you wish to send a message from the listener, do it before stopping the adapter.

This facilitates "piping" or redirecting data to `stdin`, such as…

```
cat foo.txt | java -jar my.jar
```

or

```
java -jar my.jar < foo.txt
```

allowing the application to terminate when the pipe is closed.

Four convenient factory methods are available:

```
public static final CharacterStreamReadingMessageSource stdin() { ... }

public static final CharacterStreamReadingMessageSource stdin(String charsetName) { ... }

public static final CharacterStreamReadingMessageSource stdinPipe() { ... }

public static final CharacterStreamReadingMessageSource stdinPipe(String charsetName) { ... }
```

=== Writing to streams

For target streams, there are also two implementations: `ByteStreamWritingMessageHandler` and `CharacterStreamWritingMessageHandler`. Each requires a single constructor argument - `OutputStream` for byte streams or `Writer` for character streams, and each provides a second constructor that adds the optional *bufferSize*. Since both of these ultimately implement the `MessageHandler` interface, they can be referenced from a *channel-adapter* configuration as described in more detail in Section 4.3, “Channel Adapter”.

```
<bean class="org.springframework.integration.stream.ByteStreamWritingMessageHandler">
  <constructor-arg ref="someOutputStream"/>
  <constructor-arg value="1024"/>
</bean>

<bean class="org.springframework.integration.stream.CharacterStreamWritingMessageHandler">
  <constructor-arg ref="someWriter"/>
</bean>
```

=== Stream namespace support

To reduce the configuration needed for stream related channel adapters there is a namespace defined. The following schema locations are needed to use it.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans:beans xmlns:int-stream="http://www.springframework.org/schema/integration/stream"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:beans="http://www.springframework.org/schema/beans"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
      https://www.springframework.org/schema/beans/spring-beans.xsd
      http://www.springframework.org/schema/integration/stream
      https://www.springframework.org/schema/integration/stream/spring-integration-stream.xsd">
```

To configure the inbound channel adapter the following code snippet shows the different configuration options that are supported.

```
<int-stream:stdin-channel-adapter id="adapterWithDefaultCharset"/>

<int-stream:stdin-channel-adapter id="adapterWithProvidedCharset" charset="UTF-8"/>
```

Starting with *version 5.0* you can set the `detect-eof` attribute which sets the `blockToDetectEOF` property - see the section called “CompletableFuture” for more information.

To configure the outbound channel adapter you can use the namespace support as well. The following code snippet shows the different configuration for an outbound channel adapters.

```
<int-stream:stdout-channel-adapter id="stdoutAdapterWithDefaultCharset"
    channel="testChannel"/>

<int-stream:stdout-channel-adapter id="stdoutAdapterWithProvidedCharset" charset="UTF-8"
    channel="testChannel"/>

<int-stream:stderr-channel-adapter id="stderrAdapter" channel="testChannel"/>

<int-stream:stdout-channel-adapter id="newlineAdapter" append-newline="true"
    channel="testChannel"/>
```

== Syslog Support

=== Introduction

Spring Integration 2.2 introduced the Syslog transformer `SyslogToMapTransformer`. This transformer, together with a `UDP` or `TCP` inbound adapter could be used to receive and analyze syslog records from other hosts. The transformer creates a message payload containing a map of the elements from the syslog message.

Spring Integration 3.0 introduced convenient namespace support for configuring a Syslog inbound adapter in a single element.

Starting with *version 4.1.1*, the framework now supports the extended Syslog format, as specified in RFC 5424>. In addition, when using TCP and RFC5424, both `octet counting` and `non-transparent framing` described in RFC 6587 are supported.

=== Syslog <inbound-channel-adapter>

This element encompasses a `UDP` or `TCP` inbound channel adapter and a `MessageConverter` to convert the Syslog message to a Spring Integration message. The `DefaultMessageConverter` delegates to the `SyslogToMapTransformer`, creating a message with its payload being the `Map` of Syslog fields. In addition, all fields except the message are also made available as headers in the message, prefixed with `syslog_`. In this mode, only RFC 3164 (BSD) syslogs are supported.

Since *version 4.1*, the `DefaultMessageConverter` has a property `asMap` (default `true`); when it is `false`, the converter will leave the message payload as the original complete syslog message, in a `byte[]`, while still setting the headers.

Since *version 4.1.1*, RFC 5424 is also supported, using the `RFC5424MessageConverter`; in this case the fields are not copied as headers, unless `asMap` is set to `false`, in which case the original message is the payload and the decoded fields are headers.

Important

To use RFC 5424 with a TCP transport, additional configuration is required, to enable the different framing techniques described in RFC 6587. The adapter needs a TCP connection factory configured with a `RFC6587SyslogDeserializer`. By default, this deserializer will handle `octet counting` and `non-transparent framing`, using a linefeed (LF) to delimit syslog messages; it uses a `ByteArrayLfSerializer` when `octet counting` is not detected. To use different `non-transparent` framing, you can provide it with some other deserializer. While the deserializer can support both `octet counting` and `non-transparent framing`, only one form of the latter is supported. If `asMap` is `false` on the converter, you must set the `retainOriginal` constructor argument in the `RFC6587SyslogDeserializer`.

==== Example Configuration

```
<int-syslog:inbound-channel-adapter id="syslogIn" port="1514" />
```

A `UDP` adapter that sends messages to channel `syslogIn` (the adapter bean name is `syslogIn.adapter`). The adapter listens on port `1514`.

```
<int-syslog:inbound-channel-adapter id="syslogIn"
 channel="fromSyslog" port="1514" />
```

A `UDP` adapter that sends message to channel `fromSyslog` (the adapter bean name is `syslogIn`). The adapter listens on port `1514`.

```
<int-syslog:inbound-channel-adapter id="bar" protocol="tcp" port="1514" />
```

A `TCP` adapter that sends messages to channel `syslogIn` (the adapter bean name is `syslogIn.adapter`). The adapter listens on port `1514`.

Note the addition of the `protocol` attribute. This attribute can contain `udp` or `tcp`; it defaults to `udp`.

```
<int-syslog:inbound-channel-adapter id="udpSyslog"
 channel="fromSyslog"
 auto-startup="false"
 phase="10000"
 converter="converter"
 send-timeout="1000"
 error-channel="errors">
  <int-syslog:udp-attributes port="1514" lookup-host="false" />
</int-syslog:inbound-channel-adapter>
```

A UDP adapter that sends messages to channel `fromSyslog`. It also shows the `SmartLifecycle` attributes `auto-startup` and `phase`. It has a reference to a custom `org.springframework.integration.syslog.MessageConverter` with id `converter` and an `error-channel`. Also notice the `udp-attributes` child element. You can set various UDP attributes here, as defined in Table 8.1, “UDP Inbound Channel Adapter Attributes”.

Note

When using the `udp-attributes` element, the `port` attribute must be provided there rather than on the `inbound-channel-adapter` element itself.

```
<int-syslog:inbound-channel-adapter id="TcpSyslog"
 protocol="tcp"
 channel="fromSyslog"
 connection-factory="cf" />

<int-ip:tcp-connection-factory id="cf" type="server" port="1514" />
```

A TCP adapter that sends messages to channel `fromSyslog`. It also shows how to reference an externally defined connection factory, which can be used for advanced configuration (socket keep alive etc). For more information, see the section called “CompletableFuture”.

Note

The externally configured `connection-factory` must be of type `server` and, the port is defined there rather than on the `inbound-channel-adapter` element itself.

```
<int-syslog:inbound-channel-adapter id="rfc5424Tcp"
 protocol="tcp"
 channel="fromSyslog"
 connection-factory="cf"
 converter="rfc5424" />

<int-ip:tcp-connection-factory id="cf"
 using-nio="true"
 type="server"
 port="1514"
 deserializer="rfc6587" />

<bean id="rfc5424" class="org.springframework.integration.syslog.RFC5424MessageConverter" />

<bean id="rfc6587" class="org.springframework.integration.syslog.inbound.RFC6587SyslogDeserializer" />
```

A TCP adapter that sends messages to channel `fromSyslog`. It is configured to use the `RFC 5424` converter and is configured with a reference to an externally defined connection factory with the `RFC 6587` deserializer (required for RFC 5424).

== TCP and UDP Support

Spring Integration provides Channel Adapters for receiving and sending messages over internet protocols. Both UDP (User Datagram Protocol) and TCP (Transmission Control Protocol) adapters are provided. Each adapter provides for one-way communication over the underlying protocol. In addition, simple inbound and outbound tcp gateways are provided. These are used when two-way communication is needed.

=== Introduction

Two flavors each of UDP inbound and outbound channel adapters are provided `UnicastSendingMessageHandler` sends a datagram packet to a single destination. `UnicastReceivingChannelAdapter` receives incoming datagram packets. `MulticastSendingMessageHandler` sends (broadcasts) datagram packets to a multicast address. `MulticastReceivingChannelAdapter` receives incoming datagram packets by joining to a multicast address.

TCP inbound and outbound channel adapters are provided `TcpSendingMessageHandler` sends messages over TCP. `TcpReceivingChannelAdapter` receives messages over TCP.

An inbound TCP gateway is provided; this allows for simple request/response processing. While the gateway can support any number of connections, each connection can only process serially. The thread that reads from the socket waits for, and sends, the response before reading again. If the connection factory is configured for single use connections, the connection is closed after the socket times out.

An outbound TCP gateway is provided; this allows for simple request/response processing. If the associated connection factory is configured for single use connections, a new connection is immediately created for each new request. Otherwise, if the connection is in use, the calling thread blocks on the connection until either a response is received or a timeout or I/O error occurs.

The TCP and UDP inbound channel adapters, and the TCP inbound gateway, support the "error-channel" attribute. This provides the same basic functionality as described in the section called “Enter the GatewayProxyFactoryBean”.

=== UDP Adapters

==== Outbound (XML Configuration)

```
<int-ip:udp-outbound-channel-adapter id="udpOut"
    host="somehost"
    port="11111"
    multicast="false"
    channel="exampleChannel"/>
```

A simple UDP outbound channel adapter.

Tip

When setting multicast to true, provide the multicast address in the host attribute.

UDP is an efficient, but unreliable protocol. Two attributes are added to improve reliability. When check-length is set to true, the adapter precedes the message data with a length field (4 bytes in network byte order). This enables the receiving side to verify the length of the packet received. If a receiving system uses a buffer that is too short the contain the packet, the packet can be truncated. The length header provides a mechanism to detect this.

Starting with *version 4.3*, the `port` can be set to `0`, in which case the Operating System chooses the port; the chosen port can be discovered by invoking `getPort()` after the adapter is started and `isListening()` returns `true`.

```
<int-ip:udp-outbound-channel-adapter id="udpOut"
    host="somehost"
    port="11111"
    multicast="false"
    check-length="true"
    channel="exampleChannel"/>
```

An outbound channel adapter that adds length checking to the datagram packets.

Tip

The recipient of the packet must also be configured to expect a length to precede the actual data. For a Spring Integration UDP inbound channel adapter, set its `check-length` attribute.

The second reliability improvement allows an application-level acknowledgment protocol to be used. The receiver must send an acknowledgment to the sender within a specified time.

```
<int-ip:udp-outbound-channel-adapter id="udpOut"
    host="somehost"
    port="11111"
    multicast="false"
    check-length="true"
    acknowledge="true"
    ack-host="thishost"
    ack-port="22222"
    ack-timeout="10000"
    channel="exampleChannel"/>
```

An outbound channel adapter that adds length checking to the datagram packets and waits for an acknowledgment.

Tip

Setting acknowledge to true implies the recipient of the packet can interpret the header added to the packet containing acknowledgment data (host and port). Most likely, the recipient will be a Spring Integration inbound channel adapter.

Tip

When multicast is true, an additional attribute min-acks-for-success specifies how many acknowledgments must be received within the ack-timeout.

For even more reliable networking, TCP can be used.

Starting with *version 4.3*, the `ackPort` can be set to `0`, in which case the Operating System chooses the port.

==== Outbound (Java Configuration)

```
@Bean
@ServiceActivator(inputChannel = "udpOut")
public UnicastSendingMessageHandler handler() {
 return new UnicastSendingMessageHandler("localhost", 11111);
}
```

(or `MulticastSendingChannelAdapter` for multicast).

==== Outbound (Java DSL Configuration)

```
@Bean
public IntegrationFlow udpOutFlow() {
 return IntegrationFlows.from("udpOut")
   .handle(Udp.outboundAdapter("localhost", 1234))
   .get();
}
```

==== Inbound (XML Configuration)

```
<int-ip:udp-inbound-channel-adapter id="udpReceiver"
    channel="udpOutChannel"
    port="11111"
    receive-buffer-size="500"
    multicast="false"
    check-length="true"/>
```

A basic unicast inbound udp channel adapter.

```
<int-ip:udp-inbound-channel-adapter id="udpReceiver"
    channel="udpOutChannel"
    port="11111"
    receive-buffer-size="500"
    multicast="true"
    multicast-address="225.6.7.8"
    check-length="true"/>
```

A basic multicast inbound udp channel adapter.

By default, reverse DNS lookups are done on inbound packets to convert IP addresses to hostnames for use in message headers. In environments where DNS is not configured, this can cause delays. This default behavior can be overridden by setting the `lookup-host` attribute to "false".

==== Inbound (Java Configuration)

```
@Bean
public UnicastReceivingChannelAdapter udpIn() {
 UnicastReceivingChannelAdapter adapter = new UnicastReceivingChannelAdapter(11111);
 adapter.setOutputChannelName("udpChannel");
 return adapter;
}
```

==== Inbound (Java DSL Configuration)

```
@Bean
public IntegrationFlow udpIn() {
 return IntegrationFlows.from(Udp.inboundAdapter(11111))
   .channel("udpChannel")
   .get();
}
```

==== Server Listening Events

Starting with *version 5.0.2*, a `UdpServerListeningEvent` is emitted when an inbound adapter is started and has begun listening. This is useful when the adapter is configured to listen on port 0, meaning that the operating system chooses the port. It can also be used instead of polling `isListening()`, if you need to wait before starting some other process that will connect to the socket.

==== Advanced Outbound Configuration

The `destination-expression` and `socket-expression` options are available for the `<int-ip:udp-outbound-channel-adapter>` (`UnicastSendingMessageHandler`).

The `destination-expression` can be used as a runtime alternative to the hardcoded `host`/`port` pair to determine the destination address for the outgoing datagram packet against a `requestMessage` as the root object for the evaluation context. The expression must evaluate to an `URI`, or `String` in the URI style (see RFC-2396) or `SocketAddress`. The inbound `IpHeaders.PACKET_ADDRESS` header can be used for this expression as well. In the Framework, this header is populated by the `DatagramPacketMessageMapper`, when we receive datagrams in the `UnicastReceivingChannelAdapter` and convert them to messages. The header value is exactly the result of `DatagramPacket.getSocketAddress()` of the incoming datagram.

With the `socket-expression`, the Outbound Channel Adapter can use e.g. an Inbound Channel Adapter socket to send datagrams through same port which they were received. It's useful in a scenario when our application works as a UDP server and clients operate behind NAT. This expression must evaluate to a `DatagramSocket`. The `requestMessage` is used as the root object for the evaluation context. The `socket-expression` parameter cannot be used with parameters `multicast` and `acknowledge`.

```
<int-ip:udp-inbound-channel-adapter id="inbound" port="0" channel="in" />

<int:channel id="in" />

<int:transformer expression="new String(payload).toUpperCase()"
                       input-channel="in" output-channel="out"/>

<int:channel id="out" />

<int-ip:udp-outbound-channel-adapter id="outbound"
                        socket-expression="@inbound.socket"
                        destination-expression="headers['ip_packetAddress']"
                        channel="out" />
```

The equivalent configuration using Java DSL Configuration:

```
@Bean
public IntegrationFlow udpEchoUpcaseServer() {
 return IntegrationFlows.from(Udp.inboundAdapter(11111).id("udpIn"))
   .<byte[], String>transform(p -> new String(p).toUpperCase())
   .handle(Udp.outboundAdapter("headers['ip_packetAddress']")
     .socketExpression("@udpIn.socket"))
   .get();
}
```

=== TCP Connection Factories

For TCP, the configuration of the underlying connection is provided using a Connection Factory. Two types of connection factory are provided; a client connection factory and a server connection factory. Client connection factories are used to establish outgoing connections; Server connection factories listen for incoming connections.

A client connection factory is used by an outbound channel adapter but a reference to a client connection factory can also be provided to an inbound channel adapter and that adapter will receive any incoming messages received on connections created by the outbound adapter.

A server connection factory is used by an inbound channel adapter or gateway (in fact the connection factory will not function without one). A reference to a server connection factory can also be provided to an outbound adapter; that adapter can then be used to send replies to incoming messages to the same connection.

> **Tip**
>
> Reply messages will only be routed to the connection if the reply contains the header `ip_connectionId` that was inserted into the original message by the connection factory.

> **Tip**
>
> This is the extent of message correlation performed when sharing connection factories between inbound and outbound adapters. Such sharing allows for asynchronous two-way communication over TCP. By default, only payload information is transferred using TCP; therefore any message correlation must be performed by downstream components such as aggregators or other endpoints. Support for transferring selected headers was introduced in version 3.0. For more information refer to the section called “CompletableFuture”.

A maximum of one adapter of each type may be given a reference to a connection factory.

Connection factories using `java.net.Socket` and `java.nio.channel.SocketChannel` are provided.

```
<int-ip:tcp-connection-factory id="server"
    type="server"
    port="1234"/>
```

A simple server connection factory that uses `java.net.Socket` connections.

```
<int-ip:tcp-connection-factory id="server"
    type="server"
    port="1234"
    using-nio="true"/>
```

A simple server connection factory that uses `java.nio.channel.SocketChannel` connections.

> **Note**
>
> Starting with Spring Integration *version 4.2*, if the server is configured to listen on a random port (0), the actual port chosen by the OS can be obtained using `getPort()`. Also, `getServerSocketAddress()` is available to get the complete `SocketAddress`. See the javadocs for the `TcpServerConnectionFactory` interface for more information.

```
<int-ip:tcp-connection-factory id="client"
    type="client"
    host="localhost"
    port="1234"
    single-use="true"
    so-timeout="10000"/>
```

A client connection factory that uses `java.net.Socket` connections and creates a new connection for each message.

```
<int-ip:tcp-connection-factory id="client"
    type="client"
    host="localhost"
    port="1234"
    single-use="true"
    so-timeout="10000"
    using-nio=true/>
```

A client connection factory that uses `java.nio.channel.Socket` connections and creates a new connection for each message.

TCP is a streaming protocol; this means that some structure has to be provided to data transported over TCP, so the receiver can demarcate the data into discrete messages. Connection factories are configured to use (de)serializers to convert between the message payload and the bits that are sent over TCP. This is accomplished by providing a deserializer and serializer for inbound and outbound messages respectively. A number of standard (de)serializers are provided.

The `ByteArrayCrlfSerializer`*, converts a byte array to a stream of bytes followed by carriage return and linefeed characters (\r\n). This is the default (de)serializer and can be used with telnet as a client, for example.

The `ByteArraySingleTerminatorSerializer`*, converts a byte array to a stream of bytes followed by a single termination character (default 0x00).

The `ByteArrayLfSerializer`*, converts a byte array to a stream of bytes followed by a single linefeed character (0x0a).

The `ByteArrayStxEtxSerializer`*, converts a byte array to a stream of bytes preceded by an STX (0x02) and followed by an ETX (0x03).

The `ByteArrayLengthHeaderSerializer`, converts a byte array to a stream of bytes preceded by a binary length in network byte order (big endian). This a very efficient deserializer because it does not have to parse every byte looking for a termination character sequence. It can also be used for payloads containing binary data; the above serializers only support text in the payload. The default size of the length header is 4 bytes (Integer), allowing for messages up to (2^31 - 1) bytes. However, the length header can be a single byte (unsigned) for messages up to 255 bytes, or an unsigned short (2 bytes) for messages up to (2^16 - 1) bytes. If you need any other format for the header, you can subclass this class and provide implementations for the readHeader and writeHeader methods. The absolute maximum data size supported is (2^31 - 1) bytes.

The `ByteArrayRawSerializer`*, converts a byte array to a stream of bytes and adds no additional message demarcation data; with this (de)serializer, the end of a message is indicated by the client closing the socket in an orderly fashion. When using this serializer, message reception will hang until the client closes the socket, or a timeout occurs; a timeout will NOT result in a message. When this serializer is being used, and the client is a Spring Integration application, the client must use a connection factory that is configured with single-use=true - this causes the adapter to close the socket after sending the message; the serializer will not, itself, close the connection. This serializer should only be used with connection factories used by channel adapters (not gateways), and the connection factories should be used by either an inbound or outbound adapter, and not both. Also see `ByteArrayElasticRawDeserializer` below.

> **Note**
>
> Before version 4.2.2, when using NIO, this serializer treated a timeout (during read) as an end of file and the data read so far was emitted as a message. This is unreliable and should not be used to delimit messages; it now treats such conditions as an exception. In the unlikely event you are using it this way, the previous behavior can be restored by setting the `treatTimeoutAsEndOfMessage` constructor argument to `true`.

Each of these is a subclass of `AbstractByteArraySerializer` which implements both `org.springframework.core.serializer.Serializer` and `org.springframework.core.serializer.Deserializer`. For backwards compatibility, connections using any subclass of `AbstractByteArraySerializer` for serialization will also accept a String which will be converted to a byte array first. Each of these (de)serializers converts an input stream containing the corresponding format to a byte array payload.

To avoid memory exhaustion due to a badly behaved client (one that does not adhere to the protocol of the configured serializer), these serializers impose a maximum message size. If the size is exceeded by an incoming message, an exception will be thrown. The default maximum message size is 2048 bytes, and can be increased by setting the `maxMessageSize` property. If you are using the default (de)serializer and wish to increase the maximum message size, you must declare it as an explicit bean with the property set and configure the connection factory to use that bean.

The classes marked with * above use an intermediate buffer and copy the decoded data to a final buffer of the correct size. Starting with *version 4.3*, these can be configured with a `poolSize` property to allow these raw buffers to be reused instead of being allocated and discarded for each message, which is the default behavior. Setting the property to a negative value will create a pool that has no bounds. If the pool is bounded, you can also set the `poolWaitTimeout` property (milliseconds) after which an exception is thrown if no buffer becomes available; it defaults to infinity. Such an exception will cause the socket to be closed.

If you wish to use the same mechanism in custom deserializers, subclass `AbstractPooledBufferByteArraySerializer` instead of its super class `AbstractByteArraySerializer`, and implement `doDeserialize()` instead of `deserialize()`. The buffer will be returned to the pool automatically. `AbstractPooledBufferByteArraySerializer` also provides a convenient utility method `copyToSizedArray()`.

Version 5.0 added the `ByteArrayElasticRawDeserializer`. This is similar to the deserializer side of `ByteArrayRawSerializer` above, except it is not necessary to set a `maxMessageSize`. Internally, it uses a `ByteArrayOutputStream` which allows the buffer to grow as needed. The client must close the socket in an orderly manner to signal end of message.

The `MapJsonSerializer` uses a Jackson `ObjectMapper` to convert between a `Map` and JSON. This can be used in conjunction with a `MessageConvertingTcpMessageMapper` and a `MapMessageConverter` to transfer selected headers and the payload in a JSON format.

Note

The Jackson `ObjectMapper` cannot demarcate messages in the stream. Therefore, the `MapJsonSerializer` needs to delegate to another (de)serializer to handle message demarcation. By default, a `ByteArrayLfSerializer` is used, resulting in messages with the format `<json><LF>` on the wire, but you can configure it to use others instead.

The final standard serializer is `org.springframework.core.serializer.DefaultSerializer` which can be used to convert Serializable objects using java serialization.`org.springframework.core.serializer.DefaultDeserializer` is provided for inbound deserialization of streams containing Serializable objects.

To implement a custom (de)serializer pair, implement the `org.springframework.core.serializer.Deserializer` and `org.springframework.core.serializer.Serializer` interfaces.

If you do not wish to use the default (de)serializer (`ByteArrayCrLfSerializer`), you must supply `serializer` and `deserializer` attributes on the connection factory (example below).

```
<bean id="javaSerializer"
      class="org.springframework.core.serializer.DefaultSerializer" />
<bean id="javaDeserializer"
      class="org.springframework.core.serializer.DefaultDeserializer" />

<int-ip:tcp-connection-factory id="server"
    type="server"
    port="1234"
    deserializer="javaDeserializer"
    serializer="javaSerializer"/>
```

A server connection factory that uses `java.net.Socket` connections and uses Java serialization on the wire.

For full details of the attributes available on connection factories, see the reference at the end of this section.

By default, reverse DNS lookups are done on inbound packets to convert IP addresses to hostnames for use in message headers. In environments where DNS is not configured, this can cause connection delays. This default behavior can be overridden by setting the `lookup-host` attribute to "false".

> **Note**
>
> It is possible to modify the creation of and/or attributes of sockets - see the section called “CompletableFuture”. As is noted there, such modifications are possible whether or not SSL is being used.

==== TCP Caching Client Connection Factory

As noted above, TCP sockets can be *single-use* (one request/response) or shared. Shared sockets do not perform well with outbound gateways, in high-volume environments, because the socket can only process one request/response at a time.

To improve performance, users could use collaborating channel adapters instead of gateways, but that requires application-level message correlation. See the section called “CompletableFuture” for more information.

Spring Integration 2.2 introduced a caching client connection factory, where a pool of shared sockets is used, allowing a gateway to process multiple concurrent requests with a pool of shared connections.

==== TCP Failover Client Connection Factory

It is now possible to configure a TCP connection factory that supports failover to one or more other servers. When sending a message, the factory will iterate over all its configured factories until either the message can be sent, or no connection can be found. Initially, the first factory in the configured list is used; if a connection subsequently fails the next factory will become the current factory.

```
<bean id="failCF" class="o.s.i.ip.tcp.connection.FailoverClientConnectionFactory">
    <constructor-arg>
        <list>
            <ref bean="clientFactory1"/>
            <ref bean="clientFactory2"/>
        </list>
    </constructor-arg>
</bean>
```

> **Note**
>
> When using the failover connection factory, the singleUse property must be consistent between the factory itself and the list of factories it is configured to use.

==== TCP Thread Affinity Connection Factory

Spring Integration *version 5.0* introduced this connection factory. It binds a connection to the calling thread and the same connection is reused each time that thread sends a message. This continues until the connection is closed (by the server or network) or until the thread calls the `releaseConnection()` method. The connections themselves are provided by another client factory implementation; which must be configured to provide non-shared (single-use) connections so that each thread gets a connection.

Example configuration:

```
@Bean
public TcpNetClientConnectionFactory cf() {
    TcpNetClientConnectionFactory cf = new TcpNetClientConnectionFactory("localhost",
            Integer.parseInt(System.getProperty(PORT)));
    cf.setSingleUse(true);
    return cf;
}

@Bean
public ThreadAffinityClientConnectionFactory tacf() {
    return new ThreadAffinityClientConnectionFactory(cf());
}

@Bean
@ServiceActivator(inputChannel = "out")
public TcpOutboundGateway outGate() {
    TcpOutboundGateway outGate = new TcpOutboundGateway();
    outGate.setConnectionFactory(tacf());
    outGate.setReplyChannelName("toString");
    return outGate;
}
```

=== TCP Connection Interceptors

Connection factories can be configured with a reference to a `TcpConnectionInterceptorFactoryChain`. Interceptors can be used to add behavior to connections, such as negotiation, security, and other setup. No interceptors are currently provided by the framework but, for an example, see the `InterceptedSharedConnectionTests` in the source repository.

The `HelloWorldInterceptor` used in the test case works as follows:

When configured with a client connection factory, when the first message is sent over a connection that is intercepted, the interceptor sends *Hello* over the connection, and expects to receive *world!*. When that occurs, the negotiation is complete and the original message is sent; further messages that use the same connection are sent without any additional negotiation.

When configured with a server connection factory, the interceptor requires the first message to be *Hello* and, if it is, returns *world!*. Otherwise it throws an exception causing the connection to be closed.

All `TcpConnection` methods are intercepted. Interceptor instances are created for each connection by an interceptor factory. If an interceptor is stateful, the factory should create a new instance for each connection; if there is no state, the same interceptor can wrap each connection. Interceptor factories are added to the configuration of an interceptor factory chain, which is provided to a connection factory using the `interceptor-factory` attribute. Interceptors must extend `TcpConnectionInterceptorSupport`; factories must implement the `TcpConnectionInterceptorFactory` interface. `TcpConnectionInterceptorSupport` is provided with passthrough methods; by extending this class, you only need to implement those methods you wish to intercept.

```
<bean id="helloWorldInterceptorFactory"
    class="o.s.i.ip.tcp.connection.TcpConnectionInterceptorFactoryChain">
    <property name="interceptors">
        <array>
            <bean class="o.s.i.ip.tcp.connection.HelloWorldInterceptorFactory"/>
        </array>
    </property>
</bean>

<int-ip:tcp-connection-factory id="server"
    type="server"
    port="12345"
    using-nio="true"
    single-use="true"
    interceptor-factory-chain="helloWorldInterceptorFactory"/>

<int-ip:tcp-connection-factory id="client"
    type="client"
    host="localhost"
    port="12345"
    single-use="true"
    so-timeout="100000"
    using-nio="true"
    interceptor-factory-chain="helloWorldInterceptorFactory"/>
```

Configuring a connection interceptor factory chain.

=== TCP Connection Events

Beginning with version 3.0, changes to `TcpConnection` s are reported by `TcpConnectionEvent` s. `TcpConnectionEvent` is a subclass of `ApplicationEvent` and thus can be received by any `ApplicationListener` defined in the `ApplicationContext`, for example Event Inbound Channel Adapter.

`TcpConnectionEvents` have the following properties:

- `connectionId` - the connection identifier which can be used in a message header to send data to the connection
- `connectionFactoryName` - the bean name of the connection factory the connection belongs to
- `throwable` - the `Throwable` (for `TcpConnectionExceptionEvent` events only)
- `source` - the `TcpConnection`; this can be used, for example, to determine the remote IP Address with `getHostAddress()` (cast required)

In addition, since *version 4.0* the standard deserializers discussed in the section called “CompletableFuture” now emit `TcpDeserializationExceptionEvent` s when problems are encountered decoding the data stream. These events contain the exception, the buffer that was in the process of being built, and an offset into the buffer (if available) at the point the exception occurred. Applications can use a normal `ApplicationListener`, or see the section called “CompletableFuture”, to capture these events, allowing analysis of the problem.

Starting with *versions 4.0.7, 4.1.3*, `TcpConnectionServerExceptionEvent s` are published whenever an unexpected exception occurs on a server socket (such as a `BindException` when the server socket is in use). These events have a reference to the connection factory and the cause.

Starting with *version 4.2*, `TcpConnectionFailedCorrelationEvent` s are published whenever an endpoint (inbound gateway or collaborating outbound channel adapter) receives a message that cannot be routed to a connection because the `ip_connectionId` header is invalid. Outbound gateways also publish this event when a late reply is received (the sender thread has timed out). The event contains the connection id as well as an exception in the `cause` property that contains the failed message.

Starting with *version 4.3*, a `TcpConnectionServerListeningEvent` is emitted when a server connection factory is started. This is useful when the factory is configured to listen on port 0, meaning that the operating system chooses the port. It can also be used instead of polling `isListening()`, if you need to wait before starting some other process that will connect to the socket.

> **Important**
>
> To avoid delaying the listening thread from accepting connections, the event is published on a separate thread.

Starting with *version 4.3.2*, a `TcpConnectionFailedEvent` is emitted whenever a client connection can’t be created. The source of the event is the connection factory which can be used to determine the host and port to which the connection could not be established.

=== TCP Adapters

TCP inbound and outbound channel adapters that utilize the above connection factories are provided. These adapters have attributes `connection-factory` and `channel`. The channel attribute specifies the channel on which messages arrive at an outbound adapter and on which messages are placed by an inbound adapter. The connection-factory attribute indicates which connection factory is to be used to manage connections for the adapter. While both inbound and outbound adapters can share a connection factory, server connection factories are always *owned* by an inbound adapter; client connection factories are always *owned* by an outbound adapter. One, and only one, adapter of each type may get a reference to a connection factory.

```
<bean id="javaSerializer"
      class="org.springframework.core.serializer.DefaultSerializer"/>
<bean id="javaDeserializer"
      class="org.springframework.core.serializer.DefaultDeserializer"/>

<int-ip:tcp-connection-factory id="server"
    type="server"
    port="1234"
    deserializer="javaDeserializer"
    serializer="javaSerializer"
    using-nio="true"
    single-use="true"/>

<int-ip:tcp-connection-factory id="client"
    type="client"
    host="localhost"
    port="#{server.port}"
    single-use="true"
    so-timeout="10000"
    deserializer="javaDeserializer"
    serializer="javaSerializer"/>

<int:channel id="input" />

<int:channel id="replies">
    <int:queue/>
</int:channel>

<int-ip:tcp-outbound-channel-adapter id="outboundClient"
    channel="input"
    connection-factory="client"/>

<int-ip:tcp-inbound-channel-adapter id="inboundClient"
    channel="replies"
    connection-factory="client"/>

<int-ip:tcp-inbound-channel-adapter id="inboundServer"
    channel="loop"
    connection-factory="server"/>

<int-ip:tcp-outbound-channel-adapter id="outboundServer"
    channel="loop"
    connection-factory="server"/>

<int:channel id="loop"/>
```

In this configuration, messages arriving in channel *input* are serialized over connections created by *client* received at the server and placed on channel *loop*. Since *loop* is the input channel for *outboundServer* the message is simply looped back over the same connection and received by *inboundClient* and deposited in channel *replies*. Java serialization is used on the wire.

Normally, inbound adapters use a type="server" connection factory, which listens for incoming connection requests. In some cases, it is desirable to establish the connection in reverse, whereby the inbound adapter connects to an external server and then waits for inbound messages on that connection.

This topology is supported by using *client-mode="true"* on the inbound adapter. In this case, the connection factory must be of type *client* and must have *single-use* set to false.

Two additional attributes are used to support this mechanism: *retry-interval* specifies (in milliseconds) how often the framework will attempt to reconnect after a connection failure. *scheduler* is used to supply a `TaskScheduler` used to schedule the connection attempts, and to test that the connection is still active.

For an outbound adapter, the connection is normally established when the first message is sent. *client-mode="true"* on an outbound adapter will cause the connection to be established when the adapter is started. Adapters are automatically started by default. Again, the connection factory must be of type client and have *single-use* set to false and *retry-interval* and *scheduler* are also supported. If a connection fails, it will be re-established either by the scheduler or when the next message is sent.

For both inbound and outbound, if the adapter is started, you may force the adapter to establish a connection by sending a <control-bus /> command: `@adapter_id.retryConnection()` and examine the current state with `@adapter_id.isClientModeConnected()`.

=== TCP Gateways

The inbound TCP gateway `TcpInboundGateway` and outbound TCP gateway `TcpOutboundGateway` use a server and client connection factory respectively. Each connection can process a single request/response at a time.

The inbound gateway, after constructing a message with the incoming payload and sending it to the `requestChannel`, waits for a response and sends the payload from the response message by writing it to the connection.

> **Note**
>
> For the inbound gateway, care must be taken to retain, or populate, the *ip_connectionId* header because it is used to correlate the message to a connection. Messages that originate at the gateway will automatically have the header set. If the reply is constructed as a new message, you will need to set the header. The header value can be captured from the incoming message.

As with inbound adapters, inbound gateways normally use a type="server" connection factory, which listens for incoming connection requests. In some cases, it is desirable to establish the connection in reverse, whereby the inbound gateway connects to an external server and then waits for, and replies to, inbound messages on that connection.

This topology is supported by using *client-mode="true"* on the inbound gateway. In this case, the connection factory must be of type *client* and must have *single-use* set to false.

Two additional attributes are used to support this mechanism: *retry-interval* specifies (in milliseconds) how often the framework will attempt to reconnect after a connection failure. *scheduler* is used to supply a `TaskScheduler` used to schedule the connection attempts, and to test that the connection is still active.

If the gateway is started, you may force the gateway to establish a connection by sending a <control-bus /> command: `@adapter_id.retryConnection()` and examine the current state with `@adapter_id.isClientModeConnected()`.

The outbound gateway, after sending a message over the connection, waits for a response and constructs a response message and puts in on the reply channel. Communications over the connections are single-threaded. Users should be aware that only one message can be handled at a time and, if another thread attempts to send a message before the current response has been received, it will block until any previous requests are complete (or time out). If, however, the client connection factory is configured for single-use connections each new request gets its own connection and is processed immediately.

```
<int-ip:tcp-inbound-gateway id="inGateway"
    request-channel="tcpChannel"
    reply-channel="replyChannel"
    connection-factory="cfServer"
    reply-timeout="10000"/>
```

A simple inbound TCP gateway; if a connection factory configured with the default (de)serializer is used, messages will be \r\n delimited data and the gateway can be used by a simple client such as telnet.

```
<int-ip:tcp-outbound-gateway id="outGateway"
    request-channel="tcpChannel"
    reply-channel="replyChannel"
    connection-factory="cfClient"
    request-timeout="10000"
    remote-timeout="10000"/> <!-- or e.g.
remote-timeout-expression="headers['timeout']" -->
```

A simple outbound TCP gateway.

`client-mode` is not currently available with the outbound gateway.

=== TCP Message Correlation

==== Overview

One goal of the IP Endpoints is to provide communication with systems other than another Spring Integration application. For this reason, only message payloads are sent and received, by default. Since 3.0, headers can be transferred, using JSON, Java serialization, or with custom `Serializer` s and `Deserializer` s; see the section called “CompletableFuture” for more information. No message correlation is provided by the framework, except when using the gateways, or collaborating channel adapters on the server side. In the paragraphs below we discuss the various correlation techniques available to applications. In most cases, this requires specific application-level correlation of messages, even when message payloads contain some natural correlation data (such as an order number).

==== Gateways

The gateways will automatically correlate messages. However, an outbound gateway should only be used for relatively low-volume use. When the connection factory is configured for a single shared connection to be used for all message pairs (*single-use="false"*), only one message can be processed at a time. A new message will have to wait until the reply to the previous message has been received. When a connection factory is configured for each new message to use a new connection (*single-use="true"*), the above restriction does not apply. While this may give higher throughput than a shared connection environment, it comes with the overhead of opening and closing a new connection for each message pair.

Therefore, for high-volume messages, consider using a collaborating pair of channel adapters. However, you will need to provide collaboration logic.

Another solution, introduced in Spring Integration 2.2, is to use a `CachingClientConnectionFactory`, which allows the use of a pool of shared connections.

==== Collaborating Outbound and Inbound Channel Adapters

To achieve high-volume throughput (avoiding the pitfalls of using gateways as mentioned above) you may consider configuring a pair of collaborating outbound and inbound channel adapters. Collaborating adapters can also be used (server-side or client-side) for totally asynchronous communication (rather than with request/reply semantics). On the server side, message correlation is automatically handled by the adapters because the inbound adapter adds a header allowing the outbound adapter to determine which connection to use to send the reply message.

> **Note**
>
> On the server side, care must be taken to populate the *ip_connectionId* header because it is used to correlate the message to a connection. Messages that originate at the inbound adapter will automatically have the header set. If you wish to construct other messages to send, you will need to set the header. The header value can be captured from an incoming message.

On the client side, the application will have to provide its own correlation logic, if needed. This can be done in a number of ways.

If the message payload has some natural correlation data, such as a transaction id or an order number, AND there is no need to retain any information (such as a reply channel header) from the original outbound message, the correlation is simple and would done at the application level in any case.

If the message payload has some natural correlation data, such as a transaction id or an order number, but there is a need to retain some information (such as a reply channel header) from the original outbound message, you may need to retain a copy of the original outbound message (perhaps by using a publish-subscribe channel) and use an aggregator to recombine the necessary data.

For either of the previous two paragraphs, if the payload has no natural correlation data, you may need to provide a transformer upstream of the outbound channel adapter to enhance the payload with such data. Such a transformer may transform the original payload to a new object containing both the original payload and some subset of the message headers. Of course, live objects (such as reply channels) from the headers can not be included in the transformed payload.

If such a strategy is chosen you will need to ensure the connection factory has an appropriate serializer/deserializer pair to handle such a payload, such as the `DefaultSerializer/Deserializer` which use java serialization, or a custom serializer and deserializer. The `ByteArray*Serializer` options mentioned in the section called “CompletableFuture”, including the default `ByteArrayCrLfSerializer`, do not support such payloads, unless the transformed payload is a `String` or `byte[]`,

> **Note**
>
> Before the 2.2 release, when a *client* connection factory was used by collaborating channel adapters, the *so-timeout* attribute defaulted to the default reply timeout (10 seconds). This meant that if no data were received by the inbound adapter for this period of time, the socket was closed.
>
> This default behavior was not appropriate in a truly asynchronous environment, so it now defaults to an infinite timeout. You can reinstate the previous default behavior by setting the *so-timeout* attribute on the client connection factory to 10000 milliseconds.

==== Transferring Headers

TCP is a streaming protocol; `Serializers` and `Deserializers` are used to demarcate messages within the stream. Prior to 3.0, only message payloads (String or byte[]) could be transferred over TCP. Beginning with 3.0, you can now transfer selected headers as well as the payload. It is important to understand, though, that "live" objects, such as the `replyChannel` header cannot be serialized.

Sending header information over TCP requires some additional configuration.

The first step is to provide the `ConnectionFactory` with a `MessageConvertingTcpMessageMapper` using the `mapper` attribute. This mapper delegates to any `MessageConverter` implementation to convert the message to/from some object that can be (de)serialized by the configured `serializer` and `deserializer`.

A `MapMessageConverter` is provided, which allows the specification of a list of headers that will be added to a `Map` object, along with the payload. The generated Map has two entries: `payload` and `headers`. The `headers` entry is itself a `Map` containing the selected headers.

The second step is to provide a (de)serializer that can convert between a `Map` and some wire format. This can be a custom `(de)Serializer`, which would typically be needed if the peer system is not a Spring Integration application.

A `MapJsonSerializer` is provided that will convert a Map to/from JSON. This uses a Spring Integration `JsonObjectMapper` to perform this function. You can provide a custom `JsonObjectMapper` if needed. By default, the serializer inserts a linefeed `0x0a` character between objects. See the JavaDocs for more information.

> **Note**
>
> At the time of writing, the `JsonObjectMapper` uses whichever version of `Jackson` is on the classpath.

You can also use standard Java serialization of the Map, using the `DefaultSerializer` and `DefaultDeserializer`.

The following example shows the configuration of a connection factory that transfers the `correlationId`, `sequenceNumber`, and `sequenceSize` headers using JSON.

```
<int-ip:tcp-connection-factory id="client"
    type="client"
    host="localhost"
    port="12345"
    mapper="mapper"
    serializer="jsonSerializer"
    deserializer="jsonSerializer"/>

<bean id="mapper"
      class="o.sf.integration.ip.tcp.connection.MessageConvertingTcpMessageMapper">
    <constructor-arg name="messageConverter">
        <bean class="o.sf.integration.support.converter.MapMessageConverter">
            <property name="headerNames">
                <list>
                    <value>correlationId</value>
                    <value>sequenceNumber</value>
                    <value>sequenceSize</value>
                </list>
            </property>
        </bean>
    </constructor-arg>
</bean>

<bean id="jsonSerializer" class="o.sf.integration.ip.tcp.serializer.MapJsonSerializer" />
```

A message sent with the above configuration, with payload *foo* would appear on the wire like so:

```
{"headers":{"correlationId":"bar","sequenceSize":5,"sequenceNumber":1},"payload":"foo"}
```

=== A Note About NIO

Using NIO (see `using-nio` in the section called “CompletableFuture”) avoids dedicating a thread to read from each socket. For a small number of sockets, you will likely find that *not* using NIO, together with an async handoff (e.g. to a `QueueChannel`), will perform as well as, or better than, using NIO.

Consider using NIO when handling a large number of connections. However, the use of NIO has some other ramifications. A pool of threads (in the task executor) is shared across all the sockets; each incoming message is assembled and sent to the configured channel as a separate unit of work on a thread selected from that pool. Two sequential messages arriving on the *same* socket *might* be processed by different threads. This means that the order in which the messages are sent to the channel is indeterminate; the strict ordering of the messages arriving on the socket is not maintained.

For some applications, this is not an issue; for others it is. If strict ordering is required, consider setting `using-nio` to false and using async handoff.

Alternatively, you may choose to insert a resequencer downstream of the inbound endpoint to return the messages to their proper sequence. Set *apply-sequence* to true on the connection factory, and messages arriving on a TCP connection will have *sequenceNumber* and *correlationId* headers set. The resequencer uses these headers to return the messages to their proper sequence.

Pool Size

The pool size attribute is no longer used; previously, it specified the size of the default thread pool when a task-executor was not specified. It was also used to set the connection backlog on server sockets. The first function is no longer needed (see below); the second function is replaced by the *backlog* attribute.

Previously, when using a fixed thread pool task executor (which was the default), with NIO, it was possible to get a deadlock and processing would stop. The problem occurred when a buffer was full, a thread reading from the socket was trying to add more data to the buffer, and there were no threads available to make space in the buffer. This only occurred with a very small pool size, but it could be possible under extreme conditions. Since 2.2, two changes have eliminated this problem. First, the default task executor is a cached thread pool executor. Second, deadlock detection logic has been added such that if thread starvation occurs, instead of deadlocking, an exception is thrown, thus releasing the deadlocked resources.

> **Important**
>
> Now that the default task executor is unbounded, it is possible that an out of memory condition might occur with high rates of incoming messages, if message processing takes extended time. If your application exhibits this type of behavior, you are advised to use a pooled task executor with an appropriate pool size, but see the next section.

==== Thread Pool Task Executor with CALLER_RUNS Policy

There are some important considerations when using a fixed thread pool with the `CallerRunsPolicy` (`CALLER_RUNS` when using the `<task/>` namespace) and the queue capacity is small.

The following does not apply if you are not using a fixed thread pool.

With NIO connections there are 3 distinct task types; the IO Selector processing is performed on one dedicated thread - detecting events, accepting new connections, and dispatching the IO read operations to other threads, using the task executor. When an IO reader thread (to which the read operation is dispatched) reads data, it hands off to another thread to assemble the incoming message; large messages may take several reads to complete. These "assembler" threads can block waiting for data. When a new read event occurs, the reader determines if this socket already has an assembler and runs a new one if not. When the assembly process is complete, the assembler thread is returned to the pool.

This can cause a deadlock when the pool is exhausted and the CALLER_RUNS rejection policy is in use, and the task queue is full. When the pool is empty and there is no room in the queue, the IO selector thread receives an `OP_READ` event and dispatches the read using the executor; the queue is full, so the selector thread itself starts the read process; now, it detects that there is not an assembler for this socket and, before it does the read, fires off an assembler; again, the queue is full, and the selector thread becomes the assembler. The assembler is now blocked awaiting the data to be read, which will never happen. The connection factory is now deadlocked because the selector thread can’t handle new events.

We must avoid the selector (or reader) threads performing the assembly task to avoid this deadlock. It is desirable to use seperate pools for the IO and assembly operations.

The framework provides a `CompositeExecutor`, which allows the configuration of two distinct executors; one for performing IO operations, and one for message assembly. In this environment, an IO thread can never become an assembler thread, and the deadlock cannot occur.

In addition, the task executors should be configured to use a `AbortPolicy` (ABORT when using `<task>`). When an IO cannot be completed, it is deferred for a short time and retried continually until it can be completed and an assembler allocated. By default, the delay is 100ms but it can be changed using the `readDelay` property on the connection factory (`read-delay` when configuring with the XML namespace).

Example configuration of the composite executor is shown below.

```java
@Bean
private CompositeExecutor compositeExecutor() {
    ThreadPoolTaskExecutor ioExec = new ThreadPoolTaskExecutor();
    ioExec.setCorePoolSize(4);
    ioExec.setMaxPoolSize(10);
    ioExec.setQueueCapacity(0);
    ioExec.setThreadNamePrefix("io-");
    ioExec.setRejectedExecutionHandler(new AbortPolicy());
    ioExec.initialize();
    ThreadPoolTaskExecutor assemblerExec = new ThreadPoolTaskExecutor();
    assemblerExec.setCorePoolSize(4);
    assemblerExec.setMaxPoolSize(10);
    assemblerExec.setQueueCapacity(0);
    assemblerExec.setThreadNamePrefix("assembler-");
    assemblerExec.setRejectedExecutionHandler(new AbortPolicy());
    assemblerExec.initialize();
    return new CompositeExecutor(ioExec, assemblerExec);
}
```

```xml
<bean id="myTaskExecutor" class="org.springframework.integration.util.CompositeExecutor">
    <constructor-arg ref="io"/>
    <constructor-arg ref="assembler"/>
</bean>

<task:executor id="io" pool-size="4-10" queue-capacity="0" rejection-policy="ABORT" />
<task:executor id="assembler" pool-size="4-10" queue-capacity="0" rejection-policy="ABORT" />
```

```
<bean id="myTaskExecutor" class="org.springframework.integration.util.CompositeExecutor">
    <constructor-arg>
        <bean class="org.springframework.scheduling.concurrent.ThreadPoolTaskExecutor">
            <property name="threadNamePrefix" value="io-" />
            <property name="corePoolSize" value="4" />
            <property name="maxPoolSize" value="8" />
            <property name="queueCapacity" value="0" />
            <property name="rejectedExecutionHandler">
                <bean class="java.util.concurrent.ThreadPoolExecutor.AbortPolicy" />
            </property>
        </bean>
    </constructor-arg>
    <constructor-arg>
        <bean class="org.springframework.scheduling.concurrent.ThreadPoolTaskExecutor">
            <property name="threadNamePrefix" value="assembler-" />
            <property name="corePoolSize" value="4" />
            <property name="maxPoolSize" value="10" />
            <property name="queueCapacity" value="0" />
            <property name="rejectedExecutionHandler">
                <bean class="java.util.concurrent.ThreadPoolExecutor.AbortPolicy" />
            </property>
        </bean>
    </constructor-arg>
</bean>
```

=== SSL/TLS Support

==== Overview

Secure Sockets Layer/Transport Layer Security is supported. When using NIO, the JDK 5+ `SSLEngine` feature is used to handle handshaking after the connection is established. When not using NIO, standard `SSLSocketFactory` and `SSLServerSocketFactory` objects are used to create connections. A number of strategy interfaces are provided to allow significant customization; default implementations of these interfaces provide for the simplest way to get started with secure communications.

==== Getting Started

Regardless of whether NIO is being used, you need to configure the `ssl-context-support` attribute on the connection factory. This attribute references a <bean/> definition that describes the location and passwords for the required key stores.

SSL/TLS peers require two keystores each; a keystore containing private/public key pairs identifying the peer; a truststore, containing the public keys for peers that are trusted. See the documentation for the `keytool` utility provided with the JDK. The essential steps are

1. Create a new key pair and store in a keystore.

2. Export the public key.

3. Import the public key into the peer's truststore.

Repeat for the other peer.

> **Note**
>
> It is common in test cases to use the same key stores on both peers, but this should be avoided for production.

After establishing the key stores, the next step is to indicate their locations to the `TcpSSLContextSupport` bean, and provide a reference to that bean to the connection factory.

```
<bean id="sslContextSupport"
    class="o.sf.integration.ip.tcp.connection.support.DefaultTcpSSLContextSupport">
    <constructor-arg value="client.ks"/>
    <constructor-arg value="client.truststore.ks"/>
    <constructor-arg value="secret"/>
    <constructor-arg value="secret"/>
</bean>

<ip:tcp-connection-factory id="clientFactory"
    type="client"
    host="localhost"
    port="1234"
    ssl-context-support="sslContextSupport" />
```

The `DefaulTcpSSLContextSupport` class also has an optional `protocol` property, which can be `SSL` or `TLS` (default).

The keystore file names (first two constructor arguments) use the Spring `Resource` abstraction; by default the files will be located on the classpath, but this can be overridden by using the `file:` prefix, to find the files on the filesystem instead.

Starting with *version 4.3.6*, when using NIO, you can specify an `ssl-handshake-timeout` (seconds) on the connection factory. This timeout (default 30) is used during SSL handshake when waiting for data; if the timeout is exceeded, the process is aborted and the socket closed.

==== Host Verification

Starting with version 5.0.8, you can configure whether or not to enable host verification. Starting with version 5.1, it will be enabled by default; before that version, the mechanism to enable it depends on whether or not you are using NIO.

Host verification is used to ensure the server you are connected to matches information in the certificate, even if the certificate is trusted.

When using NIO, configure the `DefaultTcpNioSSLConnectionSupport`, for example.

```
@Bean
public DefaultTcpNioSSLConnectionSupport connectionSupport() {
    DefaultTcpSSLContextSupport sslContextSupport = new DefaultTcpSSLContextSupport("test.ks",
            "test.truststore.ks", "secret", "secret");
    sslContextSupport.setProtocol("SSL");
    DefaultTcpNioSSLConnectionSupport tcpNioConnectionSupport =
            new DefaultTcpNioSSLConnectionSupport(sslContextSupport, true);
    return tcpNioConnectionSupport;
}
```

The second constructor argument enables host verification. The `connectionSupport` bean is then injected into the NIO connection factory.

When not using NIO, the configuration is in the `TcpSocketSupport`:

```
connectionFactory.setTcpSocketSupport(new DefaultTcpSocketSupport(true));
```

Again, the constructor argument enables host verification.

=== Advanced Techniques

==== Strategy Interfaces

In many cases, the configuration described above is all that is needed to enable secure communication over TCP/IP. However, a number of strategy interfaces are provided to allow customization and modification of socket factories and sockets.

- `TcpSSLContextSupport`
- `TcpSocketFactorySupport`
- `TcpSocketSupport`
- `TcpNetConnectionSupport`
- `TcpNioConnectionSupport`

TcpSSLContextSupport.

```
public interface TcpSSLContextSupport {

    SSLContext getSSLContext() throws Exception;

}
```

Implementations of this interface are responsible for creating an SSLContext. The implementation provided by the framework is the `DefaultTcpSSLContextSupport` described above. If you require different behavior, implement this interface and provide the connection factory with a reference to a bean of your class' implementation.

TcpSocketFactorySupport.

```
public interface TcpSocketFactorySupport {

    ServerSocketFactory getServerSocketFactory();

    SocketFactory getSocketFactory();

}
```

Implementations of this interface are responsible for obtaining references to `ServerSocketFactory` and `SocketFactory`. Two implementations are provided; the first is `DefaultTcpNetSocketFactorySupport` for non-SSL sockets (when no `ssl-context-support` attribute is defined); this simply uses the JDK's default factories. The second implementation is `DefaultTcpNetSSLSocketFactorySupport`; this is used, by default, when an `ssl-context-support` attribute is defined; it uses the `SSLContext` created by that bean to create the socket factories.

> **Note**
>
> This interface only applies if `using-nio` is "false"; socket factories are not used by NIO.

TcpSocketSupport.

```
public interface TcpSocketSupport {

    void postProcessServerSocket(ServerSocket serverSocket);

    void postProcessSocket(Socket socket);

}
```

Implementations of this interface can modify sockets after they are created, and after all configured attributes have been applied, but before the sockets are used. This applies whether or not NIO is being used. For example, you could use an implementation of this interface to modify the supported cipher suites on an SSL socket, or you could add a listener that gets notified after SSL handshaking is complete.

The sole implementation provided by the framework is the `DefaultTcpSocketSupport` which does not modify the sockets in any way

To supply your own implementation of `TcpSocketFactorySupport` or `TcpSocketSupport`, provide the connection factory with references to beans of your custom type using the `socket-factory-support` and `socket-support` attributes, respectively.

TcpNetConnectionSupport.

```
public interface TcpNetConnectionSupport {

 TcpNetConnection createNewConnection(Socket socket,
   boolean server, boolean lookupHost,
   ApplicationEventPublisher applicationEventPublisher,
   String connectionFactoryName) throws Exception;

}
```

This interface is invoked to create `TcpNetConnection` objects (or objects from subclasses). The framework provides a single implementation `DefatulTcpNetConnectionSupport` which creates simple `TcpNetConnection` objects by default. It has two properties `pushbackCapable` and `pushbackBufferSize`; when push back is enabled, the implementation returns a subclass that wraps the connection's `InputStream` in a `PushbackInputStream`. Aligned with the `PushbackInputStream` default, the buffer size defaults to 1. This enables deserializers to "unread" (push back) bytes into the stream. The following is a trivial example of how it might be used in a delegating deserializer which "peeks" at the first byte to determine which deserializer to invoke:

```
public class CompositeDeserializer implements Deserializer<byte[]> {

    private final ByteArrayStxEtxSerializer stxEtx = new ByteArrayStxEtxSerializer();

    private final ByteArrayCrLfSerializer crlf = new ByteArrayCrLfSerializer();

    @Override
    public byte[] deserialize(InputStream inputStream) throws IOException {
        PushbackInputStream pbis = (PushbackInputStream) inputStream;
        int first = pbis.read();
        if (first < 0) {
            throw new SoftEndOfStreamException();
        }
        pbis.unread(first);
        if (first == ByteArrayStxEtxSerializer.STX) {
            this.receivedStxEtx = true;
            return this.stxEtx.deserialize(pbis);
        }
        else {
            this.receivedCrLf = true;
            return this.crlf.deserialize(pbis);
        }
    }

}
```

TcpNioConnectionSupport.

```
public interface TcpNioConnectionSupport {

    TcpNioConnection createNewConnection(SocketChannel socketChannel,
            boolean server, boolean lookupHost,
            ApplicationEventPublisher applicationEventPublisher,
            String connectionFactoryName) throws Exception;

}
```

This interface is invoked to create `TcpNioConnection` objects (or objects from subclasses). Two implementations are provided `DefaultTcpNioSSLConnectionSupport` and `DefaultTcpNioConnectionSupport` which are used depending on whether SSL is in use or not. A common use case would be to subclass `DefaultTcpNioSSLConnectionSupport` and override `postProcessSSLEngine`; see the example below. As with the `DefatulTcpNetConnectionSupport`, these implementations also support push back.

==== Example: Enabling SSL Client Authentication

To enable client certificate authentication when using SSL, the technique depends on whether NIO is in use or not. When NIO is not being used, provide a custom `TcpSocketSupport` implementation to post-process the server socket:

```
serverFactory.setTcpSocketSupport(new DefaultTcpSocketSupport() {

    @Override
    public void postProcessServerSocket(ServerSocket serverSocket) {
        ((SSLServerSocket) serverSocket).setNeedClientAuth(true);
    }

});
```

(When using XML configuration, provide a reference to your bean using the `socket-support` attribute).

When using NIO, provide a custom `TcpNioSslConnectionSupport` implementation to post-process the `SSLEngine`.

```
@Bean
public DefaultTcpNioSSLConnectionSupport tcpNioConnectionSupport() {
    return new DefaultTcpNioSSLConnectionSupport(serverSslContextSupport) {

            @Override
            protected void postProcessSSLEngine(SSLEngine sslEngine) {
                sslEngine.setNeedClientAuth(true);
            }

    }
}

@Bean
public TcpNioServerConnectionFactory server() {
    ...
    serverFactory.setTcpNioConnectionSupport(tcpNioConnectionSupport());
    ...
}
```

(When using XML configuration, since *version 4.3.7*, provide a reference to your bean using the `nio-connection-support` attribute).

=== IP Configuration Attributes

Attribute Name	Client?	Server?	Allowed Values	Attribute Description
type	Y	Y	client, server	Determines whether the connection factory is a client or server.
host	Y	N		The host name or ip address of the destination.

Attribute Name	Client?	Server?	Allowed Values	Attribute Description
port	Y	Y		The port.
serializer	Y	Y		An implementation of `Serializer` used to serialize the payload. Defaults to `ByteArrayCrLfSerializer`
deserializer	Y	Y		An implementation of `Deserializer` used to deserialize the payload. Defaults to `ByteArrayCrLfSerializer`
using-nio	Y	Y	true, false	Whether or not connection uses NIO. Refer to the java.nio package for more information. See the section called “CompletableFuture”. Default false.
using-direct-buffers	Y	N	true, false	When using NIO, whether or not the connection uses direct buffers. Refer to `java.nio.ByteBuffer` documentation for more information. Must be false if using-nio is false.
apply-sequence	Y	Y	true, false	When using NIO, it may be necessary to resequence messages. When this attribute is set to true, *correlationId* and *sequenceNumber* headers will be added to received messages. See the section called “CompletableFuture”. Default false.
so-timeout	Y	Y		Defaults to 0 (infinity), except for server connection factories with single-use="true". In that case, it defaults to the default reply timeout (10 seconds).
so-send-buffer-size	Y	Y		See `java.net.Socket. setSendBufferSize()`.
so-receive-buffer-size	Y	Y		See `java.net.Socket. setReceiveBufferSize()`.
so-keep-alive	Y	Y	true, false	See `java.net.Socket. setKeepAlive()`.
so-linger	Y	Y		Sets linger to true with supplied value. See `java.net.Socket. setSoLinger()`.
so-tcp-no-delay	Y	Y	true, false	See `java.net.Socket. setTcpNoDelay()`.
so-traffic-class	Y	Y		See `java.net.Socket. setTrafficClass()`.

Attribute Name	Client?	Server?	Allowed Values	Attribute Description
local-address	N	Y		On a multi-homed system, specifies an IP address for the interface to which the socket will be bound.
task-executor	Y	Y		Specifies a specific Executor to be used for socket handling. If not supplied, an internal cached thread executor will be used. Needed on some platforms that require the use of specific task executors such as a WorkManagerTaskExecutor.
single-use	Y	Y	true, false	Specifies whether a connection can be used for multiple messages. If true, a new connection will be used for each message.
pool-size	N	N		This attribute is no longer used. For backward compatibility, it sets the backlog but users should use backlog to specify the connection backlog in server factories
backlog	N	Y		Sets the connection backlog for server factories.
lookup-host	Y	Y	true, false	Specifies whether reverse lookups are done on IP addresses to convert to host names for use in message headers. If false, the IP address is used instead. Defaults to true.
interceptor-factory-chain	Y	Y		See the section called “CompletableFuture”
ssl-context-support	Y	Y		See the section called “CompletableFuture”
socket-factory-support	Y	Y		See the section called “CompletableFuture”
socket-support	Y	Y		See the section called “CompletableFuture”
nio-connection-support	Y	Y		See the section called “CompletableFuture”
read-delay	Y	Y	long > 0	The delay (in milliseconds) before retrying a read after the previous attempt failed due to insufficient threads. Default 100. Only applies if `using-nio` is `true`.

Table 8.1. UDP Inbound Channel Adapter Attributes

Attribute Name	Allowed Values	Attribute Description
port		The port on which the adapter listens.
multicast	true, false	Whether or not the udp adapter uses multicast.
multicast-address		When multicast is true, the multicast address to which the adapter joins.
pool-size		Specifies the concurrency. Specifies how many packets can be handled concurrently. It only applies if task-executor is not configured. Defaults to 5.
task-executor		Specifies a specific Executor to be used for socket handling. If not supplied, an internal pooled executor will be used. Needed on some platforms that require the use of specific task executors such as a WorkManagerTaskExecutor. See pool-size for thread requirements.
receive-buffer-size		The size of the buffer used to receive DatagramPackets. Usually set to the MTU size. If a smaller buffer is used than the size of the sent packet, truncation can occur. This can be detected by means of the check-length attribute..
check-length	true, false	Whether or not a udp adapter expects a data length field in the packet received. Used to detect packet truncation.
so-timeout		See `java.net.DatagramSocket` setSoTimeout() methods for more information.
so-send-buffer-size		Used for udp acknowledgment packets. See `java.net.DatagramSocket` setSendBufferSize() methods for more information.
so-receive-buffer- size		See `java.net.DatagramSocket` setReceiveBufferSize() for more information.
local-address		On a multi-homed system, specifies an IP address for the interface to which the socket will be bound.
error-channel		If an Exception is thrown by a downstream component, the MessagingException message containing the exception and failed message is sent to this channel.
lookup-host	true, false	Specifies whether reverse lookups are done on IP addresses to convert to host names for use in message headers. If false, the IP address is used instead. Defaults to true.

Table 8.2. UDP Outbound Channel Adapter Attributes

Attribute Name	**Allowed Values**	**Attribute Description**
host		The host name or ip address of the destination. For multicast udp adapters, the multicast address.
port		The port on the destination.
multicast	true, false	Whether or not the udp adapter uses multicast.
acknowledge	true, false	Whether or not a udp adapter requires an acknowledgment from the destination. when enabled, requires setting the following 4 attributes.
ack-host		When acknowledge is true, indicates the host or ip address to which the acknowledgment should be sent. Usually the current host, but may be different, for example when Network Address Transaction (NAT) is being used.
ack-port		When acknowledge is true, indicates the port to which the acknowledgment should be sent. The adapter listens on this port for acknowledgments.
ack-timeout		When acknowledge is true, indicates the time in milliseconds that the adapter will wait for an acknowledgment. If an acknowledgment is not received in time, the adapter will throw an exception.
min-acks-for-success		Defaults to 1. For multicast adapters, you can set this to a larger value, requiring acknowledgments from multiple destinations.
check-length	true, false	Whether or not a udp adapter includes a data length field in the packet sent to the destination.
time-to-live		For multicast adapters, specifies the time to live attribute for the `MulticastSocket`; controls the scope of the multicasts. Refer to the Java API documentation for more information.
so-timeout		See `java.net.DatagramSocket` setSoTimeout() methods for more information.
so-send-buffer-size		See `java.net.DatagramSocket` setSendBufferSize() methods for more information.
so-receive-buffer- size		Used for udp acknowledgment packets. See `java.net.DatagramSocket` setReceiveBufferSize() methods for more information.
local-address		On a multi-homed system, for the UDP adapter, specifies an IP address for the interface to which the socket will be bound for reply messages. For a multicast adapter it is also used to determine which interface the multicast packets will be sent over.

Attribute Name	Allowed Values	Attribute Description
task-executor		Specifies a specific Executor to be used for acknowledgment handling. If not supplied, an internal single threaded executor will be used. Needed on some platforms that require the use of specific task executors such as a WorkManagerTaskExecutor. One thread will be dedicated to handling acknowledgments (if the acknowledge option is true).
destination-expression	SpEL expression	A SpEL expression to be evaluated to determine which `SocketAddress` to use as a destination address for the outgoing UDP packets.
socket-expression	SpEL expression	A SpEL expression to be evaluated to determine which datagram socket use for sending outgoing UDP packets.

Table 8.3. TCP Inbound Channel Adapter Attributes

Attribute Name	Allowed Values	Attribute Description
channel		The channel to which inbound messages will be sent.
connection-factory		If the connection factory has a type *server*, the factory is *owned* by this adapter. If it has a type *client*, it is *owned* by an outbound channel adapter and this adapter will receive any incoming messages on the connection created by the outbound adapter.
error-channel		If an Exception is thrown by a downstream component, the MessagingException message containing the exception and failed message is sent to this channel.
client-mode	true, false	When true, the inbound adapter will act as a client, with respect to establishing the connection and then receive incoming messages on that connection. Default = false. Also see *retry-interval* and *scheduler*. The connection factory must be of type *client* and have *single-use* set to false.
retry-interval		When in *client-mode*, specifies the number of milliseconds to wait between connection attempts, or after a connection failure. Default 60,000 (60 seconds).
scheduler	true, false	Specifies a `TaskScheduler` to use for managing the *client-mode* connection. Defaults to a `ThreadPoolTaskScheduler` with a pool size of `.

Table 8.4. TCP Outbound Channel Adapter Attributes

Attribute Name	Allowed Values	Attribute Description
channel		The channel on which outbound messages arrive.

Attribute Name	Allowed Values	Attribute Description
connection-factory		If the connection factory has a type *client*, the factory is *owned* by this adapter. If it has a type *server*, it is *owned* by an inbound channel adapter and this adapter will attempt to correlate messages to the connection on which an original inbound message was received.
client-mode	true, false	When true, the outbound adapter will attempt to establish the connection as soon as it is started. When false, the connection is established when the first message is sent. Default = false. Also see *retry-interval* and *scheduler*. The connection factory must be of type *client* and have *single-use* set to false.
retry-interval		When in *client-mode*, specifies the number of milliseconds to wait between connection attempts, or after a connection failure. Default 60,000 (60 seconds).
scheduler	true, false	Specifies a `TaskScheduler` to use for managing the *client-mode* connection. Defaults to a `ThreadPoolTaskScheduler` with a pool size of `.

Table 8.5. TCP Inbound Gateway Attributes

Attribute Name	Allowed Values	Attribute Description
connection-factory		The connection factory must be of type server.
request-channel		The channel to which incoming messages will be sent.
reply-channel		The channel on which reply messages may arrive. Usually replies will arrive on a temporary reply channel added to the inbound message header
reply-timeout		The time in milliseconds for which the gateway will wait for a reply. Default 1000 (1 second).
error-channel		If an Exception is thrown by a downstream component, the MessagingException message containing the exception and failed message is sent to this channel; any reply from that flow will then be returned as a response by the gateway.
client-mode	true, false	When true, the inbound gateway will act as a client, with respect to establishing the connection and then receive (and reply to) incoming messages on that connection. Default = false. Also see *retry-interval* and *scheduler*. The connection factory must be of type *client* and have *single-use* set to false.

Attribute Name	Allowed Values	Attribute Description
retry-interval		When in *client-mode*, specifies the number of milliseconds to wait between connection attempts, or after a connection failure. Default 60,000 (60 seconds).
scheduler	true, false	Specifies a `TaskScheduler` to use for managing the *client-mode* connection. Defaults to a `ThreadPoolTaskScheduler` with a pool size of `.

Table 8.6. TCP Outbound Gateway Attributes

Attribute Name	Allowed Values	Attribute Description
connection-factory		The connection factory must be of type client.
request-channel		The channel on which outgoing messages will arrive.
reply-channel		Optional. The channel to which reply messages may be sent.
remote-timeout		The time in milliseconds for which the gateway will wait for a reply from the remote system. Mutually exclusive with `remote-timeout-expression`. Default: 10000 (10 seconds). Note: in versions prior to *4.2* this value defaulted to `reply-timeout` (if set).
remote-timeout-expression		A SpEL expression, evaluated against the message to determine the time in milliseconds for which the gateway will wait for a reply from the remote system. Mutually exclusive with `remote-timeout`.
request-timeout		If a single-use connection factory is not being used, The time in milliseconds for which the gateway will wait to get access to the shared connection.
reply-timeout		The time in milliseconds for which the gateway will wait when sending the reply to the reply-channel. Only applies if the reply-channel might block, such as a bounded QueueChannel that is currently full.

IP Message Headers. === IP Message Headers The following `MessageHeader` s are used by this module:

Header Name	IpHeaders Constant	Description
ip_hostname	HOSTNAME	The host name from which a TCP message or UDP packet was received. If `lookupHost` is `false`, this will contain the ip address.
ip_address	IP_ADDRESS	The ip address from which a TCP message or UDP packet was received.

Header Name	IpHeaders Constant	Description
ip_port	PORT	The remote port for a UDP packet.
ip_localInetAddress	IP_LOCAL_ADDRESS	The local `InetAddress` to which the socket is connected (since *version 4.2.5*).
ip_ackTo	ACKADDRESS	The remote ip address to which UDP application-level acks will be sent. The framework includes acknowledgment information in the data packet.
ip_ackId	ACK_ID	A correlation id for UDP application-level acks. The framework includes acknowledgment information in the data packet.
ip_tcp_remotePort	REMOTE_PORT	The remote port for a TCP connection.
ip_connectionId	CONNECTION_ID	A unique identifier for a TCP connection; set by the framework for inbound messages; when sending to a server-side inbound channel adapter, or replying to an inbound gateway, this header is required so the endpoint can determine which connection to send the message to.
ip_actualConnectionId	ACTUAL_ CONNECTION_ID	For information only - when using a cached or failover client connection factory, contains the actual underlying connection id.
contentType	MessageHeaders. CONTENT_TYPE	An optional content type for inbound messages; see below. Note that, unlike the other header constants, this constant is in the class `MessageHeaders` not `IpHeaders`.

For inbound messages, `ip_hostname`, `ip_address`, `ip_tcp_remotePort` and `ip_connectionId` are mapped by the default `TcpHeaderMapper`. Set the mapper's `addContentTypeHeader` property to `true` and the mapper will set the `contentType` header (`application/octet-stream;charset="UTF-8"`) by default. You can change the default by setting the `contentType` property. Users can add additional headers by subclassing `TcpHeaderMapper` and overriding the method `supplyCustomHeaders`. For example, when using SSL, properties of the `SSLSession` can be added by obtaining the session object from the `TcpConnection` object which is provided as an argument to the `supplyCustomHeaders` method.

For outbound messages, `String` payloads are converted to `byte[]` using the default (`UTF-8`) charset. Set the `charset` property to change the default.

When customizing the mapper properties, or subclassing, declare the mapper as a bean and provide an instance to the connection factory using the `mapper` property

=== Annotation-Based Configuration

The following example from the samples repository is used to illustrate some of the configuration options when using annotations instead of XML.

```
@EnableIntegration ❶
@IntegrationComponentScan ❷
@Configuration
public static class Config {

    @Value(${some.port})
    private int port;

    @MessagingGateway(defaultRequestChannel="toTcp") ❸
    public interface Gateway {

        String viaTcp(String in);

    }

    @Bean
    @ServiceActivator(inputChannel="toTcp") ❹
    public MessageHandler tcpOutGate(AbstractClientConnectionFactory connectionFactory) {
        TcpOutboundGateway gate = new TcpOutboundGateway();
        gate.setConnectionFactory(connectionFactory);
        gate.setOutputChannelName("resultToString");
        return gate;
    }

    @Bean ❺
    public TcpInboundGateway tcpInGate(AbstractServerConnectionFactory connectionFactory)  {
        TcpInboundGateway inGate = new TcpInboundGateway();
        inGate.setConnectionFactory(connectionFactory);
        inGate.setRequestChannel(fromTcp());
        return inGate;
    }

    @Bean
    public MessageChannel fromTcp() {
        return new DirectChannel();
    }

    @MessageEndpoint
    public static class Echo { ❻

        @Transformer(inputChannel="fromTcp", outputChannel="toEcho")
        public String convert(byte[] bytes) {
            return new String(bytes);
        }

        @ServiceActivator(inputChannel="toEcho")
        public String upCase(String in) {
            return in.toUpperCase();
        }

        @Transformer(inputChannel="resultToString")
        public String convertResult(byte[] bytes) {
            return new String(bytes);
        }

    }

    @Bean
    public AbstractClientConnectionFactory clientCF() { ❼
        return new TcpNetClientConnectionFactory("localhost", this.port);
    }

    @Bean
    public AbstractServerConnectionFactory serverCF() { ❽
        return new TcpNetServerConnectionFactory(this.port);
    }

}
```

❶ Standard Spring Integration annotation enabling the infrastructure for an integration application.
❷ Searches for `@MessagingGateway` interfaces.
❸ The entry point to the client-side of the flow. The calling application can `@Autowired` this `Gateway` bean and invoke its method.
❹ Outbound endpoints consist of a `MessageHandler` and a consumer that wraps it. In this scenario, the `@ServiceActivator` configures the endpoint according to the channel type.
❺ Inbound endpoints (in the TCP/UDP module) are all message-driven so just need to be declared as simple `@Bean` s.
❻ This class provides a number of POJO methods for use in this sample flow (a `@Transformer` and `@ServiceActivator` on the server side, and a `@Transformer` on the client side).
❼ The client-side connection factory.
❽ The server-side connection factory.

== Twitter Support

Spring Integration provides support for interacting with Twitter. With the Twitter adapters you can both receive and send Twitter messages. You can also perform a Twitter search based on a schedule and publish the search results within Messages. Since *version 4.0*, a search outbound gateway is provided to perform dynamic searches.

=== Introduction

Twitter is a social networking and micro-blogging service that enables its users to send and read messages known as tweets. Tweets are text-based posts of up to 140 characters displayed on the author’s profile page and delivered to the author’s subscribers who are known as followers.

> **Important**
>
> Versions of Spring Integration prior to 2.1 were dependent upon the Twitter4J API, but with the release of Spring Social 1.0 GA, Spring Integration, as of version 2.1, now builds directly upon Spring Social’s Twitter support, instead of Twitter4J. All Twitter endpoints require the configuration of a `TwitterTemplate` because even search operations require an authenticated template.

Spring Integration provides a convenient namespace configuration to define Twitter artifacts. You can enable it by adding the following within your XML header.

```
xmlns:int-twitter="http://www.springframework.org/schema/integration/twitter"
xsi:schemaLocation="http://www.springframework.org/schema/integration/twitter
https://www.springframework.org/schema/integration/twitter/spring-integration-twitter.xsd"
```

=== Twitter OAuth Configuration

For authenticated operations, Twitter uses OAuth - an authentication protocol that allows users to approve an application to act on their behalf without sharing their password. More information can be found at https://oauth.net or in this article https://hueniverse.com/oauth from Hueniverse. Please also see OAuth FAQ for more information about OAuth and Twitter.

In order to use OAuth authentication/authorization with Twitter you must create a new Application on the Twitter Developers site. Follow the directions below to create a new application and obtain consumer keys and an access token:

- Go to https://dev.twitter.com

- Click on the `Register an app` link and fill out all required fields on the form provided; set `Application Type` to `Client` and depending on the nature of your application select `Default Access Type` as *Read & Write* or *Read-only* and Submit the form. If everything is successful you'll be presented with the `Consumer Key` and `Consumer Secret`. Copy both values in a safe place.
- On the same page you should see a `My Access Token` button on the side bar (right). Click on it and you'll be presented with two more values: `Access Token` and `Access Token Secret`. Copy these values in a safe place as well.

=== Twitter Template

As mentioned above, Spring Integration relies upon Spring Social, and that library provides an implementation of the template pattern, `o.s.social.twitter.api.impl.TwitterTemplate` to interact with Twitter. For anonymous operations (e.g., search), you don't have to define an instance of `TwitterTemplate` explicitly, since a default instance will be created and injected into the endpoint. However, for authenticated operations (update status, send direct message, etc.), you must configure a `TwitterTemplate` as a bean and inject it explicitly into the endpoint, because the authentication configuration is required. Below is a sample configuration of TwitterTemplate:

```
<bean id="twitterTemplate" class="o.s.social.twitter.api.impl.TwitterTemplate">
 <constructor-arg value="4XzBPacJQxyBzzzH"/>
 <constructor-arg value="AbRxUAvyCtqQtvxFK8w5ZMtMj20KFhB6o"/>
 <constructor-arg value="21691649-4YZY5iJEOfz2A9qCFd9SjBRGb3HLmIm4HNE"/>
 <constructor-arg value="AbRxUAvyNCtqQtxFK8w5ZMtMj20KFhB6o"/>
</bean>
```

Note

The values above are not real.

```
 As you can see from the configuration above, all we need to do is to provide OAuth `attributes` as
 constructor arguments.
The values would be those you obtained in the previous step.
The order of constructor arguments is: 1) `consumerKey`, 2) `consumerSecret`, 3) `accessToken`, and 4)
 `accessTokenSecret`.
```

A more practical way to manage OAuth connection attributes would be via Spring's property placeholder support by simply creating a property file (e.g., oauth.properties):

```
twitter.oauth.consumerKey=4XzBPacJQxyBzzzH
twitter.oauth.consumerSecret=AbRxUAvyCtqQtvxFK8w5ZMtMj20KFhB6o
twitter.oauth.accessToken=21691649-4YZY5iJEOfz2A9qCFd9SjBRGb3HLmIm4HNE
twitter.oauth.accessTokenSecret=AbRxUAvyNCtqQtxFK8w5ZMtMj20KFhB6o
```

Then, you can configure a `property-placeholder` to point to the above property file:

```
<context:property-placeholder location="classpath:oauth.properties"/>

<bean id="twitterTemplate" class="o.s.social.twitter.api.impl.TwitterTemplate">
    <constructor-arg value="${twitter.oauth.consumerKey}"/>
    <constructor-arg value="${twitter.oauth.consumerSecret}"/>
    <constructor-arg value="${twitter.oauth.accessToken}"/>
    <constructor-arg value="${twitter.oauth.accessTokenSecret}"/>
</bean>
```

=== Twitter Inbound Adapters

Twitter inbound adapters allow you to receive Twitter Messages. There are several types of twitter messages, or tweets

Spring Integration version 2.0 and above provides support for receiving tweets as *Timeline Updates*, *Direct Messages*, *Mention Messages* as well as Search Results.

Important

Every Inbound Twitter Channel Adapter is a *Polling Consumer* which means you have to provide a poller configuration. Twitter defines a concept of Rate Limiting. You can read more about it here: Rate Limiting. In a nutshell, Rate Limiting is a mechanism that Twitter uses to manage how often an application can poll for updates. You should consider this when setting your poller intervals so that the adapter polls in compliance with the Twitter policies.

With Spring Integration prior to *version 3.0*, a hard-coded limit within the adapters was used to ensure the polling interval could not be less than 15 seconds. This is no longer the case and the poller configuration is applied directly.

Another issue that we need to worry about is handling duplicate Tweets. The same adapter (e.g., Search or Timeline Update) while polling on Twitter may receive the same values more than once. For example if you keep searching on Twitter with the same search criteria you'll end up with the same set of tweets unless some other new tweet that matches your search criteria was posted in between your searches. In that situation you'll get all the tweets you had before plus the new one. But what you really want is only the new tweet(s). Spring Integration provides an elegant mechanism for handling these situations. The latest Tweet id will be stored in an instance of the `org.springframework.integration.metadata.MetadataStore` strategy (e.g. last retrieved tweet in this case). For more information see the section called "CompletableFuture".

Note

The key used to persist the latest *twitter id* is the value of the (required) `id` attribute of the Twitter Inbound Channel Adapter component plus the `profileId` of the Twitter user.

Prior to *version 4.0*, the page size was hard-coded to 20. This is now configurable using the `page-size` attribute (defaults to 20).

==== Inbound Message Channel Adapter

This adapter allows you to receive updates from everyone you follow. It's essentially the "Timeline Update" adapter.

```
<int-twitter:inbound-channel-adapter
    twitter-template="twitterTemplate"
    channel="inChannel">
    <int:poller fixed-rate="5000" max-messages-per-poll="3"/>
</int-twitter:inbound-channel-adapter>
```

==== Direct Inbound Message Channel Adapter

This adapter allows you to receive Direct Messages that were sent to you from other Twitter users.

```
<int-twitter:dm-inbound-channel-adapter
    twitter-template="twiterTemplate"
    channel="inboundDmChannel">
    <int-poller fixed-rate="5000" max-messages-per-poll="3"/>
</int-twitter:dm-inbound-channel-adapter>
```

==== Mentions Inbound Message Channel Adapter

This adapter allows you to receive Twitter Messages that Mention you via @user syntax.

```
<int-twitter:mentions-inbound-channel-adapter
    twitter-template="twiterTemplate"
  channel="inboundMentionsChannel">
    <int:poller fixed-rate="5000" max-messages-per-poll="3"/>
</int-twitter:mentions-inbound-channel-adapter>
```

==== Search Inbound Message Channel Adapter

This adapter allows you to perform searches. As you can see it is not necessary to define twitter-template since a search can be performed anonymously, however you must define a search query.

```
<int-twitter:search-inbound-channel-adapter
    query="#springintegration"
  channel="inboundMentionsChannel">
     <int:poller fixed-rate="5000" max-messages-per-poll="3"/>
</int-twitter:search-inbound-channel-adapter>
```

Refer to https://dev.twitter.com/docs/using-search to learn more about Twitter queries.

As you can see the configuration of all of these adapters is very similar to other inbound adapters with one exception. Some may need to be injected with the `twitter-template`. Once received each Twitter Message would be encapsulated in a Spring Integration Message and sent to the channel specified by the `channel` attribute. Currently the Payload type of any Message is `org.springframework.integration.twitter.core.Tweet` which is very similar to the object with the same name in Spring Social. As we migrate to Spring Social we'll be depending on their API and some of the artifacts that are currently in use will be obsolete, however we've already made sure that the impact of such migration is minimal by aligning our API with the current state (at the time of writing) of Spring Social.

To get the text from the `org.springframework.social.twitter.api.Tweet` simply invoke the `getText()` method.

=== Twitter Outbound Adapter

Twitter outbound channel adapters allow you to send Twitter Messages, or tweets.

Spring Integration version 2.0 and above supports sending *Status Update Messages* and *Direct Messages*. Twitter outbound channel adapters will take the Message payload and send it as a Twitter message. Currently the only supported payload type is`String`, so consider adding a *transformer* if the payload of the incoming message is not a String.

==== Twitter Outbound Update Channel Adapter

This adapter allows you to send regular status updates by simply sending a Message to the channel identified by the `channel` attribute.

```
<int-twitter:outbound-channel-adapter
    twitter-template="twitterTemplate"
    channel="twitterChannel"/>
```

```
The only extra configuration that is required for this adapter is the `twitter-template` reference.
```

Starting with *version 4.0* the `<int-twitter:outbound-channel-adapter>` supports a `tweet-data-expression` to populate the `TweetData` argument (Spring Social Twitter) using the message as the root object of the expression evaluation context. The result can be a `String`, which will be used for the `TweetData` message; a `Tweet` object, the `text` of which will be used for the `TweetData` message;

or an entire `TweetData` object. For convenience, the `TweetData` can be built from the expression directly without needing a fully qualified class name:

```
<int-twitter:outbound-channel-adapter
    twitter-template="twitterTemplate"
    channel="twitterChannel"
    tweet-data-expression="new TweetData(payload).withMedia(headers.media).displayCoordinates(true)/>
```

This allows, for example, attaching an image to the tweet.

==== Twitter Outbound Direct Message Channel Adapter

This adapter allows you to send Direct Twitter Messages (i.e., @user) by simply sending a Message to the channel identified by the `channel` attribute.

```
<int-twitter:dm-outbound-channel-adapter
    twitter-template="twitterTemplate"
    channel="twitterChannel"/>
```

```
The only extra configuration that is required for this adapter is the `twitter-template` reference.
```

When it comes to Twitter Direct Messages, you must specify who you are sending the message to - the *target userid*. The Twitter Outbound Direct Message Channel Adapter will look for a target userid in the Message headers under the name `twitter_dmTargetUserId` which is also identified by the following constant: `TwitterHeaders.DM_TARGET_USER_ID`. So when creating a Message all you need to do is add a value for that header.

```
Message message = MessageBuilder.withPayload("hello")
        .setHeader(TwitterHeaders.DM_TARGET_USER_ID, "z_oleg").build();
```

The above approach works well if you are creating the Message programmatically. However it's more common to provide the header value within a messaging flow. The value can be provided by an upstream <header-enricher>.

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:header name="twitter_dmTargetUserId" value="z_oleg"/>
</int:header-enricher>
```

It's quite common that the value must be determined dynamically. For those cases you can take advantage of SpEL support within the <header-enricher>.

```
<int:header-enricher input-channel="in" output-channel="out">
    <int:header name="twitter_dmTargetUserId"
        expression="@twitterIdService.lookup(headers.username)"/>
</int:header-enricher>
```

Important

Twitter does not allow you to post duplicate Messages. This is a common problem during testing when the same code works the first time but does not work the second time. So, make sure to change the content of the Message each time. Another thing that works well for testing is to append a timestamp to the end of each message.

=== Twitter Search Outbound Gateway

In Spring Integration, an outbound gateway is used for two-way request/response communication with an external service. The Twitter Search Outbound Gateway allows you to issue dynamic twitter searches. The reply message payload is a collection of `Tweet` objects. If the search returns no results, the payload is an empty collection. You can limit the number of tweets and you can page through a larger set of tweets by making multiple calls. To facilitate this, search reply messages contain a header `twitter_searchMetadata` with its value being a `SearchMetadata` object. For more information on the `Tweet`, `SearchParameters` and `SearchMetadata` classes, refer to the Spring Social Twitter documentation.

Configuring the Outbound Gateway

```
<int-twitter:search-outbound-gateway id="twitter"
 request-channel="in"  ❶
 twitter-template="twitterTemplate"  ❷
 search-args-expression="payload"  ❸
 reply-channel="out"  ❹
 reply-timeout="123"  ❺
 order="1"  ❻
 auto-startup="false"  ❼
 phase="100" /> ❽
```

❶ The channel used to send search requests to this gateway.

❷ A reference to a `TwitterTemplate` with authentication configuration.

❸ A SpEL expression that evaluates to argument(s) for the search. Default: **"payload"** - in which case the payload can be a `String` (e.g "#springintegration") and the gateway limits the query to 20 tweets, or the payload can be a `SearchParameters` object.
The expression can also be specified as a SpEL List. The first element (String) is the query, the remaining elements (Numbers) are `pageSize, sinceId, maxId` respectively - refer to the Spring Social Twitter documentation for more information about these parameters. When specifying a `SearchParameters` object directly in the SpEL expression, you do not have to fully qualify the class name. Some examples:
`new SearchParameters(payload).count(5).sinceId(headers.sinceId)`
`{payload, 30}`
`{payload, headers.pageSize, headers.sinceId, headers.maxId}`

❹ The channel to which to send the reply; if omitted, the `replyChannel` header is used.

❺ The timeout when sending the reply message to the reply channel; only applies if the reply channel can block, for example a bounded queue channel that is full.

❻ When subscribed to a publish/subscribe channel, the order in which this endpoint will be invoked.

❼ `SmartLifecycle` method.

❽ `SmartLifecycle` method.

== WebFlux Support

=== Introduction

The WebFlux Spring Integration module (`spring-integration-webflux`) allows for the execution of HTTP requests and the processing of inbound HTTP requests in Reactive manner. The WebFlux support consists of the following gateway implementations: `WebFluxInboundEndpoint`, `WebFluxRequestExecutingMessageHandler`. The implementation is fully based on the Spring WebFlux and Project Reactor foundations. Also see the section called “CompletableFuture” for more information since many options are shared between reactive and regular HTTP components.

=== WebFlux Inbound Components

Starting with *version 5.0*, the `WebFluxInboundEndpoint`, `WebHandler`, implementation is provided. This component is similar to the MVC-based `HttpRequestHandlingEndpointSupport` with which it shares some common options via the newly extracted `BaseHttpInboundEndpoint`. Instead of MVC, it is used in the Spring WebFlux Reactive environment. A simple sample for explanation:

```
@Configuration
@EnableWebFlux
@EnableIntegration
public class ReactiveHttpConfiguration {

    @Bean
    public WebFluxInboundEndpoint simpleInboundEndpoint() {
        WebFluxInboundEndpoint endpoint = new WebFluxInboundEndpoint();
        RequestMapping requestMapping = new RequestMapping();
        requestMapping.setPathPatterns("/test");
        endpoint.setRequestMapping(requestMapping);
        endpoint.setRequestChannelName("serviceChannel");
        return endpoint;
    }

    @ServiceActivator(inputChannel = "serviceChannel")
    String service() {
        return "It works!";
    }

}
```

As can be seen, the configuration is similar to the `HttpRequestHandlingEndpointSupport` mentioned above, except that we use `@EnableWebFlux` to add the WebFlux infrastructure to our integration application. Also, the `WebFluxInboundEndpoint` performs `sendAndReceive` operation to the downstream flow using back-pressure, on demand based capabilities, provided by the reactive HTTP server implementation.

> **Note**
>
> The reply part is non-blocking as well and based on the internal `FutureReplyChannel` which is flat-mapped to a reply `Mono` for on demand resolution.

The `WebFluxInboundEndpoint` can be configured with a custom `ServerCodecConfigurer`, `RequestedContentTypeResolver` and even a `ReactiveAdapterRegistry`. The latter provides a mechanism where we can return a reply as any reactive type - Reactor `Flux`, RxJava `Observable`, `Flowable` etc. This way, we can simply implement Server Sent Events scenarios with Spring Integration components:

```
@Bean
public IntegrationFlow sseFlow() {
    return IntegrationFlows
            .from(WebFlux.inboundGateway("/sse")
                    .requestMapping(m -> m.produces(MediaType.TEXT_EVENT_STREAM_VALUE)))
            .handle((p, h) -> Flux.just("foo", "bar", "baz"))
            .get();
}
```

Also see the section called “CompletableFuture” and the section called “CompletableFuture” for more possible configuration options.

When the request body is empty, or `payloadExpression` returns `null`, the request params `MultiValueMap<String, String>` is used for a `payload` of the target message to process.

=== WebFlux Outbound Components

The `WebFluxRequestExecutingMessageHandler` (starting with *version 5.0*) implementation is very similar to `HttpRequestExecutingMessageHandler`, using a `WebClient` from the Spring Framework WebFlux module. To configure it, define a bean like this:

```
<bean id="httpReactiveOutbound"
    class="org.springframework.integration.webflux.outbound.WebFluxRequestExecutingMessageHandler">
     <constructor-arg value="http://localhost:8080/example" />
     <property name="outputChannel" ref="responseChannel" />
</bean>
```

You can configure a `WebClient` instance to use:

```
<beans:bean id="webClient" class="org.springframework.web.reactive.function.client.WebClient"
    factory-method="create"/>

<bean id="httpReactiveOutbound"
    class="org.springframework.integration.webflux.outbound.WebFluxRequestExecutingMessageHandler">
     <constructor-arg value="http://localhost:8080/example" />
     <constructor-arg re="webClient" />
     <property name="outputChannel" ref="responseChannel" />
</bean>
```

The `WebClient` `exchange()` operation returns a `Mono<ClientResponse>` which is mapped (using several `Mono.map()` steps) to an `AbstractIntegrationMessageBuilder` as the output from the `WebFluxRequestExecutingMessageHandler`. Together with the `ReactiveChannel` as an `outputChannel`, the `Mono<ClientResponse>` evaluation is deferred until a downstream subscription is made. Otherwise, it is treated as an `async` mode and the `Mono` response is adapted to an `SettableListenableFuture` for an asynchronous reply from the `WebFluxRequestExecutingMessageHandler`. The target payload of the output message depends on the `WebFluxRequestExecutingMessageHandler` configuration. The `setExpectedResponseType(Class<?>)` or `setExpectedResponseTypeExpression(Expression)` identifies the target type of the response body element conversion. If the `replyPayloadToFlux` is set to `true`, the response body is converted to a `Flux` with the provided `expectedResponseType` for each element and this `Flux` is sent as the payload downstream. A splitter afterwards can be used to iterate over this `Flux` in a reactive manner.

In addition a `BodyExtractor<?, ClientHttpResponse>` can be injected into the `WebFluxRequestExecutingMessageHandler` instead of `expectedResponseType` and `replyPayloadToFlux` properties. It can be used for low-level access to the `ClientHttpResponse` and more control over body and HTTP headers conversion. The `ClientHttpResponseBodyExtractor` is provided out-of-the-box as identity function to produce downstream the whole `ClientHttpResponse` and any other possible custom logic.

Also see the section called “CompletableFuture” for more possible configuration options.

=== WebFlux Namespace Support

==== Introduction

Spring Integration provides a *webflux* namespace and the corresponding schema definition. To include it in your configuration, simply provide the following namespace declaration in your application context configuration file:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-webflux="http://www.springframework.org/schema/integration/webflux"
  xsi:schemaLocation="
    http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/webflux
    https://www.springframework.org/schema/integration/webflux/spring-integration-webflux.xsd">
    ...
</beans>
```

==== Inbound

To configure Spring Integration WebFlux via XML you may use appropriate components from the mentioned `int-webflux` namespace - `inbound-channel-adapter` or `inbound-gateway` according request/response requirements respectively:

```
<inbound-channel-adapter id="reactiveFullConfig" channel="requests"
                         path="test1"
                         auto-startup="false"
                         phase="101"
                         request-payload-type="byte[]"
                         error-channel="errorChannel"
                         payload-expression="payload"
                         supported-methods="PUT"
                         status-code-expression="'202'"
                         header-mapper="headerMapper"
                         codec-configurer="codecConfigurer"
                         reactive-adapter-registry="reactiveAdapterRegistry"
                         requested-content-type-resolver="requestedContentTypeResolver">
    <request-mapping headers="foo"/>
    <cross-origin origin="foo"
                  method="PUT"/>
    <header name="foo" expression="'foo'"/>
</inbound-channel-adapter>

<inbound-gateway id="reactiveFullConfig" request-channel="requests"
                 path="test1"
                 auto-startup="false"
                 phase="101"
                 request-payload-type="byte[]"
                 error-channel="errorChannel"
                 payload-expression="payload"
                 supported-methods="PUT"
                 reply-timeout-status-code-expression="'504'"
                 header-mapper="headerMapper"
                 codec-configurer="codecConfigurer"
                 reactive-adapter-registry="reactiveAdapterRegistry"
                 requested-content-type-resolver="requestedContentTypeResolver">
    <request-mapping headers="foo"/>
    <cross-origin origin="foo"
                  method="PUT"/>
    <header name="foo" expression="'foo'"/>
</inbound-gateway>
```

==== Outbound

If you want to execute the http request in a reactive, non-blocking way, you can use the `outbound-gateway` or `outbound-channel-adapter`.

```
<int-webflux:outbound-gateway id="reactiveExample1"
    request-channel="requests"
    url="http://localhost/test"
    http-method-expression="headers.httpMethod"
    extract-request-payload="false"
    expected-response-type-expression="payload"
    charset="UTF-8"
    reply-timeout="1234"
    reply-channel="replies"/>

<int-webflux:outbound-channel-adapter id="reactiveExample2"
    url="http://localhost/example"
    http-method="GET"
    channel="requests"
    charset="UTF-8"
    extract-payload="false"
    expected-response-type="java.lang.String"
    order="3"
    auto-startup="false"/>
```

=== Configuring WebFlux Endpoints with Java

Inbound Gateway Using Java Configuration.

```
@Bean
public WebFluxInboundEndpoint jsonInboundEndpoint() {
    WebFluxInboundEndpoint endpoint = new WebFluxInboundEndpoint();
    RequestMapping requestMapping = new RequestMapping();
    requestMapping.setPathPatterns("/persons");
    endpoint.setRequestMapping(requestMapping);
    endpoint.setRequestChannel(fluxResultChannel());
    return endpoint;
}

@Bean
public MessageChannel fluxResultChannel() {
    return new FluxMessageChannel();
}

@ServiceActivator(inputChannel = "fluxResultChannel")
Flux<Person> getPersons() {
    return Flux.just(new Person("Jane"), new Person("Jason"), new Person("John"));
}
```

Inbound Gateway Using the Java DSL.

```
@Bean
public IntegrationFlow inboundChannelAdapterFlow() {
    return IntegrationFlows
        .from(WebFlux.inboundChannelAdapter("/reactivePost")
            .requestMapping(m -> m.methods(HttpMethod.POST))
            .requestPayloadType(ResolvableType.forClassWithGenerics(Flux.class, String.class))
            .statusCodeFunction(m -> HttpStatus.ACCEPTED))
        .channel(c -> c.queue("storeChannel"))
        .get();
}
```

Outbound Gateway Using Java Configuration.

```
@ServiceActivator(inputChannel = "reactiveHttpOutRequest")
@Bean
public WebFluxRequestExecutingMessageHandler reactiveOutbound(WebClient client) {
    WebFluxRequestExecutingMessageHandler handler =
        new WebFluxRequestExecutingMessageHandler("http://localhost:8080/foo", client);
    handler.setHttpMethod(HttpMethod.POST);
    handler.setExpectedResponseType(String.class);
    return handler;
}
```

Outbound Gateway Using the Java DSL.

```
@Bean
public IntegrationFlow outboundReactive() {
    return f -> f
        .handle(WebFlux.<MultiValueMap<String, String>>outboundGateway(m ->
                UriComponentsBuilder.fromUriString("http://localhost:8080/foo")
                        .queryParams(m.getPayload())
                        .build()
                        .toUri())
                .httpMethod(HttpMethod.GET)
                .expectedResponseType(String.class));
}
```

=== WebFlux Header Mappings

Since WebFlux components are fully based on the HTTP protocol there is no difference in the HTTP headers mapping. See the section called “CompletableFuture” for more possible options and components to use for mapping headers.

== WebSockets Support

=== Introduction

Starting with *version 4.1* Spring Integration has introduced *WebSocket* support. It is based on architecture, infrastructure and API from the Spring Framework’s *web-socket* module. Therefore, many of Spring WebSocket’s components (e.g. `SubProtocolHandler` or `WebSocketClient`) and configuration options (e.g. `@EnableWebSocketMessageBroker`) can be reused within Spring Integration. For more information, please, refer to the Spring Framework WebSocket Support chapter in the Spring Framework reference manual.

Note

Since the Spring Framework WebSocket infrastructure is based on the *Spring Messaging* foundation and provides a basic Messaging framework based on the same `MessageChannel` s, `MessageHandler` s that Spring Integration uses, and some POJO-method annotation mappings, Spring Integration can be directly involved in a WebSocket flow, even without WebSocket adapters. For this purpose you can simply configure a Spring Integration `@MessagingGateway` with appropriate annotations:

```
@MessagingGateway
@Controller
public interface WebSocketGateway {

    @MessageMapping("/greeting")
    @SendToUser("/queue/answer")
    @Gateway(requestChannel = "greetingChannel")
    String greeting(String payload);

}
```

=== Overview

Since the WebSocket protocol is *streaming* by definition and we can *send* and *receive* messages to/from a WebSocket at the same time, we can simply deal with an appropriate `WebSocketSession`, regardless of being on the client or server side. To encapsulate the connection management and `WebSocketSession` registry, the `IntegrationWebSocketContainer` is provided with `ClientWebSocketContainer` and `ServerWebSocketContainer` implementations. Thanks to the

WebSocket API and its implementation in the Spring Framework, with many extensions, the same classes are used on the server side as well as the client side (from a Java perspective, of course). Hence most connection and `WebSocketSession` registry options are the same on both sides. That allows us to reuse many configuration items and infrastructure hooks to build WebSocket applications on the server side as well as on the client side:

```
//Client side
@Bean
public WebSocketClient webSocketClient() {
    return new SockJsClient(Collections.singletonList(new WebSocketTransport(new
 JettyWebSocketClient())));
}

@Bean
public IntegrationWebSocketContainer clientWebSocketContainer() {
    return new ClientWebSocketContainer(webSocketClient(), "ws://my.server.com/endpoint");
}

//Server side
@Bean
public IntegrationWebSocketContainer serverWebSocketContainer() {
    return new ServerWebSocketContainer("/endpoint").withSockJs();
}
```

The `IntegrationWebSocketContainer` is designed to achieve *bidirectional* messaging and can be shared between Inbound and Outbound Channel Adapters (see below), can be referenced only from one of them (when using one-way - sending or receiving - WebSocket messaging). It can be used without any Channel Adapter, but in this case, `IntegrationWebSocketContainer` only plays a role as the `WebSocketSession` registry.

> **Note**
>
> The `ServerWebSocketContainer` implements `WebSocketConfigurer` to register an internal `IntegrationWebSocketContainer.IntegrationWebSocketHandler` as an `Endpoint` under the provided `paths` and other server WebSocket options (such as `HandshakeHandler` or `SockJS fallback`) within the `ServletWebSocketHandlerRegistry` for the target vendor WebSocket Container. This registration is achieved with an infrastructural `WebSocketIntegrationConfigurationInitializer` component, which does the same as the `@EnableWebSocket` annotation. This means that using just `@EnableIntegration` (or any Spring Integration Namespace in the application context) you can omit the `@EnableWebSocket` declaration, because all WebSocket Endpoints are detected by the Spring Integration infrastructure.

=== WebSocket Inbound Channel Adapter

The `WebSocketInboundChannelAdapter` implements the receiving part of `WebSocketSession` interaction. It must be supplied with a `IntegrationWebSocketContainer`, and the adapter registers itself as a `WebSocketListener` to handle incoming messages and `WebSocketSession` events.

> **Note**
>
> Only one `WebSocketListener` can be registered in the `IntegrationWebSocketContainer`.

For WebSocket _sub-protocol_s, the `WebSocketInboundChannelAdapter` can be configured with `SubProtocolHandlerRegistry` as the second constructor argument. The adapter delegates to the `SubProtocolHandlerRegistry` to determine the appropriate `SubProtocolHandler` for the accepted `WebSocketSession` and to convert `WebSocketMessage` to a `Message` according to the sub-protocol implementation.

> **Note**
>
> By default, the `WebSocketInboundChannelAdapter` relies just only on the raw `PassThruSubProtocolHandler` implementation, which simply converts the `WebSocketMessage` to a `Message`.

The `WebSocketInboundChannelAdapter` accepts and sends to the underlying integration flow only `Message` s with `SimpMessageType.MESSAGE` or an empty `simpMessageType` header. All other `Message` types are handled through the `ApplicationEvent` s emitted from a `SubProtocolHandler` implementation (e.g. `StompSubProtocolHandler`).

On the server side `WebSocketInboundChannelAdapter` can be configured with the `useBroker = true` option, if the `@EnableWebSocketMessageBroker` configuration is present. In this case all `non-MESSAGE` `Message` types are delegated to the provided `AbstractBrokerMessageHandler`. In addition, if the Broker Relay is configured with destination prefixes, those Messages, which match to the Broker destinations, are routed to the `AbstractBrokerMessageHandler`, instead of to the `outputChannel` of the `WebSocketInboundChannelAdapter`.

If `useBroker = false` and received message is of `SimpMessageType.CONNECT` type, the `WebSocketInboundChannelAdapter` sends `SimpMessageType.CONNECT_ACK` message to the `WebSocketSession` immediately without sending it to the channel.

> **Note**
>
> Spring's WebSocket Support allows the configuration of only one Broker Relay, hence we don't require an `AbstractBrokerMessageHandler` reference, it is detected in the Application Context.

For more configuration options see the section called "CompletableFuture".

=== WebSocket Outbound Channel Adapter

The `WebSocketOutboundChannelAdapter` accepts Spring Integration messages from its `MessageChannel`, determines the `WebSocketSession` `id` from the `MessageHeaders`, retrieves the `WebSocketSession` from the provided `IntegrationWebSocketContainer` and delegates the conversion and sending `WebSocketMessage` work to the appropriate `SubProtocolHandler` from the provided `SubProtocolHandlerRegistry`.

On the client side, the `WebSocketSession` `id` message header isn't required, because `ClientWebSocketContainer` deals only with a single connection and its `WebSocketSession` respectively.

To use the STOMP sub-protocol, this adapter should be configured with a `StompSubProtocolHandler`. Then you can send any STOMP message type to this adapter, using `StompHeaderAccessor.create(StompCommand...)` and a `MessageBuilder`, or just using a `HeaderEnricher` (see the section called "Header Enricher").

For more configuration options see below.

=== WebSockets Namespace Support

Spring Integration *WebSocket* namespace includes several components described below. To include it in your configuration, simply provide the following namespace declaration in your application context configuration file:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-websocket="http://www.springframework.org/schema/integration/websocket"
  xsi:schemaLocation="
    http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/websocket
    https://www.springframework.org/schema/integration/websocket/spring-integration-websocket.xsd">
    ...
</beans>
```

<int-websocket:client-container>

```
<int-websocket:client-container
                id=""  ❶
                client=""  ❷
                uri=""  ❸
                uri-variables=""  ❹
                origin=""  ❺
                send-time-limit=""  ❻
                send-buffer-size-limit=""  ❼
                auto-startup=""  ❽
                phase="">  ❾
               <int-websocket:http-headers>
                <entry key="" value=""/>
               </int-websocket:http-headers>  ❿
</int-websocket:client-container>
```

❶ The component bean name.

❷ The `WebSocketClient` bean reference.

❸ The `uri` or `uriTemplate` to the target WebSocket service. If it is used as a `uriTemplate` with URI variable placeholders, the `uri-variables` attribute is required.

❹ Comma-separated values for the URI variable placeholders within the `uri` attribute value. The values are replaced into the placeholders according to the order in the `uri`. See `UriComponents.expand(Object... uriVariableValues)`.

❺ The `Origin` Handshake HTTP header value.

❻ The WebSocket session *send* timeout limit. Defaults to `10000`.

❼ The WebSocket session *send* message size limit. Defaults to `524288`.

❽ Boolean value indicating whether this endpoint should start automatically. Defaults to `false`, assuming that this container will be started from the the section called “CompletableFuture”.

❾ The lifecycle phase within which this endpoint should start and stop. The lower the value the earlier this endpoint will start and the later it will stop. The default is `Integer.MAX_VALUE`. Values can be negative. See `SmartLifeCycle`.

❿ A `Map` of `HttpHeaders` to be used with the Handshake request.

<int-websocket:server-container>

```
<int-websocket:server-container
     id=""  ❶
     path=""  ❷
     handshake-handler=""  ❸
     handshake-interceptors=""  ❹
     decorator-factories=""  ❺
     send-time-limit=""  ❻
     send-buffer-size-limit=""  ❼
     allowed-origins="">  ❽
      <int-websocket:sockjs
      client-library-url=""   ❾
      stream-bytes-limit=""   ❿
      session-cookie-needed=""   11
      heartbeat-time=""   12
      disconnect-delay=""   13
      message-cache-size=""   14
      websocket-enabled=""   15
      scheduler=""   16
      message-codec=""   17
      transport-handlers=""  18
      suppress-cors="true"="" />  19
</int-websocket:server-container>
```

❶ The component bean name.

❷ A path (or comma-separated paths) that maps a particular request to a `WebSocketHandler`. Exact path mapping URIs (such as `"/myPath"`) are supported as well as ant-style path patterns (such as `/myPath/**`).

❸ The `HandshakeHandler` bean reference. Default to `DefaultHandshakeHandler`.

❹ List of `HandshakeInterceptor` bean references.

❺ Configure one or more factories (`WebSocketHandlerDecoratorFactory`) to decorate the handler used to process WebSocket messages. This may be useful for some advanced use cases, for example to allow Spring Security to forcibly close the WebSocket session when the corresponding HTTP session expires. See Spring Session Project for more information.

❻ See the same option on the `<int-websocket:client-container>`.

❼ See the same option on the `<int-websocket:client-container>`.

❽ Configure allowed Origin header values. Multiple origins may be specified as a comma-separated list. This check is mostly designed for browser clients. There is noting preventing other types of client to modify the Origin header value. When SockJS is enabled and allowed origins are restricted, transport types that do not use Origin headers for cross origin requests (jsonp-polling, iframe-xhr-polling, iframe-eventsource and iframe-htmlfile) are disabled. As a consequence, IE6/IE7 are not supported and IE8/IE9 will only be supported without cookies. By default, all origins are allowed.

❾ Transports with no native cross-domain communication (e.g. "eventsource", "htmlfile") must get a simple page from the "foreign" domain in an invisible iframe so that code in the iframe can run from a domain local to the SockJS server. Since the iframe needs to load the SockJS javascript client library, this property allows specifying where to load it from. By default this is set to point to `https://d1fxtkz8shb9d2.cloudfront.net/sockjs-0.3.4.min.js`. However it can also be set to point to a URL served by the application. Note that it's possible to specify a relative URL in which case the URL must be relative to the iframe URL. For example assuming a SockJS endpoint mapped to "/sockjs", and resulting iframe URL "/sockjs/iframe.html", then the The relative URL must start with "../../" to traverse up to the location above the SockJS mapping. In case of a prefix-based Servlet mapping one more traversal may be needed.

❿ Minimum number of bytes that can be send over a single HTTP streaming request before it will be closed. Defaults to `128K` (i.e. 128*1024 bytes).

11 The "cookie_needed" value in the response from the SockJs `"/info"` endpoint. This property indicates whether the use of a JSESSIONID cookie is required for the application to function correctly, e.g. for load balancing or in Java Servlet containers for the use of an HTTP session.

12 The amount of time in milliseconds when the server has not sent any messages and after which the server should send a heartbeat frame to the client in order to keep the connection from breaking. The default value is `25,000` (25 seconds).

13 The amount of time in milliseconds before a client is considered disconnected after not having a receiving connection, i.e. an active connection over which the server can send data to the client. The default value is `5000`.

14 The number of server-to-client messages that a session can cache while waiting for the next HTTP polling request from the client. The default size is `100`.

15 Some load balancers don't support websockets. Set this option to `false` to disable the WebSocket transport on the server side. The default value is `true`.

16 The `TaskScheduler` bean reference; a new `ThreadPoolTaskScheduler` instance will be created if no value is provided. This scheduler instance will be used for scheduling heart-beat messages.

17 The `SockJsMessageCodec` bean reference to use for encoding and decoding SockJS messages. By default `Jackson2SockJsMessageCodec` is used requiring the Jackson library to be present on the classpath.

18 List of `TransportHandler` bean references.

19 The option to disable automatic addition of CORS headers for SockJS requests. The default value is `false`.

<int-websocket:outbound-channel-adapter>

```
<int-websocket:outbound-channel-adapter
                            id=""  ❶
                            channel=""  ❷
                            container=""  ❸
                            default-protocol-handler=""  ❹
                            protocol-handlers=""  ❺
                            message-converters=""  ❻
                            merge-with-default-converters=""  ❼
                            auto-startup=""  ❽
                            phase=""/>  ❾
```

❶ The component bean name. If the `channel` attribute isn't provided, a `DirectChannel` is created and registered with the application context with this `id` attribute as the bean name. In this case, the endpoint is registered with the bean name `id + '.adapter'`. And the `MessageHandler` is registered with the bean alias `id + '.handler'`.

❷ Identifies the channel attached to this adapter.

❸ The reference to the `IntegrationWebSocketContainer` bean, which encapsulates the low-level connection and WebSocketSession handling operations. Required.

❹ Optional reference to a `SubProtocolHandler` instance. It is used when the client did not request a sub-protocol or it is a single protocol-handler. If this reference or `protocol-handlers` list aren't provided the `PassThruSubProtocolHandler` is used by default.

❺ List of `SubProtocolHandler` bean references for this Channel Adapter. If only a single bean reference is provided and a `default-protocol-handler` isn't provided, that single `SubProtocolHandler` will be used as the `default-protocol-handler`. If this attribute or `default-protocol-handler` aren't provided, the `PassThruSubProtocolHandler` is used by default.

❻ List of `MessageConverter` bean references for this Channel Adapter.

❼ Flag to indicate if the default converters should be registered after any custom converters. This flag is used only if `message-converters` are provided, otherwise all default converters will be registered. Defaults to `false`. The default converters are (in the order): `StringMessageConverter`, `ByteArrayMessageConverter` and `MappingJackson2MessageConverter` if the Jackson library is present on the classpath.

❽ Boolean value indicating whether this endpoint should start automatically. Default to `true`.

❾ The lifecycle phase within which this endpoint should start and stop. The lower the value the earlier this endpoint will start and the later it will stop. The default is `Integer.MIN_VALUE`. Values can be negative. See `SmartLifeCycle`.

<int-websocket:inbound-channel-adapter>

```
<int-websocket:inbound-channel-adapter
                            id=""  ❶
                            channel=""  ❷
                            error-channel=""  ❸
                            container=""  ❹
                            default-protocol-handler=""  ❺
                            protocol-handlers=""  ❻
                            message-converters=""  ❼
                            merge-with-default-converters=""  ❽
                            send-timeout=""  ❾
                            payload-type=""  ❿
                            use-broker=""  11
                            auto-startup=""  12
                            phase=""/> 13
```

❶ The component bean name. If the `channel` attribute isn't provided, a `DirectChannel` is created and registered with the application context with this `id` attribute as the bean name. In this case, the endpoint is registered with the bean name `id + '.adapter'`.

❷ Identifies the channel attached to this adapter.

❸ The `MessageChannel` bean reference to which the `ErrorMessages` should be sent.

❹ See the same option on the `<int-websocket:outbound-channel-adapter>`.

❺ See the same option on the `<int-websocket:outbound-channel-adapter>`.

❻ See the same option on the `<int-websocket:outbound-channel-adapter>`.

❼ See the same option on the `<int-websocket:outbound-channel-adapter>`.

❽ See the same option on the `<int-websocket:outbound-channel-adapter>`.

❾ Maximum amount of time in milliseconds to wait when sending a message to the channel if the channel may block. For example, a `QueueChannel` can block until space is available if its maximum capacity has been reached.

❿ Fully qualified name of the java type for the target `payload` to convert from the incoming `WebSocketMessage`. Default to `String`.

11 Flag to indicate if this adapter will send `non-MESSAGE` `WebSocketMessage` s and messages with broker destinations to the `AbstractBrokerMessageHandler` from the application context. The `Broker Relay` configuration is required when this attribute is `true`. This attribute is used only on the server side. On the client side, it is ignored. Defaults to `false`.

12 See the same option on the `<int-websocket:outbound-channel-adapter>`.

13 See the same option on the `<int-websocket:outbound-channel-adapter>`.

=== ClientStompEncoder

Starting with *version 4.3.13*, the `ClientStompEncoder` is provided as an extension of standard `StompEncoder` for using on client side of the WebSocket Channel Adapters. An instance of the `ClientStompEncoder` must be injected into the `StompSubProtocolHandler` for proper client side message preparation. One of the problem of the default `StompSubProtocolHandler` that it was designed for the server side, so it updates the `SEND` `stompCommand` header into `MESSAGE` as it must be by the STOMP protocol from server side. If client doesn't send its messages in the proper `SEND` web socket frame, some STOMP brokers won't accept them. The purpose of the `ClientStompEncoder`, in this case, is to override `stompCommand` header to the `SEND` value before encoding the message to the `byte[]`.

== Web Services Support

=== Outbound Web Service Gateways

To invoke a Web Service upon sending a message to a channel, there are two options - both of which build upon the Spring Web Services project: `SimpleWebServiceOutboundGateway` and `MarshallingWebServiceOutboundGateway`. The former will accept either a `String` or `javax.xml.transform.Source` as the message payload. The latter provides support for any implementation of the `Marshaller` and `Unmarshaller` interfaces. Both require a Spring Web Services `DestinationProvider` for determining the URI of the Web Service to be called.

```
simpleGateway = new SimpleWebServiceOutboundGateway(destinationProvider);

marshallingGateway = new MarshallingWebServiceOutboundGateway(destinationProvider, marshaller);
```

Note

When using the namespace support described below, you will only need to set a URI. Internally, the parser will configure a fixed URI `DestinationProvider` implementation. If you do need dynamic resolution of the URI at runtime, however, then the `DestinationProvider` can provide such behavior as looking up the URI from a registry. See the Spring Web Services DestinationProvider JavaDoc for more information about this strategy.

Starting with *version 5.0* the `SimpleWebServiceOutboundGateway` and `MarshallingWebServiceOutboundGateway` can be supplied with an external `WebServiceTemplate` instance, which may be configured for any custom properties, including `checkConnectionForFault` allowing your application to deal with non-conforming services.

For more detail on the inner workings, see the Spring Web Services reference guide's chapter covering client access as well as the chapter covering Object/XML mapping.

=== Inbound Web Service Gateways

To send a message to a channel upon receiving a Web Service invocation, there are two options again: `SimpleWebServiceInboundGateway` and `MarshallingWebServiceInboundGateway`. The former will extract a `javax.xml.transform.Source` from the `WebServiceMessage` and set it as the message payload. The latter provides support for implementation of the `Marshaller` and `Unmarshaller` interfaces. If the incoming web service message is a SOAP message the SOAP Action header will be added to the headers of the`Message` that is forwarded onto the request channel.

```
simpleGateway = new SimpleWebServiceInboundGateway();
simpleGateway.setRequestChannel(forwardOntoThisChannel);
simpleGateway.setReplyChannel(listenForResponseHere); //Optional

marshallingGateway = new MarshallingWebServiceInboundGateway(marshaller);
//set request and optionally reply channel
```

Both gateways implement the Spring Web Services `MessageEndpoint` interface, so they can be configured with a `MessageDispatcherServlet` as per standard Spring Web Services configuration.

For more detail on how to use these components, see the Spring Web Services reference guide's chapter covering creating a Web Service. The chapter covering Object/XML mapping is also applicable again.

To include the `SimpleWebServiceInboundGateway` and `MarshallingWebServiceInboundGateway` configurations to the Spring WS infrastructure you should add the `EndpointMapping` definition between `MessageDispatcherServlet` and the target `MessageEndpoint` implementations like you do that with normal Spring WS application. For this purpose (from Spring Integration perspective), the Spring WS provides these convenient `EndpointMapping` implementations:

- `o.s.ws.server.endpoint.mapping.UriEndpointMapping`
- `o.s.ws.server.endpoint.mapping.PayloadRootQNameEndpointMapping`
- `o.s.ws.soap.server.endpoint.mapping.SoapActionEndpointMapping`
- `o.s.ws.server.endpoint.mapping.XPathPayloadEndpointMapping`

The beans for these classes must be specified in the application context referencing to the `SimpleWebServiceInboundGateway` and/or `MarshallingWebServiceInboundGateway` bean definitions according to the WS mapping algorithm.

Please, refer to the Endpoint mappings for the more information.

=== Web Service Namespace Support

To configure an outbound Web Service Gateway, use the "outbound-gateway" element from the "ws" namespace:

```
<int-ws:outbound-gateway id="simpleGateway"
                         request-channel="inputChannel"
                         uri="https://example.org"/>
```

Note

Notice that this example does not provide a *reply-channel*. If the Web Service were to return a non-empty response, the Message containing that response would be sent to the reply channel provided in the request Message's `REPLY_CHANNEL` header, and if that were not available a channel resolution Exception would be thrown. If you want to send the reply to another channel instead, then provide a *reply-channel* attribute on the *outbound-gateway* element.

Tip

When invoking a Web Service that returns an empty response after using a String payload for the request Message, *no reply Message will be sent by default*. Therefore you don't need to set a *reply-channel* or have a REPLY_CHANNEL header in the request Message. If for any reason you actually *do* want to receive the empty response as a Message, then provide the *ignore-empty-responses* attribute with a value of *false* (this only applies for Strings, because using a Source or Document object simply leads to a NULL response and will therefore *never* generate a reply Message).

To set up an inbound Web Service Gateway, use the "inbound-gateway":

```
<int-ws:inbound-gateway id="simpleGateway"
                    request-channel="inputChannel"/>
```

To use Spring OXM Marshallers and/or Unmarshallers, provide bean references. For outbound:

```
<int-ws:outbound-gateway id="marshallingGateway"
                     request-channel="requestChannel"
                     uri="https://example.org"
                     marshaller="someMarshaller"
                     unmarshaller="someUnmarshaller"/>
```

And for inbound:

```
<int-ws:inbound-gateway id="marshallingGateway"
                    request-channel="requestChannel"
                    marshaller="someMarshaller"
                    unmarshaller="someUnmarshaller"/>
```

Note

Most `Marshaller` implementations also implement the `Unmarshaller` interface. When using such a `Marshaller`, only the "marshaller" attribute is necessary. Even when using a `Marshaller`, you may also provide a reference for the "request-callback" on the outbound gateways.

For either outbound gateway type, a "destination-provider" attribute can be specified instead of the "uri" (exactly one of them is required). You can then reference any Spring Web Services DestinationProvider implementation (e.g. to lookup the URI at runtime from a registry).

For either outbound gateway type, the "message-factory" attribute can also be configured with a reference to any Spring Web Services `WebServiceMessageFactory` implementation.

For the simple inbound gateway type, the "extract-payload" attribute can be set to false to forward the entire `WebServiceMessage` instead of just its payload as a `Message` to the request channel. This might be useful, for example, when a custom Transformer works against the `WebServiceMessage` directly.

Starting with *version 5.0* the `web-service-template` reference attribute is presented for the injection of a `WebServiceTemplate` with any possible custom properties.

=== Outbound URI Configuration

For all URI-schemes supported by Spring Web Services (URIs and Transports) `<uri-variable/>` substitution is provided:

```
<ws:outbound-gateway id="gateway" request-channel="input"
        uri="https://springsource.org/{foo}-{bar}">
    <ws:uri-variable name="foo" expression="payload.substring(1,7)"/>
    <ws:uri-variable name="bar" expression="headers.x"/>
</ws:outbound-gateway>

<ws:outbound-gateway request-channel="inputJms"
        uri="jms:{destination}?deliveryMode={deliveryMode}&amp;priority={priority}"
        message-sender="jmsMessageSender">
    <ws:uri-variable name="destination" expression="headers.jmsQueue"/>
    <ws:uri-variable name="deliveryMode" expression="headers.deliveryMode"/>
    <ws:uri-variable name="priority" expression="headers.jms_priority"/>
</ws:outbound-gateway>
```

If a `DestinationProvider` is supplied, variable substitution is not supported and a configuration error will result if variables are provided.

Controlling URI Encoding

By default, the URL string is encoded (see UriComponentsBuilder) to the URI object before sending the request. In some scenarios with a non-standard URI it is undesirable to perform the encoding. Since *version 4.1* the `<ws:outbound-gateway/>` provides an `encode-uri` attribute. To disable encoding the URL, this attribute should be set to `false` (by default it is `true`). If you wish to partially encode some of the URL, this can be achieved using an `expression` within a `<uri-variable/>`:

```
<ws:outbound-gateway url="http://somehost/%2f/fooApps?bar={param}" encode-uri="false">
          <http:uri-variable name="param"
            expression="T(org.apache.commons.httpclient.util.URIUtil)
                                             .encodeWithinQuery('Hello World!')"/>
</ws:outbound-gateway>
```

Note, `encode-uri` is ignored, if `DestinationProvider` is supplied.

=== WS Message Headers

The Spring Integration WebService Gateways will map the SOAP Action header automatically. It will be copied by default to and from Spring Integration `MessageHeaders` using the DefaultSoapHeaderMapper.

Of course, you can pass in your own implementation of SOAP specific header mappers, as the gateways have respective properties to support that.

Any user-defined SOAP headers will NOT be copied to or from a SOAP Message, unless explicitly specified by the *requestHeaderNames* and/or *replyHeaderNames* properties of the `DefaultSoapHeaderMapper`.

When using the XML namespace for configuration, these properties can be set using the `mapped-request-headers` and `mapped-reply-headers`, or a custom mapper can be provided using the `header-mapper` attribute.

Tip

When mapping user-defined headers, the values can also contain simple wildcard patterns (e.g. "foo*" or "*foo") to be matched. For example, if you need to copy all user-defined headers simply use the wildcard character `*`.

Starting with *version 4.1*, the `AbstractHeaderMapper` (a `DefaultSoapHeaderMapper` superclass) allows the `NON_STANDARD_HEADERS` token to be configured for the *requestHeaderNames* and/or *replyHeaderNames* properties (in addition to existing `STANDARD_REQUEST_HEADERS` and `STANDARD_REPLY_HEADERS`) to map all user-defined headers. Note, it is recommended to use the combination like this `STANDARD_REPLY_HEADERS, NON_STANDARD_HEADERS` instead of a `*`, to avoid mapping of *request* headers to the reply.

Starting with *version 4.3*, patterns in the header mappings can be negated by preceding the pattern with `!`. Negated patterns get priority, so a list such as `STANDARD_REQUEST_HEADERS,foo,ba*,!bar,!baz,qux,!foo` will **NOT** map `foo` (nor `bar` nor `baz`); the standard headers plus `bad`, `qux` will be mapped.

> **Important**
>
> If you have a user defined header that begins with `!` that you **do** wish to map, you need to escape it with `\` thus: `STANDARD_REQUEST_HEADERS,\!myBangHeader` and it **WILL** be mapped.

Inbound SOAP headers (request headers for the inbound gateway, reply-headers for the outbound gateway) are mapped as `SoapHeaderElement` objects. The contents can be explored by accessing the `Source`:

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
    <soapenv:Header>
        <auth>
            <username>user</username>
            <password>pass</password>
        </auth>
        <bar>BAR</bar>
        <baz>BAZ</baz>
        <qux>qux</qux>
    </soapenv:Header>
    <soapenv:Body>
        ...
    </soapenv:Body>
</soapenv:Envelope>
```

If `mapped-request-headers` is `"auth, ba*"`, the `auth`, `bar` and `baz` headers are mapped but `qux` is not.

```
...
SoapHeaderElement header = (SoapHeaderElement) headers.get("auth");
DOMSource source = (DOMSource) header.getSource();
NodeList nodeList = source.getNode().getChildNodes();
assertEquals("username", nodeList.item(0).getNodeName());
assertEquals("user", nodeList.item(0).getFirstChild().getNodeValue());
...
```

Starting with *version 5.0*, the `DefaultSoapHeaderMapper` supports user-defined headers of type `javax.xml.transform.Source` and populates them as child nodes of the `<soapenv:Header>`:

```
Map<String, Object> headers = new HashMap<>();

String authXml =
     "<auth xmlns='http://test.auth.org'>"
           + "<username>user</username>"
           + "<password>pass</password>"
           + "</auth>";
headers.put("auth", new StringSource(authXml));
...
DefaultSoapHeaderMapper mapper = new DefaultSoapHeaderMapper();
mapper.setRequestHeaderNames("auth");
```

And in the end we have SOAP envelope as:

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
    <soapenv:Header>
        <auth xmlns="http://test.auth.org">
            <username>user</username>
            <password>pass</password>
        </auth>
    </soapenv:Header>
    <soapenv:Body>
        ...
    </soapenv:Body>
</soapenv:Envelope>
```

=== MTOM Support

The Marshalling Inbound and Outbound WebService Gateways support attachments directly via built-in functionality of the marshaller, e.g. `Jaxb2Marshaller` provides the `mtomEnabled` option. Starting with *version 5.0*, the Simple WebService Gateways can operate with inbound and outbound `MimeMessage` s directly, which have an API to manipulate attachments. When you need to send WebService message with attachments (either a reply from a server, or a client request) you should use the `WebServiceMessageFactory` directly and send a `WebServiceMessage` with attachments as a `payload` to the request or reply channel of the gateway:

```
WebServiceMessageFactory messageFactory = new SaajSoapMessageFactory(MessageFactory.newInstance());
MimeMessage webServiceMessage = (MimeMessage) messageFactory.createWebServiceMessage();

String request = "<test>foo</test>";

TransformerFactory transformerFactory = TransformerFactory.newInstance();
Transformer transformer = transformerFactory.newTransformer();
transformer.transform(new StringSource(request), webServiceMessage.getPayloadResult());

webServiceMessage.addAttachment("myAttachment", new ByteArrayResource("my_data".getBytes()), "plain/
text");

this.webServiceChannel.send(new GenericMessage<>(webServiceMessage));
```

== XML Support - Dealing with XML Payloads

=== Introduction

Spring Integration’s XML support extends the core of Spring Integration with the following components:

- *Marshalling Transformer*
- *Unmarshalling Transformer*
- *Xslt Transformer*
- *XPath Transformer*
- *XPath Splitter*
- *XPath Router*
- *XPath Header Enricher*
- *XPath Filter*
- *#xpath SpEL Function*
- *Validating Filter*

These components are designed to make working with XML messages in Spring Integration simple. The provided messaging components are designed to work with XML represented in a range of formats including instances of `java.lang.String`, `org.w3c.dom.Document` and `javax.xml.transform.Source`. It should be noted however that where a DOM representation is required, for example in order to evaluate an XPath expression, the `String` payload will be converted into the required type and then converted back again to `String`. Components that require an instance of `DocumentBuilder` will create a namespace-aware instance if one is not provided. In cases where you require greater control over document creation, you can provide an appropriately configured instance of `DocumentBuilder`.

=== Namespace Support

All components within the Spring Integration XML module provide namespace support. In order to enable namespace support, you need to import the respective schema for the Spring Integration XML Module. A typical setup is shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-xml="http://www.springframework.org/schema/integration/xml"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/xml
    https://www.springframework.org/schema/integration/xml/spring-integration-xml.xsd">
</beans>
```

==== XPath Expressions

Many of the components within the Spring Integration XML module work with XPath Expressions. Each of those components will either reference an XPath Expression that has been defined as top-level element or via a nested `<xpath-expression/>` element.

All forms of XPath expressions result in the creation of an `XPathExpression` using the Spring `org.springframework.xml.xpath.XPathExpressionFactory`. When creating XPath expressions, the best XPath implementation that is available on the classpath is being used, either JAXP 1.3+ or Jaxen, whereby JAXP is preferred.

Note

Spring Integration under the covers uses the XPath functionality as provided by the *Spring Web Services* project (https://www.spring.io/spring-ws). Specifically, Spring Web Services' XML module (spring-xml-x.x.x.jar) is being used. Therefore, for a deeper understanding, please refer to the respective documentation as well at: https://docs.spring.io/spring-ws/docs/current/reference/html/common.html#xpath

Here is an overview of all available configuration parameters of the `xpath-expression` element:

```
<int-xml:xpath-expression expression="" ❶
          id=""              ❷
          namespace-map=""   ❸
          ns-prefix=""       ❹
          ns-uri="">         ❺
    <map></map>              ❻
</int-xml:xpath-expression>
```

❶ Defines an XPath expression. *Required*.

❷ The Identifier of the underlying bean definition. Will be an instance of `org.springframework.xml.xpath.XPathExpression`*Optional*.

❸ Reference to a map containing namespaces. The key of the map defines the namespace prefix and the value of the map sets the namespace URI. It is not valid to specify both this attribute and the `map` sub element, or setting the `ns-prefix` and `ns-uri` attribute. *Optional*.

❹ Allows you to set the namespace prefix directly as and attribute on the XPath expression element. If you set `ns-prefix`, you must also set the `ns-uri` attribute. *Optional*.

❺ Allows you to set the namespace URI directly as an attribute on the XPath expression element. If you set `ns-uri`, you must also set the `ns-prefix` attribute. *Optional*.

❻ Defines a map containing namespaces. Only one map child element is allowed. The key of the map defines the namespace prefix and the value of the map sets the namespace URI.

It is not valid to specify both this sub-element and the `map` attribute, or setting the `ns-prefix` and `ns-uri` attributes. *Optional*.

===== Providing Namespaces (Optional) to XPath Expressions

For the XPath Expression Element, namespace information can be optionally provided as configuration parameters. As such, namespaces can be defined using one of the following 3 choices:

- Reference a map using the `namespace-map` attribute
- Provide a map of namespaces using the `map` sub-element
- Specifying the `ns-prefix` and the `ns-uri` attribute

All three options are mutually exclusive. Only one option can be set.

Below, please find several different usage examples on how to use XPath expressions using the XML namespace support including the various option for setting the XML namespaces as discussed above.

```
<int-xml:xpath-filter id="filterReferencingXPathExpression"
                      xpath-expression-ref="refToXpathExpression"/>

<int-xml:xpath-expression id="refToXpathExpression" expression="/name"/>

<int-xml:xpath-filter id="filterWithoutNamespace">
    <int-xml:xpath-expression expression="/name"/>
</int-xml:xpath-filter>

<int-xml:xpath-filter id="filterWithOneNamespace">
    <int-xml:xpath-expression expression="/ns1:name"
                              ns-prefix="ns1" ns-uri="www.example.org"/>
</int-xml:xpath-filter>

<int-xml:xpath-filter id="filterWithTwoNamespaces">
    <int-xml:xpath-expression expression="/ns1:name/ns2:type">
        <map>
            <entry key="ns1" value="www.example.org/one"/>
            <entry key="ns2" value="www.example.org/two"/>
        </map>
    </int-xml:xpath-expression>
</int-xml:xpath-filter>

<int-xml:xpath-filter id="filterWithNamespaceMapReference">
    <int-xml:xpath-expression expression="/ns1:name/ns2:type"
                              namespace-map="defaultNamespaces"/>
</int-xml:xpath-filter>

<util:map id="defaultNamespaces">
    <util:entry key="ns1" value="www.example.org/one"/>
    <util:entry key="ns2" value="www.example.org/two"/>
</util:map>
```

===== Using XPath Expressions with Default Namespaces

When working with default namespaces, you may run into situations that behave differently than originally expected. Let’s assume we have the following XML document:

```
<?xml version="1.0" encoding="UTF-8"?>
<order>
    <orderItem>
        <isbn>0321200683</isbn>
        <quantity>2</quantity>
    </orderItem>
    <orderItem>
        <isbn>1590596439</isbn>
        <quantity>1</quantity>
    </orderItem>
</order>
```

This document is not declaring any namespace. Therefore, applying the following XPath Expression will work as expected:

```
<int-xml:xpath-expression expression="/order/orderItem" />
```

You might expect that the same expression will also work for the following XML file. It looks exactly the same as the previous example but in addition it also declares a default namespace:

http://www.example.org/orders

```
<?xml version="1.0" encoding="UTF-8"?>
<order xmlns="http://www.example.org/orders">
 <orderItem>
  <isbn>0321200683</isbn>
  <quantity>2</quantity>
 </orderItem>
 <orderItem>
  <isbn>1590596439</isbn>
  <quantity>1</quantity>
 </orderItem>
</order>
```

However, the XPath Expression used previously will fail in this case.

In order to solve this issue, you must provide a namespace prefix and a namespace URI using either the *ns-prefix* and *ns-uri* attribute or by providing a *namespace-map* attribute instead. The namespace URI must match the namespace declared in your XML document, which in this example is http://www.example.org/orders.

The namespace prefix, however, can be arbitrarily chosen. In fact, just providing an empty String will actually work (Null is not allowed). In the case of a namespace prefix consisting of an empty String, your Xpath Expression will use a colon (":") to indicate the default namespace. If you leave the colon off, the XPath expression will not match. The following XPath Expression will match against the XML document above:

```
<int-xml:xpath-expression expression="/:order/:orderItem"
    ns-prefix="" ns-uri="https://www.example.org/prodcuts"/>
```

Of course you can also provide any other arbitrarily chosen namespace prefix. The following XPath expression using the *myorder* namespace prefix will match also:

```
<int-xml:xpath-expression expression="/myorder:order/myorder:orderItem"
    ns-prefix="myorder" ns-uri="https://www.example.org/prodcuts"/>
```

It is important to remember that the namespace URI is the really important piece of information to declare, not the prefix itself. The Jaxen FAQ summarizes the point very well:

> In XPath 1.0, all unprefixed names are unqualified. There is no requirement that the prefixes used in the XPath expression are the same as the prefixes used in the document being queried. Only the namespace URIs need to match, not the prefixes.

=== Transforming XML Payloads

==== Configuring Transformers as Beans

This section will explain the workings of the following transformers and how to configure them as *beans*:

- UnmarshallingTransformer
- MarshallingTransformer
- XsltPayloadTransformer

All of the provided XML transformers extend AbstractTransformer or AbstractPayloadTransformer and therefore implement Transformer. When configuring XML transformers as beans in Spring Integration, you would normally configure the *Transformer* in conjunction with a MessageTransformingHandler. This allows the transformer to be used as an *Endpoint*. Finally, the namespace support will be discussed, which allows for the simple configuration of the transformers as elements in XML.

===== UnmarshallingTransformer

An UnmarshallingTransformer allows an XML `Source` to be unmarshalled using implementations of the Spring OXM `Unmarshaller`. Spring's Object/XML Mapping support provides several implementations supporting marshalling and unmarshalling using JAXB, Castor and JiBX amongst others. The unmarshaller requires an instance of `Source`. If the message payload is not an instance of `Source`, conversion will be attempted. Currently `String`, `File` and `org.w3c.dom.Document` payloads are supported. Custom conversion to a `Source` is also supported by injecting an implementation of a SourceFactory.

> **Note**
>
> If a `SourceFactory` is not set explicitly, the property on the `UnmarshallingTransformer` will by default be set to a DomSourceFactory.

Starting with *version 5.0*, the `UnmarshallingTransformer` also supports an `org.springframework.ws.mime.MimeMessage` as the incoming payload. This can be useful in scenarios when we receive a raw `WebServiceMessage` via SOAP with MTOM attachments. See the section called "CompletableFuture" for more information.

```
<bean id="unmarshallingTransformer" class="o.s.i.xml.transformer.UnmarshallingTransformer">
    <constructor-arg>
        <bean class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
            <property name="contextPath" value="org.example" />
        </bean>
    </constructor-arg>
</bean>
```

===== MarshallingTransformer

The MarshallingTransformer allows an object graph to be converted into XML using a Spring OXM `Marshaller`. By default the `MarshallingTransformer` will return a `DomResult`. However, the type of result can be controlled by configuring an alternative `ResultFactory` such as `StringResultFactory`. In many cases it will be more convenient to transform the payload into an alternative XML format. To achieve this, configure a `ResultTransformer`. Two implementations are provided, one which converts to `String` and another which converts to `Document`.

```
<bean id="marshallingTransformer" class="o.s.i.xml.transformer.MarshallingTransformer">
    <constructor-arg>
        <bean class="org.springframework.oxm.jaxb.Jaxb2Marshaller">
            <property name="contextPath" value="org.example"/>
        </bean>
    </constructor-arg>
    <constructor-arg>
        <bean class="o.s.i.xml.transformer.ResultToDocumentTransformer"/>
    </constructor-arg>
</bean>
```

By default, the `MarshallingTransformer` will pass the payload Object to the `Marshaller`, but if its boolean `extractPayload` property is set to `false`, the entire `Message` instance will be passed to the `Marshaller` instead. That may be useful for certain custom implementations of the `Marshaller` interface, but typically the payload is the appropriate source Object for marshalling when delegating to any of the various out-of-the-box `Marshaller` implementations.

===== XsltPayloadTransformer

XsltPayloadTransformer transforms XML payloads using Extensible Stylesheet Language Transformations (XSLT). The transformer's constructor requires an instance of either Resource or Templates to be passed in. Passing in a `Templates` instance allows for greater configuration of the `TransformerFactory` used to create the template instance.

As with the UnmarshallingTransformer, the `XsltPayloadTransformer` will do the actual XSLT transformation using instances of `Source`. Therefore, if the message payload is not an instance of `Source`, conversion will be attempted. `String` and `Document` payloads are supported directly.

Custom conversion to a `Source` is also supported by injecting an implementation of a SourceFactory.

Note

If a `SourceFactory` is not set explicitly, the property on the `XsltPayloadTransformer` will by default be set to a DomSourceFactory.

By default, the `XsltPayloadTransformer` will create a message with a Result payload, similar to the `XmlPayloadMarshallingTransformer`. This can be customised by providing a ResultFactory and/or a ResultTransformer.

```
<bean id="xsltPayloadTransformer" class="o.s.i.xml.transformer.XsltPayloadTransformer">
  <constructor-arg value="classpath:org/example/xsl/transform.xsl"/>
  <constructor-arg>
    <bean class="o.s.i.xml.transformer.ResultToDocumentTransformer"/>
  </constructor-arg>
</bean>
```

Starting with Spring Integration 3.0, you can now specify the transformer factory class name using a constructor argument. This is configured using the `transformer-factory-class` attribute when using the namespace.

===== ResultTransformers

Both the `MarshallingTransformer` and the `XsltPayloadTransformer` allow you to specify a ResultTransformer. Thus, if the Marshalling or XSLT transformation returns a Result, than you have the option to also use a `ResultTransformer` to transform the `Result` into another format. Spring Integration provides 2 concrete`ResultTransformer` implementations:

- ResultToDocumentTransformer
- ResultToStringTransformer

Using ResultTransformers with the MarshallingTransformer

By default, the *MarshallingTransformer* will always return a Result. By specifying a `ResultTransformer`, you can customize the type of payload returned.

Using ResultTransformers with the XsltPayloadTransformer

The behavior is slighly more complex for the *XsltPayloadTransformer*. By default, if the input payload is an instance of `String` or Document the *resultTransformer* property is ignored.

However, if the input payload is a Source or any other type, then the *resultTransformer* property is applied. Additionally, you can set the property *alwaysUseResultFactory* to `true`, which will also cause the specified *resultTransformer* to being used.

For more information and examples, please see the section called “CompletableFuture”

==== Namespace Support for XML Transformers

Namespace support for all XML transformers is provided in the Spring Integration XML namespace, a template for which can be seen below. The namespace support for transformers creates an instance of either`EventDrivenConsumer` or `PollingConsumer` according to the type of the provided input channel. The namespace support is designed to reduce the amount of XML configuration by allowing the creation of an endpoint and transformer using one element.

UnmarshallingTransformer

The namespace support for the `UnmarshallingTransformer` is shown below. Since the namespace is now creating an endpoint instance rather than a transformer, a poller can also be nested within the element to control the polling of the input channel.

```
<int-xml:unmarshalling-transformer id="defaultUnmarshaller"
    input-channel="input" output-channel="output"
    unmarshaller="unmarshaller"/>

<int-xml:unmarshalling-transformer id="unmarshallerWithPoller"
    input-channel="input" output-channel="output"
    unmarshaller="unmarshaller">
    <int:poller fixed-rate="2000"/>
<int-xml:unmarshalling-transformer/>
```

MarshallingTransformer

The namespace support for the marshalling transformer requires an `input-channel`, `output-channel` and a reference to a `marshaller`. The optional `result-type` attribute can be used to control the type of result created. Valid values are `StringResult` or `DomResult` (the default).

```
<int-xml:marshalling-transformer
     input-channel="marshallingTransformerStringResultFactory"
     output-channel="output"
     marshaller="marshaller"
     result-type="StringResult" />

<int-xml:marshalling-transformer
    input-channel="marshallingTransformerWithResultTransformer"
    output-channel="output"
    marshaller="marshaller"
    result-transformer="resultTransformer" />

<bean id="resultTransformer" class="o.s.i.xml.transformer.ResultToStringTransformer"/>
```

Where the provided result types are not sufficient, a reference to a custom implementation of `ResultFactory` can be provided as an alternative to setting the `result-type` attribute, using the `result-factory` attribute. The attributes *result-type* and *result-factory* are mutually exclusive.

Note

Internally, the result types `StringResult` and `DomResult` are represented by the `ResultFactory` s StringResultFactory and DomResultFactory respectively.

XsltPayloadTransformer

Namespace support for the `XsltPayloadTransformer` allows you to either pass in a `Resource`, in order to create the Templates instance, or alternatively, you can pass in a precreated `Templates` instance as a reference. In common with the marshalling transformer, the type of the result output can be controlled by specifying either the `result-factory` or `result-type` attribute. A `result-transformer` attribute can also be used to reference an implementation of `ResultTransformer` where conversion of the result is required before sending.

Important

If you specify the `result-factory` or the `result-type` attribute, then the `alwaysUseResultFactory` property on the underlying XsltPayloadTransformer will be set to `true` by the XsltPayloadTransformerParser.

```
<int-xml:xslt-transformer id="xsltTransformerWithResource"
    input-channel="withResourceIn" output-channel="output"
    xsl-resource="org/springframework/integration/xml/config/test.xsl"/>

<int-xml:xslt-transformer id="xsltTransformerWithTemplatesAndResultTransformer"
    input-channel="withTemplatesAndResultTransformerIn" output-channel="output"
    xsl-templates="templates"
    result-transformer="resultTransformer"/>
```

Often you may need to have access to Message data, such as the Message Headers, in order to assist with transformation. For example, you may need to get access to certain Message Headers and pass them on as parameters to a transformer (e.g., `transformer.setParameter(..)`). Spring Integration provides two convenient ways to accomplish this, as illustrated in following example:

```
<int-xml:xslt-transformer id="paramHeadersCombo"
    input-channel="paramHeadersComboChannel" output-channel="output"
    xsl-resource="classpath:transformer.xslt"
    xslt-param-headers="testP*, *foo, bar, baz">

    <int-xml:xslt-param name="helloParameter" value="hello"/>
    <int-xml:xslt-param name="firstName" expression="headers.fname"/>
</int-xml:xslt-transformer>
```

If message header names match 1:1 to parameter names, you can simply use `xslt-param-headers` attribute. There you can also use wildcards for simple pattern matching, which supports the following simple pattern styles: "xxx*", "**xxx", "*xxx**" and "xxx*yyy".

You can also configure individual Xslt parameters via the *<xslt-param/>* sub element. There you can use either the `expression` or `value` attribute. The `expression` attribute should be any valid SpEL expression with Message being the root object of the expression evaluation context. The `value` attribute, just like any `value` in Spring beans, allows you to specify simple scalar values. You can also use property placeholders (e.g., ${some.value}). So as you can see, with the `expression` and `value` attribute, Xslt parameters could now be mapped to any accessible part of the Message as well as any literal value.

Starting with Spring Integration 3.0, you can now specify the transformer factory class name using the `transformer-factory-class` attribute.

==== Namespace Configuration and ResultTransformers

The usage of `ResultTransformers` was previously introduced in the section called “CompletableFuture”. The following example illustrates several special use-cases using XML namespace configuration. First, we define the `ResultTransformer`:

```
<beans:bean id="resultToDoc" class="o.s.i.xml.transformer.ResultToDocumentTransformer"/>
```

This `ResultTransformer` will accept either a `StringResult` or a `DOMResult` as input and converts the input into a `Document`.

Now, let’s declare the transformer:

```
<int-xml:xslt-transformer input-channel="in" output-channel="fahrenheitChannel"
    xsl-resource="classpath:noop.xslt" result-transformer="resultToDoc"/>
```

If the incoming message’s payload is of type `Source`, then as first step the `Result` is determined using the `ResultFactory`. As we did not specify a `ResultFactory`, the default `DomResultFactory` is used, meaning that the transformation will yield a `DomResult`.

However, as we specified a *ResultTransformer*, it will be used and the resulting Message payload will be of type`Document`.

Important

If the incoming message’s payload is of type `String`, the payload after the Xslt transformation will be a String. Similarly, if the incoming message’s payload is of type `Document`, the payload after the Xslt transformation will be a`Document`. The specified *ResultTransformer* will be ignored with `String` or `Document` payloads.

If the message payload is neither a `Source`, `String` or `Document`, as a fallback option, it is attempted to create a`Source` using the default SourceFactory. As we did not specify a `SourceFactory` explicitly using the *source-factory* attribute, the default DomSourceFactory is used. If successful, the XSLT transformation is executed as if the payload was of type `Source`, which we described in the previous paragraphs.

> **Note**
>
> The `DomSourceFactory` supports the creation of a `DOMSource` from a either `Document`, `File` or `String` payloads.

The next transformer declaration adds a *result-type* attribute using `StringResult` as its value. First, the *result-type* is internally represented by the `StringResultFactory`. Thus, you could have also added a reference to a `StringResultFactory`, using the *result-factory* attribute, which would haven been the same.

```
<int-xml:xslt-transformer input-channel="in" output-channel="fahrenheitChannel"
  xsl-resource="classpath:noop.xslt" result-transformer="resultToDoc"
  result-type="StringResult"/>
```

Because we are using a `ResultFactory`, the *alwaysUseResultFactory* property of the `XsltPayloadTransformer` class will be implicitly set to `true`. Consequently, the referenced `ResultToDocumentTransformer` will be used.

Therefore, if you transform a payload of type `String`, the resulting payload will be of type Document.

XsltPayloadTransformer and <xsl:output method="text"/>

`<xsl:output  method="text"/>` tells the XSLT template to only produce text content from the input source. In this particular case there is no reason to have a `DomResult`. Therefore, the XsltPayloadTransformer defaults to `StringResult` if the output property called `method` of the underlying `javax.xml.transform.Transformer` returns `"text"`. This coercion is performed independent from the inbound payload type. Keep in mind that this [quote] smart behavior is only available, if the `result-type` or `result-factory` attributes aren't provided for the respective `<int-xml:xslt-transformer>` component.

=== Transforming XML Messages Using XPath

When it comes to message transformation XPath is a great way to transform Messages that have XML payloads by defining XPath transformers via <xpath-transformer/> element.

Simple XPath transformation

Let's look at the following transformer configuration:

```
<int-xml:xpath-transformer input-channel="inputChannel" output-channel="outputChannel"
      xpath-expression="/person/@name" />
```

...and Message

```
Message<?> message =
  MessageBuilder.withPayload("<person name='John Doe' age='42' married='true'/>").build();
```

After sending this message to the *inputChannel* the XPath transformer configured above will transform this XML Message to a simple Message with payload of *John Doe* all based on the simple XPath Expression specified in the `xpath-expression` attribute.

XPath also has the capability to perform simple conversion of extracted elements to a desired type. Valid return types are defined in `javax.xml.xpath.XPathConstants` and follows the conversion rules specified by the `javax.xml.xpath.XPath` interface.

The following constants are defined by the `XPathConstants` class: *BOOLEAN, DOM_OBJECT_MODEL, NODE, NODESET, NUMBER, STRING*

You can configure the desired type by simply using the `evaluation-type` attribute of the `<xpath-transformer/>` element.

```
<int-xml:xpath-transformer input-channel="numberInput" xpath-expression="/person/@age"
                           evaluation-type="NUMBER_RESULT" output-channel="output"/>

<int-xml:xpath-transformer input-channel="booleanInput"
                           xpath-expression="/person/@married = 'true'"
                           evaluation-type="BOOLEAN_RESULT" output-channel="output"/>
```

Node Mappers

If you need to provide custom mapping for the node extracted by the XPath expression simply provide a reference to the implementation of the `org.springframework.xml.xpath.NodeMapper` - an interface used by `XPathOperations` implementations for mapping Node objects on a per-node basis. To provide a reference to a `NodeMapper` simply use `node-mapper` attribute:

```
<int-xml:xpath-transformer input-channel="nodeMapperInput" xpath-expression="/person/@age"
                           node-mapper="testNodeMapper" output-channel="output"/>
```

...and Sample NodeMapper implementation:

```
class TestNodeMapper implements NodeMapper {
  public Object mapNode(Node node, int nodeNum) throws DOMException {
    return node.getTextContent() + "-mapped";
  }
}
```

XML Payload Converter

You can also use an implementation of the `org.springframework.integration.xml.XmlPayloadConverter` to provide more granular transformation:

```
<int-xml:xpath-transformer input-channel="customConverterInput"
                           output-channel="output" xpath-expression="/test/@type"
                           converter="testXmlPayloadConverter" />
```

...and Sample XmlPayloadConverter implementation:

```
class TestXmlPayloadConverter implements XmlPayloadConverter {
  public Source convertToSource(Object object) {
    throw new UnsupportedOperationException();
  }
  //
  public Node convertToNode(Object object) {
    try {
      return DocumentBuilderFactory.newInstance().newDocumentBuilder().parse(
          new InputSource(new StringReader("<test type='custom'/>")));
    }
    catch (Exception e) {
      throw new IllegalStateException(e);
    }
  }
  //
  public Document convertToDocument(Object object) {
    throw new UnsupportedOperationException();
  }
}
```

The `DefaultXmlPayloadConverter` is used if this reference is not provided, and it should be sufficient in most cases since it can convert from `Node`, `Document`, `Source`, `File`, `String`, `InputStream` and `byte[]` typed payloads. If you need to extend beyond the capabilities of that default implementation, then an upstream `Transformer` is probably a better option than providing a reference to a custom implementation of this strategy here.

=== Splitting XML Messages

`XPathMessageSplitter` supports messages with either `String` or `Document` payloads. The splitter uses the provided XPath expression to split the payload into a number of nodes. By default this will result in each `Node` instance becoming the payload of a new message. Where it is preferred that each message be a Document the `createDocuments` flag can be set. Where a `String` payload is passed in the payload will be converted then split before being converted back to a number of String messages. The XPath splitter implements `MessageHandler` and should therefore be configured in conjunction with an appropriate endpoint (see the namespace support below for a simpler configuration alternative).

```
<bean id="splittingEndpoint"
      class="org.springframework.integration.endpoint.EventDrivenConsumer">
    <constructor-arg ref="orderChannel" />
    <constructor-arg>
        <bean class="org.springframework.integration.xml.splitter.XPathMessageSplitter">
            <constructor-arg value="/order/items" />
            <property name="documentBuilder" ref="customisedDocumentBuilder" />
            <property name="outputChannel" ref="orderItemsChannel" />
        </bean>
    </constructor-arg>
</bean>
```

XPath splitter namespace support allows the creation of a Message Endpoint with an input channel and output channel.

```
<!-- Split the order into items creating a new message for each item node -->
<int-xml:xpath-splitter id="orderItemSplitter"
                       input-channel="orderChannel"
                       output-channel="orderItemsChannel">
    <int-xml:xpath-expression expression="/order/items"/>
</int-xml:xpath-splitter>

<!-- Split the order into items creating a new document for each item-->
<int-xml:xpath-splitter id="orderItemDocumentSplitter"
                       input-channel="orderChannel"
                       output-channel="orderItemsChannel"
                       create-documents="true">
    <int-xml:xpath-expression expression="/order/items"/>
    <int:poller fixed-rate="2000"/>
</int-xml:xpath-splitter>
```

Starting with `version 4.2`, the `XPathMessageSplitter` exposes `outputProperties` (such as `OutputKeys.OMIT_XML_DECLARATION`) property for the `javax.xml.transform.Transformer` instances when a request `payload` isn't of `org.w3c.dom.Node` type:

```
<util:properties id="outputProperties">
 <beans:prop key="#{T (javax.xml.transform.OutputKeys).OMIT_XML_DECLARATION}">yes</beans:prop>
</util:properties>

<xpath-splitter input-channel="input"
             output-properties="outputProperties">
    <xpath-expression expression="/orders/order"/>
</xpath-splitter>
```

Starting with `version 4.2`, the `XPathMessageSplitter` exposes an `iterator` option as a `boolean` flag (defaults to `true`). This allows the "streaming" of split nodes in the downstream flow. With the `iterator` mode, each node is transformed while iterating. When false, all entries are transformed first, before the split nodes start being sent to the output channel (transform, send, transform, send Vs. transform, transform, send, send). See Section 6.3, “Splitter” for more information.

=== Routing XML Messages Using XPath

Similar to SpEL-based routers, Spring Integration provides support for routing messages based on XPath expressions, allowing you to create a Message Endpoint with an input channel but no output channel. Instead, one or more output channels are determined dynamically.

```
<int-xml:xpath-router id="orderTypeRouter" input-channel="orderChannel">
    <int-xml:xpath-expression expression="/order/type"/>
</int-xml:xpath-router>
```

Note

For an overview of attributes that are common among Routers, please see chapter: *the section called “Common Router Parameters”*

Internally XPath expressions will be evaluated as *NODESET* type and converted to a `List<String>` representing channel names. Typically such a list will contain a single channel name. However, based on the results of an XPath Expression, the XPath router can also take on the characteristics of a *Recipient List Router* if the XPath Expression returns more then one value. In that case, the `List<String>` will contain more then one channel name and consequently Messages will be sent to all channels in the list.

Thus, assuming that the XML file passed to the router configured below contains many `responder` sub-elements representing channel names, the message will be sent to all of those channels.

```
<!-- route the order to all responders-->
<int-xml:xpath-router id="responderRouter" input-channel="orderChannel">
    <int-xml:xpath-expression expression="/request/responders"/>
</int-xml:xpath-router>
```

If the returned values do not represent the channel names directly, additional mapping parameters can be specified, in order to map those returned values to actual channel names. For example if the `/request/responders` expression results in two values `responderA` and `responderB` but you don't want to couple the responder names to channel names, you may provide additional mapping configuration such as the following:

```
<!-- route the order to all responders-->
<int-xml:xpath-router id="responderRouter" input-channel="orderChannel">
    <int-xml:xpath-expression expression="/request/responders"/>
    <int-xml:mapping value="responderA" channel="channelA"/>
    <int-xml:mapping value="responderB" channel="channelB"/>
</int-xml:xpath-router>
```

As already mentioned, the default evaluation type for XPath expressions is *NODESET*, which is converted to a `List<String>` of channel names, therefore handling single channel scenarios as well as multiple ones.

Nonetheless, certain XPath expressions may evaluate as String type from the very beginning. Take for example the following XPath Expression:

```
name(./node())
```

This expression will return the name of the root node. It will resulting in an exception, if the default evaluation type *NODESET* is being used.

For these scenarious, you may use the `evaluate-as-string` attribute, which will allow you to manage the evaluation type. It is `FALSE` by default, however if set to `TRUE`, the String evaluation type will be used.

Note

To provide some background information: XPath 1.0 specifies 4 data types:

- Node-sets
- Strings
- Number
- Boolean

When the XPath Router evaluates expressions using the optional `evaluate-as-string` attribute, the return value is determined per the `string()` function as defined in the XPath specification. This means that if the expression selects multiple nodes, it will return the string value of the first node.

For further information, please see:

- Specification: XML Path Language (XPath) Version 1.0
- XPath specification - string() function

For example if we want to route based on the name of the root node, we can use the following configuration:

```
<int-xml:xpath-router id="xpathRouterAsString"
        input-channel="xpathStringChannel"
        evaluate-as-string="true">
    <int-xml:xpath-expression expression="name(./node())"/>
</int-xml:xpath-router>
```

==== XML Payload Converter

For XPath Routers, you can also specify the Converter to use when converting payloads prior to XPath evaluation. As such, the XPath Router supports custom implementations of the `XmlPayloadConverter` strategy, and when configuring an `xpath-router` element in XML, a reference to such an implementation may be provided via the `converter` attribute.

If this reference is not explicitly provided, the `DefaultXmlPayloadConverter` is used. It should be sufficient in most cases, since it can convert from Node, Document, Source, File, and String typed payloads. If you need to extend beyond the capabilities of that default implementation, then an upstream Transformer is generally a better option in most cases, rather than providing a reference to a custom implementation of this strategy here.

=== XPath Header Enricher

The XPath Header Enricher defines a Header Enricher Message Transformer that evaluates XPath expressions against the message payload and inserts the result of the evaluation into a message header.

Please see below for an overview of all available configuration parameters:

```
<int-xml:xpath-header-enricher default-overwrite="true"    ❶
                               id=""                       ❷
                               input-channel=""            ❸
                               output-channel=""           ❹
                               should-skip-nulls="true">   ❺
    <int:poller></int:poller>                              ❻
    <int-xml:header name=""                                ❼
                    evaluation-type="STRING_RESULT"        ❽
                    header-type="int"                      ❾
                    overwrite="true"                       ❿
                    xpath-expression=""                    11
                    xpath-expression-ref=""/>              12
</int-xml:xpath-header-enricher>
```

❶ Specify the default boolean value for whether to overwrite existing header values. This will only take effect for sub-elements that do not provide their own *overwrite* attribute. If the *default- overwrite* attribute is not provided, then the specified header values will NOT overwrite any existing ones with the same header names. *Optional*.

❷ Id for the underlying bean definition. *Optional*.

❸ The receiving Message channel of this endpoint. *Optional*.

❹ Channel to which enriched messages shall be send to. *Optional*.

❺ Specify whether null values, such as might be returned from an expression evaluation, should be skipped. The default value is true. Set this to false if a null value should trigger removal of the corresponding header instead.*Optional*.

❻ *Optional*.

❼ The name of the header to be enriched. *Mandatory*.

8. The result type expected from the XPath evaluation. This will be the type of the header value, if there is no `header-type` attribute provided. The following values are allowed: `BOOLEAN_RESULT`, `STRING_RESULT`, `NUMBER_RESULT`, `NODE_RESULT` and `NODE_LIST_RESULT`. Defaults internally to `XPathEvaluationType.STRING_RESULT` if not set. *Optional*.
9. The fully qualified class name for the header value type. The result of XPath evaluation will be converted to this type using the `ConversionService`. This allows, for example, a `NUMBER_RESULT` (a double) to be converted to an `Integer`. The type can be declared as a primitive (e.g. `int`) but the result will always be the equivalent wrapper class (e.g. `Integer`). The same integration `ConversionService` discussed in the section called “Payload Type Conversion” is used for the conversion, so conversion to custom types is supported, by adding a custom converter to the service.*Optional*.
10. Boolean value to indicate whether this header value should overwrite an existing header value for the same name if already present on the input Message.
11. The XPath Expression as a String. Either this attribute or `xpath-expression-ref` must be provided, but not both.
12. The XPath Expression reference. Either this attribute or `xpath-expression` must be provided, but not both.

=== Using the XPath Filter

This component defines an XPath-based Message Filter. Under the covers this components uses a `MessageFilter` that wraps an instance of `AbstractXPathMessageSelector`.

Note

Please also refer to the chapter on Message Filters for further details.

In order to use the XPath Filter you must as a minimum provide an XPath Expression either by declaring the `xpath-expression` sub-element or by referencing an XPath Expression using the `xpath-expression-ref` attribute.

If the provided XPath expression will evaluate to a `boolean` value, no further configuration parameters are necessary. However, if the XPath expression will evaluate to a String, the `match-value` attribute should be specified against which the evaluation result will be matched.

There are three options for the `match-type`:

- **exact** - correspond to `equals` on `java.lang.String`. The underlying implementation uses a `StringValueTestXPathMessageSelector`
- **case-insensitive** - correspond to `equals-ignore-case` on `java.lang.String`. The underlying implementation uses a `StringValueTestXPathMessageSelector`
- **regex** - matches operations one `java.lang.String`. The underlying implementation uses a `RegexTestXPathMessageSelector`

When providing a *match-type* value of *regex*, the value provided with the `match-value` attribute must be a valid Regular Expression.

```
<int-xml:xpath-filter discard-channel=""                      ❶
                      id=""                                   ❷
                      input-channel=""                        ❸
                      match-type="exact"                      ❹
                      match-value=""                          ❺
                      output-channel=""                       ❻
                      throw-exception-on-rejection="false"    ❼
                      xpath-expression-ref="">                ❽
    <int-xml:xpath-expression ... />                          ❾
    <int:poller ... />                                        ❿
</int-xml:xpath-filter>
```

❶ Message Channel where you want rejected messages to be sent. *Optional*.

❷ Id for the underlying bean definition. *Optional*.

❸ The receiving Message channel of this endpoint. *Optional*.

❹ Type of match to apply between the XPath evaluation result and the *match-value*. Default is *exact*. *Optional*.

❺ String value to be matched against the XPath evaluation result. If this attribute is not provided, then the XPath evaluation MUST produce a boolean result directly. *Optional*.

❻ The channel to which Messages that matched the filter criterias shall be dispatched to. *Optional*.

❼ By default, this property is set to *false* and rejected Messages (Messages that did not match the filter criteria) will be silently dropped. However, if set to *true* message rejection will result in an error condition and the exception will be propagated upstream to the caller. *Optional*.

❽ Reference to an XPath expression instance to evaluate.

❾ This sub-element sets the XPath expression to be evaluated. If this is not defined you MUST define the `xpath-expression-ref` attribute. Also, only one `xpath-expression` element can be set.

❿ *Optional*.

=== #xpath SpEL Function

Spring Integration, since version *3.0*, provides the `#xpath` built-in SpEL function, which invokes the static method `XPathUtils.evaluate(...)`. This method delegates to an `org.springframework.xml.xpath.XPathExpression`. The following shows some usage examples:

```
<transformer expression="#xpath(payload, '/name')"/>

<filter expression="#xpath(payload, headers.xpath, 'boolean')"/>

<splitter expression="#xpath(payload, '//book', 'document_list')"/>

<router expression="#xpath(payload, '/person/@age', 'number')">
    <mapping channel="output1" value="16"/>
    <mapping channel="output2" value="45"/>
</router>
```

`#xpath` also supports a third optional parameter for converting the result of the xpath evaluation. It can be one of the String constants `'string'`, `'boolean'`, `'number'`, `'node'`, `'node_list'` and `'document_list'` or an `org.springframework.xml.xpath.NodeMapper` instance. By default the `#xpath` SpEL function returns a String representation of the xpath evaluation.

Note

To enable the `#xpath` SpEL function, simply add the `spring-integration-xml.jar` to the CLASSPATH; there is no need to declare any component(s) from the Spring Integration Xml Namespace.

For more information see the section called “CompletableFuture”.

=== XML Validating Filter

The XML Validating Filter allows you to validate incoming messages against provided schema instances. The following schema types are supported:

- xml-schema (http://www.w3.org/2001/XMLSchema)
- relax-ng (https://relaxng.org/ns/structure/1.0)

Messages that fail validation can either be silently dropped or they can be forwarded to a definable `discard-channel`. Furthermore you can configure this filter to throw an `Exception` in case validation fails.

Please see below for an overview of all available configuration parameters:

```
<int-xml:validating-filter discard-channel=""                        ❶
                           id=""                                     ❷
                           input-channel=""                          ❸
                           output-channel=""                         ❹
                           schema-location=""                        ❺
                           schema-type="xml-schema"                  ❻
                           throw-exception-on-rejection="false"      ❼
                           xml-converter=""                          ❽
                           xml-validator="">                         ❾
    <int:poller .../>                                                ❿
</int-xml:validating-filter>
```

❶ Message Channel where you want rejected messages to be sent. *Optional*.
❷ Id for the underlying bean definition. *Optional*.
❸ The receiving Message channel of this endpoint. *Optional*.
❹ Message Channel where you want accepted messages to be sent. *Optional*.
❺ Sets the location of the schema to validate the Message’s payload against. Internally uses the `org.springframework.core.io.Resource` interface. You can set this attribute or the `xml-validator` attribute but not both. *Optional*.
❻ Sets the schema type. Can be either `xml-schema` or `relax-ng`. *Optional*. If not set it defaults to `xml-schema` which internally translates to `org.springframework.xml.validation.XmlValidatorFactory#SCHEMA_W3C_XML`
❼ If `true` a `MessageRejectedException` is thrown in case validation fails for the provided Message’s payload.*Optional*. Defaults to `false` if not set.
❽ Reference to a custom `org.springframework.integration.xml.XmlPayloadConverter` strategy. *Optional*.
❾ Reference to a custom `sorg.springframework.xml.validation.XmlValidator` strategy. You can set this attribute or the `schema-location` attribute but not both. *Optional*.
❿ *Optional*.

== XMPP Support

Spring Integration provides Channel Adapters for XMPP.

=== Introduction

XMPP describes a way for multiple agents to communicate with each other in a distributed system. The canonical use case is to send and receive chat messages, though XMPP can be, and is, used for far more applications. XMPP is used to describe a network of actors. Within that network, actors may address each other directly, as well as broadcast status changes (e.g. "presence").

XMPP provides the messaging fabric that underlies some of the biggest Instant Messaging networks in the world, including Google Talk (GTalk) - which is also available from within GMail - and Facebook Chat. There are many good open-source XMPP servers available. Two popular implementations are *Openfire* and *ejabberd*

Spring integration provides support for XMPP via XMPP adapters which support sending and receiving both XMPP chat messages and presence changes from other entries in your roster. As with other adapters, the XMPP adapters come with support for a convenient namespace-based configuration. To configure the XMPP namespace, include the following elements in the headers of your XML configuration file:

```
xmlns:int-xmpp="http://www.springframework.org/schema/integration/xmpp"
xsi:schemaLocation="http://www.springframework.org/schema/integration/xmpp
 https://www.springframework.org/schema/integration/xmpp/spring-integration-xmpp.xsd"
```

=== XMPP Connection

Before using inbound or outbound XMPP adapters to participate in the XMPP network, an actor must establish its XMPP connection. This connection object could be shared by all XMPP adapters connected to a particular account. Typically this requires - at a minimum -`user`, `password`, and `host`. To create a basic XMPP connection, you can utilize the convenience of the namespace.

```
<int-xmpp:xmpp-connection
    id="myConnection"
    user="user"
    password="password"
    host="host"
    port="port"
    resource="theNameOfTheResource"
    subscription-mode="accept_all"/>
```

Note

For added convenience you can rely on the default naming convention and omit the `id` attribute. The default name *xmppConnection* will be used for this connection bean.

If the XMPP Connection goes stale, reconnection attempts will be made with an automatic login as long as the previous connection state was logged (authenticated). We also register a `ConnectionListener` which will log connection events if the DEBUG logging level is enabled.

The `subscription-mode` initiates the Roster listener to deal with incoming subscriptions from other users. This functionality isn't always available for the target XMPP servers. For example GCM/FCM fully disables it. To switch off the Roster listener for subscriptions you should configure it with an empty string when using XML configuration: `subscription-mode=""`, or with `XmppConnectionFactoryBean.setSubscriptionMode(null)` when using Java Configuration. Doing so will disable Roster at the login phase as well. See `Roster.setRosterLoadedAtLogin(Boolean)` for more information.

=== XMPP Messages

==== Inbound Message Channel Adapter

The Spring Integration adapters support receiving chat messages from other users in the system. To do this, the *Inbound Message Channel Adapter* "logs in" as a user on your behalf and receives the messages sent to that user. Those messages are then forwarded to your Spring Integration client. Configuration support for the XMPP *Inbound Message Channel Adapter* is provided via the `inbound-channel-adapter` element.

```
<int-xmpp:inbound-channel-adapter id="xmppInboundAdapter"
 channel="xmppInbound"
 xmpp-connection="testConnection"
 payload-expression="getExtension('google:mobile:data').json"
 stanza-filter="stanzaFilter"
 auto-startup="true"/>
```

As you can see amongst the usual attributes this adapter also requires a reference to an XMPP Connection.

It is also important to mention that the XMPP inbound adapter is an *event driven adapter* and a `Lifecycle` implementation. When started it will register a `PacketListener` that will listen for incoming XMPP Chat Messages. It forwards any received messages to the underlying adapter which will convert them to Spring Integration Messages and send them to the specified `channel`. It will unregister the `PacketListener` when it is stopped.

Starting with *version 4.3* the `ChatMessageListeningEndpoint` (and its `<int-xmpp:inbound-channel-adapter>`) supports a `org.jivesoftware.smack.filter.StanzaFilter` injection to be registered on the provided `XMPPConnection` together with an internal `StanzaListener` implementation. See their JavaDocs for more information.

Also with the *version 4.3* the `payload-expression` has been introduced for the `ChatMessageListeningEndpoint`. The incoming `org.jivesoftware.smack.packet.Message` represents a root object of evaluation context. This option is useful in case of the section called “CompletableFuture”. For example, for the GCM protocol we can extract the body using expression:

```
payload-expression="getExtension('google:mobile:data').json"
```

for the XHTML protocol:

```
payload-
expression="getExtension(T(org.jivesoftware.smackx.xhtmlim.packet.XHTMLExtension).NAMESPACE).bodies[0]"
```

To simplify the access to the Extension in the XMPP Message, the `extension` variable is added into the `EvaluationContext`. Note, it is done only when one and only one Extension is present in the Message. The samples above with the `namespace` manipulations can be simplified to something like:

```
 ----
 payload-expression="#extension.json"
 payload-expression="#extension.bodies[0]"
 ----
```

==== Outbound Message Channel Adapter

You may also send chat messages to other users on XMPP using the *Outbound Message Channel Adapter*. Configuration support for the XMPP *Outbound Message Channel Adapter* is provided via the `outbound-channel-adapter` element.

```
<int-xmpp:outbound-channel-adapter id="outboundEventAdapter"
      channel="outboundEventChannel"
      xmpp-connection="testConnection"/>
```

The adapter expects as its input - at a minimum - a payload of type `java.lang.String`, and a header value for `XmppHeaders.CHAT_TO` that specifies to which user the Message should be sent. To create a message you might use the following Java code:

```
Message<String> xmppOutboundMsg = MessageBuilder.withPayload("Hello, XMPP!" )
      .setHeader(XmppHeaders.CHAT_TO, "userhandle")
      .build();
```

Another mechanism of setting the header is by using the XMPP header-enricher support. Here is an example.

```
<int-xmpp:header-enricher input-channel="input" output-channel="output">
 <int-xmpp:chat-to value="test1@example.org"/>
</int-xmpp:header-enricher>
```

Starting with *version 4.3* the packet extension support has been added to the `ChatMessageSendingMessageHandler` (`<int-xmpp:outbound-channel-adapter>`). Alongside with the regular `String` and `org.jivesoftware.smack.packet.Message` `payload`, now you can send a message with a `payload` as a `org.jivesoftware.smack.packet.ExtensionElement` which is populated to the `org.jivesoftware.smack.packet.Message.addExtension()` instead of `setBody()`. For the convenience an `extension-provider` option has been added for the `ChatMessageSendingMessageHandler` to allow to inject `org.jivesoftware.smack.provider.ExtensionElementProvider`, which builds an `ExtensionElement` against the `payload` at runtime. For this case the payload must be `String` in JSON or XML format depending of the XEP protocol.

=== XMPP Presence

XMPP also supports broadcasting state. You can use this capability to let people who have you on their roster see your state changes. This happens all the time with your IM clients; you change your away status, and then set an away message, and everybody who has you on their roster sees your icon or username change to reflect this new state, and additionally might see your new "away" message. If you would like to receive notification, or notify others, of state changes, you can use Spring Integration's "presence" adapters.

==== Inbound Presence Message Channel Adapter

Spring Integration provides an *Inbound Presence Message Channel Adapter* which supports receiving Presence events from other users in the system who happen to be on your Roster. To do this, the adapter "logs in" as a user on your behalf, registers a `RosterListener` and forwards received Presence update events as Messages to the channel identified by the `channel` attribute. The payload of the Message will be a `org.jivesoftware.smack.packet.Presence` object (see https://www.igniterealtime.org/builds/smack/docs/latest/javadoc/org/jivesoftware/smack/packet/Presence.html).

Configuration support for the XMPP *Inbound Presence Message Channel Adapter* is provided via the `presence-inbound-channel-adapter` element.

```
<int-xmpp:presence-inbound-channel-adapter channel="outChannel"
  xmpp-connection="testConnection" auto-startup="false"/>
```

As you can see amongst the usual attributes this adapter also requires a reference to an XMPP Connection. It is also important to mention that this adapter is an event driven adapter and a `Lifecycle` implementation. It will register a `RosterListener` when started and will unregister that `RosterListener` when stopped.

==== Outbound Presence Message Channel Adapter

Spring Integration also supports sending Presence events to be seen by other users in the network who happen to have you on their Roster. When you send a Message to the *Outbound Presence Message Channel Adapter* it extracts the payload, which is expected to be of type `org.jivesoftware.smack.packet.Presence` and sends it to the XMPP Connection, thus advertising your presence events to the rest of the network.

Configuration support for the XMPP *Outbound Presence Message Channel Adapter* is provided via the `presence-outbound-channel-adapter` element.

```
<int-xmpp:presence-outbound-channel-adapter id="eventOutboundPresenceChannel"
 xmpp-connection="testConnection"/>
```

It can also be a *Polling Consumer* (if it receives Messages from a Pollable Channel) in which case you would need to register a Poller.

```
<int-xmpp:presence-outbound-channel-adapter id="pollingOutboundPresenceAdapter"
  xmpp-connection="testConnection"
  channel="pollingChannel">
 <int:poller fixed-rate="1000" max-messages-per-poll="1"/>
</int-xmpp:presence-outbound-channel-adapter>
```

Like its inbound counterpart, it requires a reference to an XMPP Connection.

Note

If you are relying on the default naming convention for an XMPP Connection bean (described earlier), and you have only one XMPP Connection bean configured in your Application Context, you may omit the `xmpp-connection` attribute. In that case, the bean with the name *xmppConnection* will be located and injected into the adapter.

=== Advanced Configuration

Since Spring Integration XMPP support is based on the Smack 4.0 API (https://www.igniterealtime.org/projects/smack/), it is important to know a few details related to more complex configuration of the XMPP Connection object.

As stated earlier the `xmpp-connection` namespace support is designed to simplify basic connection configuration and only supports a few common configuration attributes. However, the `org.jivesoftware.smack.ConnectionConfiguration` object defines about 20 attributes, and there is no real value of adding namespace support for all of them. So, for more complex connection configurations, simply configure an instance of our `XmppConnectionFactoryBean` as a regular bean, and inject a `org.jivesoftware.smack.ConnectionConfiguration` as a constructor argument to that FactoryBean. Every property you need, can be specified directly on that ConnectionConfiguration instance (a bean definition with the *p* namespace would work well). This way SSL, or any other attributes, could be set directly. Here’s an example:

```
<bean id="xmppConnection" class="o.s.i.xmpp.XmppConnectionFactoryBean">
    <constructor-arg>
        <bean class="org.jivesoftware.smack.ConnectionConfiguration">
            <constructor-arg value="myServiceName"/>
            <property name="socketFactory" ref="..."/>
        </bean>
    </constructor-arg>
</bean>

<int:channel id="outboundEventChannel"/>

<int-xmpp:outbound-channel-adapter id="outboundEventAdapter"
    channel="outboundEventChannel"
    xmpp-connection="xmppConnection"/>
```

Another important aspect of the Smack API is static initializers. For more complex cases (e.g., registering a SASL Mechanism), you may need to execute certain static initializers. One of those static initializers is `SASLAuthentication`, which allows you to register supported SASL mechanisms. For that level of complexity, we would recommend Spring JavaConfig-style of the XMPP Connection configuration. Then, you can configure the entire component through Java code and execute all other necessary Java code including static initializers at the appropriate time.

```
@Configuration
public class CustomConnectionConfiguration {
  @Bean
  public XMPPConnection xmppConnection() {
 SASLAuthentication.supportSASLMechanism("EXTERNAL", 0); // static initializer

 ConnectionConfiguration config = new ConnectionConfiguration("localhost", 5223);
 config.setTrustorePath("path_to_truststore.jks");
 config.setSecurityEnabled(true);
 config.setSocketFactory(SSLSocketFactory.getDefault());
 return new XMPPConnection(config);
  }
}
```

For more information on the JavaConfig style of Application Context configuration, refer to the following section in the Spring Reference Manual.

=== XMPP Message Headers

The Spring Integration XMPP Adapters will map standard XMPP properties automatically. These properties will be copied by default to and from Spring Integration `MessageHeaders` using the DefaultXmppHeaderMapper.

Any user-defined headers will NOT be copied to or from an XMPP Message, unless explicitly specified by the *requestHeaderNames* and/or *replyHeaderNames* properties of the `DefaultXmppHeaderMapper`.

Tip

When mapping user-defined headers, the values can also contain simple wildcard patterns (e.g. "foo*" or "*foo") to be matched.

Starting with *version 4.1*, the `AbstractHeaderMapper` (a `DefaultXmppHeaderMapper` superclass) allows the `NON_STANDARD_HEADERS` token to be configured for the *requestHeaderNames* property (in addition to existing `STANDARD_REQUEST_HEADERS`) to map all user-defined headers.

Class `org.springframework.xmpp.XmppHeaders` identifies the default headers that will be used by the `DefaultXmppHeaderMapper`:

- xmpp_from
- xmpp_subject
- xmpp_thread
- xmpp_to
- xmpp_type

Starting with *version 4.3*, patterns in the header mappings can be negated by preceding the pattern with `!`. Negated patterns get priority, so a list such as `STANDARD_REQUEST_HEADERS,foo,ba*,!bar,!baz,qux,!foo` will **NOT** map `foo` (nor `bar` nor `baz`); the standard headers plus `bad`, `qux` will be mapped.

> **Important**
>
> If you have a user defined header that begins with `!` that you **do** wish to map, you need to escape it with `\` thus: `STANDARD_REQUEST_HEADERS,\!myBangHeader` and it **WILL** be mapped.

=== XMPP Extensions

The XMPP protocol stands for **eXstensible Messaging and Presence Protocol**. The "extensible" part is important. XMPP is based around XML, a data format that supports a concept known as *namespacing*.

Through namespacing, you can add bits to XMPP that are not defined in the original specifications. This is important because the XMPP specification deliberately describes only a set of core things like:

- How a client connects to a server
- Encryption (SSL/TLS)
- Authentication
- How servers can communicate with each other to relay messages
- and a few other basic building blocks.

Once you have implemented this, you have an XMPP client and can send any kind of data you like. But that's not the end.

For example, perhaps you decide that you want to include formatting in a message (bold, italic, etc.) which is not defined in the core XMPP specification. Well, you can make up a way to do that, but unless everyone else does it the same way as you, no other software will be able interpret it (they will just ignore namespaces they don't understand).

So the XMPP Standards Foundation (XSF) publishes a series of extra documents, known as XMPP Enhancement Proposals (XEPs). In general each XEP describes a particular activity (from message formatting, to file transfers, multi-user chats and many more), and they provide a standard format for everyone to use for that activity.

The Smack API provides many XEP implementations with its `extensions` and `experimental` projects. And starting with Spring Integration *version 4.3* any XEP can be use with the existing XMPP channel adapters.

To be able to process XEPs or any other custom XMPP extensions, the Smack's `ProviderManager` pre-configuration must be provided. It can be done via direct usage from the `static` Java code:

```
ProviderManager.addIQProvider("element", "namespace", new MyIQProvider());
ProviderManager.addExtensionProvider("element", "namespace", new MyExtProvider());
```

or via `.providers` configuration file in the specific instance and JVM argument:

```
-Dsmack.provider.file=file:///c:/my/provider/mycustom.providers
```

where `mycustom.providers` might be like this:

```
<?xml version="1.0"?>
<smackProviders>
<iqProvider>
    <elementName>query</elementName>
    <namespace>jabber:iq:time</namespace>
    <className>org.jivesoftware.smack.packet.Time</className>
</iqProvider>

<iqProvider>
    <elementName>query</elementName>
    <namespace>https://jabber.org/protocol/disco#items</namespace>
    <className>org.jivesoftware.smackx.provider.DiscoverItemsProvider</className>
</iqProvider>

<extensionProvider>
    <elementName>subscription</elementName>
    <namespace>https://jabber.org/protocol/pubsub</namespace>
    <className>org.jivesoftware.smackx.pubsub.provider.SubscriptionProvider</className>
</extensionProvider>
</smackProviders>
```

For example the most popular XMPP messaging extension is Google Cloud Messaging (GCM). The Smack provides the particular `org.jivesoftware.smackx.gcm.provider.GcmExtensionProvider` for that and registers that by default with the `smack-experimental` jar in the classpath using `experimental.providers` resource:

```
<!-- GCM JSON payload -->
<extensionProvider>
    <elementName>gcm</elementName>
    <namespace>google:mobile:data</namespace>
    <className>org.jivesoftware.smackx.gcm.provider.GcmExtensionProvider</className>
</extensionProvider>
```

Also the `GcmPacketExtension` is present for the target messaging protocol to parse incoming packets and build outgoing:

```
GcmPacketExtension gcmExtension = (GcmPacketExtension)
 xmppMessage.getExtension(GcmPacketExtension.NAMESPACE);
String message = gcmExtension.getJson());
```

```
GcmPacketExtension packetExtension = new GcmPacketExtension(gcmJson);
Message smackMessage = new Message();
smackMessage.addExtension(packetExtension);
```

See the section called “CompletableFuture” and the section called “CompletableFuture” above for more information.

== Zookeeper Support

=== Introduction

Zookeeper support was added to the framework in *version 4.2*, comprised of:

- MetadataStore
- LockRegistry
- Leadership Event Handling

=== Zookeeper Metadata Store

The `ZookeeperMetadataStore` can be used where any `MetadataStore` is needed, such as peristent file list filters, etc. See the section called “CompletableFuture” for more information.

```
<bean id="client" class="org.springframework.integration.zookeeper.config.CuratorFrameworkFactoryBean">
    <constructor-arg value="${connect.string}" />
</bean>

<bean id="meta" class="org.springframework.integration.zookeeper.metadata.ZookeeperMetadataStore">
    <constructor-arg ref="client" />
</bean>
```

```
@Bean
public MetadataStore zkStore(CuratorFramework client) {
    return new ZookeeperMetadataStore(client);
}
```

=== Zookeeper Lock Registry

The `ZookeeperLockRegistry` can be used where any `LockRegistry` is needed, such as when using an `Aggregator` in a clustered environment, with a shared `MessageStore`.

A `LocRegistry` is used to "look up" a lock based on a key (the aggregator uses the `correlationId`). By default, locks in the `ZookeeperLockRegistry` are maintained in zookeeper under the path `/SpringIntegration-LockRegistry/`. You can customize the path by providing an implementation of `ZookeeperLockRegistry.KeyToPathStrategy`.

```
public interface KeyToPathStrategy {

    String pathFor(String key);

    boolean bounded();

}
```

If the strategy returns `true` from `isBounded`, unused locks do not need to be harvested. For unbounded strategies (such as the default) you will need to invoke `expireUnusedOlderThan(long age)` from time to time, to remove old unused locks from memory.

=== Zookeeper Leadership Event Handling

To configure an application for leader election using Zookeeper in XML:

```
<int-zk:leader-listener client="client" path="/siNamespace" role="cluster" />
```

`client` is a reference to a `CuratorFramework` bean; a `CuratorFrameworkFactoryBean` is available. When a leader is elected, an `OnGrantedEvent` will be published for the role `cluster`; any endpoints in that role will be started. When leadership is revoked, an `OnRevokedEvent` will be published for the role `cluster`; any endpoints in that role will be stopped. See Section 8.2, “Endpoint Roles” for more information.

In Java configuration you can create an instance of the leader initiator like this:

```
@Bean
public LeaderInitiatorFactoryBean leaderInitiator(CuratorFramework client) {
    return new LeaderInitiatorFactoryBean()
                .setClient(client)
                .setPath("/siTest/")
                .setRole("cluster");
}
```

= Appendices

Advanced Topics and Additional Resources

== Spring Expression Language (SpEL)

=== Introduction

Many Spring Integration components can be configured using expressions. These expressions are written in the Spring Expression Language.

In most cases, the *#root* object is the `Message` which, of course, has two properties - `headers` and `payload` - allowing such expressions as `payload`, `payload.foo`, `headers['my.header']` etc.

In some cases, additional variables are provided, for example the `<int-http:inbound-gateway/>` provides `#requestParams` (parameters from the HTTP request) and `#pathVariables` (values from path placeholders in the URI).

For all SpEL expressions, a `BeanResolver` is available, enabling references to any bean in the application context. For example `@myBean.foo(payload)`. In addition, two `PropertyAccessors` are available; a `MapAccessor` enables accessing values in a `Map` using a key, and a `ReflectivePropertyAccessor` which allows access to fields and or JavaBean compliant properties (using getters and setters). This is how the `Message` headers and payload properties are accessible.

=== SpEL Evaluation Context Customization

Starting with Spring Integration 3.0, it is possible to add additional `PropertyAccessor` s to the SpEL evaluation contexts used by the framework. The framework provides the `JsonPropertyAccessor` which can be used (read-only) to access fields from a `JsonNode`, or JSON in a `String`. Or you can create your own `PropertyAccessor` if you have specific needs.

In addition, custom functions can be added. Custom functions are `static` methods declared on a class. Functions and property accessors are available in any SpEL expression used throughout the framework.

The following configuration shows how to directly configure the `IntegrationEvaluationContextFactoryBean` with custom property accessors and functions. However, for convenience, namespace support is provided for both, as described in the following sections, and the framework will automatically configure the factory bean on your behalf.

```
<bean id="integrationEvaluationContext"
   class="org.springframework.integration.config.IntegrationEvaluationContextFactoryBean">
 <property name="propertyAccessors">
  <util:map>
   <entry key="foo">
    <bean class="foo.MyCustomPropertyAccessor"/>
   </entry>
  </util:map>
 </property>
 <property name="functions">
  <map>
   <entry key="barcalc" value="#{T(foo.MyFunctions).getMethod('calc', T(foo.MyBar))}"/>
  </map>
 </property>
</bean>
```

This factory bean definition will override the default `integrationEvaluationContext` bean definition, adding the custom accessor to the list (which also includes the standard accessors mentioned above), and one custom function.

Note that custom functions are static methods. In the above example, the custom function is a static method `calc` on class `MyFunctions` and takes a single parameter of type `MyBar`.

Say you have a `Message` with a payload that has a type `MyFoo` on which you need to perform some action to create a `MyBar` object from it, and you then want to invoke a custom function `calc` on that object.

The standard property accessors wouldn't know how to get a `MyBar` from a `MyFoo` so you could write and configure a custom property accessor to do so. So, your final expression might be `"#barcalc(payload.myBar)"`.

The factory bean has another property `typeLocator` which allows you to customize the `TypeLocator` used during SpEL evaluation. This might be necessary when running in some environments that use a non-standard `ClassLoader`. In the following example, SpEL expressions will always use the bean factory's class loader:

```
<bean id="integrationEvaluationContext"
  class="org.springframework.integration.config.IntegrationEvaluationContextFactoryBean">
 <property name="typeLocator">
  <bean class="org.springframework.expression.spel.support.StandardTypeLocator">
   <constructor-arg value="#{beanFactory.beanClassLoader}"/>
  </bean>
 </property>
</bean>
```

=== SpEL Functions

Namespace support is provided for easy addition of SpEL custom functions. You can specify `<spel-function/>` components to provide custom SpEL functions to the `EvaluationContext` used throughout the framework. Instead of configuring the factory bean above, simply add one or more of these components and the framework will automatically add them to the default *integrationEvaluationContext* factory bean.

For example, assuming we have a useful static method to evaluate XPath:

```
<int:spel-function id="xpath"
 class="com.foo.test.XPathUtils" method="evaluate(java.lang.String, java.lang.Object)"/>

<int:transformer input-channel="in" output-channel="out"
   expression="#xpath('//foo/@bar', payload)" />
```

With this sample:

- The default `IntegrationEvaluationContextFactoryBean` bean with id *integrationEvaluationContext* is registered with the application context.
- The `<spel-function/>` is parsed and added to the `functions` Map of *integrationEvaluationContext* as map entry with `id` as the key and the static `Method` as the value.
- The *integrationEvaluationContext* factory bean creates a new `StandardEvaluationContext` instance, and it is configured with the default `PropertyAccessor` s, `BeanResolver` and the custom functions.
- That `EvaluationContext` instance is injected into the `ExpressionEvaluatingTransformer` bean.

To provide a SpEL Function via Java Configuration, you should declare a `SpelFunctionFactoryBean` bean for each function. The sample above can be configured as follows:

```
@Bean
public SpelFunctionFactoryBean xpath() {
    return new SpelFunctionFactoryBean(XPathUtils.class, "evaluate");
}
```

Note

SpEL functions declared in a parent context are also made available in any child context(s). Each context has its own instance of the *integrationEvaluationContext* factory bean because each needs a different `BeanResolver`, but the function declarations are inherited and can be overridden if needed by declaring a SpEL function with the same name.

Built-in SpEL Functions

Spring Integration provides some standard functions, which are registered with the application context automatically on start up:

#jsonPath - to evaluate a *jsonPath* on some provided object. This function invokes `JsonPathUtils.evaluate(...)`. This static method delegates to the Jayway JsonPath library. The following shows some usage examples:

```
<transformer expression="#jsonPath(payload, '$.store.book[0].author')"/>

<filter expression="#jsonPath(payload,'$..book[2].isbn') matches '\d-\d{3}-\d{5}-\d'"/>

<splitter expression="#jsonPath(payload, '$.store.book')"/>

<router expression="#jsonPath(payload, headers.jsonPath)">
 <mapping channel="output1" value="reference"/>
 <mapping channel="output2" value="fiction"/>
</router>
```

#jsonPath also supports the third optional parameter - an array of `com.jayway.jsonpath.Filter`, which could be provided by a reference to a bean or bean method, for example.

Note

Using this function requires the Jayway JsonPath library (json-path.jar) to be on the classpath; otherwise the *#jsonPath* SpEL function won't be registered.

For more information regarding JSON see *JSON Transformers* in Section 7.1, “Transformer”.

#xpath - to evaluate an *xpath* on some provided object. For more information regarding xml and xpath see the section called “CompletableFuture”.

=== PropertyAccessors

Namespace support is provided for the easy addition of SpEL custom `PropertyAccessor` implementations. You can specify the `<spel-property-accessors/>` component to provide a list of custom `PropertyAccessor` s to the `EvaluationContext` used throughout the framework. Instead of configuring the factory bean above, simply add one or more of these components, and the framework will automatically add the accessors to the default *integrationEvaluationContext* factory bean:

```
<int:spel-property-accessors>
 <bean id="jsonPA" class="org.springframework.integration.json.JsonPropertyAccessor"/>
 <ref bean="fooPropertyAccessor"/>
</int:spel-property-accessors>
```

With this sample, two custom `PropertyAccessor` s will be injected to the `EvaluationContext` in the order that they are declared.

To provide `PropertyAccessor` s via Java Configuration, you should declare a `SpelPropertyAccessorRegistrar` bean with the name `spelPropertyAccessorRegistrar` (`IntegrationContextUtils.SPEL_PROPERTY_ACCESSOR_REGISTRAR_BEAN_NAME` constant). The sample above can be configured as follows:

```
@Bean
public SpelPropertyAccessorRegistrar spelPropertyAccessorRegistrar() {
    return new SpelPropertyAccessorRegistrar(new JsonPropertyAccessor())
                    .add(fooPropertyAccessor());
}
```

Note

Custom `PropertyAccessor` s declared in a parent context are also made available in any child context(s). They are placed at the end of result list (but before the default `org.springframework.context.expression.MapAccessor` and `o.s.expression.spel.support.ReflectivePropertyAccessor`). If a `PropertyAccessor` with the same bean id is declared in a child context(s), it will override the parent accessor. Beans declared within a `<spel-property-accessors/>` must have an *id* attribute. The final order of usage is: the accessors in the current context, in the order in which they are declared, followed by any from parent contexts, in order, followed by the `MapAccessor` and finally the `ReflectivePropertyAccessor`.

== Message Publishing

The AOP Message Publishing feature allows you to construct and send a message as a by-product of a method invocation. For example, imagine you have a component and every time the state of this component changes you would like to be notified via a Message. The easiest way to send such notifications would be to send a message to a dedicated channel, but how would you connect the method invocation that changes the state of the object to a message sending process, and how should the notification Message be structured? The AOP Message Publishing feature handles these responsibilities with a configuration-driven approach.

=== Message Publishing Configuration

Spring Integration provides two approaches: XML and Annotation-driven.

==== Annotation-driven approach via @Publisher annotation

The annotation-driven approach allows you to annotate any method with the `@Publisher` annotation, specifying a *channel* attribute. The Message will be constructed from the return value of the method invocation and sent to a channel specified by the *channel* attribute. To further manage message structure, you can also use a combination of both `@Payload` and `@Header` annotations.

Internally this message publishing feature of Spring Integration uses both Spring AOP by defining `PublisherAnnotationAdvisor` and Spring 3.0's Expression Language (SpEL) support, giving you considerable flexibility and control over the structure of the *Message* it will publish.

The `PublisherAnnotationAdvisor` defines and binds the following variables:

- *#return* - will bind to a return value allowing you to reference it or its attributes (e.g., *#return.foo* where *foo* is an attribute of the object bound to *#return*)
- *#exception* - will bind to an exception if one is thrown by the method invocation.
- *#args* - will bind to method arguments, so individual arguments could be extracted by name (e.g., *#args.fname* as in the above method)

Let's look at a couple of examples:

```
@Publisher
public String defaultPayload(String fname, String lname) {
  return fname + " " + lname;
}
```

In the above example the Message will be constructed with the following structure:

- Message payload - will be the return type and value of the method. This is the default.
- A newly constructed message will be sent to a default publisher channel configured with an annotation post processor (see the end of this section).

```
@Publisher(channel="testChannel")
public String defaultPayload(String fname, @Header("last") String lname) {
  return fname + " " + lname;
}
```

In this example everything is the same as above, except that we are not using a default publishing channel. Instead we are specifying the publishing channel via the *channel* attribute of the `@Publisher` annotation. We are also adding a `@Header` annotation which results in the Message header named *last* having the same value as the *lname* method parameter. That header will be added to the newly constructed Message.

```
@Publisher(channel="testChannel")
@Payload
public String defaultPayloadButExplicitAnnotation(String fname, @Header String lname) {
  return fname + " " + lname;
}
```

The above example is almost identical to the previous one. The only difference here is that we are using a `@Payload` annotation on the method, thus explicitly specifying that the return value of the method should be used as the payload of the Message.

```
@Publisher(channel="testChannel")
@Payload("#return + #args.lname")
public String setName(String fname, String lname, @Header("x") int num) {
  return fname + " " + lname;
}
```

Here we are expanding on the previous configuration by using the Spring Expression Language in the `@Payload` annotation to further instruct the framework how the message should be constructed. In this particular case the message will be a concatenation of the return value of the method invocation and the *lname* input argument. The Message header named *x* will have its value determined by the *num* input argument. That header will be added to the newly constructed Message.

```
@Publisher(channel="testChannel")
public String argumentAsPayload(@Payload String fname, @Header String lname) {
  return fname + " " + lname;
}
```

In the above example you see another usage of the `@Payload` annotation. Here we are annotating a method argument which will become the payload of the newly constructed message.

As with most other annotation-driven features in Spring, you will need to register a post-processor (`PublisherAnnotationBeanPostProcessor`).

```
<bean class="org.springframework.integration.aop.PublisherAnnotationBeanPostProcessor"/>
```

You can instead use namespace support for a more concise configuration:

```
<int:annotation-config default-publisher-channel="defaultChannel"/>
```

Similar to other Spring annotations (@Component, @Scheduled, etc.), `@Publisher` can also be used as a meta-annotation. That means you can define your own annotations that will be treated in the same way as the `@Publisher` itself.

```
@Target({ElementType.METHOD, ElementType.TYPE})
@Retention(RetentionPolicy.RUNTIME)
@Publisher(channel="auditChannel")
public @interface Audit {
}
```

Here we defined the `@Audit` annotation which itself is annotated with `@Publisher`. Also note that you can define a `channel` attribute on the meta-annotation thus encapsulating the behavior of where messages will be sent inside of this annotation. Now you can annotate any method:

```
@Audit
public String test() {
    return "foo";
}
```

In the above example every invocation of the `test()` method will result in a Message with a payload created from its return value. Each Message will be sent to the channel named *auditChannel*. One of the benefits of this technique is that you can avoid the duplication of the same channel name across multiple annotations. You also can provide a level of indirection between your own, potentially domain-specific annotations and those provided by the framework.

You can also annotate the class which would mean that the properties of this annotation will be applied on every public method of that class.

```
@Audit
static class BankingOperationsImpl implements BankingOperations {

  public String debit(String amount) {
     . . .

  }

  public String credit(String amount) {
     . . .
  }

}
```

==== XML-based approach via the <publishing-interceptor> element

The XML-based approach allows you to configure the same AOP-based Message Publishing functionality with simple namespace-based configuration of a `MessagePublishingInterceptor`. It certainly has some benefits over the annotation-driven approach since it allows you to use AOP pointcut expressions, thus possibly intercepting multiple methods at once or intercepting and publishing methods to which you don't have the source code.

To configure Message Publishing via XML, you only need to do the following two things:

- Provide configuration for `MessagePublishingInterceptor` via the `<publishing-interceptor>` XML element.
- Provide AOP configuration to apply the `MessagePublishingInterceptor` to managed objects.

```
<aop:config>
  <aop:advisor advice-ref="interceptor" pointcut="bean(testBean)" />
</aop:config>
<publishing-interceptor id="interceptor" default-channel="defaultChannel">
  <method pattern="echo" payload="'Echoing: ' + #return" channel="echoChannel">
    <header name="foo" value="bar"/>
  </method>
  <method pattern="repl*" payload="'Echoing: ' + #return" channel="echoChannel">
    <header name="foo" expression="'bar'.toUpperCase()"/>
  </method>
  <method pattern="echoDef*" payload="#return"/>
</publishing-interceptor>
```

As you can see the `<publishing-interceptor>` configuration looks rather similar to the Annotation-based approach, and it also utilizes the power of the Spring 3.0 Expression Language.

In the above example the execution of the `echo` method of a `testBean` will render a *Message* with the following structure:

- The Message payload will be of type String with the content "Echoing: [value]" where `value` is the value returned by an executed method.
- The Message will have a header with the name "foo" and value "bar".
- The Message will be sent to `echoChannel`.

The second method is very similar to the first. Here every method that begins with *repl* will render a Message with the following structure:

- The Message payload will be the same as in the above sample

- The Message will have a header named "foo" whose value is the result of the SpEL expression `'bar'.toUpperCase()`.
- The Message will be sent to `echoChannel`.

The second method, mapping the execution of any method that begins with `echoDef` of `testBean`, will produce a Message with the following structure.

- The Message payload will be the value returned by an executed method.
- Since the `channel` attribute is not provided explicitly, the Message will be sent to the `defaultChannel` defined by the *publisher*.

For simple mapping rules you can rely on the *publisher* defaults. For example:

```
<publishing-interceptor id="anotherInterceptor"/>
```

This will map the return value of every method that matches the pointcut expression to a payload and will be sent to a *default-channel*. If the *defaultChannel_is not specified (as above) the messages will be sent to the global _nullChannel*.

Async Publishing

One important thing to understand is that publishing occurs in the same thread as your component's execution. So by default in is synchronous. This means that the entire message flow would have to wait until the publisher's flow completes. However, quite often you want the complete opposite and that is to use this Message publishing feature to initiate asynchronous sub-flows. For example, you might host a service (HTTP, WS etc.) which receives a remote request.You may want to send this request internally into a process that might take a while. However you may also want to reply to the user right away. So, instead of sending inbound requests for processing via the output channel (the conventional way), you can simply use *output-channel* or a *replyChannel* header to send a simple acknowledgment-like reply back to the caller while using the Message publisher feature to initiate a complex flow.

EXAMPLE: Here is the simple service that receives a complex payload, which needs to be sent further for processing, but it also needs to reply to the caller with a simple acknowledgment.

```
public String echo(Object complexPayload) {
     return "ACK";
}
```

So instead of hooking up the complex flow to the output channel we use the Message publishing feature instead. We configure it to create a new Message using the input argument of the service method (above) and send that to the *localProcessChannel*. And to make sure this sub-flow is asynchronous all we need to do is send it to any type of asynchronous channel (ExecutorChannel in this example).

```
<int:service-activator  input-channel="inputChannel" output-channel="outputChannel" ref="sampleservice"/
>

<bean id="sampleservice" class="test.SampleService"/>

<aop:config>
  <aop:advisor advice-ref="interceptor" pointcut="bean(sampleservice)" />
</aop:config>

<int:publishing-interceptor id="interceptor" >
  <int:method pattern="echo" payload="#args[0]" channel="localProcessChannel">
    <int:header name="sample_header" expression="'some sample value'"/>
  </int:method>
</int:publishing-interceptor>

<int:channel id="localProcessChannel">
  <int:dispatcher task-executor="executor"/>
</int:channel>

<task:executor id="executor" pool-size="5"/>
```

Another way of handling this type of scenario is with a wire-tap.

==== Producing and publishing messages based on a scheduled trigger

In the above sections we looked at the Message publishing feature of Spring Integration which constructs and publishes messages as by-products of Method invocations. However in those cases, you are still responsible for invoking the method. In Spring Integration 2.0 we've added another related useful feature: support for scheduled Message producers/publishers via the new "expression" attribute on the *inbound-channel-adapter* element. Scheduling could be based on several triggers, any one of which may be configured on the *poller* sub-element. Currently we support `cron`, `fixed-rate`, `fixed-delay` as well as any custom trigger implemented by you and referenced by the *trigger* attribute value.

As mentioned above, support for scheduled producers/publishers is provided via the *<inbound-channel-adapter>* xml element. Let's look at couple of examples:

```
<int:inbound-channel-adapter id="fixedDelayProducer"
       expression="'fixedDelayTest'"
       channel="fixedDelayChannel">
    <int:poller fixed-delay="1000"/>
</int:inbound-channel-adapter>
```

In the above example an inbound Channel Adapter will be created which will construct a Message with its payload being the result of the expression defined in the `expression` attribute. Such messages will be created and sent every time the delay specified by the `fixed-delay` attribute occurs.

```
<int:inbound-channel-adapter id="fixedRateProducer"
       expression="'fixedRateTest'"
       channel="fixedRateChannel">
    <int:poller fixed-rate="1000"/>
</int:inbound-channel-adapter>
```

This example is very similar to the previous one, except that we are using the `fixed-rate` attribute which will allow us to send messages at a fixed rate (measuring from the start time of each task).

```
<int:inbound-channel-adapter id="cronProducer"
       expression="'cronTest'"
       channel="cronChannel">
    <int:poller cron="7 6 5 4 3 ?"/>
</int:inbound-channel-adapter>
```

This example demonstrates how you can apply a Cron trigger with a value specified in the `cron` attribute.

```
<int:inbound-channel-adapter id="headerExpressionsProducer"
       expression="'headerExpressionsTest'"
       channel="headerExpressionsChannel"
       auto-startup="false">
    <int:poller fixed-delay="5000"/>
    <int:header name="foo" expression="6 * 7"/>
    <int:header name="bar" value="x"/>
</int:inbound-channel-adapter>
```

Here you can see that in a way very similar to the Message publishing feature we are enriching a newly constructed Message with extra Message headers which can take scalar values or the results of evaluating Spring expressions.

If you need to implement your own custom trigger you can use the `trigger` attribute to provide a reference to any spring configured bean which implements the `org.springframework.scheduling.Trigger` interface.

```
<int:inbound-channel-adapter id="triggerRefProducer"
       expression="'triggerRefTest'" channel="triggerRefChannel">
    <int:poller trigger="customTrigger"/>
</int:inbound-channel-adapter>

<beans:bean id="customTrigger" class="o.s.scheduling.support.PeriodicTrigger">
    <beans:constructor-arg value="9999"/>
</beans:bean>
```

== Transaction Support

=== Understanding Transactions in Message flows

Spring Integration exposes several hooks to address transactional needs of you message flows. But to better understand these hooks and how you can benefit from them we must first revisit the 6 mechanisms that could be used to initiate Message flows and see how transactional needs of these flows could be addressed within each of these mechanisms.

Here are the 6 mechanisms to initiate a Message flow and their short summary (details for each are provided throughout this manual):

- *Gateway Proxy* - Your basic Messaging Gateway
- *MessageChannel* - Direct interactions with MessageChannel methods (e.g., channel.send(message))
- *Message Publisher* - the way to initiate message flow as the by-product of method invocations on Spring beans
- *Inbound Channel Adapters/Gateways* - the way to initiate message flow based on connecting third-party system with Spring Integration messaging system(e.g., [JmsMessage] # Jms Inbound Adapter[SI Message] # SI Channel)
- *Scheduler* - the way to initiate message flow based on scheduling events distributed by a pre-configured Scheduler
- *Poller* - similar to the Scheduler and is the way to initiate message flow based on scheduling or interval-based events distributed by a pre-configured Poller

These 6 could be split in 2 general categories:

- *Message flows initiated by a USER process* - Example scenarios in this category would be invoking a Gateway method or explicitly sending a Message to a MessageChannel. In other words, these message flows depend on a third party process (e.g., some code that we wrote) to be initiated.

- *Message flows initiated by a DAEMON process* - Example scenarios in this category would be a Poller polling a Message queue to initiate a new Message flow with the polled Message or a Scheduler scheduling the process by creating a new Message and initiating a message flow at a predefined time.

Clearly the *Gateway Proxy*, *MessageChannel.send(..)* and *MessagePublisher* all belong to the 1st category and *Inbound Adapters/Gateways*, *Scheduler* and *Poller* belong to the 2nd.

So, how do we address transactional needs in various scenarios within each category and is there a need for Spring Integration to provide something explicitly with regard to transactions for a particular scenario? Or, can Spring's Transaction Support be leveraged instead?.

The first and most obvious goal is NOT to re-invent something that has already been invented unless you can provide a better solution. In our case Spring itself provides first class support for transaction management. So our goal here is not to provide something new but rather delegate/use Spring to benefit from the existing support for transactions. In other words as a framework we must expose hooks to the Transaction management functionality provided by Spring. But since Spring Integration configuration is based on Spring Configuration it is not always necessary to expose these hooks as they are already exposed via Spring natively. Remember every Spring Integration component is a Spring Bean after all.

With this goal in mind let's look at the two scenarios.

If you think about it, Message flows that are initiated by the *USER process* (Category 1) and obviously configured in a Spring Application Context, are subject to transactional configuration of such processes and therefore don't need to be explicitly configured by Spring Integration to support transactions. The transaction could and should be initiated through standard Transaction support provided by Spring. The Spring Integration message flow will honor the transactional semantics of the components naturally because it is Spring configured. For example, a Gateway or ServiceActivator method could be annotated with `@Transactional` or `TransactionInterceptor` could be defined in an XML configuration with a point-cut expression pointing to specific methods that should be transactional. The bottom line is that you have full control over transaction configuration and boundaries in these scenarios.

However, things are a bit different when it comes to Message flows initiated by the *DAEMON process* (Category 2). Although configured by the developer these flows do not directly involve a human or some other process to be initiated. These are trigger-based flows that are initiated by a trigger process (DAEMON process) based on the configuration of such process. For example, we could have a Scheduler initiating a message flow every Friday night of every week. We can also configure a trigger that initiates a Message flow every second, etc. So, we obviously need a way to let these trigger-based processes know of our intention to make the resulting Message flows transactional so that a Transaction context could be created whenever a new Message flow is initiated. In other words we need to expose some Transaction configuration, but ONLY enough to delegate to Transaction support already provided by Spring (as we do in other scenarios).

Spring Integration provides transactional support for Pollers. Pollers are a special type of component because we can call receive() within that poller task against a resource that is itself transactional thus including *receive()* call in the the boundaries of the Transaction allowing it to be rolled back in case of a task failure. If we were to add the same support for channels, the added transactions would affect all downstream components starting with that *send()* call. That is providing a rather wide scope for transaction demarcation without any strong reason especially when Spring already provides several ways to address the transactional needs of any component downstream. However the *receive()* method being included in a transaction boundary is the "strong reason" for pollers.

==== Poller Transaction Support

Any time you configure a Poller you can provide transactional configuration via the *transactional* sub-element and its attributes:

```
<int:poller max-messages-per-poll="1" fixed-rate="1000">
    <transactional transaction-manager="txManager"
                   isolation="DEFAULT"
                   propagation="REQUIRED"
                   read-only="true"
                   timeout="1000"/>
</poller>
```

As you can see this configuration looks very similar to native Spring transaction configuration. You must still provide a reference to a Transaction manager and specify transaction attributes or rely on defaults (e.g., if the *transaction-manager* attribute is not specified, it will default to the bean with the name *transactionManager*). Internally the process would be wrapped in Spring's native Transaction where `TransactionInterceptor` is responsible for handling transactions. For more information on how to configure a Transaction Manager, the types of Transaction Managers (e.g., JTA, Datasource etc.) and other details related to transaction configuration please refer to Spring's Reference manual (Chapter 10 - Transaction Management).

With the above configuration all Message flows initiated by this poller will be transactional. For more information and details on a Poller's transactional configuration please refer to section - *21.1.1. Polling and Transactions*.

Along with transactions, several more cross cutting concerns might need to be addressed when running a Poller. To help with that, the Poller element accepts an *<advice-chain> _ sub-element which allows you to define a custom chain of Advice instances to be applied on the Poller. (see section 4.4 for more details) In Spring Integration 2.0, the Poller went through the a refactoring effort and is now using a proxy mechanism to address transactional concerns as well as other cross cutting concerns. One of the significant changes evolving from this effort is that we made _<transactional>* and *<advice-chain>* elements mutually exclusive. The rationale behind this is that if you need more than one advice, and one of them is Transaction advice, then you can simply include it in the *<advice-chain>* with the same convenience as before but with much more control since you now have an option to position any advice in the desired order.

```
<int:poller max-messages-per-poll="1" fixed-rate="10000">
  <advice-chain>
    <ref bean="txAdvice"/>
    <ref bean="someAotherAdviceBean" />
    <beans:bean class="foo.bar.SampleAdvice"/>
  </advice-chain>
</poller>

<tx:advice id="txAdvice" transaction-manager="txManager">
  <tx:attributes>
    <tx:method name="get*" read-only="true"/>
    <tx:method name="*"/>
  </tx:attributes>
</tx:advice>
```

As you can see from the example above, we have provided a very basic XML-based configuration of Spring Transaction advice - "txAdvice" and included it within the *<advice-chain>* defined by the Poller. If you only need to address transactional concerns of the Poller, then you can still use the *<transactional>* element as a convenience.

=== Transaction Boundaries

Another important factor is the boundaries of Transactions within a Message flow. When a transaction is started, the transaction context is bound to the current thread. So regardless of how many endpoints and channels you have in your Message flow your transaction context will be preserved as long as you are ensuring that the flow continues on the same thread. As soon as you break it by introducing a *Pollable Channel* or *Executor Channel* or initiate a new thread manually in some service, the Transactional boundary will be broken as well. Essentially the Transaction will END right there, and if a successful handoff has transpired between the threads, the flow would be considered a success and a COMMIT signal would be sent even though the flow will continue and might still result in an Exception somewhere downstream. If such a flow were synchronous, that Exception could be thrown back to the initiator of the Message flow who is also the initiator of the transactional context and the transaction would result in a ROLLBACK. The middle ground is to use transactional channels at any point where a thread boundary is being broken. For example, you can use a Queue-backed Channel that delegates to a transactional MessageStore strategy, or you could use a JMS-backed channel.

=== Transaction Synchronization

In some environments, it is advantageous to synchronize operations with a transaction that encompasses the entire flow. For example, consider a <file:inbound-channel-adapter/> at the start of a flow, that performs a number of database updates. If the transaction commits, we might want to move the file to a *success* directory, while we might want to move it to a *failures* directory if the transaction rolls back.

Spring Integration 2.2 introduces the capability of synchronizing these operations with a transaction. In addition, you can configure a `PseudoTransactionManager` if you don't have a *real* transaction, but still want to perform different actions on success, or failure. For more information, see the section called "CompletableFuture".

Key strategy interfaces for this feature are

```
public interface TransactionSynchronizationFactory {

    TransactionSynchronization create(Object key);
}

public interface TransactionSynchronizationProcessor {

    void processBeforeCommit(IntegrationResourceHolder holder);

    void processAfterCommit(IntegrationResourceHolder holder);

    void processAfterRollback(IntegrationResourceHolder holder);

}
```

The factory is responsible for creating a TransactionSynchronization object. You can implement your own, or use the one provided by the framework: `DefaultTransactionSynchronizationFactory`. This implementation returns a `TransactionSynchronization` that delegates to a default implementation of `TransactionSynchronizationProcessor`, the `ExpressionEvaluatingTransactionSynchronizationProcessor`. This processor supports three SpEL expressions, *beforeCommitExpression*, *afterCommitExpression*, and *afterRollbackExpression*.

These actions should be self-explanatory to those familiar with transactions. In each case, the *#root* variable is the original `Message`; in some cases, other SpEL variables are made available, depending on the `MessageSource` being polled by the poller. For example, the `MongoDbMessageSource` provides the *#mongoTemplate* variable which references the message source's `MongoTemplate`; the

`RedisStoreMessageSource` provides the *#store* variable which references the `RedisStore` created by the poll.

To enable the feature for a particular poller, you provide a reference to the `TransactionSynchronizationFactory` on the poller's <transactional/> element using the *synchronization-factory* attribute.

Starting with *version 5.0*, a new `PassThroughTransactionSynchronizationFactory` is provided which is applied by default to polling endpoints when no `TransactionSynchronizationFactory` is configured but an advice of type TransactionInterceptor exists in the advice chain. When using any out-of-the-box `TransactionSynchronizationFactory` implementation, polling endpoints bind a polled message to the current transactional context and provide it as a `failedMessage` in a `MessagingException` if an exception is thrown after the TX advice. When using a custom TX advice that does not implement `TransactionInterceptor`, a `PassThroughTransactionSynchronizationFactory` can be configured explicitly to achieve this behavior. In either case, the `MessagingException` becomes the payload of the `ErrorMessage` that is sent to the `errorChannel` and the cause is the raw exception thrown by the advice. Previously, the `ErrorMessage` had a payload that was the raw exception thrown by the advice and did not provide a reference to the `failedMessage` information, making it difficult to determine the reasons for the transaction commit problem.

To simplify configuration of these components, namespace support for the default factory has been provided. Configuration is best described using an example:

```
<int-file:inbound-channel-adapter id="inputDirPoller"
    channel="someChannel"
    directory="/foo/bar"
    filter="filter"
    comparator="testComparator">
    <int:poller fixed-rate="5000">
        <int:transactional transaction-manager="transactionManager" synchronization-
factory="syncFactory" />
    </int:poller>
</int-file:inbound-channel-adapter>

<int:transaction-synchronization-factory id="syncFactory">
    <int:after-commit expression="payload.renameTo('/success/' +
 payload.name)" channel="committedChannel" />
    <int:after-rollback expression="payload.renameTo('/failed/' +
 payload.name)" channel="rolledBackChannel" />
</int:transaction-synchronization-factory>
```

The result of the SpEL evaluation is sent as the payload to either the *committedChannel* or *rolledBackChannel* (in this case, this would be `Boolean.TRUE` or `Boolean.FALSE` - the result of the `java.io.File.renameTo()` method call).

If you wish to send the entire payload for further Spring Integration processing, simply use the expression *payload*.

Important

It is important to understand that this is simply synchronizing the actions with a transaction, it does not make a resource that is not inherently transactional actually transactional. Instead, the transaction (be it JDBC or otherwise) is started before the poll, and committed/rolled back when the flow completes, followed by the synchronized action.

It is also important to understand that if you provide a custom `TransactionSynchronizationFactory`, it is responsible for creating a resource

> synchronization that will cause the bound resource to be unbound automatically, when the transaction completes. The default `TransactionSynchronizationFactory` does this by returning a subclass of `ResourceHolderSynchronization`, with the default *shouldUnbindAtCompletion()* returning `true`.

In addition to the *after-commit* and *after-rollback* expressions, *before-commit* is also supported. In that case, if the evaluation (or downstream processing) throws an exception, the transaction will be rolled back instead of being committed.

=== Pseudo Transactions

Referring to the above section, you may be thinking it would be useful to take these *success* or *failure* actions when a flow completes, even if there is no *real* transactional resources (such as JDBC) downstream of the poller. For example, consider a <file:inbound-channel-adapter/> followed by an <ftp:outbout-channel-adapter/>. Neither of these components is transactional but we might want to move the input file to different directories, based on the success or failure of the ftp transfer.

To provide this functionality, the framework provides a `PseudoTransactionManager`, enabling the above configuration even when there is no real transactional resource involved. If the flow completes normally, the *beforeCommit* and *afterCommit* synchronizations will be called, on failure the *afterRollback* will be called. Of course, because it is not a real transaction there will be no actual commit or rollback. The pseudo transaction is simply a vehicle used to enable the synchronization features.

To use a `PseudoTransactionManager`, simply define it as a <bean/>, in the same way you would configure a real transaction manager:

```
<bean id="transactionManager" class="o.s.i.transaction.PseudoTransactionManager" />
```

== Security in Spring Integration

=== Introduction

Security is one of the important functions in any modern enterprise (or cloud) application, moreover it is critical for distributed systems, such as those built using Enterprise Integration Patterns. Messaging independence and loosely-coupling allow target systems to communicate with each other with any type of data in the message's `payload`. We can either trust all those messages or *secure* our service against "infecting" messages.

Spring Integration together with [Spring Security](http://projects.spring.io/spring-security/) provide a simple and comprehensive way to secure message channels, as well as other part of the integration solution.

=== Securing channels

Spring Integration provides the interceptor `ChannelSecurityInterceptor`, which extends `AbstractSecurityInterceptor` and intercepts send and receive calls on the channel. Access decisions are then made with reference to a `ChannelSecurityMetadataSource` which provides the metadata describing the send and receive access policies for certain channels. The interceptor requires that a valid `SecurityContext` has been established by authenticating with Spring Security. See the Spring Security reference documentation for details.

Namespace support is provided to allow easy configuration of security constraints. This consists of the secured channels tag which allows definition of one or more channel name patterns in conjunction with a definition of the security configuration for send and receive. The pattern is a `java.util.regexp.Pattern`.

```
<?xml version="1.0" encoding="UTF-8"?>
<beans:beans xmlns:int="http://www.springframework.org/schema/integration"
   xmlns:int-security="http://www.springframework.org/schema/integration/security"
  xmlns:beans="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:security="http://www.springframework.org/schema/security"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
      https://www.springframework.org/schema/beans/spring-beans.xsd
      http://www.springframework.org/schema/security
      https://www.springframework.org/schema/security/spring-security.xsd
      http://www.springframework.org/schema/integration
      https://www.springframework.org/schema/integration/spring-integration.xsd
      http://www.springframework.org/schema/integration/security
      https://www.springframework.org/schema/integration/security/spring-integration-security.xsd">

<int-security:secured-channels>
    <int-security:access-policy pattern="admin.*" send-access="ROLE_ADMIN"/>
    <int-security:access-policy pattern="user.*" receive-access="ROLE_USER"/>
</int-security:secured-channels>
```

By default the secured-channels namespace element expects a bean named *authenticationManager* which implements `AuthenticationManager` and a bean named *accessDecisionManager* which implements `AccessDecisionManager`. Where this is not the case references to the appropriate beans can be configured as attributes of the *secured-channels* element as below.

```
<int-security:secured-channels access-decision-manager="customAccessDecisionManager"
                              authentication-manager="customAuthenticationManager">
    <int-security:access-policy pattern="admin.*" send-access="ROLE_ADMIN"/>
    <int-security:access-policy pattern="user.*" receive-access="ROLE_USER"/>
</int-security:secured-channels>
```

Starting with *version 4.2*, the `@SecuredChannel` annotation is available for Java & Annotation configuration in `@Configuration` classes.

With the `@SecuredChannel` annotation, the Java configuration variant of the XML configuration above is:

```
@Configuration
@EnableIntegration
public class ContextConfiguration {

    @Bean
    @SecuredChannel(interceptor = "channelSecurityInterceptor", sendAccess = "ROLE_ADMIN")
    public SubscribableChannel adminChannel() {
     return new DirectChannel();
    }

    @Bean
    @SecuredChannel(interceptor = "channelSecurityInterceptor", receiveAccess = "ROLE_USER")
    public SubscribableChannel userChannel() {
     return new DirectChannel();
    }

    @Bean
    public ChannelSecurityInterceptor channelSecurityInterceptor(
            AuthenticationManager authenticationManager,
      AccessDecisionManager accessDecisionManager) {
     ChannelSecurityInterceptor channelSecurityInterceptor = new ChannelSecurityInterceptor();
     channelSecurityInterceptor.setAuthenticationManager(authenticationManager);
     channelSecurityInterceptor.setAccessDecisionManager(accessDecisionManager);
     return channelSecurityInterceptor;
    }

}
```

=== SecurityContext Propagation

To be sure that our interaction with the application is secure, according to its security system rules, we should supply some *security context* with an *authentication* (principal) object. The Spring Security project provides a flexible, canonical mechanism to authenticate our application clients over HTTP, WebSocket or SOAP protocols (as can be done for any other integration protocol with a simple Spring Security extension) and it provides a `SecurityContext` for further authorization checks on the application objects, such as message channels. By default, the `SecurityContext` is tied with the current `Thread` 's execution state using the (`ThreadLocalSecurityContextHolderStrategy`). It is accessed by an AOP interceptor on secured methods to check if that `principal` of the invocation has sufficient permissions to call that method, for example. This works well with the current thread, but often, processing logic can be performed on another thread or even on several threads, or on to some external system(s).

Standard thread-bound behavior is easy to configure if our application is built on the Spring Integration components and its message channels. In this case, the secured objects may be any service activator or transformer, secured with a `MethodSecurityInterceptor` in their `<request-handler-advice-chain>` (see the section called “CompletableFuture”) or even `MessageChannel` (see the section called “CompletableFuture” above). When using `DirectChannel` communication, the `SecurityContext` is available automatically, because the downstream flow runs on the current thread. But in case of the `QueueChannel`, `ExecutorChannel` and `PublishSubscribeChannel` with an `Executor`, messages are transferred from one thread to another (or several) by the nature of those channels. In order to support such scenarios, we can either transfer an `Authentication` object within the message headers and extract and authenticate it on the other side before secured object access. Or, we can *propagate* the `SecurityContext` to the thread receiving the transferred message.

Starting with *version 4.2* `SecurityContext` propagation has been introduced. It is implemented as a `SecurityContextPropagationChannelInterceptor`, which can simply be added to any `MessageChannel` or configured as a `@GlobalChannelInterceptor`. The logic of this interceptor is based on the `SecurityContext` extraction from the current thread from the `preSend()` method, and its populating to another thread from the `postReceive()` (`beforeHandle()`) method. Actually, this interceptor is an extension of the more generic `ThreadStatePropagationChannelInterceptor`, which wraps the message-to-send together with the state-to-propagate in an internal `Message<?>` extension - `MessageWithThreadState<S>`, - on one side and extracts the original message back and state-to-propagate on another. The `ThreadStatePropagationChannelInterceptor` can be extended for any context propagation use-case and `SecurityContextPropagationChannelInterceptor` is a good sample on the matter.

> **Important**
>
> Since the logic of the `ThreadStatePropagationChannelInterceptor` is based on message modification (it returns an internal `MessageWithThreadState` object to send), you should be careful when combining this interceptor with any other which is intended to modify messages too, e.g. through the `MessageBuilder.withPayload(...)...build()` - the state-to-propagate may be lost. In most cases to overcome the issue, it’s sufficient to order interceptors for the channel and ensure the `ThreadStatePropagationChannelInterceptor` is the last one in the stack.

Propagation and population of `SecurityContext` is just one half of the work. Since the message isn’t an owner of the threads in the message flow and we should be sure that we are secure against any incoming messages, we have to *clean up* the `SecurityContext` from `ThreadLocal`. The `SecurityContextPropagationChannelInterceptor` provides `afterMessageHandled()`

interceptor's method implementation to do the clean up operation to free the Thread in the end of invocation from that propagated principal. This means that, when the thread that processes the handed-off message, completes the processing of the message (successfully or otherwise), the context is cleared so that it can't be inadvertently be used when processing another message.

> **Note**
>
> When working with Asynchronous Gateway, you should use an appropriate `AbstractDelegatingSecurityContextSupport` implementation from Spring Security Concurrency Support, when security context propagation should be ensured over gateway invocation:

```
@Configuration
@EnableIntegration
@IntegrationComponentScan
public class ContextConfiguration {

    @Bean
    public AsyncTaskExecutor securityContextExecutor() {
        return new DelegatingSecurityContextAsyncTaskExecutor(
                         new SimpleAsyncTaskExecutor());
    }

}

...

@MessagingGateway(asyncExecutor = "securityContextExecutor")
public interface SecuredGateway {

    @Gateway(requestChannel = "queueChannel")
    Future<String> send(String payload);

}
```

== Configuration

=== Introduction

Spring Integration offers a number of configuration options. Which option you choose depends upon your particular needs and at what level you prefer to work. As with the Spring framework in general, it is also possible to mix and match the various techniques according to the particular problem at hand. For example, you may choose the XSD-based namespace for the majority of configuration combined with a handful of objects that are configured with annotations. As much as possible, the two provide consistent naming. XML elements defined by the XSD schema will match the names of annotations, and the attributes of those XML elements will match the names of annotation properties. Direct usage of the API is of course always an option, but we expect that most users will choose one of the higher-level options, or a combination of the namespace-based and annotation-driven configuration.

=== Namespace Support

Spring Integration components can be configured with XML elements that map directly to the terminology and concepts of enterprise integration. In many cases, the element names match those of the Enterprise Integration Patterns.

To enable Spring Integration's core namespace support within your Spring configuration files, add the following namespace reference and schema mapping in your top-level *beans* element:

```
<beans xmlns="http://www.springframework.org/schema/beans"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:int="http://www.springframework.org/schema/integration"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
           https://www.springframework.org/schema/beans/spring-beans.xsd
           http://www.springframework.org/schema/integration
           https://www.springframework.org/schema/integration/spring-integration.xsd">
```

You can choose any name after "xmlns:"; *int* is used here for clarity, but you might prefer a shorter abbreviation. Of course if you are using an XML-editor or IDE support, then the availability of auto-completion may convince you to keep the longer name for clarity. Alternatively, you can create configuration files that use the Spring Integration schema as the primary namespace:

```
<beans:beans xmlns="http://www.springframework.org/schema/integration"
       xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
       xmlns:beans="http://www.springframework.org/schema/beans"
       xsi:schemaLocation="http://www.springframework.org/schema/beans
           https://www.springframework.org/schema/beans/spring-beans.xsd
           http://www.springframework.org/schema/integration
           https://www.springframework.org/schema/integration/spring-integration.xsd">
```

When using this alternative, no prefix is necessary for the Spring Integration elements. On the other hand, if you want to define a generic Spring "bean" within the same configuration file, then a prefix would be required for the bean element (`<beans:bean .../>`). Since it is generally a good idea to modularize the configuration files themselves based on responsibility and/or architectural layer, you may find it appropriate to use the latter approach in the integration-focused configuration files, since generic beans are seldom necessary within those same files. For purposes of this documentation, we will assume the "integration" namespace is primary.

Many other namespaces are provided within the Spring Integration distribution. In fact, each adapter type (JMS, File, etc.) that provides namespace support defines its elements within a separate schema. In order to use these elements, simply add the necessary namespaces with an "xmlns" entry and the corresponding "schemaLocation" mapping. For example, the following root element shows several of these namespace declarations:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:int="http://www.springframework.org/schema/integration"
  xmlns:int-file="http://www.springframework.org/schema/integration/file"
  xmlns:int-jms="http://www.springframework.org/schema/integration/jms"
  xmlns:int-mail="http://www.springframework.org/schema/integration/mail"
  xmlns:int-rmi="http://www.springframework.org/schema/integration/rmi"
  xmlns:int-ws="http://www.springframework.org/schema/integration/ws"
  xsi:schemaLocation="http://www.springframework.org/schema/beans
    https://www.springframework.org/schema/beans/spring-beans.xsd
    http://www.springframework.org/schema/integration
    https://www.springframework.org/schema/integration/spring-integration.xsd
    http://www.springframework.org/schema/integration/file
    https://www.springframework.org/schema/integration/file/spring-integration-file.xsd
    http://www.springframework.org/schema/integration/jms
    https://www.springframework.org/schema/integration/jms/spring-integration-jms.xsd
    http://www.springframework.org/schema/integration/mail
    https://www.springframework.org/schema/integration/mail/spring-integration-mail.xsd
    http://www.springframework.org/schema/integration/rmi
    https://www.springframework.org/schema/integration/rmi/spring-integration-rmi.xsd
    http://www.springframework.org/schema/integration/ws
    https://www.springframework.org/schema/integration/ws/spring-integration-ws.xsd">
 ...
</beans>
```

The reference manual provides specific examples of the various elements in their corresponding chapters. Here, the main thing to recognize is the consistency of the naming for each namespace URI and schema location.

=== Configuring the Task Scheduler

In Spring Integration, the ApplicationContext plays the central role of a Message Bus, and there are only a couple configuration options to consider. First, you may want to control the central TaskScheduler instance. You can do so by providing a single bean with the name "taskScheduler". This is also defined as a constant:

```
IntegrationContextUtils.TASK_SCHEDULER_BEAN_NAME
```

By default Spring Integration relies on an instance of `ThreadPoolTaskScheduler` as described in the Task Execution and Scheduling section of the Spring Framework reference manual. That default TaskScheduler will startup automatically with a pool of 10 threads, but see the section called “CompletableFuture”. If you provide your own TaskScheduler instance instead, you can set the *autoStartup* property to *false*, and/or you can provide your own pool size value.

When Polling Consumers provide an explicit task-executor reference in their configuration, the invocation of the handler methods will happen within that executor’s thread pool and not the main scheduler pool. However, when no task-executor is provided for an endpoint’s poller, it will be invoked by one of the main scheduler’s threads.

Caution

Do not run long-running tasks on poller threads; use a task executor instead. If you have a lot of polling endpoints, you can cause thread starvation, unless you increase the pool size. Also, polling consumers have a default `receiveTimeout` of 1 second; since the poller thread blocks for this time, it is recommended that a task executor be used when many such endpoints exist, again to avoid starvation. Alternatively, reduce the `receiveTimeout`.

Note

An endpoint is a *Polling Consumer* if its input channel is one of the queue-based (i.e. pollable) channels. *Event Driven Consumers* are those having input channels that have dispatchers instead of queues (i.e. they are subscribable). Such endpoints have no poller configuration since their handlers will be invoked directly.

Important

When running in a JEE container, you may need to use Spring’s `TimerManagerTaskScheduler` as described here, instead of the default *taskScheduler*. To do that, simply define a bean with the appropriate JNDI name for your environment, for example:

```
<bean id="taskScheduler" class="o.s.scheduling.commonj.TimerManagerTaskScheduler">
    <property name="timerManagerName" value="tm/MyTimerManager" />
    <property name="resourceRef" value="true" />
</bean>
```

The next section will describe what happens if Exceptions occur within the asynchronous invocations.

=== Error Handling

As described in the overview at the very beginning of this manual, one of the main motivations behind a Message-oriented framework like Spring Integration is to promote loose-coupling between components. The Message Channel plays an important role in that producers and consumers do not have to know about each other. However, the advantages also have some drawbacks. Some things become more complicated in a very loosely coupled environment, and one example is error handling.

When sending a Message to a channel, the component that ultimately handles that Message may or may not be operating within the same thread as the sender. If using a simple default `DirectChannel` (with the `<channel>` element that has no `<queue>` sub-element and no *task-executor* attribute), the Message-handling will occur in the same thread that sends the initial message. In that case, if an `Exception` is thrown, it can be caught by the sender (or it may propagate past the sender if it is an uncaught `RuntimeException`). So far, everything is fine. This is the same behavior as an Exception-throwing operation in a normal call stack.

A message flow that runs on a caller thread might be invoked via a `Messaging Gateway` (see Section 8.4, “Messaging Gateways”) or a `MessagingTemplate` (see the section called “MessagingTemplate”). In either case, the default behavior is to throw any exceptions to the caller. For the `Messaging Gateway`, see the section called “Error Handling” for details about how the exception is thrown and how to configure the gateway to route the errors to an error channel instead. When using a `MessagingTemplate`, or sending to a `MessageChannel` directly, exceptions are always thrown to the caller.

When adding asynchronous processing, things become rather more complicated. For instance, if the *channel* element *does* provide a *queue* sub-element, then the component that handles the Message *will* be operating in a different thread than the sender. The same is true when an `ExecutorChannel` is used. The sender may have dropped the `Message` into the channel and moved on to other things. There is no way for the `Exception` to be thrown directly back to that sender using standard `Exception` throwing techniques. Instead, handling errors for asynchronous processes requires an asynchronous error-handling mechanism as well.

Spring Integration supports error handling for its components by publishing errors to a Message Channel. Specifically, the `Exception` will become the payload of a Spring Integration `ErrorMessage`. That `Message` will then be sent to a Message Channel that is resolved in a way that is similar to the *replyChannel* resolution. First, if the request `Message` being handled at the time the `Exception` occurred contains an *errorChannel* header (the header name is defined in the constant: `MessageHeaders.ERROR_CHANNEL`), the `ErrorMessage` will be sent to that channel. Otherwise, the error handler will send to a "global" channel whose bean name is "errorChannel" (this is also defined as a constant: `IntegrationContextUtils.ERROR_CHANNEL_BEAN_NAME`).

A default "errorChannel" bean is created behind the scenes by the Framework. However, you can just as easily define your own if you want to control the settings.

```
<int:channel id="errorChannel">
    <int:queue capacity="500"/>
</int:channel>
```

Note

The default "errorChannel" is a `PublishSubscribeChannel`.

The most important thing to understand here is that the messaging-based error handling will only apply to Exceptions that are thrown by a Spring Integration task that is executing within a `TaskExecutor`.

This does *not* apply to Exceptions thrown by a handler that is operating within the same thread as the sender (e.g. through a `DirectChannel` as described above).

> **Note**
>
> When Exceptions occur in a scheduled poller task's execution, those exceptions will be wrapped in `ErrorMessage` s and sent to the *errorChannel* as well.

To enable global error handling, simply register a handler on that channel. For example, you can configure Spring Integration's `ErrorMessageExceptionTypeRouter` as the handler of an endpoint that is subscribed to the *errorChannel*. That router can then spread the error messages across multiple channels based on `Exception` type.

Starting with *version 4.3.10*, the `ErrorMessagePublisher` and the `ErrorMessageStrategy` are provided. They can be used as general mechanism for publishing `ErrorMessage` s and can be called or extended in any error handling scenarios. The `ErrorMessageSendingRecoverer` extends this class as a `RecoveryCallback` implementation that can be used with retry, such as the RequestHandlerRetryAdvice. The `ErrorMessageStrategy` is used to build an `ErrorMessage` based on the provided exception and an `AttributeAccessor` context. It can be injected to any `MessageProducerSupport` and `MessagingGatewaySupport` - and the `requestMessage` is stored under `ErrorMessageUtils.INPUT_MESSAGE_CONTEXT_KEY` in the `AttributeAccessor` context. The `ErrorMessageStrategy` can use that `requestMessage` as the `originalMessage` property of the `ErrorMessage` it creates. The `DefaultErrorMessageStrategy` does exactly that.

=== Global Properties

Certain global framework properties can be overridden by providing a properties file on the classpath.

The default properties can be found in `/META-INF/spring.integration.default.properties` in the `spring-integration-core` jar. You can see them on GitHub here, but here are the current default values:

```
spring.integration.channels.autoCreate=true ❶
spring.integration.channels.maxUnicastSubscribers=0x7fffffff ❷
spring.integration.channels.maxBroadcastSubscribers=0x7fffffff ❸
spring.integration.taskScheduler.poolSize=10 ❹
spring.integration.messagingTemplate.throwExceptionOnLateReply=false ❺
spring.integration.readOnly.headers= ❻
spring.integration.endpoints.noAutoStartup= ❼
spring.integration.postProcessDynamicBeans=false ❽
```

❶ When true, `input-channel` s will be automatically declared as `DirectChannel` s when not explicitly found in the application context.

❷ This property provides the default number of subscribers allowed on, say, a `DirectChannel`. It can be used to avoid inadvertently subscribing multiple endpoints to the same channel. This can be overridden on individual channels with the `max-subscribers` attribute.

❸ This property provides the default number of subscribers allowed on, say, a `PublishSubscribeChannel`. It can be used to avoid inadvertently subscribing more than the expected number of endpoints to the same channel. This can be overridden on individual channels with the `max-subscribers` attribute.

❹ The number of threads available in the default `taskScheduler` bean; see the section called “CompletableFuture”.

❺ When `true`, messages that arrive at a gateway reply channel will throw an exception, when the gateway is not expecting a reply - because the sending thread has timed out, or already received a reply.

❻ A comma-separated list of message header names which should not be populated into `Message` s during a header copying operation. The list is used by the `DefaultMessageBuilderFactory` bean and propagated to the `IntegrationMessageHeaderAccessor` instances (see the section called “MessageHeaderAccessor API”), used to build messages via `MessageBuilder` (see the section called “The MessageBuilder Helper Class”). By default only `MessageHeaders.ID` and `MessageHeaders.TIMESTAMP` are not copied during message building. *Since version 4.3.2*

❼ A comma-separated list of `AbstractEndpoint` bean names patterns (`xxx*`, `*xxx`, `*xxx*` or `xxx*yyy`) which should not be started automatically during application startup. These endpoints can be started later manually by their bean name via `Control Bus` (see the section called “CompletableFuture”), by their role using the `SmartLifecycleRoleController` (see Section 8.2, “Endpoint Roles”) or via simple `Lifecycle` bean injection. The effect of this global property can be explicitly overridden by specifying `auto-startup` XML or `autoStartup` annotation attribute, or via call to the `AbstractEndpoint.setAutoStartup()` in bean definition. *Since version 4.3.12*

❽ A boolean flag to indicate that `BeanPostProcessor` s should post-process beans registered at runtime, e.g. message channels created via `IntegrationFlowContext` can be supplied with global channel interceptors. *Since version 4.3.15*

These properties can be overridden by adding a file `/META-INF/spring.integration.properties` to the classpath. It is not necessary to provide all the properties, just those that you want to override.

=== Annotation Support

In addition to the XML namespace support for configuring Message Endpoints, it is also possible to use annotations. First, Spring Integration provides the class-level `@MessageEndpoint` as a *stereotype* annotation, meaning that it is itself annotated with Spring’s `@Component` annotation and is therefore recognized automatically as a bean definition when using Spring component-scanning.

Even more important are the various method-level annotations that indicate the annotated method is capable of handling a message. The following example demonstrates both:

```
@MessageEndpoint
public class FooService {

    @ServiceActivator
    public void processMessage(Message message) {
        ...
    }
}
```

Exactly what it means for the method to "handle" the Message depends on the particular annotation. Annotations available in Spring Integration include:

- @Aggregator
- @Filter
- @Router
- @ServiceActivator

- @Splitter
- @Transformer
- @InboundChannelAdapter
- @BridgeFrom
- @BridgeTo
- @MessagingGateway
- @IntegrationComponentScan

The behavior of each is described in its own chapter or section within this reference.

Note

If you are using XML configuration in combination with annotations, the `@MessageEndpoint` annotation is not required. If you want to configure a POJO reference from the "ref" attribute of a `<service-activator/>` element, it is sufficient to provide the method-level annotations. In that case, the annotation prevents ambiguity even when no "method" attribute exists on the `<service-activator/>` element.

In most cases, the annotated handler method should not require the `Message` type as its parameter. Instead, the method parameter type can match the message's payload type.

```
public class FooService {

    @ServiceActivator
    public void bar(Foo foo) {
        ...
    }

}
```

When the method parameter should be mapped from a value in the `MessageHeaders`, another option is to use the parameter-level `@Header` annotation. In general, methods annotated with the Spring Integration annotations can either accept the `Message` itself, the message payload, or a header value (with @Header) as the parameter. In fact, the method can accept a combination, such as:

```
public class FooService {

    @ServiceActivator
    public void bar(String payload, @Header("x") int valueX, @Header("y") int valueY) {
        ...
    }

}
```

There is also a `@Headers` annotation that provides all of the Message headers as a Map:

```
public class FooService {

    @ServiceActivator
    public void bar(String payload, @Headers Map<String, Object> headerMap) {
        ...
    }

}
```

Note

The value of the annotation can also be a SpEL expression (e.g., `someHeader.toUpperCase()`) which is useful when you wish to manipulate the header value before injecting it. It also provides an optional *required* property which specifies whether the attribute value must be available within the headers. The default value for *required* is `true`.

For several of these annotations, when a Message-handling method returns a non-null value, the endpoint will attempt to send a reply. This is consistent across both configuration options (namespace and annotations) in that such an endpoint's output channel will be used if available, and the REPLY_CHANNEL message header value will be used as a fallback.

Tip

The combination of output channels on endpoints and the reply channel message header enables a pipeline approach where multiple components have an output channel, and the final component simply allows the reply message to be forwarded to the reply channel as specified in the original request message. In other words, the final component depends on the information provided by the original sender and can dynamically support any number of clients as a result. This is an example of Return Address.

In addition to the examples shown here, these annotations also support inputChannel and outputChannel properties.

```
@Service
public class FooService {

    @ServiceActivator(inputChannel="input", outputChannel="output")
    public void bar(String payload, @Headers Map<String, Object> headerMap) {
        ...
    }

}
```

The processing of these annotations creates the same beans (`AbstractEndpoint` s and `MessageHandler` s (or `MessageSource` s for the inbound channel adapter - see below) as with similar xml components. The bean names are generated with this pattern: `[componentName].[methodName].[decapitalizedAnnotationClassShortName]` (e.g for the sample above - `fooService.bar.serviceActivator`) for the `AbstractEndpoint` and the same name with an additional `.handler` (`.source`) suffix for the `MessageHandler` (`MessageSource`) bean. The `MessageHandler` s (`MessageSource` s) are also eligible to be tracked by the section called "CompletableFuture".

Starting with *version 4.0*, all Messaging Annotations provide `SmartLifecycle` options - `autoStartup` and `phase` to allow endpoint lifecycle control on application context initialization. They default to `true` and `0` respectively. To change the state of an endpoint (e.g` start()/stop()) `obtain a reference to the endpoint bean using the `BeanFactory` (or autowiring) and invoke the method(s), or send a *command message* to the `Control Bus` (the section called "CompletableFuture"). For these purposes you should use the `beanName` mentioned above.

@Poller

Before *Spring Integration 4.0*, the above Messaging Annotations required that the `inputChannel` was a reference to a `SubscribableChannel`. For `PollableChannel` s there was need to use a `<int:bridge/>`, to configure a `<int:poller/>` to make the composite endpoint - a `PollingConsumer`. Starting with *version 4.0*, the `@Poller` annotation has been introduced to allow the configuration of `poller` attributes directly on the above Messaging Annotations:

```
public class AnnotationService {

    @Transformer(inputChannel = "input", outputChannel = "output",
        poller = @Poller(maxMessagesPerPoll = "${poller.maxMessagesPerPoll}", fixedDelay =
 "${poller.fixedDelay}"))
    public String handle(String payload) {
        ...
    }
}
```

This annotation provides only simple `PollerMetadata` options. The `@Poller`'s attributes `maxMessagesPerPoll`, `fixedDelay`, `fixedRate` and `cron` can be configured with *property-placeholders*. If it is necessary to provide more polling options (e.g. transaction, advice-chain, error-handler etc.), the `PollerMetadata` should be configured as a generic bean with its bean name used for `@Poller`'s `value` attribute. In this case, no other attributes are allowed (they would be specified on the `PollerMetadata` bean). Note, if `inputChannel` is `PollableChannel` and no `@Poller` is configured, the default `PollerMetadata` will be used, if it is present in the application context. To declare the default poller using `@Configuration`, use:

```
@Bean(name = PollerMetadata.DEFAULT_POLLER)
public PollerMetadata defaultPoller() {
    PollerMetadata pollerMetadata = new PollerMetadata();
    pollerMetadata.setTrigger(new PeriodicTrigger(10));
    return pollerMetadata;
}
```

With this endpoint using the default poller:

```
public class AnnotationService {

    @Transformer(inputChannel = "aPollableChannel", outputChannel = "output")
    public String handle(String payload) {
        ...
    }
}
```

To use a named poller, use:

```
@Bean
public PollerMetadata myPoller() {
    PollerMetadata pollerMetadata = new PollerMetadata();
    pollerMetadata.setTrigger(new PeriodicTrigger(1000));
    return pollerMetadata;
}
```

With this endpoint using the default poller:

```
public class AnnotationService {

    @Transformer(inputChannel = "aPollableChannel", outputChannel = "output"
                           poller = @Poller("myPoller"))
    public String handle(String payload) {
         ...
    }
}
```

Starting with *version 4.3.3*, the `@Poller` annotation now has the `errorChannel` attribute for easier configuration of the underlying `MessagePublishingErrorHandler`. This attribute play the same role as `error-channel` in the `<poller>` xml component. See the section called “Endpoint Namespace Support” for more information.

@InboundChannelAdapter

Starting with *version 4.0*, the `@InboundChannelAdapter` method annotation is available. This produces a `SourcePollingChannelAdapter` integration component based on a `MethodInvokingMessageSource` for the annotated method. This annotation is an analogue of `<int:inbound-channel-adapter>` XML component and has the same restrictions: the method cannot have parameters, and the return type must not be `void`. It has two attributes: `value` - the required `MessageChannel` bean name and `poller` - an optional `@Poller` annotation, as described above. If there is need to provide some `MessageHeaders`, use a `Message<?>` return type and build the `Message<?>` within the method using a `MessageBuilder` to configure its `MessageHeaders`.

```
@InboundChannelAdapter("counterChannel")
public Integer count() {
    return this.counter.incrementAndGet();
}

@InboundChannelAdapter(value = "fooChannel", poller = @Poller(fixed-rate = "5000"))
public String foo() {
    return "foo";
}
```

Starting with *version 4.3* the `channel` alias for the `value` annotation attribute has been introduced for better source code readability. Also the target `MessageChannel` bean is resolved in the `SourcePollingChannelAdapter` by the provided name (`outputChannelName` options) on the first `receive()` call, not during initialization phase. It allows the *late binding* logic, when the target `MessageChannel` bean from the consumer perspective is created and registered a bit later than the `@InboundChannelAdapter` parsing phase.

The first example requires that the default poller has been declared elsewhere in the application context.

@MessagingGateway

See the section called “@MessagingGateway Annotation”.

@IntegrationComponentScan

The standard Spring Framework `@ComponentScan` annotation doesn’t scan interfaces for stereotype `@Component` annotations. To overcome this limitation and allow the configuration of `@MessagingGateway` (see the section called “@MessagingGateway Annotation”), the `@IntegrationComponentScan` mechanism has been introduced. This annotation must be placed along with a `@Configuration` annotation, and customized for the scanning options, such as `basePackages` and `basePackageClasses`. In this case all discovered interfaces annotated with `@MessagingGateway` will be parsed and registered as a `GatewayProxyFactoryBean` s. All other class-based components are parsed by the standard `@ComponentScan`. In future, more scanning logic may be added to the `@IntegrationComponentScan`.

==== Messaging Meta-Annotations

Starting with *version 4.0*, all Messaging Annotations can be configured as meta-annotations and all user-defined Messaging Annotations can define the same attributes to override their default values. In addition, meta-annotations can be configured hierarchically:

```
@Target({ElementType.METHOD, ElementType.ANNOTATION_TYPE})
@Retention(RetentionPolicy.RUNTIME)
@ServiceActivator(inputChannel = "annInput", outputChannel = "annOutput")
public @interface MyServiceActivator {

    String[] adviceChain = { "annAdvice" };
}

@Target({ElementType.METHOD, ElementType.ANNOTATION_TYPE})
@Retention(RetentionPolicy.RUNTIME)
@MyServiceActivator
public @interface MyServiceActivator1 {

    String inputChannel();

    String outputChannel();
}
...

@MyServiceActivator1(inputChannel = "inputChannel", outputChannel = "outputChannel")
public Object service(Object payload) {
   ...
}
```

This allows users to set defaults for various attributes and enables isolation of framework Java dependencies to user annotations, avoiding their use in user classes. If the framework finds a method with a user annotation that has a framework meta-annotation, it is treated as if the method was annotated directly with the framework annotation.

==== Annotations on @Beans

Starting with *version 4.0*, Messaging Annotations can be configured on `@Bean` method definitions in `@Configuration` classes, to produce Message Endpoints based on the beans, not methods. It is useful when `@Bean` definitions are "out of the box" `MessageHandler` s (`AggregatingMessageHandler`, `DefaultMessageSplitter` etc.), `Transformer` s (`JsonToObjectTransformer`, `ClaimCheckOutTransformer` etc.), `MessageSource` s (`FileReadingMessageSource`, `RedisStoreMessageSource` etc.):

```
@Configuration
@EnableIntegration
public class MyFlowConfiguration {

    @Bean
    @InboundChannelAdapter(value = "inputChannel", poller = @Poller(fixedDelay = "1000"))
    public MessageSource<String> consoleSource() {
        return CharacterStreamReadingMessageSource.stdin();
    }

    @Bean
    @Transformer(inputChannel = "inputChannel", outputChannel = "httpChannel")
    public ObjectToMapTransformer toMapTransformer() {
        return new ObjectToMapTransformer();
    }

    @Bean
    @ServiceActivator(inputChannel = "httpChannel")
    public MessageHandler httpHandler() {
    HttpRequestExecutingMessageHandler handler = new HttpRequestExecutingMessageHandler("http://foo/
service");
        handler.setExpectedResponseType(String.class);
        handler.setOutputChannelName("outputChannel");
        return handler;
    }

    @Bean
    @ServiceActivator(inputChannel = "outputChannel")
    public LoggingHandler loggingHandler() {
        return new LoggingHandler("info");
    }

}
```

Starting with *version 5.0*, a support is also provided for a `@Bean` annotated with the `InboundChannelAdapter` that return `java.util.function.Supplier` which can produce either a POJO or a `Message`:

```
@Configuration
@EnableIntegration
public class MyFlowConfiguration {

    @Bean
    @InboundChannelAdapter(value = "inputChannel", poller = @Poller(fixedDelay = "1000"))
    public Supplier<String> pojoSupplier() {
        return () -> "foo";
    }

    @Bean
    @InboundChannelAdapter(value = "inputChannel", poller = @Poller(fixedDelay = "1000"))
    public Supplier<Message<String>> messageSupplier() {
        return () -> new GenericMessage<>("foo");
    }
}
```

The meta-annotation rules work on `@Bean` methods as well (`@MyServiceActivator` above can be applied to a `@Bean` definition).

Note

When using these annotations on consumer `@Bean` definitions, if the bean definition returns an appropriate `MessageHandler` (depending on the annotation type), attributes such as `outputChannel`, `requiresReply`, `order` etc, must be set on the `MessageHandler` `@Bean` definition itself. The only annotation attributes used are `adviceChain`, `autoStartup`, `inputChannel`, `phase`, `poller`, all other attributes are for the handler.

Note

The bean names are generated with this algorithm: * The `MessageHandler` (`MessageSource`) `@Bean` gets its own standard name from the method name or `name` attribute on the `@Bean`. This works like there is no Messaging Annotation on the `@Bean` method. * The `AbstractEndpoint` bean name is generated with the pattern: `[configurationComponentName].[methodName].[decapitalizedAnnotationClassShortName]`. For example the endpoint (`SourcePollingChannelAdapter`) for the `consoleSource()` definition above gets a bean name like: `myFlowConfiguration.consoleSource.inboundChannelAdapter`. Also see the section called “Endpoint Bean Names”.

Important

When using these annotations on `@Bean` definitions, the `inputChannel` must reference a declared bean; channels are not automatically declared in this case.

Note

With Java & Annotation configuration we can use any `@Conditional` (e.g. `@Profile`) definition on the `@Bean` method level, meaning to skip the bean registration by some condition reason:

```
@Bean
@ServiceActivator(inputChannel = "skippedChannel")
@Profile("foo")
public MessageHandler skipped() {
    return System.out::println;
}
```

Together with the existing Spring Container logic, the Messaging Endpoint bean, based on the `@ServiceActivator` annotation, won’t be registered as well.

==== Creating a Bridge with Annotations

Starting with *version 4.0*, the Messaging Annotation and Java configuration provides `@BridgeFrom` and `@BridgeTo` `@Bean` method annotations to mark `MessageChannel` beans in `@Configuration` classes. This is just for completeness, providing a convenient mechanism to declare a `BridgeHandler` and its Message Endpoint configuration:

```
@Bean
public PollableChannel bridgeFromInput() {
    return new QueueChannel();
}

@Bean
@BridgeFrom(value = "bridgeFromInput", poller = @Poller(fixedDelay = "1000"))
public MessageChannel bridgeFromOutput() {
    return new DirectChannel();
}
@Bean
public QueueChannel bridgeToOutput() {
    return new QueueChannel();
}

@Bean
@BridgeTo("bridgeToOutput")
public MessageChannel bridgeToInput() {
    return new DirectChannel();
}
```

These annotations can be used as meta-annotations as well.

==== Advising Annotated Endpoints

See the section called “CompletableFuture”.

=== Message Mapping rules and conventions

Spring Integration implements a flexible facility to map Messages to Methods and their arguments without providing extra configuration by relying on some default rules as well as defining certain conventions.

==== Simple Scenarios

Single un-annotated parameter (object or primitive) which is not a Map/Properties with non-void return type;

```
public String foo(Object o);
```

Details:

Input parameter is Message Payload. If parameter type is not compatible with Message Payload an attempt will be made to convert it using Conversion Service provided by Spring 3.0. The return value will be incorporated as a Payload of the returned Message

Single un-annotated parameter (object or primitive) which is not a Map/Properties with Message return type;

```
public Message  foo(Object o);
```

Details:

Input parameter is Message Payload. If parameter type is not compatible with Message Payload an attempt will be made to convert it using Conversion Service provided by Spring 3.0. The return value is a newly constructed Message that will be sent to the next destination.

_Single parameter which is a Message or its subclass with arbitrary object/primitive return type; _

```
public int foo(Message  msg);
```

Details:

Input parameter is Message itself. The return value will become a payload of the Message that will be sent to the next destination.

Single parameter which is a Message or its subclass with Message or its subclass as a return type;

```
public Message foo(Message msg);
```

Details:

Input parameter is Message itself. The return value is a newly constructed Message that will be sent to the next destination.

Single parameter which is of type Map or Properties with Message as a return type;

```
public Message foo(Map m);
```

Details:

This one is a bit interesting. Although at first it might seem like an easy mapping straight to Message Headers, the preference is always given to a Message Payload. This means that if Message Payload is of type Map, this input argument will represent Message Payload. However if Message Payload is not of type Map, then no conversion via Conversion Service will be attempted and the input argument will be mapped to Message Headers.

Two parameters where one of them is arbitrary non-Map/Properties type object/primitive and another is Map/Properties type object (regardless of the return)

```
public Message foo(Map h, <T> t);
```

Details:

This combination contains two input parameters where one of them is of type Map. Naturally the non-Map parameters (regardless of the order) will be mapped to a Message Payload and the Map/Properties (regardless of the order) will be mapped to Message Headers giving you a nice POJO way of interacting with Message structure.

No parameters (regardless of the return)

```
public String foo();
```

Details:

This Message Handler method will be invoked based on the Message sent to the input channel this handler is hooked up to, however no Message data will be mapped, thus making Message act as event/ trigger to invoke such handlerThe output will be mapped according to the rules above

No parameters, void return

```
public void foo();
```

Details:

Same as above, but no output

Annotation based mappings

Annotation based mapping is the safest and least ambiguous approach to map Messages to Methods. There wil be many pointers to annotation based mapping throughout this manual, however here are couple of examples:

```
public String foo(@Payload String s, @Header("foo") String b)
```

Very simple and explicit way of mapping Messages to method. As you'll see later on, without an annotation this signature would result in an ambiguous condition. However by explicitly mapping the first argument to a Message Payload and the second argument to a value of the *foo* Message Header, we have avoided any ambiguity.

```
public String foo(@Payload String s, @RequestParam("foo") String b)
```

Looks almost identical to the previous example, however @RequestMapping or any other non-Spring Integration mapping annotation is irrelevant and therefore will be ignored leaving the second parameter unmapped. Although the second parameter could easily be mapped to a Payload, there can only be one Payload. Therefore this method mapping is ambiguous.

```
public String foo(String s, @Header("foo") String b)
```

The same as above. The only difference is that the first argument will be mapped to the Message Payload implicitly.

```
public String foo(@Headers Map m, @Header("foo") Map f, @Header("bar") String bar)
```

Yet another signature that would definitely be treated as ambiguous without annotations because it has more than 2 arguments. Furthermore, two of them are Maps. However, with annotation-based mapping, the ambiguity is easily avoided. In this example the first argument is mapped to all the Message Headers, while the second and third argument map to the values of Message Headers *foo* and *bar*. The payload is not being mapped to any argument.

==== Complex Scenarios

Multiple parameters:

Multiple parameters could create a lot of ambiguity with regards to determining the appropriate mappings. The general advice is to annotate your method parameters with `@Payload` and/or `@Header`/`@Headers`. Below are some of the examples of ambiguous conditions which result in an Exception being raised.

```
public String foo(String s, int i)
```

- the two parameters are equal in weight, therefore there is no way to determine which one is a payload.

```
public String foo(String s, Map m, String b)
```

- almost the same as above. Although the Map could be easily mapped to Message Headers, there is no way to determine what to do with the two Strings.

```
public String foo(Map m, Map f)
```

- although one might argue that one Map could be mapped to Message Payload and another one to Message Headers, it would be unreasonable to rely on the order (e.g., first is Payload, second Headers)

> **Tip**
>
> Basically any method signature with more than one method argument which is not (Map, <T>), and those parameters are not annotated, will result in an ambiguous condition thus triggering an Exception.

Multiple methods:

Message Handlers with multiple methods are mapped based on the same rules that are described above, however some scenarios might still look confusing.

Multiple methods (same or different name) with legal (mappable) signatures:

```
public class Foo {
    public String foo(String str, Map m);

    public String foo(Map m);
}
```

As you can see, the Message could be mapped to either method. The first method would be invoked where Message Payload could be mapped to *str* and Message Headers could be mapped to *m*. The second method could easily also be a candidate where only Message Headers are mapped to *m*. To make meters worse both methods have the same name which at first might look very ambiguous considering the following configuration:

```
<int:service-activator input-channel="input" output-channel="output" method="foo">
    <bean class="org.bar.Foo"/>
</int:service-activator>
```

At this point it would be important to understand Spring Integration mapping Conventions where at the very core, mappings are based on Payload first and everything else next. In other words the method whose argument could be mapped to a Payload will take precedence over all other methods.

On the other hand let’s look at slightly different example:

```
public class Foo {
    public String foo(String str, Map m);

    public String foo(String str);
}
```

If you look at it you can probably see a truly ambiguous condition. In this example since both methods have signatures that could be mapped to a Message Payload. They also have the same name. Such handler methods will trigger an Exception. However if the method names were different you could influence the mapping with a *method* attribute (see below):

```
public class Foo {
    public String foo(String str, Map m);

    public String bar(String str);
}
```

```
<int:service-activator input-channel="input" output-channel="output" method="bar">
    <bean class="org.bar.Foo"/>
</int:service-activator>
```

Now there is no ambiguity since the configuration explicitly maps to the *bar* method which has no name conflicts.

== Testing support

Spring Integration provides a number of utilities and annotations to help when testing your application. Test support is presented by two modules: `spring-integration-test-support` which contains core items and shared utilities, and `spring-integration-test` which provides mocking and application context configuration components for integration tests.

`spring-integration-test-support` (`spring-integration-test` in versions before *5.0*) provides basic, standalone utilities, rules and matchers for unit testing (it also has no dependencies on Spring Integration itself, and is used internally in Framework tests). `spring-integration-test` is aimed to help with integration testing and provides a comprehensive high level API to mock integration components and verify behavior of individual components, including whole integration flows or just parts thereof. A thorough treatment of testing in the enterprise is beyond the scope of this reference manual.

See the Test-Driven Development in Enterprise Integration Projects paper, by Gregor Hohpe and Wendy Istvanick, for a source of ideas and principles for testing your target integration solution.

=== Introduction

The Spring Integration Test Framework and test utilities are fully based on existing JUnit, Hamcrest and Mockito libraries. The Application Context interaction is based on the Spring Test Framework. Please, refer to the documentation for those projects for further information.

Thanks to the canonical implementation of the EIP in Spring Integration Framework and its first class citizens like `MessageChannel`, `Endpoint` and `MessageHandler` abstractions and supported out-of-the-box loose coupling principles, we can implement integration solutions of any complexity. With the Spring Integration API for the flow definitions, we can improve, modify or even replace some part of the flow without impacting (mostly) other components in the integration solution. Testing such an integration solution is still a challenge, from an *end-to-end* perspective, as well as with an *in-isolation* approach. There are several existing tools which help to test or mock some integration protocols and they work very well with Spring Integration Channel Adapters; examples include:

- Spring `MockMVC` and its `MockRestServiceServer` for HTTP;
- Some RDBMS vendors provide embedded data bases for JDBC or JPA support;
- ActiveMQ can be embedded for testing JMS or STOMP protocols;
- There are tools for embedded MongoDB and Redis;
- Tomcat and Jetty have embedded libraries to test real HTTP, Web Services or WebSockets;
- The `FtpServer` and `SshServer` from the Apache Mina project can be used for testing (S)FTP protocols;
- Gemfire and Hazelcast can be run as real data grid nodes in the tests;
- The Curator Framework provides a `TestingServer` for Zookeeper interaction;
- Apache Kafka provides admin tools to embed a Kafka Broker in the tests.

Most of these tools and libraries are used in Spring Integration tests and from the GitHub repository, in the `test` directory of each module, you can discover ideas how to build your own tests for integration solutions.

The rest of this chapter describes the testing tools and utilities provided by the Spring Integration Framework.

=== Testing Utilities

The `spring-integration-test-support` module provides utilities and helpers for unit testing.

==== TestUtils

The `TestUtils` class is mostly used for properties assertions in JUnit tests:

```
@Test
public void loadBalancerRef() {
    MessageChannel channel = channels.get("lbRefChannel");
    LoadBalancingStrategy lbStrategy = TestUtils.getPropertyValue(channel,
                 "dispatcher.loadBalancingStrategy", LoadBalancingStrategy.class);
    assertTrue(lbStrategy instanceof SampleLoadBalancingStrategy);
}
```

`TestUtils.getPropertyValue()` is based on Spring's `DirectFieldAccessor` and provides the ability to get a value from the target private property. As you see by the example above it also supports nested properties access, using dotted notation.

The `createTestApplicationContext()` factory method produce a `TestApplicationContext` instance with the supplied Spring Integration environment.

See the JavaDocs of other `TestUtils` methods for more information about this class.

==== SocketUtils

The `SocketUtils` provides several methods to select a random port(s) for exposing server-side components without conflicts:

```
<bean id="socketUtils" class="org.springframework.integration.test.util.SocketUtils" />

<int-syslog:inbound-channel-adapter id="syslog"
            channel="sysLogs"
            port="#{socketUtils.findAvailableUdpSocket(1514)}" />

<int:channel id="sysLogs">
    <int:queue/>
</int:channel>
```

Which is used from the unit test as:

```
@Autowired @Qualifier("syslog.adapter")
private UdpSyslogReceivingChannelAdapter adapter;

@Autowired
private PollableChannel sysLogs;
...
@Test
public void testSimplestUdp() throws Exception {
    int port = TestUtils.getPropertyValue(adapter1, "udpAdapter.port", Integer.class);
    byte[] buf = "<157>JUL 26 22:08:35 WEBERN TESTING[70729]: TEST SYSLOG MESSAGE".getBytes("UTF-8");
    DatagramPacket packet = new DatagramPacket(buf, buf.length,
                          new InetSocketAddress("localhost", port));
    DatagramSocket socket = new DatagramSocket();
    socket.send(packet);
    socket.close();
    Message<?> message = foo.receive(10000);
    assertNotNull(message);
}
```

Note

This tecnique is not foolproof; some other process could be allocated the "free" port before your test opens it. It is generally more preferable to use a server port `0` and let the operating system select the port for you, then discover the selected port in your test. We have converted most framework tests to use this preferred technique.

==== OnlyOnceTrigger

The `OnlyOnceTrigger` is useful for polling endpoints when it is good to produce only one test message and verify the behavior without impacting of unexpected other period messages:

```
<bean id="testTrigger" class="org.springframework.integration.test.util.OnlyOnceTrigger" />

<int:poller id="jpaPoller" trigger="testTrigger">
    <int:transactional transaction-manager="transactionManager" />
</int:poller>
```

```
@Autowired
@Qualifier("jpaPoller")
PollerMetadata poller;

@Autowired
OnlyOnceTrigger testTrigger;
...
@Test
@DirtiesContext
public void testWithEntityClass() throws Exception {
    this.testTrigger.reset();
    ...
    JpaPollingChannelAdapter jpaPollingChannelAdapter = new JpaPollingChannelAdapter(jpaExecutor);

    SourcePollingChannelAdapter adapter = JpaTestUtils.getSourcePollingChannelAdapter(
      jpaPollingChannelAdapter, this.outputChannel, this.poller, this.context,
      this.getClass().getClassLoader());
    adapter.start();
    ...
}
```

==== Support Components

The `org.springframework.integration.test.support` package contains various abstract classes which should be implemented in target tests. See their JavaDocs for more information.

==== Hamcrest and Mockito Matchers

The `org.springframework.integration.test.matcher` package contains several `Matcher` implementations to assert `Message` and its properties in unit tests:

```
import static org.springframework.integration.test.matcher.PayloadMatcher.hasPayload;
...
@Test
public void transform_withFilePayload_convertedToByteArray() throws Exception {
    Message<?> result = this.transformer.transform(message);
    assertThat(result, is(notNullValue()));
    assertThat(result, hasPayload(is(instanceOf(byte[].class))));
    assertThat(result, hasPayload(SAMPLE_CONTENT.getBytes(DEFAULT_ENCODING)));
}
```

The `MockitoMessageMatchers` factory can be used for mocks stubbing and verifications:

```
static final Date SOME_PAYLOAD = new Date();

static final String SOME_HEADER_VALUE = "bar";

static final String SOME_HEADER_KEY = "test.foo";
...
Message<?> message = MessageBuilder.withPayload(SOME_PAYLOAD)
                .setHeader(SOME_HEADER_KEY, SOME_HEADER_VALUE)
                .build();
MessageHandler handler = mock(MessageHandler.class);
handler.handleMessage(message);
verify(handler).handleMessage(messageWithPayload(SOME_PAYLOAD));
verify(handler).handleMessage(messageWithPayload(is(instanceOf(Date.class))));
...
MessageChannel channel = mock(MessageChannel.class);
when(channel.send(messageWithHeaderEntry(SOME_HEADER_KEY, is(instanceOf(Short.class)))))
        .thenReturn(true);
assertThat(channel.send(message), is(false));
```

Additional utilities will eventually be added or migrated. For example `RemoteFileTestSupport` implementations for the (S)FTP tests can be moved from the `test` directory of those particular modules to this `spring-integration-test-support` artifact.

=== Spring Integration and test context

Typically, tests for Spring applications use the Spring Test Framework and since Spring Integration is based on the Spring Framework foundation, everything we can do with the Spring Test Framework is applied as well when testing integration flows. The `org.springframework.integration.test.context` package provides some components for enhancing the test context for integration needs. First of all we configure our test class with a `@SpringIntegrationTest` annotation to enable the Spring Integration Test Framework:

```
@RunWith(SpringRunner.class)
@SpringIntegrationTest(noAutoStartup = {"inboundChannelAdapter", "*Source*"})
public class MyIntegrationTests {

    @Autowired
    private MockIntegrationContext mockIntegrationContext;

}
```

The `@SpringIntegrationTest` annotation populates a `MockIntegrationContext` bean which can be autowired to the test class to access its methods. With the provided `noAutoStartup` option, the Spring Integration Test Framework prevents endpoints that are normally `autoStartup=true` from starting. The endpoints are matched to the provided patterns, which support the following simple pattern styles: `xxx*`, `*xxx`, `*xxx*` and `xxx*yyy`.

This is useful, when we would like to not have real connections to the target systems from Inbound Channel Adapters, for example an AMQP Inbound Gateway, JDBC Polling Channel Adapter, WebSocket Message Producer in client mode etc.

The `MockIntegrationContext` is aimed to be used in the target test-cases for modifications to beans in the real application context, for example those endpoints that have `autoStartup` overridden to false can be replaced with mocks:

```
@Test
public void testMockMessageSource() {
    MessageSource<String> messageSource = () -> new GenericMessage<>("foo");

    this.mockIntegrationContext.substituteMessageSourceFor("mySourceEndpoint", messageSource);

    Message<?> receive = this.results.receive(10_000);
    assertNotNull(receive);
}
```

Note

The `mySourceEndpoint` refers here to the bean name of the `SourcePollingChannelAdapter` for which we replace the real `MessageSource` with our mock. Similarly the `MockIntegrationContext.substituteMessageHandlerFor()` expects a bean name for the `IntegrationConsumer`, which wraps a `MessageHandler` as an endpoint.

After test is performed you can restore the state of endpoint beans to the real configuration using `MockIntegrationContext.resetBeans()`:

```
@After
public void tearDown() {
    this.mockIntegrationContext.resetBeans();
}
```

See the Javadoc for more information.

=== Integration Mocks

The `org.springframework.integration.test.mock` package offers tools and utilities for mocking, stubbing, and verification of activity on Spring Integration components. The mocking functionality is fully based on and compatible with the well known Mockito Framework. (The current Mockito transitive dependency is on version 2.5.x or higher.)

==== MockIntegration

The `MockIntegration` factory provides an API to build mocks for Spring Integration beans which are parts of the integration flow - `MessageSource`, `MessageProducer`, `MessageHandler`, `MessageChannel`. The target mocks can be used during configuration phase:

```
<int:inbound-channel-adapter id="inboundChannelAdapter" channel="results">
    <bean class="org.springframework.integration.test.mock.MockIntegration" factory-
method="mockMessageSource">
        <constructor-arg value="a"/>
        <constructor-arg>
            <array>
                <value>b</value>
                <value>c</value>
            </array>
        </constructor-arg>
    </bean>
</int:inbound-channel-adapter>
```

```
@InboundChannelAdapter(channel = "results")
@Bean
public MessageSource<Integer> testingMessageSource() {
    return MockIntegration.mockMessageSource(1, 2, 3);
}
...
StandardIntegrationFlow flow = IntegrationFlows
        .from(MockIntegration.mockMessageSource("foo", "bar", "baz"))
        .<String, String>transform(String::toUpperCase)
        .channel(out)
        .get();
IntegrationFlowRegistration registration = this.integrationFlowContext.registration(flow)
        .register();
```

as well as in the target test method to replace the real endpoints before performing verifications and assertions. For this purpose, the aforementioned `MockIntegrationContext` should be used from the test:

```
this.mockIntegrationContext.substituteMessageSourceFor("mySourceEndpoint",
        MockIntegration.mockMessageSource("foo", "bar", "baz"));
Message<?> receive = this.results.receive(10_000);
assertNotNull(receive);
assertEquals("FOO", receive.getPayload());
```

Unlike the Mockito `MessageSource` mock object, the `MockMessageHandler` is just a regular `AbstractMessageProducingHandler` extension with a chain API to stub handling for incoming messages. The `MockMessageHandler` provides `handleNext(Consumer<Message<?>>)` to specify a one-way stub for the next request message; used to mock message handlers that don't produce replies. The `handleNextAndReply(Function<Message<?>, ?>)` is provided for performing the same stub logic for the next request message and producing a reply for it. They can be chained to simulate any arbitrary request-reply scenarios for all expected request messages variants. These consumers and functions are applied to the incoming messages, one at a time from the stack, until the last, which is then used for all remaining messages. The behavior is similar to the Mockito `Answer` or `doReturn()` API.

In addition, a Mockito `ArgumentCaptor<Message<?>>` can be supplied to the `MockMessageHandler` in a constructor argument. Each request message for the `MockMessageHandler` is captured by that `ArgumentCaptor`. During the test, its `getValue()/ getAllValues()` can be used to verify and assert those request messages.

The `MockIntegrationContext` provides an `substituteMessageHandlerFor()` API for replacing the actual configured `MessageHandler` with a `MockMessageHandler`, in the particular endpoint in the application context under test.

A typical usage might be:

```
ArgumentCaptor<Message<?>> messageArgumentCaptor = ArgumentCaptor.forClass(Message.class);

MessageHandler mockMessageHandler =
        mockMessageHandler(messageArgumentCaptor)
                .handleNextAndReply(m -> m.getPayload().toString().toUpperCase());

this.mockIntegrationContext.substituteMessageHandlerFor("myService.serviceActivator",
                               mockMessageHandler);
GenericMessage<String> message = new GenericMessage<>("foo");
this.myChannel.send(message);
Message<?> received = this.results.receive(10000);
assertNotNull(received);
assertEquals("FOO", received.getPayload());
assertSame(message, messageArgumentCaptor.getValue());
```

See `MockIntegration` and `MockMessageHandler` JavaDocs for more information.

=== Other Resources

As well as exploring the test cases in the framework itself, the spring-integration-samples repository has some sample apps specifically around testing, such as `testing-examples` and `advanced-testing-examples`. In some cases, the samples themselves have comprehensive end-to-end tests, such as the `file-split-ftp` sample.

== Spring Integration Samples

=== Introduction

As of Spring Integration 2.0, the *samples* are no longer included with the Spring Integration distribution. Instead we have switched to a much simpler collaborative model that should promote better community participation and, ideally, more contributions. Samples now have a dedicated Git repository and a dedicated JIRA Issue Tracking system. Sample development will also have its own lifecycle which is not dependent on the lifecycle of the framework releases, although the repository will still be tagged with each major release for compatibility reasons.

The great benefit to the community is that we can now add more samples and make them available to you right away without waiting for the next release. Having its own JIRA that is not tied to the the actual framework is also a great benefit. You now have a dedicated place to suggest samples as well as report issues with existing samples. Or, _ you may want to submit a sample to us_ as an attachment through the JIRA or, better, through the collaborative model that Git promotes. If we believe your sample adds value, we would be more then glad to add it to the *samples* repository, properly crediting you as the author.

=== Where to get Samples

The Spring Integration Samples project is hosted on GitHub. You can find the repository at:

https://github.com/SpringSource/spring-integration-samples

In order to check out or *clone* (Git parlance) the samples, please make sure you have a Git client installed on your system. There are several GUI-based products available for many platforms, e.g. EGit for the Eclipse IDE. A simple Google search will help you find them. Of course you can also just use the command line interface for <https://git-scm.com/,Git>.

Note

If you need more information on how to install and/or use Git, please visit: https://git-scm.com/.

In order to checkout (clone in Git terms) the Spring Integration samples repository using the Git command line tool, issue the following commands:

```
$ git clone https://github.com/SpringSource/spring-integration-samples.git
```

That is all you need to do in order to clone the entire samples repository into a directory named *spring-integration-samples* within the working directory where you issued that *git* command. Since the samples repository is a live repository, you might want to perform periodic *pulls* (updates) to get new samples, as well as updates to the existing samples. In order to do so issue the following git *pull* command:

```
$ git pull
```

=== Submitting Samples or Sample Requests

How can I contribute my own Samples?

Github is for social coding: if you want to submit your own code examples to the Spring Integration Samples project, we encourage contributions through *pull requests* from *forks* of this repository. If you want to contribute code this way, please reference, if possible, ahttps://jira.springframework.org/browse/INTSAMPLES[*JIRA Ticket*] that provides some details regarding the provided sample.

Sign the contributor license agreement

Very important: before we can accept your Spring Integration sample, we will need you to sign the SpringSource contributor license agreement (CLA). Signing the contributor's agreement does not grant anyone commit rights to the main repository, but it does mean that we can accept your contributions, and you will get an author credit if we do. In order to read and sign the CLA, please go to:

https://support.springsource.com/spring_committer_signup

From the Project drop down, please select *Spring Integration*. The Project Lead is *Gary Russell*.

Code Contribution Process

For the actual code contribution process, please read the the *Contributor Guidelines* for Spring Integration, they apply for this project as well:

https://github.com/spring-projects/spring-integration/blob/master/CONTRIBUTING.md

This process ensures that every commit gets peer-reviewed. As a matter of fact, the core committers follow the exact same rules. We are gratefully looking forward to your Spring Integration Samples!

Sample Requests

As mentioned earlier, the *Spring Integration Samples* project has a dedicated JIRA Issue tracking system. To submit new sample requests, please visit our JIRA Issue Tracking system:

https://jira.springframework.org/browse/INTSAMPLES.

=== Samples Structure

Starting with Spring Integration 2.0, the structure of the *samples* changed as well. With plans for more samples we realized that some samples have different goals than others. While they all share the common goal of showing you how to apply and work with the Spring Integration framework, they also differ in areas where some samples are meant to concentrate on a technical use case while others focus on a business use case, and some samples are all about showcasing various techniques that could be applied to address certain scenarios (both technical and business). The new categorization of samples will allow us to better organize them based on the problem each sample addresses while giving you a simpler way of finding the right sample for your needs.

Currently there are 4 categories. Within the samples repository each category has its own directory which is named after the category name:

BASIC (samples/basic)

This is a good place to get started. The samples here are technically motivated and demonstrate the bare minimum with regard to configuration and code. These should help you to get started quickly by introducing you to the basic concepts, API and configuration of Spring Integration as well as Enterprise Integration Patterns (EIP). For example, if you are looking for an answer on how to implement and wire a *Service Activator* to a *Message Channel* or how to use a *Messaging Gateway* as a facade to your message exchange, or how to get started with using MAIL or TCP/UDP modules etc., this would be the right place to find a good sample. The bottom line is this is a good place to get started.

INTERMEDIATE (samples/intermediate)

This category targets developers who are already familiar with the Spring Integration framework (past getting started), but need some more guidance while resolving the more advanced technical problems one might deal with after switching to a Messaging architecture. For example, if you are looking for an answer on how to handle errors in various message exchange scenarios or how to properly configure the *Aggregator* for the situations where some messages might not ever arrive for aggregation, or any other issue that goes beyond a basic implementation and configuration of a particular component and addresses *what else* types of problems, this would be the right place to find these type of samples.

ADVANCED (samples/advanced)

This category targets developers who are very familiar with the Spring Integration framework but are looking to extend it to address a specific custom need by using Spring Integration's public API. For example, if you are looking for samples showing you how to implement a custom *Channel* or *Consumer* (event-based or polling-based), or you are trying to figure out what is the most appropriate way to implement a custom Bean parser on top of the Spring Integration Bean parser hierarchy when implementing your own namespace and schema for a custom component, this would be the right place to look. Here you can also find samples that will help you with *Adapter* development. Spring Integration comes with an extensive library of adapters to allow you to connect remote systems with the Spring Integration messaging framework. However you might have a need to integrate with a system for which the core framework does not provide an adapter. So, you may decide to implement your own (and potentially contribute it). This category would include samples showing you how.

APPLICATIONS (samples/applications)

This category targets developers and architects who have a good understanding of Message-driven architecture and EIP, and an above average understanding of Spring and Spring Integration who are looking for samples that address a particular *business problem*. In other words the emphasis of samples in this category is *business use cases* and how they can be solved with a Message-Driven Architecture and Spring Integration in particular. For example, if you are interested to see how a *Loan Broker* or *Travel Agent* process could be implemented and automated via Spring Integration, this would be the right place to find these types of samples.

> **Important**
>
> Remember: Spring Integration is a community driven framework, therefore community participation is IMPORTANT. That includes Samples; so, if you can't find what you are looking for, let us know!

=== Samples

Currently Spring Integration comes with quite a few samples and you can only expect more. To help you better navigate through them, each sample comes with its own `readme.txt` file which covers several details about the sample (e.g., what EIP patterns it addresses, what problem it is trying to solve, how to run sample etc.). However, certain samples require a more detailed and sometimes graphical explanation. In this section you'll find details on samples that we believe require special attention.

==== Loan Broker

In this section, we will review the *Loan Broker* sample application that is included in the Spring Integration samples. This sample is inspired by one of the samples featured in Gregor Hohpe and Bobby Woolf's book, [Enterprise Integration Patterns].

The diagram below represents the entire process

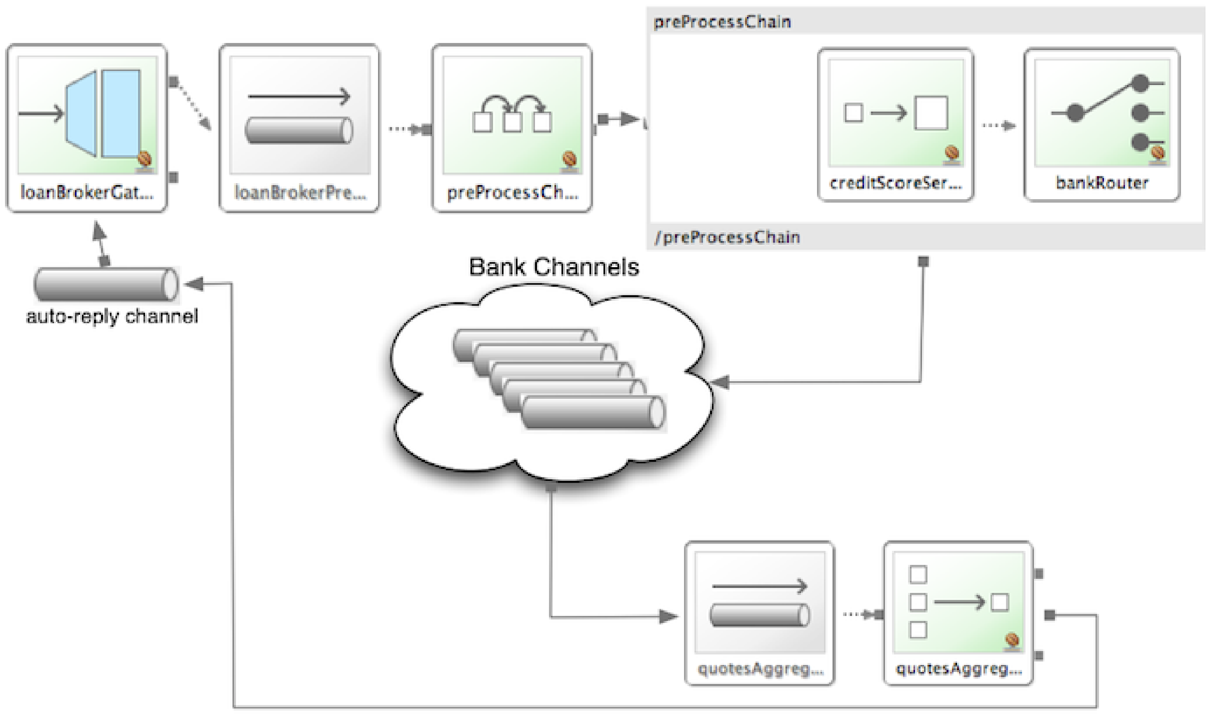

Figure 8.3. Loan Broker Sample

Now lets look at this process in more detail

At the core of an EIP architecture are the very simple yet powerful concepts of Pipes and Filters, and of course: Messages. Endpoints (Filters) are connected with one another via Channels (Pipes). The producing endpoint sends Message to the Channel, and the Message is retrieved by the Consuming endpoint. This architecture is meant to define various mechanisms that describe HOW information is exchanged between the endpoints, without any awareness of WHAT those endpoints are or what information they are exchanging. Thus, it provides for a very loosely coupled and flexible collaboration model while also decoupling Integration concerns from Business concerns. EIP extends this architecture by further defining:

- The types of pipes (Point-to-Point Channel, Publish-Subscribe Channel, Channel Adapter, etc.)
- The core filters and patterns around how filters collaborate with pipes (Message Router, Splitters and Aggregators, various Message Transformation patterns, etc.)

The details and variations of this use case are very nicely described in Chapter 9 of the EIP Book, but here is the brief summary; A Consumer while shopping for the best Loan Quote(s) subscribes to the services of a Loan Broker, which handles details such as:

- Consumer pre-screening (e.g., obtain and review the consumer’s Credit history)
- Determine the most appropriate Banks (e.g., based on consumer’s credit history/score)
- Send a Loan quote request to each selected Bank
- Collect responses from each Bank
- Filter responses and determine the best quote(s), based on consumer’s requirements.
- Pass the Loan quote(s) back to the consumer.

Obviously the real process of obtaining a loan quote is a bit more complex, but since our goal here is to demonstrate how Enterprise Integration Patterns are realized and implemented within SI, the use case has been simplified to concentrate only on the Integration aspects of the process. It is not an attempt to give you an advice in consumer finances.

As you can see, by hiring a Loan Broker, the consumer is isolated from the details of the Loan Broker's operations, and each Loan Broker's operations may defer from one another to maintain competitive advantage, so whatever we assemble/implement must be flexible so any changes could be introduced quickly and painlessly. Speaking of change, the Loan Broker sample does not actually talk to any *imaginary* Banks or Credit bureaus. Those services are stubbed out. Our goal here is to assemble, orchestrate and test the integration aspect of the process as a whole. Only then can we start thinking about wiring such process to the real services. At that time the assembled process and its configuration will not change regardless of the number of Banks a particular Loan Broker is dealing with, or the type of communication media (or protocols) used (JMS, WS, TCP, etc.) to communicate with these Banks.

DESIGN

As you analyze the 6 requirements above you'll quickly see that they all fall into the category of Integration concerns. For example, in the consumer pre-screening step we need to gather additional information about the consumer and the consumer's desires and enrich the loan request with additional meta information. We then have to filter such information to select the most appropriate list of Banks, and so on. Enrich, filter, select – these are all integration concerns for which EIP defines a solution in the form of patterns. SI provides an implementation of these patterns.

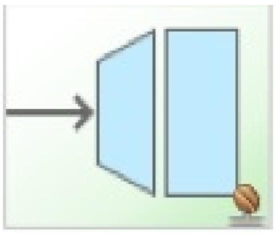

Figure 8.4. Messaging Gateway

The *Messaging Gateway* pattern provides a simple mechanism to access messaging systems, including our Loan Broker. In SI you define the *Gateway* as a Plain Old Java Interface (no need to provide an implementation), configure it via the XML <*gateway*> element or via annotation and use it as any other Spring bean. SI will take care of delegating and mapping method invocations to the Messaging infrastructure by generating a *Message* (payload is mapped to an input parameter of the method) and sending it to the designated channel.

```
<int:gateway id="loanBrokerGateway"
  default-request-channel="loanBrokerPreProcessingChannel"
  service-interface="org.springframework.integration.samples.loanbroker.LoanBrokerGateway">
  <int:method name="getBestLoanQuote">
    <int:header name="RESPONSE_TYPE" value="BEST"/>
  </int:method>
</int:gateway>
```

Our current *Gateway* provides two methods that could be invoked. One that will return the best single quote and another one that will return all quotes. Somehow downstream we need to know what type of reply the caller is looking for. The best way to achieve this in Messaging architecture is to enrich the content of the message with some meta-data describing your intentions. *Content Enricher* is one of the patterns that addresses this and although Spring Integration does provide a separate configuration element to enrich Message Headers with arbitrary data (we'll see it later), as a convenience, since_Gateway_ element is responsible to construct the initial *Message* it provides embedded capability to enrich the newly created *Message* with arbitrary *Message Headers*. In our example we are adding header RESPONSE_TYPE with value *BEST*' whenever the getBestQuote() method is invoked. For other method we are not adding any header. Now we can check downstream for an existence of this header and based on its presence and its value we can determine what type of reply the caller is looking for.

Based on the use case we also know there are some pre-screening steps that needs to be performed such as getting and evaluating the consumer's credit score, simply because some premiere Banks will only typically accept quote requests from consumers that meet a minimum credit score requirement. So it would be nice if the *Message* would be enriched with such information before it is forwarded to the Banks. It would also be nice if when several processes needs to be completed to provide such meta-information, those processes could be grouped in a single unit. In our use case we need to determine credit score and based on the credit score and some rule select a list of *Message Channels* (Bank Channels) we will sent quote request to.

Composed Message Processor

The *Composed Message Processor* pattern describes rules around building endpoints that maintain control over message flow which consists of multiple message processors. In Spring Integration *Composed Message Processor* pattern is implemented via <*chain*> element.

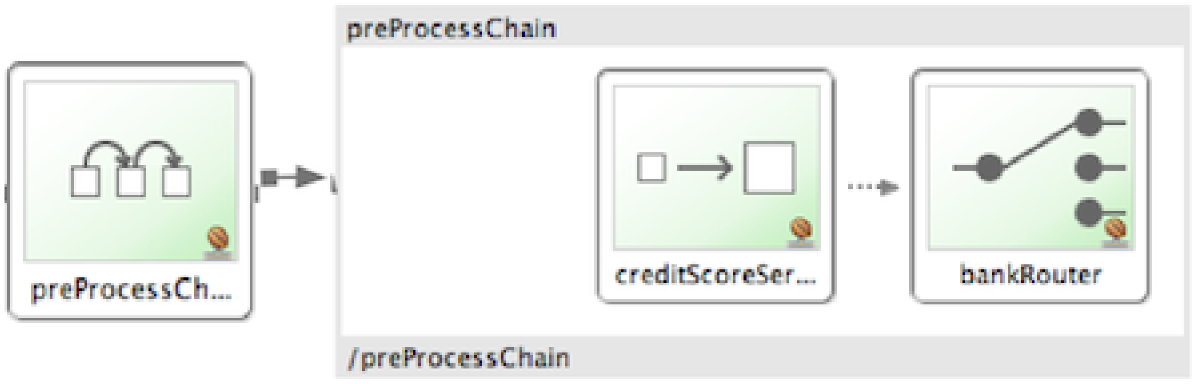

Figure 8.5. Chain

As you can see from the above configuration we have a chain with inner header-enricher element which will further enrich the content of the *Message* with the header CREDIT_SCORE and value that will be determined by the call to a credit service (simple POJO spring bean identified by *creditBureau* name) and then it will delegate to the *Message Router*

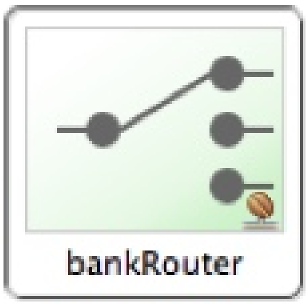

Figure 8.6. Message Router

There are several implementations of the *Message Routing* pattern available in Spring Integration. Here we are using a router that will determine a list of channels based on evaluating an expression (Spring Expression Language) which will look at the credit score that was determined is the previous step and will select the list of channels from the Map bean with id *banks* whose values are *premier* or *secondary* based o the value of credit score. Once the list of *Channels* is selected, the *Message* will be routed to those *Channels*.

Now, one last thing the Loan Broker needs to to is to receive the loan quotes form the banks, aggregate them by consumer (we don't want to show quotes from one consumer to another), assemble the response based on the consumer's selection criteria (single best quote or all quotes) and reply back to the consumer.

Figure 8.7. Message Aggregator

An *Aggregator* pattern describes an endpoint which groups related *Messages* into a single *Message*. Criteria and rules can be provided to determine an aggregation and correlation strategy. SI provides several implementations of the *Aggregator* pattern as well as a convenient name-space based configuration.

```
<int:aggregator id="quotesAggregator"
      input-channel="quotesAggregationChannel"
      method="aggregateQuotes">
  <beans:bean class="org.springframework.integration.samples.loanbroker.LoanQuoteAggregator"/>
</int:aggregator>
```

Our Loan Broker defines a *quotesAggregator* bean via the *<aggregator>* element which provides a default aggregation and correlation strategy. The default correlation strategy correlates messages based on the `correlationId` header (see *Correlation Identifier* pattern). What's interesting is that we never provided the value for this header. It was set earlier by the router automatically, when it generated a separate *Message* for each Bank channel.

Once the *Messages* are correlated they are released to the actual *Aggregator* implementation. Although default *Aggregator* is provided by SI, its strategy (gather the list of payloads from all *Messages* and construct a new *Message* with this List as payload) does not satisfy our requirement. The reason is that our consumer might require a single best quote or all quotes. To communicate the consumer's intention, earlier in the process we set the RESPONSE_TYPE header. Now we have to evaluate this header and return either all the quotes (the default aggregation strategy would work) or the best quote (the default aggregation strategy will not work because we have to determine which loan quote is the best).

Obviously selecting the best quote could be based on complex criteria and would influence the complexity of the aggregator implementation and configuration, but for now we are making it simple. If consumer wants the best quote we will select a quote with the lowest interest rate. To accomplish that the LoanQuoteAggregator.java will sort all the quotes and return the first one. The `LoanQuote.java` implements `Comparable` which compares quotes based on the rate attribute. Once the response

Message is created it is sent to the default-reply-channel of the *Messaging Gateway* (thus the consumer) which started the process. Our consumer got the Loan Quote!

Conclusion

As you can see a rather complex process was assembled based on POJO (read existing, legacy), light weight, embeddable messaging framework (Spring Integration) with a loosely coupled programming model intended to simplify integration of heterogeneous systems without requiring a heavy-weight ESB-like engine or proprietary development and deployment environment, because as a developer you should not be porting your Swing or console-based application to an ESB-like server or implementing proprietary interfaces just because you have an integration concern.

This and other samples in this section are built on top of Enterprise Integration Patterns and can be considered "building blocks" for YOUR solution; they are not intended to be complete solutions. Integration concerns exist in all types of application (whether server based or not). It should not require change in design, testing and deployment strategy if such applications need to be integrated.

==== The Cafe Sample

In this section, we will review a *Cafe* sample application that is included in the Spring Integration samples. This sample is inspired by another sample featured in Gregor Hohpe's https://www.enterpriseintegrationpatterns.com/ramblings.html[Ramblings].

The domain is that of a Cafe, and the basic flow is depicted in the following diagram:

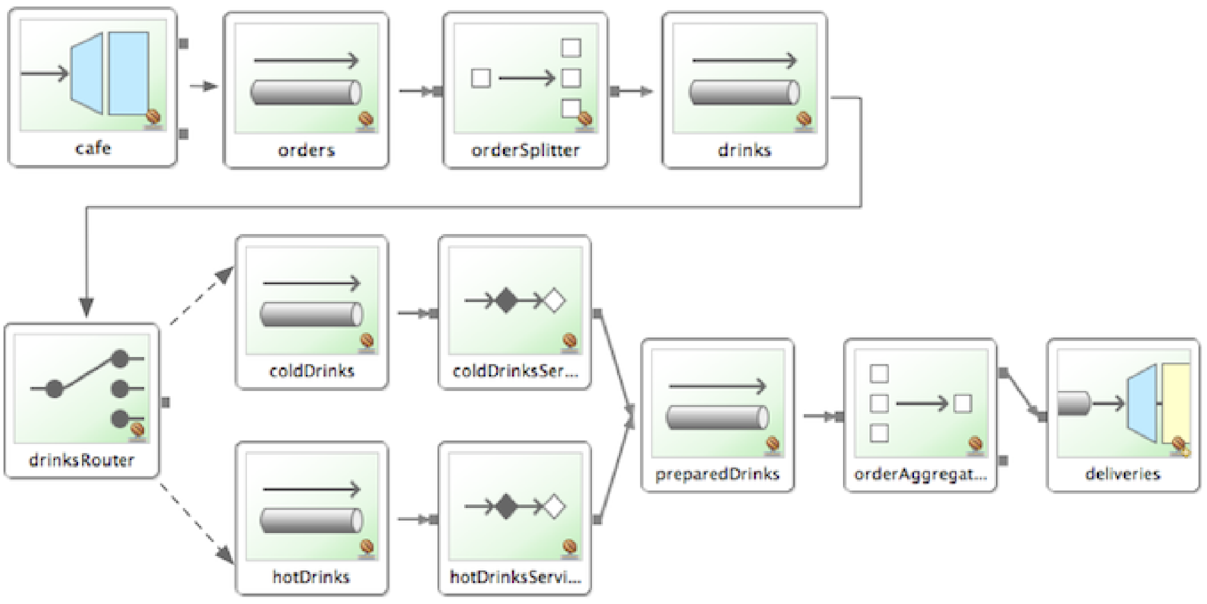

Figure 8.8. Cafe Sample

The `Order` object may contain multiple `OrderItems`. Once the order is placed, a *Splitter* will break the composite order message into a single message per drink. Each of these is then processed by a *Router* that determines whether the drink is hot or cold (checking the `OrderItem` object's *isIced* property). The `Barista` prepares each drink, but hot and cold drink preparation are handled by two distinct methods: *prepareHotDrink* and *prepareColdDrink*. The prepared drinks are then sent to the Waiter where they are aggregated into a `Delivery` object.

Here is the XML configuration:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans:beans xmlns:int="http://www.springframework.org/schema/integration"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:beans="http://www.springframework.org/schema/beans"
 xmlns:int-stream="http://www.springframework.org/schema/integration/stream"
 xsi:schemaLocation="http://www.springframework.org/schema/beans
  https://www.springframework.org/schema/beans/spring-beans.xsd
  http://www.springframework.org/schema/integration
  https://www.springframework.org/schema/integration/spring-integration.xsd
  http://www.springframework.org/schema/integration/stream
  https://www.springframework.org/schema/integration/stream/spring-integration-stream.xsd">

    <int:gateway id="cafe" service-interface="o.s.i.samples.cafe.Cafe"/>

    <int:channel  id="orders"/>
    <int:splitter input-channel="orders" ref="orderSplitter"
                  method="split" output-channel="drinks"/>

    <int:channel id="drinks"/>
    <int:router  input-channel="drinks"
                 ref="drinkRouter" method="resolveOrderItemChannel"/>

    <int:channel id="coldDrinks"><int:queue capacity="10"/></int:channel>
    <int:service-activator input-channel="coldDrinks" ref="barista"
                           method="prepareColdDrink" output-channel="preparedDrinks"/>

    <int:channel id="hotDrinks"><int:queue capacity="10"/></int:channel>
    <int:service-activator input-channel="hotDrinks" ref="barista"
                           method="prepareHotDrink" output-channel="preparedDrinks"/>

    <int:channel id="preparedDrinks"/>
    <int:aggregator input-channel="preparedDrinks" ref="waiter"
                    method="prepareDelivery" output-channel="deliveries"/>

    <int-stream:stdout-channel-adapter id="deliveries"/>

    <beans:bean id="orderSplitter"
                class="org.springframework.integration.samples.cafe.xml.OrderSplitter"/>

    <beans:bean id="drinkRouter"
                class="org.springframework.integration.samples.cafe.xml.DrinkRouter"/>

    <beans:bean id="barista" class="o.s.i.samples.cafe.xml.Barista"/>
    <beans:bean id="waiter"  class="o.s.i.samples.cafe.xml.Waiter"/>

    <int:poller id="poller" default="true" fixed-rate="1000"/>

</beans:beans>
```

As you can see, each Message Endpoint is connected to input and/or output channels. Each endpoint will manage its own Lifecycle (by default endpoints start automatically upon initialization - to prevent that add the "auto-startup" attribute with a value of "false"). Most importantly, notice that the objects are simple POJOs with strongly typed method arguments. For example, here is the Splitter:

```
public class OrderSplitter {
    public List<OrderItem> split(Order order) {
        return order.getItems();
    }
}
```

In the case of the Router, the return value does not have to be a `MessageChannel` instance (although it can be). As you see in this example, a String-value representing the channel name is returned instead.

```
public class DrinkRouter {
    public String resolveOrderItemChannel(OrderItem orderItem) {
        return (orderItem.isIced()) ? "coldDrinks" : "hotDrinks";
    }
}
```

Now turning back to the XML, you see that there are two <service-activator> elements. Each of these is delegating to the same `Barista` instance but different methods: *prepareHotDrink* or *prepareColdDrink* corresponding to the two channels where order items have been routed.

```
public class Barista {

    private long hotDrinkDelay = 5000;
    private long coldDrinkDelay = 1000;

    private AtomicInteger hotDrinkCounter = new AtomicInteger();
    private AtomicInteger coldDrinkCounter = new AtomicInteger();

    public void setHotDrinkDelay(long hotDrinkDelay) {
        this.hotDrinkDelay = hotDrinkDelay;
    }

    public void setColdDrinkDelay(long coldDrinkDelay) {
        this.coldDrinkDelay = coldDrinkDelay;
    }

    public Drink prepareHotDrink(OrderItem orderItem) {
        try {
            Thread.sleep(this.hotDrinkDelay);
            System.out.println(Thread.currentThread().getName()
                    + " prepared hot drink #" + hotDrinkCounter.incrementAndGet()
                    + " for order #" + orderItem.getOrder().getNumber()
                    + ": " + orderItem);
            return new Drink(orderItem.getOrder().getNumber(), orderItem.getDrinkType(),
                    orderItem.isIced(), orderItem.getShots());
        }
        catch (InterruptedException e) {
            Thread.currentThread().interrupt();
            return null;
        }
    }

    public Drink prepareColdDrink(OrderItem orderItem) {
        try {
            Thread.sleep(this.coldDrinkDelay);
            System.out.println(Thread.currentThread().getName()
                    + " prepared cold drink #" + coldDrinkCounter.incrementAndGet()
                    + " for order #" + orderItem.getOrder().getNumber() + ": "
                    + orderItem);
            return new Drink(orderItem.getOrder().getNumber(), orderItem.getDrinkType(),
                    orderItem.isIced(), orderItem.getShots());
        }
        catch (InterruptedException e) {
            Thread.currentThread().interrupt();
            return null;
        }
    }
}
```

As you can see from the code excerpt above, the barista methods have different delays (the hot drinks take 5 times as long to prepare). This simulates work being completed at different rates. When the `CafeDemo` *main* method runs, it will loop 100 times sending a single hot drink and a single cold drink each time. It actually sends the messages by invoking the *placeOrder* method on the Cafe interface. Above, you will see that the <gateway> element is specified in the configuration file. This triggers the creation of a proxy that implements the given *service-interface* and connects it to a channel. The channel name is provided on the @Gateway annotation of the `Cafe` interface.

```
public interface Cafe {

    @Gateway(requestChannel="orders")
    void placeOrder(Order order);

}
```

Finally, have a look at the `main()` method of the `CafeDemo` itself.

```
public static void main(String[] args) {
    AbstractApplicationContext context = null;
    if (args.length > 0) {
        context = new FileSystemXmlApplicationContext(args);
    }
    else {
        context = new ClassPathXmlApplicationContext("cafeDemo.xml", CafeDemo.class);
    }
    Cafe cafe = context.getBean("cafe", Cafe.class);
    for (int i = 1; i <= 100; i++) {
        Order order = new Order(i);
        order.addItem(DrinkType.LATTE, 2, false);
        order.addItem(DrinkType.MOCHA, 3, true);
        cafe.placeOrder(order);
    }
}
```

Tip

To run this sample as well as 8 others, refer to the `README.txt` within the "samples" directory of the main distribution as described at the beginning of this chapter.

When you run cafeDemo, you will see that the cold drinks are initially prepared more quickly than the hot drinks. Because there is an aggregator, the cold drinks are effectively limited by the rate of the hot drink preparation. This is to be expected based on their respective delays of 1000 and 5000 milliseconds. However, by configuring a poller with a concurrent task executor, you can dramatically change the results. For example, you could use a thread pool executor with 5 workers for the hot drink barista while keeping the cold drink barista as it is:

```
<int:service-activator input-channel="hotDrinks"
                     ref="barista"
                     method="prepareHotDrink"
                     output-channel="preparedDrinks"/>

  <int:service-activator input-channel="hotDrinks"
                     ref="barista"
                     method="prepareHotDrink"
                     output-channel="preparedDrinks">
      <int:poller task-executor="pool" fixed-rate="1000"/>
  </int:service-activator>

  <task:executor id="pool" pool-size="5"/>
```

Also, notice that the worker thread name is displayed with each invocation. You will see that the hot drinks are prepared by the task-executor threads. If you provide a much shorter poller interval (such as 100 milliseconds), then you will notice that occasionally it throttles the input by forcing the task-scheduler (the caller) to invoke the operation.

Note

In addition to experimenting with the poller's concurrency settings, you can also add the *transactional* sub-element and then refer to any PlatformTransactionManager instance within the context.

==== The XML Messaging Sample

The xml messaging sample in `basic/xml` illustrates how to use some of the provided components which deal with xml payloads. The sample uses the idea of processing an order for books represented as xml.

NOTE:This sample shows that the namespace prefix can be whatever you want; while we usually use, `int-xml` for integration XML components, the sample uses `si-xml`.

First the order is split into a number of messages, each one representing a single order item using the XPath splitter component.

```
<si-xml:xpath-splitter id="orderItemSplitter" input-channel="ordersChannel"
              output-channel="stockCheckerChannel" create-documents="true">
      <si-xml:xpath-expression expression="/orderNs:order/orderNs:orderItem"
                                namespace-map="orderNamespaceMap" />
  </si-xml:xpath-splitter>
```

A service activator is then used to pass the message into a stock checker POJO. The order item document is enriched with information from the stock checker about order item stock level. This enriched order item message is then used to route the message. In the case where the order item is in stock the message is routed to the warehouse.

```
<si-xml:xpath-router id="instockRouter" input-channel="orderRoutingChannel" resolution-required="true">
    <si-xml:xpath-expression expression="/orderNs:orderItem/@in-stock" namespace-map="orderNamespaceMap"
 />
    <si-xml:mapping value="true" channel="warehouseDispatchChannel"/>
    <si-xml:mapping value="false" channel="outOfStockChannel"/>
</si-xml:xpath-router>
```

Where the order item is not in stock the message is transformed using xslt into a format suitable for sending to the supplier.

```
<si-xml:xslt-transformer input-channel="outOfStockChannel"
  output-channel="resupplyOrderChannel"
  xsl-resource="classpath:org/springframework/integration/samples/xml/bigBooksSupplierTransformer.xsl"/>
```

== Additional Resources

=== Spring Integration Home

The definitive source of information about Spring Integration is the Spring Integration Home at https://spring.io. That site serves as a hub of information and is the best place to find up-to-date announcements about the project as well as links to articles, blogs, and new sample applications.

== Change History

=== Changes between 4.2 and 4.3

Please be sure to also see the Migration Guide for important changes that might affect your applications. Migration guides for all versions back to *2.1* can be found on the Wiki.

=== New Components

==== AMQP Async Outbound Gateway

See the section called “CompletableFuture”.

==== MessageGroupFactory

The new `MessageGroupFactory` strategy has been introduced to allow a control over `MessageGroup` instances in `MessageGroupStore` logic. The `SimpleMessageGroupFactory` is provided for the `SimpleMessageGroup` with the `GroupType.HASH_SET` as the default factory for the standard `MessageGroupStore` implementations. See the section called “CompletableFuture” for more information.

==== PersistentMessageGroup

The `PersistentMessageGroup`, - lazy-load proxy, - implementation is provided for persistent `MessageGroupStore` s, which return this instance for the `getMessageGroup()` when their `lazyLoadMessageGroups` is `true` (defaults). See the section called “CompletableFuture” for more information.

==== FTP/SFTP Streaming Inbound Channel Adapters

New inbound channel adapters are provided that return an `InputStream` for each file allowing you to retrieve remote files without writing them to the local file system See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

==== Stream Transformer

A new `StreamTransformer` is provided to transform an `InputStream` payload to either a `byte[]` or `String`. See the section called “Stream Transformer” for more information.

==== Integration Graph

A new `IntegrationGraphServer` together with the `IntegrationGraphController` REST service are provided to expose the runtime model of a Spring Integration application as a graph. See the section called “CompletableFuture” for more information.

==== JDBC Lock Registry

A new `JdbcLockRegistry` is provided for distributed locks shared through the data base table. See the section called “CompletableFuture” for more information.

==== Leader Initiator for Lock Registry

A new `LeaderInitiator` implementation is provided based on the `LockRegistry` strategy. See Section 8.3, “Leadership Event Handling” for more information.

=== General Changes

==== Core Changes

===== Outbound Gateway within Chain

Previously, it was possible to specify a `reply-channel` on an outbound gateway within a chain. It was completely ignored; the gateway’s reply goes to the next chain element, or to the chain’s output channel if the gateway is the last element. This condition is now detected and disallowed. If you have such configuration, simply remove the `reply-channel`.

===== Async Service Activator

An option to make the Service Asynchronous has been added. See the section called “CompletableFuture” for more information.

===== Messaging Annotation Support changes

The Messaging Annotation Support doesn’t require any more `@MessageEndpoint` (or any other `@Component`) annotation declaration on the class level. To restore the previous behaviour specify the `spring.integration.messagingAnnotations.require.componentAnnotation` of `spring.integration.properties` as `true`. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

==== Mail Changes

===== Customizable User Flag

The customizable `userFlag` added in 4.2.2 to provide customization of the flag used to denote that the mail has been seen is now available using the XML namespace. See the section called “CompletableFuture” for more information.

===== Mail Message Mapping

There is now an option to map inbound mail messages with the `MessageHeaders` containing the mail headers and the payload containing the email content. Previously, the payload was always the raw `MimeMessage`. See the section called “CompletableFuture” for more information.

==== JMS Changes

===== Header Mapper

The `DefaultJmsHeaderMapper` now maps the standard `correlationId` header as a message property by invoking its `toString()` method. See the section called “CompletableFuture” for more information.

===== Async Gateway

The JMS Outbound gateway now has an `async` property. See the section called “CompletableFuture” for more information.

==== Aggregator Changes

There is a change in behavior when a POJO aggregator releases a collection of `Message<?>` objects; this is rare but if your application does that, you will need to make a small change to your POJO. See this Important note for more information.

==== TCP/UDP Changes

===== Events

A new `TcpConnectionServerListeningEvent` is emitted when a server connection factory is started. See the section called “CompletableFuture” for more information.

The `destination-expression` and `socket-expression` are now available for the `<int-ip:udp-outbound-channel-adapter>`. See the section called “CompletableFuture” for more information.

===== Stream Deserializers

The various deserializers that can’t allocate the final buffer until the whole message has been assembled now support pooling of the raw buffer into which the data is received, rather than creating and discarding a buffer for each message. See the section called “CompletableFuture” for more information.

===== TCP Message Mapper

The message mapper now, optionally, sets a configured content type header. See IP Message Headers for more information.

==== File Changes

===== Destination Directory Creation

The generated file name for the `FileWritingMessageHandler` can represent *sub-path* to save the desired directory structure for file in the target directory. See the section called “CompletableFuture” for more information.

The `FileReadingMessageSource` now hides the `WatchService` directory scanning logic in the inner class. The `use-watch-service` and `watch-events` options are provided to enable such a behaviour. The top level `WatchServiceDirectoryScanner` has been deprecated because of inconsistency around API. See the section called “CompletableFuture” for more information.

===== Buffer Size

When writing files, you can now specify the buffer size to use.

===== Appending and Flushing

You can now avoid flushing files when appending and use a number of strategies to flush the data during idle periods. See the section called “CompletableFuture” for more information.

===== Preserving Timestamps

The outbound channel adapter can now be configured to set the destination file’s `lastmodified` timestamp. See the section called “CompletableFuture” for more information.

===== Splitter Changes

The `FileSplitter` will now automatically close an (S)FTP session when the file is completely read. This applies when the outbound gateway returns an `InputStream` or the new (S)FTP streaming channel adapters are being used. Also a new `markers-json` options has been introduced to convert `FileSplitter.FileMarker` to JSON `String` for relaxed downstream network interaction. See the section called “CompletableFuture” for more information.

===== File Filters

A new `ChainFileListFilter` is provided as an alternative to `CompositeFileListFilter`. See the section called “CompletableFuture” for more information.

==== AMQP Changes

===== Content Type Message Converter

The outbound endpoints now support a `RabbitTemplate` configured with a `ContentTypeDelegatingMessageConverter` such that the converter can be chosen based on the message content type. See the section called “CompletableFuture” for more information.

===== Headers for Delayed Message Handling

Spring AMQP 1.6 adds support for Delayed Message Exchanges. Header mapping now supports the headers (`amqp_delay` and `amqp_receivedDelay`) used by this feature.

===== AMQP-Backed Channels

AMQP-backed channels now support message mapping. See the section called “CompletableFuture” for more information.

==== Redis Changes

===== List Push/Pop Direction

Previously, the queue channel adapters always used the Redis List in a fixed direction, pushing to the left end and reading from the right end. It is now possible to configure the reading and writing direction using `rightPop` and `leftPush` options for the `RedisQueueMessageDrivenEndpoint` and `RedisQueueOutboundChannelAdapter` respectively. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Queue Inbound Gateway Default Serializer

The default serializer in the inbound gateway has been changed to a `JdkSerializationRedisSerializer` for compatibility with the outbound gateway. See the section called “CompletableFuture” for more information.

==== HTTP Changes

Previously, with requests that had a body (such as `POST`) that had no `content-type` header, the body was ignored. With this release, the content type of such requests is considered to be `application/octet-stream` as recommended by RFC 2616. See the section called “CompletableFuture” for more information.

`uriVariablesExpression` now uses a `SimpleEvaluationContext` by default (since 4.3.15).

See the section called “CompletableFuture” for more information.

==== SFTP Changes

===== Factory Bean A new factory bean is provided to simplify the configuration of Jsch proxies for SFTP. See the section called “CompletableFuture” for more information.

===== chmod

The SFTP outbound gateway (for `put` and `mput` commands) and the SFTP outbound channel adapter now support the `chmod` attribute to change the remote file permissions after uploading. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

==== FTP Changes

===== Session Changes

The `FtpSession` now supports `null` for the `list()` and `listNames()` method, since it is possible by the underlying FTP Client. With that the `FtpOutboundGateway` can now be configured without `remoteDirectory` expression. And the `<int-ftp:inbound-channel-adapter>` can be configured without `remote-directory/remote-directory-expression`. See the section called “CompletableFuture” for more information.

==== Router Changes

The `ErrorMessageExceptionTypeRouter` supports now the `Exception` superclass mappings to avoid duplication for the same channel in case of several inheritors. For this purpose the `ErrorMessageExceptionTypeRouter` loads mapping classes during initialization to fail-fast for a `ClassNotFoundException`.

See Section 6.1, “Routers” for more information.

==== Header Mapping

===== General

AMQP, WS and XMPP header mappings (e.g. `request-header-mapping`, `reply-header-mapping`) now support negated patterns. See the section called “CompletableFuture”, the section called “CompletableFuture”, and the section called “CompletableFuture” for more information.

===== AMQP Header Mapping

Previously, only standard AMQP headers were mapped by default; users had to explicitly enable mapping of user-defined headers. With this release all headers are mapped by default. In addition, the inbound `amqp_deliveryMode` header is no longer mapped by default. See the section called “CompletableFuture” for more information.

==== Groovy Scripts

Groovy scripts can now be configured with the `compile-static` hint or any other `CompilerConfiguration` options. See the section called “CompletableFuture” for more information.

==== @InboundChannelAdapter

The `@InboundChannelAdapter` has now an alias `channel` attribute for regular `value`. In addition the target `SourcePollingChannelAdapter` components can now resolve the target `outputChannel` bean from its provided name (`outputChannelName` options) in late-binding manner. See the section called “CompletableFuture” for more information.

==== XMPP changes

The XMPP Extensions (XEP) are now supported by the XMPP channel adapters. See the section called “CompletableFuture” for more information.

==== WireTap Late Binding

The `WireTap` `ChannelInterceptor` now can accept a `channelName` which is resolved to the target `MessageChannel` later, during the first active interceptor operation. See the section called “Wire Tap” for more information.

==== ChannelMessageStoreQueryProvider

The `ChannelMessageStoreQueryProvider` now supports H2 database. See the section called “CompletableFuture” for more information.

==== WebSocket Changes

The `ServerWebSocketContainer` now exposes `allowedOrigins` option and `SockJsServiceOptions` a `suppressCors` option. See the section called “CompletableFuture” for more information.

=== Changes between 4.1 and 4.2

Please be sure to also see the Migration Guide for important changes that might affect your applications. Migration guides for all versions back to *2.1* can be found on the Wiki.

=== New Components

==== Major Management/JMX Rework

A new `MetricsFactory` strategy interface has been introduced. This, together with other changes in the JMX and management infrastructure provides much more control over management configuration and runtime performance.

However, this has some important implications for (some) user environments.

For complete details, see the section called “CompletableFuture” and the section called “CompletableFuture”.

==== MongoDB Metadata Store

The `MongoDbMetadataStore` is now available. For more information, see the section called “CompletableFuture”.

==== SecuredChannel Annotation

The `@SecuredChannel` annotation has been introduced, replacing the deprecated `ChannelSecurityInterceptorFactoryBean`. For more information, see the section called “CompletableFuture”.

==== SecurityContext Propagation

The `SecurityContextPropagationChannelInterceptor` has been introduced for the `SecurityContext` propagation from one message flow’s Thread to another. For more information, see the section called “CompletableFuture”.

==== FileSplitter

The `FileSplitter`, which splits text files into lines, was added in 4.1.2. It now has full support in the `int-file:` namespace; see the section called “CompletableFuture” for more information.

==== Zookeeper Support

Zookeeper support has been added to the framework to assist when running on a clustered/multi-host environment.

- ZookeeperMetadataStore
- ZookeeperLockRegistry
- Zookeeper Leadership

See the section called "CompletableFuture" for more information.

==== Thread Barrier

A new thread `<int:barrier/>` component is available allowing a thread to be suspended until some asynchronous event occurs.

See Section 6.8, "Thread Barrier" for more information.

==== STOMP Support

STOMP support has been added to the framework as *inbound* and *outbound* channel adapters pair. See the section called "CompletableFuture" for more information.

==== Codec A new `Codec` abstraction has been introduced, to encode/decode objects to/from `byte[]`. An implementation that uses Kryo is provided. Codec-based transformers and message converters are also provided.

See Section 7.4, "Codec" for more information.

==== Message PreparedStatement Setter

A new `MessagePreparedStatementSetter` functional interface callback is available for the `JdbcMessageHandler` (`<int-jdbc:outbound-gateway>` and `<int-jdbc:outbound-channel-adapter>`) as an alternative to the `SqlParameterSourceFactory` to populate parameters on the `PreparedStatement` with the `requestMessage` context.

See the section called "CompletableFuture" for more information.

=== General Changes

==== Wire Tap

As an alternative to the existing `selector` attribute, the `<wire-tap/>` now supports the `selector-expression` attribute.

==== File Changes

See the section called "CompletableFuture" for more information about these changes.

===== Appending New Lines

The `<int-file:outbound-channel-adapter>` and `<int-file:outbound-gateway>` now support an `append-new-line` attribute. If set to `true`, a new line is appended to the file after a message is written. The default attribute value is `false`.

===== Ignoring Hidden Files

The `ignore-hidden` attribute has been introduced for the `<int-file:inbound-channel-adapter>` to pick up or not the *hidden* files from the source directory. It is `true` by default.

===== Writing InputStream Payloads

The `FileWritingMessageHandler` now also accepts `InputStream` as a valid message payload type.

===== HeadDirectoryScanner

The `HeadDirectoryScanner` can now be used with other `FileListFilter` s.

===== Last Modified Filter

The `LastModifiedFileListFilter` has been added.

===== WatchService Directory Scanner

The `WatchServiceDirectoryScanner` is now available.

===== Persistent File List Filter Changes

The `AbstractPersistentFileListFilter` has a new property `flushOnUpdate` which, when set to true, will `flush()` the metadata store if it implements `Flushable` (e.g. the `PropertiesPersistingMetadataStore`).

==== Class Package Change

The `ScatterGatherHandler` class has been moved from the `org.springframework.integration.handler` to the `org.springframework.integration.scattergather`.

==== TCP Changes

===== TCP Serializers

The TCP `Serializers` no longer `flush()` the `OutputStream`; this is now done by the `TcpNxxConnection` classes. If you are using the serializers directly within user code, you may have to `flush()` the `OutputStream`.

===== Server Socket Exceptions

`TcpConnectionServerExceptionEvent` s are now published whenever an unexpected exception occurs on a TCP server socket (also added to 4.1.3, 4.0.7). See the section called “CompletableFuture” for more information.

===== TCP Server Port

If a TCP server socket factory is configured to listen on a random port, the actual port chosen by the OS can now be obtained using `getPort()`. `getServerSocketAddress()` is also available.

See the section called “CompletableFuture” for more information.

===== TCP Gateway Remote Timeout

The `TcpOutboundGateway` now supports `remote-timeout-expression` as an alternative to the existing `remote-timeout` attribute. This allows setting the timeout based on each message.

Also, the `remote-timeout` no longer defaults to the same value as `reply-timeout` which has a completely different meaning.

See Table 8.6, “TCP Outbound Gateway Attributes” for more information.

===== TCP SSLSession Available for Header Mapping

`TcpConnection` s now support `getSslSession()` to enable users to extract information from the session to add to message headers.

See IP Message Headers for more information.

===== TCP Events

New events are now published whenever a correlation exception occurs - for example sending a message to a non-existent socket.

The `TcpConnectionEventListeningMessageProducer` is deprecated; use the generic event adapter instead.

See the section called “CompletableFuture” for more information.

==== @InboundChannelAdapter

Previously, the `@Poller` on an inbound channel adapter defaulted the `maxMessagesPerPoll` attribute to `-1` (infinity). This was inconsistent with the XML configuration of `<inbound-channel-adapter/>` s, which defaults to 1. The annotation now defaults this attribute to 1.

==== API Changes

`o.s.integration.util.FunctionIterator` now requires a `o.s.integration.util.Function` instead of a `reactor.function.Function`. This was done to remove an unnecessary hard dependency on Reactor. Any uses of this iterator will need to change the import.

Of course, Reactor is still supported for functionality such as the `Promise` gateway; the dependency was removed for those users who don’t need it.

==== JMS Changes

===== Reply Listener Lazy Initialization

It is now possible to configure the reply listener in JMS outbound gateways to be initialized on-demand and stopped after an idle period, instead of being controlled by the gateway’s lifecycle.

See the section called “CompletableFuture” for more information.

===== Conversion Errors in Message-Driven Endpoints

The `error-channel` now is used for the conversion errors, which have caused a transaction rollback and message redelivery previously.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Default Acknowledge Mode

When using an implicitly defined `DefaultMessageListenerContainer`, the default `acknowledge` is now `transacted`. `transacted` is recommended when using this container, to avoid message loss. This default now applies to the message-driven inbound adapter and the inbound gateway, it was already the default for jms-backed channels.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Shared Subscriptions

Namespace support for shared subscriptions (JMS 2.0) has been added to message-driven endpoints and the `<int-jms:publish-subscribe-channel>`. Previously, you had to wire up listener containers as `<bean/>` s to use shared connections.

See the section called “CompletableFuture” for more information.

==== Conditional Pollers Much more flexibility is now provided for dynamic polling.

See the section called “Conditional Pollers for Message Sources” for more information.

==== AMQP Changes

===== Publisher Confirms

The `<int-amqp:outbound-gateway>` now supports `confirm-correlation-expression` and `confirm-(n)ack-channel` attributes with similar purpose as for `<int-amqp:outbound-channel-adapter>`.

===== Correlation Data

For both the outbound channel adapter and gateway, if the correlation data is a `Message<?>`, it will be the basis of the message on the ack/nack channel, with the additional header(s) added. Previously, any correlation data (including `Message<?>`) was returned as the payload of the ack/nack message.

===== The Inbound Gateway properties

The `<int-amqp:inbound-gateway>` now exposes the `amqp-template` attribute to allow more control over an external bean for the reply `RabbitTemplate` or even provide your own `AmqpTemplate` implementation. In addition the `default-reply-to` is exposed to be used if request message doesn’t have `replyTo` property.

See the section called “CompletableFuture” for more information.

==== XPath Splitter Improvements

The `XPathMessageSplitter` (`<int-xml:xpath-splitter>`) now allows the configuration of `output-properties` for the internal `javax.xml.transform.Transformer` and supports an `Iterator` mode (defaults to `true`) for the xpath evaluation `org.w3c.dom.NodeList` result.

See the section called “CompletableFuture” for more information.

==== HTTP Changes

===== CORS

The HTTP Inbound Endpoints (`<int-http:inbound-channel-adapter>` and `<int-http:inbound-gateway>`) now allow the configuration of *Cross-Origin Resource Sharing (CORS)*.

See the section called “CompletableFuture” for more information.

===== Inbound Gateway Timeout

The HTTP inbound gateway can be configured as to what status code to return when a request times out. The default is now `500 Internal Server Error` instead of `200 OK`.

See the section called “CompletableFuture” for more information.

===== Form Data

Documentation is provided for when proxying `multipart/form-data` requests. See the section called “CompletableFuture” for more information.

==== Gateway Changes

===== Gateway Methods can Return CompletableFuture<?>

When using Java 8, gateway methods can now return `CompletableFuture<?>`. See the section called “CompletableFuture” for more information.

===== MessagingGateway Annotation

The request and reply timeout properties are now `String` instead of `Long` to allow configuration with property placeholders or SpEL. See the section called “@MessagingGateway Annotation”.

==== Aggregator Changes

===== Aggregator Performance

This release includes some performance improvements for aggregating components (aggregator, resequencer, etc), by more efficiently removing messages from groups when they are released. New methods (`removeMessagesFromGroup`) have been added to the message store. Set the `removeBatchSize` property (default `100`) to adjust the number of messages deleted in each operation. Currently, JDBC, Redis and MongoDB message stores support this property.

===== Output Message Group Processor

When using a `ref` or inner bean for the aggregator, it is now possible to bind a `MessageGroupProcessor` directly. In addition, a `SimpleMessageGroupProcessor` is provided that simply returns the collection of messages in the group. When an output processor produces a collection of `Message<?>`, the aggregator releases those messages individually. Configuring the `SimpleMessageGroupProcessor` makes the aggregator a message barrier, were messages are held up until they all arrive, and are then released individually. See Section 6.4, “Aggregator” for more information.

==== (S)FTP Changes

===== Inbound channel adapters

You can now specify a `remote-directory-expression` on the inbound channel adapters, to determine the directory at runtime. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Gateway Partial Results

When use FTP/SFTP outbound gateways to operate on multiple files (`mget`, `mput`), it is possible for an exception to occur after part of the request is completed. If such a condition occurs, a `PartialSuccessException` is thrown containing the partial results. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Delegating Session Factory

A delegating session factory is now available, enabling the selection of a particular session factory based on some thread context value.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Default Sftp Session Factory

Previously, the `DefaultSftpSessionFactory` unconditionally allowed connections to unknown hosts. This is now configurable (default false).

The factory now requires a configured `knownHosts` file unless the `allowUnknownKeys` property is `true` (default false).

See the section called “CompletableFuture” for more information.

===== Message Session Callback

The `MessageSessionCallback<F, T>` has been introduced to perform any custom `Session` operation(s) with the `requestMessage` context in the `<int-(s)ftp:outbound-gateway/>`.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

==== Websocket Changes

`WebSocketHandlerDecoratorFactory` support has been added to the `ServerWebSocketContainer` to allow chained customization for the internal `WebSocketHandler`. See the section called “CompletableFuture” for more information.

==== Application Event Adapters changes

The `ApplicationEvent` adapters can now operate with `payload` as `event` directly allow omitting custom `ApplicationEvent` extensions. The `publish-payload` boolean attribute has been introduced on the `<int-event:outbound-channel-adapter>` for this purpose. See the section called “CompletableFuture” for more information.

=== Changes between 4.0 and 4.1

Please be sure to also see the Migration Guide for important changes that might affect your applications. Migration guides for all versions back to *2.1* can be found on the Wiki.

==== New Components

===== Promise<?> Gateway

A Reactor `Promise` return type is now supported for Messaging Gateway methods. See the section called “Asynchronous Gateway”.

===== WebSocket support

The *WebSocket* module is now available. It is fully based on the Spring WebSocket and Spring Messaging modules and provides an `<inbound-channel-adapter>` and an `<outbound-channel-adapter>`. See the section called “CompletableFuture” for more information.

===== Scatter-Gather EIP pattern

The *Scatter-Gather* EIP pattern is now implemented. See Section 6.7, “Scatter-Gather” for more information.

===== Routing Slip Pattern

The *Routing Slip* EIP pattern implementation is now provided. See the section called “Routing Slip” for more information.

===== Idempotent Receiver Pattern

The *Idempotent Receiver* EIP implementation is now provided via the `<idempotent-receiver>` component in XML, or the `IdempotentReceiverInterceptor` and `IdempotentReceiver` annotation when using Java Configuration. See the section called “CompletableFuture” and their JavaDocs for more information.

===== BoonJsonObjectMapper

The *Boon* `JsonObjectMapper` is now provided for the JSON transformers. See Section 7.1, “Transformer” for more information.

===== Redis Queue Gateways

The `<redis-queue-inbound-gateway>` and `<redis-queue-outbound-gateway>` components are now provided. See the section called “CompletableFuture” and the section called “CompletableFuture”.

===== PollSkipAdvice

The `PollSkipAdvice` is now provided to be used within `<advice-chain>` of the `<poller>` to determine if the current *poll* should be suppressed (skipped) by some condition implemented with `PollSkipStrategy`. See Section 4.2, “Poller” for more information.

==== General Changes

===== AMQP Inbound Endpoints, Channel

Elements that utilize a message listener container (inbound endpoints, channel) now support the `missing-queues-fatal` attribute. See the section called “CompletableFuture” for more information.

===== AMQP Outbound Endpoints

The AMQP outbound endpoints support a new property `lazy-connect` (default true). When true, the connection to the broker is not established until the first message arrives (assuming there are no inbound endpoints, which always attempt to establish the connection during startup). When set the *false* an attempt to establish the connection is made during application startup. See the section called “CompletableFuture” for more information.

===== SimpleMessageStore

The `SimpleMessageStore` no longer makes a copy of the group when calling `getMessageGroup()`. See Caution with SimpleMessageStore for more information.

===== Web Service Outbound Gateway: encode-uri

The `<ws:outbound-gateway/>` now provides an `encode-uri` attribute to allow disabling the encoding of the URI object before sending the request.

===== Http Inbound Channel Adapter and StatusCode

The `<http:inbound-channel-adapter>` can now be configured with a `status-code-expression` to override the default `200 OK` status. See the section called “CompletableFuture” for more information.

===== MQTT Adapter Changes

The MQTT channel adapters can now be configured to connect to multiple servers, for example, to support High Availability (HA). See the section called “CompletableFuture” for more information.

The MQTT message-driven channel adapter now supports specifying the QoS setting for each subscription. See the section called “CompletableFuture” for more information.

The MQTT outbound channel adapter now supports asynchronous sends, avoiding blocking until delivery is confirmed. See the section called “CompletableFuture” for more information.

It is now possible to programmatically subscribe to and unsubscribe from topics at runtime. See the section called “CompletableFuture” for more information.

===== FTP/SFTP Adapter Changes

The FTP and SFTP outbound channel adapters now support appending to remote files, as well as taking specific actions when a remote file already exists. The remote file templates now also support this as well as `rmdir()` and `exists()`. In addition, the remote file templates provide access to the underlying client object enabling access to low-level APIs.

See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Splitter and Iterator

`Splitter` components now support an `Iterator` as the result object for producing output messages. See Section 6.3, “Splitter” for more information.

===== Aggregator

`Aggregator` s now support a new attribute `expire-groups-upon-timeout`. See the section called “Configuring an Aggregator” for more information.

===== Content Enricher Improvements

An `null-result-expression` attribute has been added, which is evaluated and returned if `<enricher>` returns `null`. It can be added in `<header>` and `<property>`. See Section 7.2, “Content Enricher” for more information.

An `error-channel` attribute has been added, which is used to handle an error flow if `Exception` occurs downstream of the `request-channel`. This enable you to return an alternative object to use for enrichment. See Section 7.2, “Content Enricher” for more information.

===== Header Channel Registry

The `<header-enricher/>`'s `<header-channels-to-string/>` element can now override the header channel registry’s default time for retaining channel mappings. See the section called “Header Channel Registry” for more information.

===== Orderly Shutdown

Improvements have been made to the orderly shutdown algorithm. See the section called “CompletableFuture” for more information.

===== Management for RecipientListRouter

The `RecipientListRouter` provides now several *management* operations to configure *recipients* at runtime. With that the `<recipient-list-router>` can now be configured without any `<recipient>` from the start. See the section called “RecipientListRouterManagement” for more information.

===== AbstractHeaderMapper: NON_STANDARD_HEADERS token

The `AbstractHeaderMapper` implementations now provides the additional `NON_STANDARD_HEADERS` token to map any user-defined headers, which aren’t mapped by default. See the section called “CompletableFuture” for more information.

===== AMQP Channels: template-channel-transacted

The new `template-channel-transacted` attribute has been introduced for AMQP `MessageChannel` s. See the section called “CompletableFuture” for more information.

===== Syslog Adapter

The default syslog message converter now has an option to retain the original message in the payload, while still setting the headers. See the section called “CompletableFuture” for more information.

===== Async Gateway

In addition to the `Promise` return type mentioned above, gateway methods may now return a `ListenableFuture`, introduced in Spring Framework 4.0. You can also disable the async processing in the gateway, allowing a downstream flow to directly return a `Future`. See the section called “Asynchronous Gateway”.

===== Aggregator Advice Chain

`Aggregator` s and `Resequencer` s now support an `<expire-advice-chain/>` and `<expire-transactional/>` sub-elements to *advise* the `forceComplete` operation. See the section called “Configuring an Aggregator” for more information.

===== Outbound Channel Adapter and Scripts

The `<int:outbound-channel-adapter/>` now supports the `<script/>` sub-element. The underlying script must have a `void` return type or return `null`. See the section called “CompletableFuture” and the section called “CompletableFuture”.

===== Resequencer Changes

When a message group in a resequencer is timed out (using `group-timeout` or a `MessageGroupStoreReaper`), late arriving messages will now be discarded immediately by default. See Section 6.5, “Resequencer”.

===== Optional POJO method parameter

Now Spring Integration consistently handles the Java 8’s `Optional` type. See the section called “CompletableFuture”.

===== QueueChannel: backed Queue type

The `QueueChannel` backed `Queue type` has been changed from `BlockingQueue` to the more generic `Queue`. It allows the use of any external `Queue` implementation, for example Reactor’s `PersistentQueue`. See the section called “QueueChannel Configuration”.

===== ChannelInterceptor Changes

The `ChannelInterceptor` now supports additional `afterSendCompletion()` and `afterReceiveCompletion()` methods. See the section called “Channel Interceptors”.

===== IMAP PEEK

Since *version 4.1.1* there is a change of behavior if you explicitly set the javamail property `mail.[protocol].peek` to `false` (where `[protocol]` is `imap` or `imaps`). See Important: IMAP PEEK.

=== Changes between 3.0 and 4.0

Please be sure to also see the Migration Guide for important changes that might affect your applications. Migration guides for all versions back to *2.1* can be found on the Wiki.

==== New Components

===== MQTT Channel Adapters

The MQTT channel adapters (previously available in the Spring Integration Extensions repository) are now available as part of the normal Spring Integration distribution. See the section called “CompletableFuture”

===== @EnableIntegration

The `@EnableIntegration` annotation has been added, to permit declaration of standard Spring Integration beans when using `@Configuration` classes. See the section called “CompletableFuture” for more information.

===== @IntegrationComponentScan

The `@IntegrationComponentScan` annotation has been added, to permit classpath scanning for Spring Integration specific components. See the section called “CompletableFuture” for more information.

===== @EnableMessageHistory

Message history can now be enabled with the `@EnableMessageHistory` annotation in a `@Configuration` class; in addition the message history settings can be modified by a JMX MBean.

In addition auto-created `MessageHandler` s for annotated endpoints (e.g. `@ServiceActivator`, `@Splitter` etc.) now are also trackable by `MessageHistory`. For more information, see the section called “CompletableFuture”.

===== @MessagingGateway

Messaging gateway interfaces can now be configured with the `@MessagingGateway` annotation. It is an analogue of the `<int:gateway/>` xml element. For more information, see the section called “@MessagingGateway Annotation”.

===== Spring Boot @EnableAutoConfiguration

As well as the `@EnableIntegration` annotation mentioned above, a a hook has been introduced to allow the Spring Integration infrastructure beans to be configured using Spring Boot’s `@EnableAutoConfiguration`. For more information seehttp://docs.spring.io/spring-boot/docs/current/reference/html/using-boot-auto-configuration.html[Spring Boot - AutoConfigure].

===== @GlobalChannelInterceptor

As well as the `@EnableIntegration` annotation mentioned above, the `@GlobalChannelInterceptor` annotation has bean introduced. For more information, see the section called “CompletableFuture”.

===== @IntegrationConverter

The `@IntegrationConverter` annotation has bean introduced, as an analogue of `<int:converter/>` component. For more information, see the section called “CompletableFuture”.

===== @EnablePublisher

The `@EnablePublisher` annotation has been added, to allow the specification of a `default-publisher-channel` for `@Publisher` annotations. See the section called “CompletableFuture” for more information.

===== Redis Channel Message Stores

A new Redis `MessageGroupStore`, that is optimized for use when backing a `QueueChannel` for persistence, is now provided. For more information, see the section called “CompletableFuture”.

A new Redis `ChannelPriorityMessageStore` is now provided. This can be used to retrieve messages by priority. For more information, see the section called “CompletableFuture”.

===== MongodDB Channel Message Store

MongoDB support now provides the `MongoDbChannelMessageStore - a` *channel* specific `MessageStore` implementation. With `priorityEnabled = true`, it can be used in `<int:priority-queue> s` to achieve *priority* order polling of persisted messages. For more information see the section called “CompletableFuture”.

===== @EnableIntegrationMBeanExport

The `IntegrationMBeanExporter` can now be enabled with the `@EnableIntegrationMBeanExport` annotation in a `@Configuration` class. For more information, see the section called “CompletableFuture”.

===== ChannelSecurityInterceptorFactoryBean

Configuration of Spring Security for message channels using `@Configuration` classes is now supported by using a `ChannelSecurityInterceptorFactoryBean`. For more information, see the section called “CompletableFuture”.

===== Redis Command Gateway

The Redis support now provides the `<outbound-gateway>` component to perform generic Redis commands using the `RedisConnection#execute` method. For more information, see the section called “CompletableFuture”.

===== RedisLockRegistry and GemfireLockRegistry

The `RedisLockRegistry` and `GemfireLockRegistry` are now available supporting global locks visible to multiple application instances/servers. These can be used with aggregating message handlers across multiple application instances such that group release will occur on only one instance. For more information, see the section called “CompletableFuture”, the section called “CompletableFuture” and Section 6.4, “Aggregator”.

===== @Poller

Annotation-based messaging configuration can now have a `poller` attribute. This means that methods annotated with (`@ServiceActivator`, `@Aggregator` etc.) can now use an `inputChannel` that is a reference to a `PollableChannel`. For more information, see the section called “CompletableFuture”.

===== @InboundChannelAdapter and SmartLifecycle for Annotated Endpoints

The `@InboundChannelAdapter` method annotation is now available. It is an analogue of the `<int:inbound-channel-adapter>` XML component. In addition, all Messaging Annotations now provide `SmartLifecycle` options. For more information, see the section called “CompletableFuture”.

===== Twitter Search Outbound Gateway

A new twitter endpoint `<int-twitter-search-outbound-gateway/>` has been added. Unlike the search inbound adapter which polls using the same search query each time, the outbound gateway allows on-demand customized queries. For more information, see the section called “CompletableFuture”.

===== Gemfire Metadata Store

The `GemfireMetadataStore` is provided, allowing it to be used, for example, in a `AbstractPersistentAcceptOnceFileListFilter` implementation in a multiple application instance/server environment. For more information, see the section called “CompletableFuture”, the section called “CompletableFuture”, the section called “CompletableFuture” and the section called “CompletableFuture”.

===== @BridgeFrom and @BridgeTo Annotations

Annotation and Java configuration has introduced `@BridgeFrom` and `@BridgeTo` `@Bean` method annotations to mark `MessageChannel` beans in `@Configuration` classes. For more information, see the section called “CompletableFuture”.

===== Meta Messaging Annotations

Messaging Annotations (`@ServiceActivator`, `@Router`, `@MessagingGateway` etc.) can now be configured as meta-annotations for user-defined Messaging Annotations. In addition the user-defined annotations can have the same attributes (`inputChannel`, `@Poller`, `autoStartup` etc.). For more information, see the section called “CompletableFuture”.

==== General Changes

===== Requires Spring Framework 4.0

Core messaging abstractions (`Message`, `MessageChannel` etc) have moved to the Spring Framework `spring-messaging` module. Users who reference these classes directly in their code will need to make changes as described in the first section of the Migration Guide.

===== Header Type for XPath Header Enricher

The `header-type` attribute has been introduced for the `header` sub-element of the `<int-xml:xpath-header-enricher>`. This attribute provides the target type for the header value to which the result of the XPath expression evaluation will be converted. For more information see the section called “CompletableFuture”.

===== Object To Json Transformer: Node Result

The `result-type` attribute has been introduced for the `<int:object-to-json-transformer>`. This attribute provides the target type for the result of object mapping to JSON. It supports `STRING` (default) and `NODE`. For more information see the section called “JSON Transformers”.

===== JMS Header Mapping

The `DefaultJmsHeaderMapper` now maps an incoming `JMSPriority` header to the Spring Integration `priority` header. Previously `priority` was only considered for outbound messages. For more information see the section called “CompletableFuture”.

===== JMS Outbound Channel Adapter

The JMS outbound channel adapter now supports the `session-transacted` attribute (default false). Previously, you had to inject a customized `JmsTemplate` to use transactions. See the section called “CompletableFuture”.

===== JMS Inbound Channel Adapter

The JMS inbound channel adapter now supports the `session-transacted` attribute (default false). Previously, you had to inject a customized `JmsTemplate` to use transactions (the adapter allowed *transacted* in the acknowledgeMode which was incorrect, and didn’t work; this value is no longer allowed). See the section called “CompletableFuture”.

===== Datatype Channels

You can now specify a `MessageConverter` to be used when converting (if necessary) payloads to one of the accepted `datatype` s in a Datatype channel. For more information see the section called “Datatype Channel Configuration”.

===== Simpler Retry Advice Configuration

Simplified namespace support has been added to configure a `RequestHandlerRetryAdvice`. For more information see the section called “CompletableFuture”.

===== Correlation Endpoint: Time-based Release Strategy

The mutually exclusive `group-timeout` and `group-timeout-expression` attributes have been added to the `<int:aggregator>` and `<int:resequencer>`. These attributes allow forced completion of a partial `MessageGroup`, if the `ReleaseStrategy` does not release a group and no further messages arrive within the time specified. For more information see the section called “Configuring an Aggregator”.

===== Redis Metadata Store

The `RedisMetadataStore` now implements `ConcurrentMetadataStore`, allowing it to be used, for example, in a `AbstractPersistentAcceptOnceFileListFilter` implementation in a multiple application instance/server environment. For more information, see the section called “CompletableFuture”, the section called “CompletableFuture”, the section called “CompletableFuture” and the section called “CompletableFuture”.

===== JdbcChannelMessageStore and PriorityChannel

The `JdbcChannelMessageStore` now implements `PriorityCapableChannelMessageStore`, allowing it to be used as a `message-store` reference for `priority-queue` s. For more information, see the section called “CompletableFuture”.

===== AMQP Endpoints Delivery Mode

Spring AMQP, by default, creates persistent messages on the broker. This behavior can be overridden by setting the `amqp_deliveryMode` header and/or customizing the mappers. A convenient `default-delivery-mode` attribute has now been added to the adapters to provide easier configuration of this important setting. For more information, see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== FTP Timeouts

The `DefaultFtpSessionFactory` now exposes the `connectTimeout`, `defaultTimeout` and `dataTimeout` properties, avoiding the need to subclass the factory just to set these common properties. The `postProcess*` methods are still available for more advanced configuration. See the section called “CompletableFuture” for more information.

===== Twitter: StatusUpdatingMessageHandler

The `StatusUpdatingMessageHandler` (`<int-twitter:outbound-channel-adapter>`) now supports the `tweet-data-expression` attribute to build a `org.springframework.social.twitter.api.TweetData` object for updating the timeline status allowing, for example, attaching an image. See the section called “CompletableFuture” for more information.

===== JPA Retrieving Gateway: id-expression

The `id-expression` attribute has been introduced for `<int-jpa:retrieving-outbound-gateway>` to perform `EntityManager.find(Class entityClass, Object primaryKey)`. See the section called “CompletableFuture” for more information.

===== TCP Deserialization Events

When one of the standard deserializers encounters a problem decoding the input stream to a message, it will now emit a `TcpDeserializationExceptionEvent`, allowing applications to examine the data at the point the exception occurred. See the section called “CompletableFuture” for more information.

===== Messaging Annotations on @Bean Definitions

Messaging Annotations (`@ServiceActivator`, `@Router`, `@InboundChannelAdapter` etc.) can now be configured on `@Bean` definitions in `@Configuration` classes. For more information, see the section called “CompletableFuture”.

=== Changes Between 2.2 and 3.0

==== New Components

===== HTTP Request Mapping

The HTTP module now provides powerful Request Mapping support for Inbound Endpoints. Class `UriPathHandlerMapping` was replaced by `IntegrationRequestMappingHandlerMapping`, which is registered under the bean name `integrationRequestMappingHandlerMapping` in the application context. Upon parsing of the HTTP Inbound Endpoint, a new `IntegrationRequestMappingHandlerMapping` bean is either registered or an existing bean is being reused. To achieve flexible Request Mapping configuration, Spring Integration provides the `<request-mapping/>` sub-element for the `<http:inbound-channel-adapter/>` and the `<http:inbound-gateway/>`. Both HTTP Inbound Endpoints are now fully based on the Request Mapping infrastructure that was introduced with Spring MVC 3.1. For example, multiple paths are supported on a single inbound endpoint. For more information see the section called “CompletableFuture”.

===== Spring Expression Language (SpEL) Configuration

A new `IntegrationEvaluationContextFactoryBean` is provided to allow configuration of custom `PropertyAccessor` s and functions for use in SpEL expressions throughout the framework. For more information see the section called “CompletableFuture”.

===== SpEL Functions Support

To customize the SpEL `EvaluationContext` with static `Method` functions, the new `<spel-function/>` component is introduced. Two built-in functions are also provided (`#jsonPath` and `#xpath`). For more information see the section called “CompletableFuture”.

===== SpEL PropertyAccessors Support

To customize the SpEL `EvaluationContext` with `PropertyAccessor` implementations the new `<spel-property-accessors/>` component is introduced. For more information see the section called “CompletableFuture”.

===== Redis: New Components

A new Redis-based MetadataStore implementation has been added. The `RedisMetadataStore` can be used to maintain state of a `MetadataStore` across application restarts. This new `MetadataStore` implementation can be used with adapters such as:

- Twitter Inbound Adapters
- Feed Inbound Channel Adapter

New queue-based components have been added. The `<int-redis:queue-inbound-channel-adapter/>` and the `<int-redis:queue-outbound-channel-adapter/>` components are provided to perform *right pop* and *left push* operations on a Redis List, respectively.

For more information see the section called “CompletableFuture”.

===== Header Channel Registry

It is now possible to instruct the framework to store reply and error channels in a registry for later resolution. This is useful for cases where the `replyChannel` or `errorChannel` might be lost; for example when serializing a message. See the section called “Header Enricher” for more information.

===== MongoDB support: New ConfigurableMongoDbMessageStore

In addition to the existing `eMongoDbMessageStore`, a new `ConfigurableMongoDbMessageStore` has been introduced. This provides a more robust and flexible implementation of `MessageStore` for MongoDB. It does not have backward compatibility, with the existing store, but it is recommended to use it for new applications. Existing applications can use it, but messages in the old store will not be available. See the section called “CompletableFuture” for more information.

===== Syslog Support

Building on the 2.2 `SyslogToMapTransformer` Spring Integration 3.0 now introduces `UDP` and `TCP` inbound channel adapters especially tailored for receiving SYSLOG messages. For more information, see the section called “CompletableFuture”.

===== *Tail* Support

File 'tail'ing inbound channel adapters are now provided to generate messages when lines are added to the end of text files; see the section called “CompletableFuture”.

===== JMX Support

- A new `<int-jmx:tree-polling-channel-adapter/>` is provided; this adapter queries the JMX MBean tree and sends a message with a payload that is the graph of objects that matches the query. By default the MBeans are mapped to primitives and simple Objects like Map, List and arrays - permitting simple transformation, for example, to JSON.
- The `IntegrationMBeanExporter` now allows the configuration of a custom `ObjectNamingStrategy` using the `naming-strategy` attribute.

For more information, see the section called “CompletableFuture”.

===== TCP/IP Connection Events and Connection Management

`TcpConnection` s now emit `ApplicationEvent` s (specifically `TcpConnectionEvent` s) when connections are opened, closed, or an exception occurs. This allows applications to be informed of changes to TCP connections using the normal Spring `ApplicationListener` mechanism.

`AbstractTcpConnection` has been renamed `TcpConnectionSupport`; custom connections that are subclasses of this class, can use its methods to publish events. Similarly, `AbstractTcpConnectionInterceptor` has been renamed to `TcpConnectionInterceptorSupport`.

In addition, a new `<int-ip:tcp-connection-event-inbound-channel-adapter/>` is provided; by default, this adapter sends all `TcpConnectionEvent` s to a `Channel`.

Further, the TCP Connection Factories, now provide a new method `getOpenConnectionIds()`, which returns a list of identifiers for all open connections; this allows applications, for example, to broadcast to all open connections.

Finally, the connection factories also provide a new method `closeConnection(String connectionId)` which allows applications to explicitly close a connection using its ID.

For more information see the section called “CompletableFuture”.

===== Inbound Channel Adapter Script Support

The `<int:inbound-channel-adapter/>` now supports `<expression/>` and `<script/>` sub-elements to create a `MessageSource`; see the section called “Channel Adapter Expressions and Scripts”.

===== Content Enricher: Headers Enrichment Support

The Content Enricher now provides configuration for `<header/>` sub-elements, to enrich the outbound Message with headers based on the reply Message from the underlying message flow. For more information see the section called “Payload Enricher”.

==== General Changes

===== Message ID Generation

Previously, message ids were generated using the JDK `UUID.randomUUID()` method. With this release, the default mechanism has been changed to use a more efficient algorithm which is significantly faster. In addition, the ability to change the strategy used to generate message ids has been added. For more information see the section called “Message ID Generation”.

===== <gateway> Changes

- It is now possible to set common headers across all gateway methods, and more options are provided for adding, to the message, information about which method was invoked.
- It is now possible to entirely customize the way that gateway method calls are mapped to messages.
- The `GatewayMethodMetadata` is now public class and it makes possible flexibly to configure the `GatewayProxyFactoryBean` programmatically from Java code.

For more information see Section 8.4, “Messaging Gateways”.

===== HTTP Endpoint Changes

- **Outbound Endpoint encode-uri** - `<http:outbound-gateway/>` and `<http:outbound-channel-adapter/>` now provide an `encode-uri` attribute to allow disabling the encoding of the URI object before sending the request.
- **Inbound Endpoint merge-with-default-converters** - `<http:inbound-gateway/>` and `<http:inbound-channel-adapter/>` now have a `merge-with-default-converters` attribute to include the list of default `HttpMessageConverter s` after the custom message converters.
- **If-(Un)Modified-Since HTTP Headers** - previously, *If-Modified-Since* and *If-Unmodified-Since* HTTP headers were incorrectly processed within from/to HTTP headers mapping in the `DefaultHttpHeaderMapper`. Now, in addition correcting that issue, `DefaultHttpHeaderMapper` provides date parsing from formatted strings for any HTTP headers that accept date-time values.

- **Inbound Endpoint Expression Variables** - In addition to the existing *#requestParams* and *#pathVariables*, the `<http:inbound-gateway/>` and `<http:inbound-channel-adapter/>` now support additional useful variables: *#matrixVariables*, *#requestAttributes*, *#requestHeaders* and *#cookies*. These variables are available in both payload and header expressions.
- **Outbound Endpoint uri-variables-expression** - HTTP Outbound Endpoints now support the `uri-variables-expression` attribute to specify an `Expression` to evaluate a `Map` for all URI variable placeholders within URL template. This allows selection of a different map of expressions based on the outgoing message.

For more information see the section called “CompletableFuture”.

===== Jackson Support (JSON)

- A new abstraction for JSON conversion has been introduced. Implementations for Jackson 1.x and Jackson 2 are currently provided, with the version being determined by presence on the classpath. Previously, only Jackson 1.x was supported.
- The `ObjectToJsonTransformer` and `JsonToObjectTransformer` now emit/consume headers containing type information.

For more information, see *JSON Transformers* in Section 7.1, “Transformer”.

===== Chain Elements *id* Attribute

Previously, the *id* attribute for elements within a `<chain>` was ignored and, in some cases, disallowed. Now, the *id* attribute is allowed for all elements within a `<chain>`. The bean names of chain elements is a combination of the surrounding chain’s *id* and the *id* of the element itself. For example: *fooChain $child.fooTransformer.handler*. For more information see Section 6.6, “Message Handler Chain”.

===== Aggregator *empty-group-min-timeout* property

The `AbstractCorrelatingMessageHandler` provides a new property `empty-group-min-timeout` to allow empty group expiry to run on a longer schedule than expiring partial groups. Empty groups will not be removed from the `MessageStore` until they have not been modified for at least this number of milliseconds. For more information see the section called “Configuring an Aggregator”.

===== Persistent File List Filters (file, (S)FTP)

New `FileListFilter` s that use a persistent `MetadataStore` are now available. These can be used to prevent duplicate files after a system restart. See the section called “CompletableFuture”, the section called “CompletableFuture”, and the section called “CompletableFuture” for more information.

===== Scripting Support: Variables Changes

A new `variables` attribute has been introduced for scripting components. In addition, variable bindings are now allowed for inline scripts. See the section called “CompletableFuture” and the section called “CompletableFuture” for more information.

===== Direct Channel Load Balancing configuration

Previously, when configuring `LoadBalancingStrategy` on the channel’s *dispatcher* sub-element, the only available option was to use a pre-defined enumeration of values which did not allow one to set a custom implementation of the `LoadBalancingStrategy`. You can now use `load-balancer-`

`ref` to provide a reference to a custom implementation of the `LoadBalancingStrategy`. For more information see the section called “DirectChannel”.

===== PublishSubscribeChannel Behavior

Previously, sending to a <publish-subscribe-channel/> that had no subscribers would return a `false` result. If used in conjunction with a `MessagingTemplate`, this would result in an exception being thrown. Now, the `PublishSubscribeChannel` has a property `minSubscribers` (default 0). If the message is sent to at least the minimum number of subscribers, the send is deemed to be successful (even if zero). If an application is expecting to get an exception under these conditions, set the minimum subscribers to at least 1.

===== FTP, SFTP and FTPS Changes

The FTP, SFTP and FTPS endpoints no longer cache sessions by default

The deprecated `cached-sessions` attribute has been removed from all endpoints. Previously, the embedded caching mechanism controlled by this attribute’s value didn’t provide a way to limit the size of the cache, which could grow indefinitely. The `CachingConnectionFactory` was introduced in release 2.1 and it became the preferred (and is now the only) way to cache sessions.

The `CachingConnectionFactory` now provides a new method `resetCache()`. This immediately closes idle sessions and causes in-use sessions to be closed as and when they are returned to the cache.

The `DefaultSftpSessionFactory` (in conjunction with a `CachingSessionFactory`) now supports multiplexing channels over a single SSH connection (SFTP Only).

FTP, SFTP and FTPS Inbound Adapters

Previously, there was no way to override the default filter used to process files retrieved from a remote server. The `filter` attribute determines which files are retrieved but the `FileReadingMessageSource` uses an `AcceptOnceFileListFilter`. This means that if a new copy of a file is retrieved, with the same name as a previously copied file, no message was sent from the adapter.

With this release, a new attribute `local-filter` allows you to override the default filter, for example with an `AcceptAllFileListFilter`, or some other custom filter.

For users that wish the behavior of the `AcceptOnceFileListFilter` to be maintained across JVM executions, a custom filter that retains state, perhaps on the file system, can now be configured.

Inbound Channel Adapters now support the `preserve-timestamp` attribute, which sets the local file modified timestamp to the timestamp from the server (default false).

FTP, SFTP and FTPS Gateways

- The gateways now support the **mv** command, enabling the renaming of remote files.
- The gateways now support recursive **ls** and **mget** commands, enabling the retrieval of a remote file tree.
- The gateways now support **put** and **mput** commands, enabling sending file(s) to the remote server.
- The `local-filename-generator-expression` attribute is now supported, enabling the naming of local files during retrieval. By default, the same name as the remote file is used.

- The `local-directory-expression` attribute is now supported, enabling the naming of local directories during retrieval based on the remote directory.

Remote File Template

A new higher-level abstraction (`RemoteFileTemplate`) is provided over the `Session` implementations used by the FTP and SFTP modules. While it is used internally by endpoints, this abstraction can also be used programmatically and, like all Spring `*Template` implementations, reliably closes the underlying session while allowing low level access to the session when needed.

For more information, see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== *requires-reply* Attribute for Outbound Gateways

All Outbound Gateways (e.g. `<jdbc:outbound-gateway/>` or `<jms:outbound-gateway/>`) are designed for *request-reply* scenarios. A response is expected from the external service and will be published to the `reply-channel`, or the `replyChannel` message header. However, there are some cases where the external system might not always return a result, e.g. a `<jdbc:outbound-gateway/>`, when a SELECT ends with an empty `ResultSet` or, say, a Web Service is One-Way. An option is therefore needed to configure whether or not a *reply* is required. For this purpose, the *requires-reply* attribute has been introduced for Outbound Gateway components. In most cases, the default value for *requires-reply* is `true` and, if there is not any result, a `ReplyRequiredException` will be thrown. Changing the value to `false` means that, if an external service doesn’t return anything, the message-flow will end at that point, similar to an Outbound Channel Adapter.

> **Note**
>
> The WebService outbound gateway has an additional attribute `ignore-empty-responses`; this is used to treat an empty String response as if no response was received. It is true by default but can be set to false to allow the application to receive an empty String in the reply message payload. When the attribute is true an empty string is treated as no response for the purposes of the *requires-reply* attribute. *requires-reply* is false by default for the WebService outbound gateway.

Note, the `requiresReply` property was previously present in the `AbstractReplyProducingMessageHandler` but set to `false`, and there wasn’t any way to configure it on Outbound Gateways using the XML namespace.

> **Important**
>
> Previously, a gateway receiving no reply would silently end the flow (with a DEBUG log message); with this change an exception will now be thrown by default by most gateways. To revert to the previous behavior, set `requires-reply` to false.

===== AMQP Outbound Gateway Header Mapping

Previously, the <int-amqp:outbound-gateway/> mapped headers before invoking the message converter, and the converter could overwrite headers such as `content-type`. The outbound adapter maps the headers after the conversion, which means headers like `content-type` from the outbound `Message` (if present) are used.

Starting with this release, the gateway now maps the headers after the message conversion, consistent with the adapter. If your application relies on the previous behavior (where the converter’s headers overrode the mapped headers), you either need to filter those headers (before the message reaches the gateway) or set them appropriately. The headers affected by the `SimpleMessageConverter` are `content-type` and `content-encoding`. Custom message converters may set other headers.

===== Stored Procedure Components Improvements

For more complex database-specific types, not supported by the standard `CallableStatement.getObject` method, 2 new additional attributes were introduced to the `<sql-parameter-definition/>` element with OUT-direction:

type-name

return-type

The `row-mapper` attribute of the Stored Procedure Inbound Channel Adapter `<returning-resultset/>` sub-element now supports a reference to a `RowMapper` bean definition. Previously, it contained just a class name (which is still supported).

For more information see the section called “CompletableFuture”.

===== Web Service Outbound URI Configuration

Web Service Outbound Gateway *uri* attribute now supports `<uri-variable/>` substitution for all URI-schemes supported by Spring Web Services. For more information see the section called “CompletableFuture”.

===== Redis Adapter Changes

The Redis Inbound Channel Adapter can now use a `null` value for `serializer` property, with the raw data being the message payload.

The Redis Outbound Channel Adapter now has the `topic-expression` property to determine the Redis topic against the Message at runtime.

The Redis Inbound Channel Adapter, in addition to the existing `topics` attribute, now has the `topic-patterns` attribute.

For more information, see the section called “CompletableFuture”.

===== Advising Filters

Previously, when a <filter/> had a <request-handler-advice-chain/>, the discard action was all performed within the scope of the advice chain (including any downstream flow on the `discard-channel`). The filter element now has an attribute `discard-within-advice` (default `true`), to allow the discard action to be performed after the advice chain completes. See the section called “CompletableFuture”.

===== Advising Endpoints using Annotations

Request Handler Advice Chains can now be configured using annotations. See the section called “CompletableFuture”.

===== ObjectToStringTransformer Improvements

This transformer now correctly transforms `byte[]` and `char[]` payloads to `String`. For more information see Section 7.1, “Transformer”.

===== JPA Support Changes

Payloads to *persist* or *merge* can now be of type `https://docs.oracle.com/javase/7/docs/api/java/lang/Iterable.html[java.lang.Iterable]`.

In that case, each object returned by the `Iterable` is treated as an entity and persisted or merged using the underlying `EntityManager`. *NULL* values returned by the iterator are ignored.

The JPA adapters now have additional attributes to optionally *flush* and *clear* entities from the associated persistence context after performing persistence operations.

Retrieving gateways had no mechanism to specify the first record to be retrieved which is a common use case. The retrieving gateways now support specifying this parameter using a `first-result` and `first-result-expression` attributes to the gateway definition. the section called “CompletableFuture”.

The JPA retrieving gateway and inbound adapter now have an attribute to specify the maximum number of results in a result set as an expression. In addition, the `max-results` attribute has been introduced to replace `max-number-of-results`, which has been deprecated. `max-results` and `max-results-expression` are used to provide the maximum number of results, or an expression to compute the maximum number of results, respectively, in the result set.

For more information see the section called “CompletableFuture”.

===== Delayer: delay expression

Previously, the `<delayer>` provided a `delay-header-name` attribute to determine the *delay* value at runtime. In complex cases it was necessary to precede the `<delayer>` with a `<header-enricher>`. Spring Integration 3.0 introduced the `expression` attribute and `expression` sub-element for dynamic delay determination. The `delay-header-name` attribute is now deprecated because the header evaluation can be specified in the `expression`. In addition, the `ignore-expression-failures` was introduced to control the behavior when an expression evaluation fails. For more information see the section called “CompletableFuture”.

===== JDBC Message Store Improvements

Spring Integration 3.0 adds a new set of DDL scripts for *MySQL* version 5.6.4 and higher. Now *MySQL* supports *fractional seconds* and is thus improving the FIFO ordering when polling from a MySQL-based Message Store. For more information, please see the section called “CompletableFuture”.

===== IMAP Idle Connection Exceptions

Previously, if an IMAP idle connection failed, it was logged but there was no mechanism to inform an application. Such exceptions now generate `ApplicationEvent` s. Applications can obtain these events using an `<int-event:inbound-channel-adapter>` or any `ApplicationListener` configured to receive an `ImapIdleExceptionEvent` or one of its super classes.

===== Message Headers and TCP

The TCP connection factories now enable the configuration of a flexible mechanism to transfer selected headers (as well as the payload) over TCP. A new `TcpMessageMapper` enables the selection of the headers, and an appropriate (de)serializer needs to be configured to write the resulting `Map` to the TCP stream. A `MapJsonSerializer` is provided as a convenient mechanism to transfer headers and payload over TCP. For more information see the section called “CompletableFuture”.

===== JMS Message Driven Channel Adapter

Previously, when configuring a `<message-driven-channel-adapter/>`, if you wished to use a specific `TaskExecutor`, it was necessary to declare a container bean and provide it to the adapter using the `container` attribute. The `task-executor` is now provided, allowing it to be set directly on the adapter. This is in addition to several other container attributes that were already available.

===== RMI Inbound Gateway

The RMI Inbound Gateway now supports an `error-channel` attribute. See the section called “CompletableFuture”.

===== XsltPayloadTransformer

You can now specify the transformer factory class name using the `transformer-factory-class` attribute. See the section called “CompletableFuture”

=== Changes between 2.1 and 2.2

==== New Components

===== RedisStore Inbound and Outbound Channel Adapters

Spring Integration now has RedisStore Inbound and Outbound Channel Adapters allowing you to write and read Message payloads to/from Redis collection(s). For more information please see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== MongoDB Inbound and Outbound Channel Adapters

Spring Integration now has MongoDB Inbound and Outbound Channel Adapters allowing you to write and read Message payloads to/from a MongoDB document store. For more information please see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== JPA Endpoints

Spring Integration now includes components for the Java Persistence API (JPA) for retrieving and persisting JPA entity objects. The JPA Adapter includes the following components:

- *Inbound Channel Adapter*
- *Outbound Channel Adapter*
- *Updating Outbound Gateway*
- *Retrieving Outbound Gateway*

For more information please see the section called “CompletableFuture”

==== General Changes

===== Spring 3.1 Used by Default

Spring Integration now uses Spring 3.1.

===== Adding Behavior to Endpoints

The ability to add an <advice-chain/> to a poller has been available for some time. However, the behavior added by this affects the entire integration flow. It did not address the ability to add, say, retry, to an individual endpoint. The 2.2. release introduces the <request-handler-advice-chain/> to many endpoints.

In addition, 3 standard Advice classes have been provided for this purpose:

- MessageHandlerRetryAdvice
- MessageHandlerCircuitBreakerAdvice
- ExpressionEvaluatingMessageHandlerAdvice

For more information, see the section called “CompletableFuture”.

===== Transaction Synchronization and Pseudo Transactions

Pollers can now participate in Spring’s *Transaction Synchronization* feature. This allows for synchronizing such operations as renaming files by an inbound channel adapter depending on whether the transaction commits, or rolls back.

In addition, these features can be enabled when there is not a *real* transaction present, by means of a `PseudoTransactionManager`.

For more information see the section called “CompletableFuture”.

===== File Adapter - Improved File Overwrite/Append Handling

When using the *File Oubound Channel Adapter* or the *File Outbound Gateway*, a new *mode* property was added. Prior to *Spring Integration 2.2*, target files were replaced when they existed. Now you can specify the following options:

- REPLACE (Default)
- APPEND
- FAIL
- IGNORE

For more information please see the section called “CompletableFuture”.

===== Reply-Timeout added to more Outbound Gateways

The XML Namespace support adds the *reply-timeout* attribute to the following *Outbound Gateways*:

- Amqp Outbound Gateway
- File Outbound Gateway
- Ftp Outbound Gateway
- Sftp Outbound Gateway
- Ws Outbound Gateway

===== Spring-AMQP 1.1

Spring Integration now uses Spring AMQP 1.1. This enables several features to be used within a Spring Integration application, including…

- A fixed reply queue for the outbound gateway

- HA (mirrored) queues
- Publisher Confirms
- Returned Messages
- Support for Dead Letter Exchanges/Dead Letter Queues

===== JDBC Support - Stored Procedures Components

SpEL Support

When using the Stored Procedure components of the Spring Integration JDBC Adapter, you can now provide Stored Procedure Names or Stored Function Names using Spring Expression Language (SpEL).

This allows you to specify the Stored Procedures to be invoked at runtime. For example, you can provide Stored Procedure names that you would like to execute via Message Headers. For more information please see the section called “CompletableFuture”.

JMX Support

The Stored Procedure components now provide basic JMX support, exposing some of their properties as MBeans:

- Stored Procedure Name
- Stored Procedure Name Expression
- JdbcCallOperations Cache Statistics

===== JDBC Support - Outbound Gateway

When using the JDBC Outbound Gateway, the update query is no longer mandatory. You can now provide solely a select query using the request message as a source of parameters.

===== JDBC Support - Channel-specific Message Store Implementation

A new *Message Channel*-specific Message Store Implementation has been added, providing a more scalable solution using database-specific SQL queries. For more information please see: the section called “CompletableFuture”.

===== Orderly Shutdown

A method `stopActiveComponents()` has been added to the IntegrationMBeanExporter. This allows a Spring Integration application to be shut down in an orderly manner, disallowing new inbound messages to certain adapters and waiting for some time to allow in-flight messages to complete.

===== JMS Oubound Gateway Improvements

The JMS Outbound Gateway can now be configured to use a `MessageListener` container to receive replies. This can improve performance of the gateway.

===== object-to-json-transformer

The `ObjectToJsonTransformer` now sets the *content-type* header to *application/json* by default. For more information see Section 7.1, “Transformer”.

===== HTTP Support

Java serialization over HTTP is no longer enabled by default. Previously, when setting a `expected-response-type` to a `Serializable` object, the `Accept` header was not properly set up. The `SerializingHttpMessageConverter` has now been updated to set the Accept header to `application/x-java-serialized-object`. However, because this could cause incompatibility with existing applications, it was decided to no longer automatically add this converter to the HTTP endpoints.

If you wish to use Java serialization, you will need to add the `SerializingHttpMessageConverter` to the appropriate endpoints, using the `message-converters` attribute, when using XML configuration, or using the `setMessageConverters()` method.

Alternatively, you may wish to consider using JSON instead which is enabled by simply having `Jackson` on the classpath.

=== Changes between 2.0 and 2.1

==== New Components

===== JSR-223 Scripting Support

In Spring Integration 2.0, support for Groovy was added. With Spring Integration 2.1 we expanded support for additional languages substantially by implementing support for JSR-223 (Scripting for the Java™ Platform). Now you have the ability to use any scripting language that supports JSR-223 including:

- Javascript
- Ruby/JRuby
- Python/Jython
- Groovy

For further details please see the section called “CompletableFuture”.

===== GemFire Support

Spring Integration provides support for GemFire by providing inbound adapters for entry and continuous query events, an outbound adapter to write entries to the cache, and `MessageStore` and `MessageGroupStore` implementations. Spring integration leverages the *Spring Gemfire* project, providing a thin wrapper over its components.

For further details please see the section called “CompletableFuture”.

===== AMQP Support

Spring Integration 2.1 adds several Channel Adapters for receiving and sending messages using thehttp://www.amqp.org/[*Advanced Message Queuing Protocol*] (AMQP). Furthermore, Spring Integration also provides a point-to-point Message Channel, as well as a publish/subscribe Message Channel that are backed by AMQP Exchanges and Queues.

For further details please see the section called “CompletableFuture”.

===== MongoDB Support

As of version 2.1 Spring Integration provides support for MongoDB by providing a MongoDB-based MessageStore.

For further details please see the section called “CompletableFuture”.

===== Redis Support

As of version 2.1 Spring Integration supports Redis, an advanced key-value store, by providing a Redis-based MessageStore as well as Publish-Subscribe Messaging adapters.

For further details please see the section called “CompletableFuture”.

===== Support for Spring’s Resource abstraction

As of version 2.1, we’ve introduced a new *Resource Inbound Channel Adapter* that builds upon Spring’s Resource abstraction to support greater flexibility across a variety of actual types of underlying resources, such as a file, a URL, or a class path resource. Therefore, it’s similar to but more generic than the *File Inbound Channel Adapter*.

For further details please see the section called “CompletableFuture”.

===== Stored Procedure Components

With Spring Integration 2.1, the `JDBC` Module also provides Stored Procedure support by adding several new components, including inbound/outbound channel adapters and an Outbound Gateway. The Stored Procedure support leverages Spring’shttp://static.springsource.org/spring/docs/3.0.x/javadoc-api/org/springframework/jdbc/core/simple/SimpleJdbcCall.html[`SimpleJdbcCall`] class and consequently supports stored procedures for:

- Apache Derby
- DB2
- MySQL
- Microsoft SQL Server
- Oracle
- PostgreSQL
- Sybase

The Stored Procedure components also support Sql Functions for the following databases:

- MySQL
- Microsoft SQL Server
- Oracle
- PostgreSQL

For further details please see the section called “CompletableFuture”.

===== XPath and XML Validating Filter

Spring Integration 2.1 provides a new XPath-based Message Filter, that is part of the `XML` module. The XPath Filter allows you to filter messages using provided XPath Expressions. Furthermore, documentation was added for the XML Validating Filter.

For more details please see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== Payload Enricher

Since Spring Integration 2.1, the Payload Enricher is provided. A Payload Enricher defines an endpoint that typically passes ahttp://static.springsource.org/spring-integration/api/org/springframework/integration/Message.html[`Message`] to the exposed request channel and then expects a reply message. The reply message then becomes the root object for evaluation of expressions to enrich the target payload.

For further details please see the section called “Payload Enricher”.

===== FTP and SFTP Outbound Gateways

Spring Integration 2.1 provides two new Outbound Gateways in order to interact with remote File Transfer Protocol (FTP) or Secure File Transfer Protocol (SFT) servers. These two gateways allow you to directly execute a limited set of remote commands.

For instance, you can use these Outbound Gateways to list, retrieve and delete remote files and have the Spring Integration message flow continue with the remote server’s response.

For further details please see the section called “CompletableFuture” and the section called “CompletableFuture”.

===== FTP Session Caching

As of version 2.1, we have exposed more flexibility with regards to session management for remote file adapters (e.g., FTP, SFTP etc).

Specifically, the `cache-sessions` attribute, which is available via the XML namespace support, is now *deprecated*. Alternatively, we added the `sessionCacheSize` and `sessionWaitTimeout` attributes on the `CachingSessionFactory`.

For further details please see the section called “CompletableFuture” and the section called “CompletableFuture”.

==== Framework Refactoring

===== Standardizing Router Configuration

Router parameters have been standardized across all router implementations with Spring Integration 2.1 providing a more consistent user experience.

With Spring Integration 2.1 the `ignore-channel-name-resolution-failures` attribute has been removed in favor of consolidating its behavior with the `resolution-required` attribute. Also, the `resolution-required` attribute now defaults to `true`.

Starting with Spring Integration 2.1, routers will no longer silently drop any messages, if no default output channel was defined. This means, that by default routers now require at least one resolved channel (if no `default-output-channel` was set) and by default will throw a `MessageDeliveryException` if no channel was determined (or an attempt to send was not successful).

If, however, you do desire to drop messages silently, simply set `default-output-channel="nullChannel"`.

> **Important**
>
> With the standardization of Router parameters and the consolidation of the parameters described above, there is the possibility of breaking older Spring Integration based applications.

For further details please see Section 6.1, “Routers”

===== XML Schemas updated to 2.1

Spring Integration 2.1 ships with an updated XML Schema (version 2.1), providing many improvements, e.g. the Router standardizations discussed above.

From now on, users *must* always declare the latest XML schema (currently version 2.1). Alternatively, they can use the version-less schema. Generally, the best option is to use version-less namespaces, as these will automatically use the latest available version of Spring Integration.

Declaring a version-less Spring Integration namespace:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:int="http://www.springframework.org/schema/integration"
   xsi:schemaLocation="http://www.springframework.org/schema/integration
           https://www.springframework.org/schema/integration/spring-integration.xsd
           http://www.springframework.org/schema/beans
           https://www.springframework.org/schema/beans/spring-beans.xsd">
...
</beans>
```

Declaring a Spring Integration namespace using an explicit version:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:int="http://www.springframework.org/schema/integration"
   xsi:schemaLocation="http://www.springframework.org/schema/integration
           https://www.springframework.org/schema/integration/spring-integration-2.2.xsd
           http://www.springframework.org/schema/beans
           https://www.springframework.org/schema/beans/spring-beans.xsd">
...
</beans>
```

The old 1.0 and 2.0 schemas are still there, but if an Application Context still references one of those deprecated schemas, the validator will fail on initialization.

==== Source Control Management and Build Infrastructure

===== Source Code now hosted on Github

Since version 2.0, the Spring Integration project uses Git for version control. In order to increase community visibility even further, the project was moved from SpringSource hosted Git repositories to Github. The Spring Integration Git repository is located at: spring-integration.

For the project we also improved the process of providing code contributions and we ensure that every commit is peer-reviewed. In fact, core committers now follow the same process as contributors. For more details please see:

Contributing.

===== Improved Source Code Visibility with Sonar

In an effort to provide better source code visibility and consequently to monitor the quality of Spring Integration's source code, an instance of Sonar was setup and metrics are gathered nightly and made available at:

sonar.spring.io.

==== New Samples

For the 2.1 release of Spring Integration we also expanded the Spring Integration Samples project and added many new samples, e.g. samples covering AMQP support, the new payload enricher, a sample illustrating techniques for testing Spring Integration flow fragments, as well as an example for executing Stored Procedures against Oracle. For details please visit:

spring-integration-samples.

=== Changes between 1.0 and 2.0

For a detailed migration guide in regards to upgrading an existing application that uses Spring Integration older than version 2.0, please see:

Spring Integration 1.0 to 2.0 Migration Guide

==== Spring 3 support

Spring Integration 2.0 is built on top of Spring 3.0.5 and makes many of its features available to our users.

===== Support for the Spring Expression Language (SpEL)

You can now use SpEL expressions within the *transformer, router, filter, splitter, aggregator, service-activator, header-enricher*, and many more elements of the Spring Integration core namespace as well as various adapters. There are many samples provided throughout this manual.

===== ConversionService and Converter

You can now benefit from *Conversion Service* support provided with Spring while configuring many Spring Integration components such as Datatype Channel. See the section called “Message Channel Implementations” as well the section called “CompletableFuture”. Also, the SpEL support mentioned in the previous point also relies upon the ConversionService. Therefore, you can register Converters once, and take advantage of them anywhere you are using SpEL expressions.

===== TaskScheduler and Trigger

Spring 3.0 defines two new strategies related to scheduling: *TaskScheduler and Trigger* Spring Integration (which uses a lot of scheduling) now builds upon these. In fact, Spring Integration 1.0 had originally defined some of the components (e.g. CronTrigger) that have now been migrated into Spring 3.0's core API. Now, you can benefit from reusing the same components within the entire Application Context (not just Spring Integration configuration). Configuration of Spring Integration Pollers has been greatly simplified as well by providing attributes for directly configuring rates, delays, cron expressions, and trigger references. See Section 4.3, “Channel Adapter” for sample configurations.

===== RestTemplate and HttpMessageConverter

Our outbound HTTP adapters now delegate to Spring’s RestTemplate for executing the HTTP request and handling its response. This also means that you can reuse any custom HttpMessageConverter implementations. See the section called “CompletableFuture” for more details.

==== Enterprise Integration Pattern Additions

Also in 2.0 we have added support for even more of the patterns described in Hohpe and Woolf’s Enterprise Integration Patterns book.

===== Message History

We now provide support for the Message History pattern allowing you to keep track of all traversed components, including the name of each channel and endpoint as well as the timestamp of that traversal. See the section called “CompletableFuture” for more details.

===== Message Store

We now provide support for the Message Store pattern. The Message Store provides a strategy for persisting messages on behalf of any process whose scope extends beyond a single transaction, such as the Aggregator and Resequencer. Many sections of this document provide samples on how to use a Message Store as it affects several areas of Spring Integration. See the section called “CompletableFuture”, Section 7.3, “Claim Check”, Section 4.1, “Message Channels”, Section 6.4, “Aggregator”, the section called “CompletableFuture”, and Section 6.5, “Resequencer” for more details

===== Claim Check

We have added an implementation of the Claim Check pattern. The idea behind the Claim Check pattern is that you can exchange a Message payload for a "claim ticket" and vice-versa. This allows you to reduce bandwidth and/or avoid potential security issues when sending Messages across channels. See Section 7.3, “Claim Check” for more details.

===== Control Bus

We have provided implementations of the Control Bus pattern which allows you to use messaging to manage and monitor endpoints and channels. The implementations include both a SpEL-based approach and one that executes Groovy scripts. See the section called “CompletableFuture” and the section called “CompletableFuture” for more details.

==== New Channel Adapters and Gateways

We have added several new Channel Adapters and Messaging Gateways in Spring Integration 2.0.

===== TCP/UDP Adapters

We have added Channel Adapters for receiving and sending messages over the TCP and UDP internet protocols. See the section called “CompletableFuture” for more details. Also, you can checkout the following blog: TCP/UDP support

===== Twitter Adapters

Twitter adapters provides support for sending and receiving Twitter Status updates as well as Direct Messages. You can also perform Twitter Searches with an inbound Channel Adapter. See the section called “CompletableFuture” for more details.

===== XMPP Adapters

The new XMPP adapters support both Chat Messages and Presence events. See the section called “CompletableFuture” for more details.

===== FTP/FTPS Adapters

Inbound and outbound File transfer support over FTP/FTPS is now available. See the section called “CompletableFuture” for more details.

===== SFTP Adapters

Inbound and outbound File transfer support over SFTP is now available. See the section called “CompletableFuture” for more details.

===== Feed Adapters

We have also added Channel Adapters for receiving news feeds (ATOM/RSS). See the section called “CompletableFuture” for more details.

==== Other Additions

===== Groovy Support

With Spring Integration 2.0 we’ve added Groovy support allowing you to use Groovy scripting language to provide integration and/or business logic. See the section called “CompletableFuture” for more details.

===== Map Transformers

These symmetrical transformers convert payload objects to and from a Map. See Section 7.1, “Transformer” for more details.

===== JSON Transformers

These symmetrical transformers convert payload objects to and from JSON. See Section 7.1, “Transformer” for more details.

===== Serialization Transformers

These symmetrical transformers convert payload objects to and from byte arrays. They also support the Serializer and Deserializer strategy interfaces that have been added as of Spring 3.0.5. See Section 7.1, “Transformer” for more details.

==== Framework Refactoring

The core API went through some significant refactoring to make it simpler and more usable. Although we anticipate that the impact to the end user should be minimal, please read through this document to find what was changed. Especially, visit the section called “Dynamic Routers” , Section 8.4, “Messaging Gateways”, the section called “CompletableFuture”, Section 5.1, “Message”, and Section 6.4, “Aggregator” for more details. If you are depending directly on some of the core components (Message, MessageHeaders, MessageChannel, MessageBuilder, etc.), you will notice that you need to update any import statements. We restructured some packaging to provide the flexibility we needed for extending the domain model while avoiding any cyclical dependencies (it is a policy of the framework to avoid such "tangles").

==== New Source Control Management and Build Infrastructure

With Spring Integration 2.0 we have switched our build environment to use Git for source control. To access our repository simply follow this URL: https://git.springsource.org/spring-integration. We have also switched our build system to Gradle.

==== New Spring Integration Samples

With Spring Integration 2.0 we have decoupled the samples from our main release distribution. Please read this blog to get more info New Spring Integration Samples We have also created many new samples, including samples for every new Adapter.

==== Spring Tool Suite Visual Editor for Spring Integration

There is an amazing new visual editor for Spring Integration included within the latest version of SpringSource Tool Suite. If you are not already using STS, please download it here:

Spring Tool Suite