

Spring for Apache Kafka

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Chapter 1. Preface

The Spring for Apache Kafka project applies core Spring concepts to the development of Kafka-based messaging solutions. We provide a “template” as a high-level abstraction for sending messages. We also provide support for Message-driven POJOs.

Chapter 2. What's new?

2.1. What's New in 2.2 Since 2.1

This section covers the changes made from version 2.1 to version 2.2.

2.1.1. Kafka Client Version

This version requires the 2.0.0 `kafka-clients` or higher.

2.1.2. Class and Package Changes

The `ContainerProperties` class has been moved from `org.springframework.kafka.listener.config` to `org.springframework.kafka.listener`.

The `AckMode` enum has been moved from `AbstractMessageListenerContainer` to `ContainerProperties`.

The `setBatchErrorHandler()` and `setErrorHandler()` methods have been moved from `ContainerProperties` to both `AbstractMessageListenerContainer` and `AbstractKafkaListenerContainerFactory`.

2.1.3. After Rollback Processing

A new `AfterRollbackProcessor` strategy is provided. See [After-rollback Processor](#) for more information.

2.1.4. ConcurrentKafkaListenerContainerFactory Changes

You can now use the `ConcurrentKafkaListenerContainerFactory` to create and configure any `ConcurrentMessageListenerContainer`, not only those for `@KafkaListener` annotations. See [Container factory](#) for more information.

2.1.5. Listener Container Changes

A new container property (`missingTopicsFatal`) has been added. See [Using KafkaMessageListenerContainer](#) for more information.

A `ConsumerStoppedEvent` is now emitted when a consumer terminates. See [Thread Safety](#) for more information.

Batch listeners can optionally receive the complete `ConsumerRecords<?, ?>` object instead of a `List<ConsumerRecord<?, ?>`. See [Batch listeners](#) for more information.

The `DefaultAfterRollbackProcessor` and `SeekToCurrentErrorHandler` can now recover (skip) records that keep failing, and, by default, does so after 10 failures. They can be configured to publish failed records to a dead-letter topic.

Starting with version 2.2.4, the consumer's group ID can be used while selecting the dead letter topic name.

See [After-rollback Processor](#), [Seek To Current Container Error Handlers](#), and [Publishing Dead-letter Records](#) for more information.

The `ConsumerStoppingEvent` has been added. See [Events](#) for more information.

The `SeekToCurrentErrorHandler` can now be configured to commit the offset of a recovered record when the container is configured with `AckMode.MANUAL_IMMEDIATE` (since 2.2.4). See [Seek To Current Container Error Handlers](#) for more information.

2.1.6. @KafkaListener Changes

You can now override the `concurrency` and `autoStartup` properties of the listener container factory by setting properties on the annotation. You can now add configuration to determine which headers (if any) are copied to a reply message. See [@KafkaListener Annotation](#) for more information.

You can now use `@KafkaListener` as a meta-annotation on your own annotations. See [@KafkaListener as a Meta Annotation](#) for more information.

It is now easier to configure a `Validator` for `@Payload` validation. See [@KafkaListener @Payload Validation](#) for more information.

You can now specify kafka consumer properties directly on the annotation; these will override any properties with the same name defined in the consumer factory (since version 2.2.4). See [Annotation Properties](#) for more information.

2.1.7. Header Mapping Changes

Headers of type `MimeType` and `MediaType` are now mapped as simple strings in the `RecordHeader` value. Previously, they were mapped as JSON and only `MimeType` was decoded. `MediaType` could not be decoded. They are now simple strings for interoperability.

Also, the `DefaultKafkaHeaderMapper` has a new `addToStringClasses` method, allowing the specification of types that should be mapped by using `toString()` instead of JSON. See [Message Headers](#) for more information.

2.1.8. Embedded Kafka Changes

The `KafkaEmbedded` class and its `KafkaRule` interface have been deprecated in favor of the `EmbeddedKafkaBroker` and its JUnit 4 `EmbeddedKafkaRule` wrapper. The `@EmbeddedKafka` annotation now populates an `EmbeddedKafkaBroker` bean instead of the deprecated `KafkaEmbedded`. This change allows the use of `@EmbeddedKafka` in JUnit 5 tests. The `@EmbeddedKafka` annotation now has the attribute `ports` to specify the port that populates the `EmbeddedKafkaBroker`. See [Testing Applications](#) for more information.

2.1.9. JsonSerializer/Deserializer Enhancements

You can now provide type mapping information by using producer and consumer properties.

New constructors are available on the deserializer to allow overriding the type header information with the supplied target type.

The `JsonDeserializer` now removes any type information headers by default.

You can now configure the `JsonDeserializer` to ignore type information headers by using a Kafka property (since 2.2.3).

See [Serialization, Deserialization, and Message Conversion](#) for more information.

2.1.10. Kafka Streams Changes

The streams configuration bean must now be a `KafkaStreamsConfiguration` object instead of a `StreamsConfig` object.

The `StreamsBuilderFactoryBean` has been moved from package `...core` to `...config`.

The `KafkaStreamBrancher` has been introduced for better end-user experience when conditional branches are built on top of `KStream` instance.

See [Kafka Streams Support](#) and [Configuration](#) for more information.

2.1.11. Transactional ID

When a transaction is started by the listener container, the `transactional.id` is now the `transactionIdPrefix` appended with `<group.id>.<topic>.<partition>`. This change allows proper fencing of zombies, [as described here](#).

Chapter 3. Introduction

This first part of the reference documentation is a high-level overview of Spring for Apache Kafka and the underlying concepts and some code snippets that can help you get up and running as quickly as possible.

3.1. Quick Tour for the Impatient

This is the five-minute tour to get started with Spring Kafka.

Prerequisites: You must install and run Apache Kafka. Then you must grab the spring-kafka JAR and all of its dependencies. The easiest way to do that is to declare a dependency in your build tool. The following example shows how to do so with Maven:

```
<dependency>
  <groupId>org.springframework.kafka</groupId>
  <artifactId>spring-kafka</artifactId>
  <version>2.2.4.RELEASE</version>
</dependency>
```

The following example shows how to do so with Gradle:

```
compile 'org.springframework.kafka:spring-kafka:2.2.4.RELEASE'
```

3.1.1. Compatibility

This quick tour works with the following versions:

- Apache Kafka Clients 2.0.0
- Spring Framework 5.1.x
- Minimum Java version: 8

3.1.2. A Very, Very Quick Example

As the following example shows, you can use plain Java to send and receive a message:

```

@Test
public void testAutoCommit() throws Exception {
    logger.info("Start auto");
    ContainerProperties containerProps = new ContainerProperties("topic1",
"topic2");
    final CountDownLatch latch = new CountDownLatch(4);
    containerProps.setMessageListener(new MessageListener<Integer, String>() {

        @Override
        public void onMessage(ConsumerRecord<Integer, String> message) {
            logger.info("received: " + message);
            latch.countDown();
        }

    });
    KafkaMessageListenerContainer<Integer, String> container =
createContainer(containerProps);
    container.setBeanName("testAuto");
    container.start();
    Thread.sleep(1000); // wait a bit for the container to start
    KafkaTemplate<Integer, String> template = createTemplate();
    template.setDefaultTopic(topic1);
    template.sendDefault(0, "foo");
    template.sendDefault(2, "bar");
    template.sendDefault(0, "baz");
    template.sendDefault(2, "qux");
    template.flush();
    assertTrue(latch.await(60, TimeUnit.SECONDS));
    container.stop();
    logger.info("Stop auto");
}

```

```

private KafkaMessageListenerContainer<Integer, String> createContainer(
    ContainerProperties containerProps) {
    Map<String, Object> props = consumerProps();
    DefaultKafkaConsumerFactory<Integer, String> cf =
        new DefaultKafkaConsumerFactory<Integer,
String>(props);
    KafkaMessageListenerContainer<Integer, String> container =
        new KafkaMessageListenerContainer<>(cf,
containerProps);
    return container;
}

private KafkaTemplate<Integer, String> createTemplate() {
    Map<String, Object> senderProps = senderProps();
    ProducerFactory<Integer, String> pf =
        new DefaultKafkaProducerFactory<Integer, String>(senderProps);
    KafkaTemplate<Integer, String> template = new KafkaTemplate<>(pf);
    return template;
}

private Map<String, Object> consumerProps() {
    Map<String, Object> props = new HashMap<>();
    props.put(ConsumerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:9092");
    props.put(ConsumerConfig.GROUP_ID_CONFIG, group);
    props.put(ConsumerConfig.ENABLE_AUTO_COMMIT_CONFIG, true);
    props.put(ConsumerConfig.AUTO_COMMIT_INTERVAL_MS_CONFIG, "100");
    props.put(ConsumerConfig.SESSION_TIMEOUT_MS_CONFIG, "15000");
    props.put(ConsumerConfig.KEY_DESERIALIZER_CLASS_CONFIG,
IntegerDeserializer.class);
    props.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
StringDeserializer.class);
    return props;
}

private Map<String, Object> senderProps() {
    Map<String, Object> props = new HashMap<>();
    props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:9092");
    props.put(ProducerConfig.RETRIES_CONFIG, 0);
    props.put(ProducerConfig.BATCH_SIZE_CONFIG, 16384);
    props.put(ProducerConfig.LINGER_MS_CONFIG, 1);
    props.put(ProducerConfig.BUFFER_MEMORY_CONFIG, 33554432);
    props.put(ProducerConfig.KEY_SERIALIZER_CLASS_CONFIG,
IntegerSerializer.class);
    props.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG,
StringSerializer.class);
    return props;
}

```

3.1.3. With Java Configuration

You can do the same work as appears in the previous example with Spring configuration in Java. The following example shows how to do so:

```
@Autowired
private Listener listener;

@Autowired
private KafkaTemplate<Integer, String> template;

@Test
public void testSimple() throws Exception {
    template.send("annotated1", 0, "foo");
    template.flush();
    assertTrue(this.listener.latch1.await(10, TimeUnit.SECONDS));
}

@Configuration
@EnableKafka
public class Config {

    @Bean
    ConcurrentKafkaListenerContainerFactory<Integer, String>
        kafkaListenerContainerFactory() {
        ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
            new ConcurrentKafkaListenerContainerFactory<>();
        factory.setConsumerFactory(consumerFactory());
        return factory;
    }

    @Bean
    public ConsumerFactory<Integer, String> consumerFactory() {
        return new DefaultKafkaConsumerFactory<>(consumerConfigs());
    }

    @Bean
    public Map<String, Object> consumerConfigs() {
        Map<String, Object> props = new HashMap<>();
        props.put(ConsumerConfig.BOOTSTRAP_SERVERS_CONFIG,
            embeddedKafka.getBrokersAsString());
        ...
        return props;
    }

    @Bean
    public Listener listener() {
        return new Listener();
    }
}
```

```

@Bean
public ProducerFactory<Integer, String> producerFactory() {
    return new DefaultKafkaProducerFactory<>(producerConfigs());
}

@Bean
public Map<String, Object> producerConfigs() {
    Map<String, Object> props = new HashMap<>();
    props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG,
embeddedKafka.getBrokersAsString());
    ...
    return props;
}

@Bean
public KafkaTemplate<Integer, String> kafkaTemplate() {
    return new KafkaTemplate<Integer, String>(producerFactory());
}
}

```

```

public class Listener {

    private final CountDownLatch latch1 = new CountDownLatch(1);

    @KafkaListener(id = "foo", topics = "annotated1")
    public void listen1(String foo) {
        this.latch1.countDown();
    }

}

```

3.1.4. Even Quicker, with Spring Boot

Spring Boot can make things even simpler. The following Spring Boot application sends three messages to a topic, receives them, and stops:

```

@SpringBootApplication
public class Application implements CommandLineRunner {

    public static Logger logger = LoggerFactory.getLogger(Application.class);

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args).close();
    }

    @Autowired
    private KafkaTemplate<String, String> template;

    private final CountDownLatch latch = new CountDownLatch(3);

    @Override
    public void run(String... args) throws Exception {
        this.template.send("myTopic", "foo1");
        this.template.send("myTopic", "foo2");
        this.template.send("myTopic", "foo3");
        latch.await(60, TimeUnit.SECONDS);
        logger.info("All received");
    }

    @KafkaListener(topics = "myTopic")
    public void listen(ConsumerRecord<?, ?> cr) throws Exception {
        logger.info(cr.toString());
        latch.countDown();
    }

}

```

Boot takes care of most of the configuration. When we use a local broker, the only properties we need are the following:

Example 1. application.properties

```

spring.kafka.consumer.group-id=foo
spring.kafka.consumer.auto-offset-reset=earliest

```

We need the first property because we are using group management to assign topic partitions to consumers, so we need a group. The second property ensures the new consumer group gets the messages we sent, because the container might start after the sends have completed.

Chapter 4. Reference

This part of the reference documentation details the various components that comprise Spring for Apache Kafka. The [main chapter](#) covers the core classes to develop a Kafka application with Spring.

4.1. Using Spring for Apache Kafka

This section offers detailed explanations of the various concerns that impact using Spring for Apache Kafka. For a quick but less detailed introduction, see [Quick Tour for the Impatient](#).

4.1.1. Configuring Topics

If you define a `KafkaAdmin` bean in your application context, it can automatically add topics to the broker. To do so, you can add a `NewTopic` `@Bean` for each topic to the application context. The following example shows how to do so:

```
@Bean
public KafkaAdmin admin() {
    Map<String, Object> configs = new HashMap<>();
    configs.put(AdminClientConfig.BOOTSTRAP_SERVERS_CONFIG,
        StringUtils.arrayToCommaDelimitedString(embeddedKafka().getBrokerAddresses()));
    return new KafkaAdmin(configs);
}

@Bean
public NewTopic topic1() {
    return new NewTopic("thing1", 10, (short) 2);
}

@Bean
public NewTopic topic2() {
    return new NewTopic("thing2", 10, (short) 2);
}
```

By default, if the broker is not available, a message is logged, but the context continues to load. You can programmatically invoke the admin's `initialize()` method to try again later. If you wish this condition to be considered fatal, set the admin's `fatalIfBrokerNotAvailable` property to `true`. The context then fails to initialize.



If the broker supports it (1.0.0 or higher), the admin increases the number of partitions if it is found that an existing topic has fewer partitions than the `NewTopic.numPartitions`.

For more advanced features, such as assigning partitions to replicas, you can use the `AdminClient` directly. The following example shows how to do so:

```
@Autowired
private KafkaAdmin admin;

...

AdminClient client = AdminClient.create(admin.getConfig());
...
client.close();
```

4.1.2. Sending Messages

This section covers how to send messages.

Using `KafkaTemplate`

This section covers how to use `KafkaTemplate` to send messages.

Overview

The `KafkaTemplate` wraps a producer and provides convenience methods to send data to Kafka topics. The following listing shows the relevant methods from `KafkaTemplate`:

```

ListenableFuture<SendResult<K, V>> sendDefault(V data);

ListenableFuture<SendResult<K, V>> sendDefault(K key, V data);

ListenableFuture<SendResult<K, V>> sendDefault(Integer partition, K key, V data);

ListenableFuture<SendResult<K, V>> sendDefault(Integer partition, Long timestamp,
K key, V data);

ListenableFuture<SendResult<K, V>> send(String topic, V data);

ListenableFuture<SendResult<K, V>> send(String topic, K key, V data);

ListenableFuture<SendResult<K, V>> send(String topic, Integer partition, K key, V
data);

ListenableFuture<SendResult<K, V>> send(String topic, Integer partition, Long
timestamp, K key, V data);

ListenableFuture<SendResult<K, V>> send(ProducerRecord<K, V> record);

ListenableFuture<SendResult<K, V>> send(Message<?> message);

Map<MetricName, ? extends Metric> metrics();

List<PartitionInfo> partitionsFor(String topic);

<T> T execute(ProducerCallback<K, V, T> callback);

// Flush the producer.

void flush();

interface ProducerCallback<K, V, T> {

    T doInKafka(Producer<K, V> producer);

}

```

See the [Javadoc](#) for more detail.

The `sendDefault` API requires that a default topic has been provided to the template.

The API takes in a `timestamp` as a parameter and stores this timestamp in the record. How the user-provided timestamp is stored depends on the timestamp type configured on the Kafka topic. If the topic is configured to use `CREATE_TIME`, the user specified timestamp is recorded (or generated if not specified). If the topic is configured to use `LOG_APPEND_TIME`, the user-specified timestamp is ignored and the broker adds in the local broker time.

The `metrics` and `partitionsFor` methods delegate to the same methods on the underlying `Producer`. The `execute` method provides direct access to the underlying `Producer`.

To use the template, you can configure a producer factory and provide it in the template's constructor. The following example shows how to do so:

```
@Bean
public ProducerFactory<Integer, String> producerFactory() {
    return new DefaultKafkaProducerFactory<>(producerConfigs());
}

@Bean
public Map<String, Object> producerConfigs() {
    Map<String, Object> props = new HashMap<>();
    props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:9092");
    props.put(ProducerConfig.KEY_SERIALIZER_CLASS_CONFIG, StringSerializer.class);
    props.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG,
StringSerializer.class);
    // See https://kafka.apache.org/documentation/#producerconfigs for more
properties
    return props;
}

@Bean
public KafkaTemplate<Integer, String> kafkaTemplate() {
    return new KafkaTemplate<Integer, String>(producerFactory());
}
```

You can also configure the template by using standard `<bean/>` definitions.

Then, to use the template, you can invoke one of its methods.

When you use the methods with a `Message<?>` parameter, the topic, partition, and key information is provided in a message header that includes the following items:

- `KafkaHeaders.TOPIC`
- `KafkaHeaders.PARTITION_ID`
- `KafkaHeaders.MESSAGE_KEY`
- `KafkaHeaders.TIMESTAMP`

The message payload is the data.

Optionally, you can configure the `KafkaTemplate` with a `ProducerListener` to get an asynchronous callback with the results of the send (success or failure) instead of waiting for the `Future` to complete. The following listing shows the definition of the `ProducerListener` interface:

```
public interface ProducerListener<K, V> {

    void onSuccess(String topic, Integer partition, K key, V value, RecordMetadata recordMetadata);

    void onError(String topic, Integer partition, K key, V value, Exception exception);

    boolean isInterestedInSuccess();

}
```

By default, the template is configured with a `LoggingProducerListener`, which logs errors and does nothing when the send is successful.

`onSuccess` is called only if `isInterestedInSuccess` returns `true`.

For convenience, the abstract `ProducerListenerAdapter` is provided in case you want to implement only one of the methods. It returns `false` for `isInterestedInSuccess`.

Notice that the send methods return a `ListenableFuture<SendResult>`. You can register a callback with the listener to receive the result of the send asynchronously. The following example shows how to do so:

```
ListenableFuture<SendResult<Integer, String>> future = template.send("something");
future.addCallback(new ListenableFutureCallback<SendResult<Integer, String>>() {

    @Override
    public void onSuccess(SendResult<Integer, String> result) {
        ...
    }

    @Override
    public void onFailure(Throwable ex) {
        ...
    }

});
```

`SendResult` has two properties, a `ProducerRecord` and `RecordMetadata`. See the Kafka API documentation for information about those objects.

If you wish to block the sending thread to await the result, you can invoke the future's `get()` method. You may wish to invoke `flush()` before waiting or, for convenience, the template has a constructor with an `autoFlush` parameter that causes the template to `flush()` on each send. Note,

however, that flushing likely significantly reduces performance.

Examples

This section shows examples of sending messages to Kafka:

Example 2. Non Blocking (Async)

```
public void sendToKafka(final MyOutputData data) {
    final ProducerRecord<String, String> record = createRecord(data);

    ListenableFuture<SendResult<Integer, String>> future = template.send(record);
    future.addCallback(new ListenableFutureCallback<SendResult<Integer, String>>()
    {

        @Override
        public void onSuccess(SendResult<Integer, String> result) {
            handleSuccess(data);
        }

        @Override
        public void onFailure(Throwable ex) {
            handleFailure(data, record, ex);
        }

    });
}
```

Blocking (Sync)

```
public void sendToKafka(final MyOutputData data) {
    final ProducerRecord<String, String> record = createRecord(data);

    try {
        template.send(record).get(10, TimeUnit.SECONDS);
        handleSuccess(data);
    }
    catch (ExecutionException e) {
        handleFailure(data, record, e.getCause());
    }
    catch (TimeoutException | InterruptedException e) {
        handleFailure(data, record, e);
    }
}
```

Transactions

This section describes how Spring for Apache Kafka supports transactions.

Overview

The 0.11.0.0 client library added support for transactions. Spring for Apache Kafka adds support in the following ways:

- `KafkaTransactionManager`: Used with normal Spring transaction support (`@Transactional`, `TransactionTemplate` etc).
- Transactional `KafkaMessageListenerContainer`
- Local transactions with `KafkaTemplate`

Transactions are enabled by providing the `DefaultKafkaProducerFactory` with a `transactionIdPrefix`. In that case, instead of managing a single shared `Producer`, the factory maintains a cache of transactional producers. When the user calls `close()` on a producer, it is returned to the cache for reuse instead of actually being closed. The `transactional.id` property of each producer is `transactionIdPrefix + n`, where `n` starts with `0` and is incremented for each new producer, unless the transaction is started by a listener container with a record-based listener. In that case, the `transactional.id` is `<transactionIdPrefix>.<group.id>.<topic>.<partition>`. This is to properly support fencing zombies, as described [here](#). This new behavior was added in versions 1.3.7, 2.0.6, 2.1.10, and 2.2.0. If you wish to revert to the previous behavior, you can set the `producerPerConsumerPartition` property on the `DefaultKafkaProducerFactory` to `false`.



While transactions are supported with batch listeners, zombie fencing cannot be supported because a batch may contain records from multiple topics or partitions.

Using `KafkaTransactionManager`

The `KafkaTransactionManager` is an implementation of Spring Framework's `PlatformTransactionManager`. It is provided with a reference to the producer factory in its constructor. If you provide a custom producer factory, it must support transactions. See `ProducerFactory.transactionCapable()`.

You can use the `KafkaTransactionManager` with normal Spring transaction support (`@Transactional`, `TransactionTemplate`, and others). If a transaction is active, any `KafkaTemplate` operations performed within the scope of the transaction use the transaction's `Producer`. The manager commits or rolls back the transaction, depending on success or failure. You must configure the `KafkaTemplate` to use the same `ProducerFactory` as the transaction manager.

Transactional Listener Container and Exactly Once Processing

You can provide a listener container with a `KafkaAwareTransactionManager` instance. When so configured, the container starts a transaction before invoking the listener. Any `KafkaTemplate` operations performed by the listener participate in the transaction. If the listener successfully processes the record (or multiple records, when using a `BatchMessageListener`), the container sends the offsets to the transaction by using `producer.sendOffsetsToTransaction()`, before the transaction manager commits the transaction. If the listener throws an exception, the transaction is rolled back and the consumer is repositioned so that the rolled-back record(s) can be retrieved on the next poll. See [After-rollback Processor](#) for more information and for handling records that repeatedly fail.

Transaction Synchronization

If you need to synchronize a Kafka transaction with some other transaction, configure the listener container with the appropriate transaction manager (one that supports synchronization, such as the `DataSourceTransactionManager`). Any operations performed on a transactional `KafkaTemplate` from the listener participate in a single transaction. The Kafka transaction is committed (or rolled back) immediately after the controlling transaction. Before exiting the listener, you should invoke one of the template's `sendOffsetsToTransaction` methods (unless you use a `ChainedKafkaTransactionManager`). For convenience, the listener container binds its consumer group ID to the thread, so, generally, you can use the first method. The following listing shows the two method signatures:

```
void sendOffsetsToTransaction(Map<TopicPartition, OffsetAndMetadata> offsets);

void sendOffsetsToTransaction(Map<TopicPartition, OffsetAndMetadata> offsets,
    String consumerGroupId);
```

The following example shows how to use the first signature of the `sendOffsetsToTransaction` method:

```
@Bean
KafkaMessageListenerContainer container(ConsumerFactory<String, String> cf,
    final KafkaTemplate template) {
    ContainerProperties props = new ContainerProperties("foo");
    props.setGroupId("group");
    props.setTransactionManager(new SomeOtherTransactionManager());
    ...
    props.setMessageListener((MessageListener<String, String> m -> {
        template.send("foo", "bar");
        template.send("baz", "qux");
        template.sendOffsetsToTransaction(
            Collections.singletonMap(new TopicPartition(m.topic(), m.partition()),
                new OffsetAndMetadata(m.offset() + 1)));
    });
    return new KafkaMessageListenerContainer<>(cf, props);
}
```



The offset to be committed is one greater than the offset of the records processed by the listener.



You should call this should only when you use transaction synchronization. When a listener container is configured to use a `KafkaTransactionManager`, it takes care of sending the offsets to the transaction.

Using `ChainedKafkaTransactionManager`

The `ChainedKafkaTransactionManager` was introduced in version 2.1.3. This is a subclass of `ChainedTransactionManager` that can have exactly one `KafkaTransactionManager`. Since it is a `KafkaAwareTransactionManager`, the container can send the offsets to the transaction in the same way as when the container is configured with a simple `KafkaTransactionManager`. This provides another mechanism for synchronizing transactions without having to send the offsets to the transaction in the listener code. You should chain your transaction managers in the desired order and provide the `ChainedTransactionManager` in the `ContainerProperties`.

`KafkaTemplate` Local Transactions

You can use the `KafkaTemplate` to execute a series of operations within a local transaction. The following example shows how to do so:

```
boolean result = template.executeInTransaction(t -> {
    t.sendDefault("thing1", "thing2");
    t.sendDefault("cat", "hat");
    return true;
});
```

The argument in the callback is the template itself (`this`). If the callback exits normally, the transaction is committed. If an exception is thrown, the transaction is rolled back.



If there is a `KafkaTransactionManager` (or synchronized) transaction in process, it is not used. Instead, a new "nested" transaction is used.

Using `ReplyingKafkaTemplate`

Version 2.1.3 introduced a subclass of `KafkaTemplate` to provide request/reply semantics. The class is named `ReplyingKafkaTemplate` and has one method (in addition to those in the superclass). The following listing shows the method's signature:

```
RequestReplyFuture<K, V, R> sendAndReceive(ProducerRecord<K, V> record);
```

The result is a `ListenableFuture` that is asynchronously populated with the result (or an exception, for a timeout). The result also has a `sendFuture` property, which is the result of calling `KafkaTemplate.send()`. You can use this future to determine the result of the send operation.

The following Spring Boot application shows an example of how to use the feature:

```
@SpringBootApplication
public class KRequestingApplication {
```

```

public static void main(String[] args) {
    SpringApplication.run(KRequestingApplication.class, args).close();
}

@Bean
public ApplicationRunner runner(ReplyingKafkaTemplate<String, String, String>
template) {
    return args -> {
        ProducerRecord<String, String> record = new
ProducerRecord<>("kRequests", "foo");
        RequestReplyFuture<String, String, String> replyFuture =
template.sendAndReceive(record);
        SendResult<String, String> sendResult =
replyFuture.getSendFuture().get();
        System.out.println("Sent ok: " + sendResult.getRecordMetadata());
        ConsumerRecord<String, String> consumerRecord = replyFuture.get();
        System.out.println("Return value: " + consumerRecord.value());
    };
}

@Bean
public ReplyingKafkaTemplate<String, String, String> replyingTemplate(
    ProducerFactory<String, String> pf,
    ConcurrentMessageListenerContainer<Long, String> repliesContainer) {

    return new ReplyingKafkaTemplate<>(pf, repliesContainer);
}

@Bean
public ConcurrentMessageListenerContainer<String, String> repliesContainer(
    ConcurrentKafkaListenerContainerFactory<String, String>
containerFactory) {

    ConcurrentMessageListenerContainer<String, String> repliesContainer =
        containerFactory.createContainer("replies");
    repliesContainer.getContainerProperties().setGroupId("repliesGroup");
    repliesContainer.setAutoStartup(false);
    return repliesContainer;
}

@Bean
public NewTopic kRequests() {
    return new NewTopic("kRequests", 10, (short) 2);
}

@Bean
public NewTopic kReplies() {
    return new NewTopic("kReplies", 10, (short) 2);
}

```

```
}
```

Note that we can use Boot's auto-configured container factory to create the reply container.

The template sets a header called `KafkaHeaders.CORRELATION_ID`, which must be echoed back by the server side.

In this case, the following `@KafkaListener` application responds:

```
@SpringBootApplication
public class KReplyingApplication {

    public static void main(String[] args) {
        SpringApplication.run(KReplyingApplication.class, args);
    }

    @KafkaListener(id="server", topics = "kRequests")
    @SendTo // use default replyTo expression
    public String listen(String in) {
        System.out.println("Server received: " + in);
        return in.toUpperCase();
    }

    @Bean
    public NewTopic kRequests() {
        return new NewTopic("kRequests", 10, (short) 2);
    }

    @Bean // not required if Jackson is on the classpath
    public MessagingMessageConverter simpleMapperConverter() {
        MessagingMessageConverter messagingMessageConverter = new
MessagingMessageConverter();
        messagingMessageConverter.setHeaderMapper(new SimpleKafkaHeaderMapper());
        return messagingMessageConverter;
    }
}
```

The `@KafkaListener` infrastructure echoes the correlation ID and determines the reply topic.

See [Forwarding Listener Results using @SendTo](#) for more information about sending replies. The template uses the default header `KafkaHeaders.REPLY_TOPIC` to indicate the topic to which the reply goes.

Starting with version 2.2, the template tries to detect the reply topic or partition from the configured reply container. If the container is configured to listen to a single topic or a single `TopicPartitionInitialOffset`, it is used to set the reply headers. If the container is configured

otherwise, the user must set up the reply headers. In this case, an **INFO** log message is written during initialization. The following example uses `KafkaHeaders.REPLY_TOPIC`:

```
record.headers().add(new RecordHeader(KafkaHeaders.REPLY_TOPIC,
    "kReplies".getBytes()));
```

When you configure with a single reply `TopicPartitionInitialOffset`, you can use the same reply topic for multiple templates, as long as each instance listens on a different partition. When configuring with a single reply topic, each instance must use a different `group.id`. In this case, all instances receive each reply, but only the instance that sent the request finds the correlation ID. This may be useful for auto-scaling, but with the overhead of additional network traffic and the small cost of discarding each unwanted reply. When you use this setting, we recommend that you set the template's `sharedReplyTopic` to `true`, which reduces the logging level of unexpected replies to **DEBUG** instead of the default **ERROR**.



If you have multiple client instances and you do not configure them as discussed in the preceding paragraph, each instance needs a dedicated reply topic. An alternative is to set the `KafkaHeaders.REPLY_PARTITION` and use a dedicated partition for each instance. The `Header` contains a four-byte int (big-endian). The server must use this header to route the reply to the correct topic (`@KafkaListener` does this). In this case, though, the reply container must not use Kafka's group management feature and must be configured to listen on a fixed partition (by using a `TopicPartitionInitialOffset` in its `ContainerProperties` constructor).



The `DefaultKafkaHeaderMapper` requires Jackson to be on the classpath (for the `@KafkaListener`). If it is not available, the message converter has no header mapper, so you must configure a `MessagingMessageConverter` with a `SimpleKafkaHeaderMapper`, as shown earlier.

4.1.3. Receiving Messages

You can receive messages by configuring a `MessageListenerContainer` and providing a message listener or by using the `@KafkaListener` annotation.

Message Listeners

When you use a `message listener container`, you must provide a listener to receive data. There are currently eight supported interfaces for message listeners. The following listing shows these interfaces:

```
public interface MessageListener<K, V> { ①

    void onMessage(ConsumerRecord<K, V> data);
```

```

}

public interface AcknowledgingMessageListener<K, V> { ②

    void onMessage(ConsumerRecord<K, V> data, Acknowledgment acknowledgment);

}

public interface ConsumerAwareMessageListener<K, V> extends MessageListener<K, V>
{ ③

    void onMessage(ConsumerRecord<K, V> data, Consumer<?, ?> consumer);

}

public interface AcknowledgingConsumerAwareMessageListener<K, V> extends
MessageListener<K, V> { ④

    void onMessage(ConsumerRecord<K, V> data, Acknowledgment acknowledgment,
Consumer<?, ?> consumer);

}

public interface BatchMessageListener<K, V> { ⑤

    void onMessage(List<ConsumerRecord<K, V>> data);

}

public interface BatchAcknowledgingMessageListener<K, V> { ⑥

    void onMessage(List<ConsumerRecord<K, V>> data, Acknowledgment
acknowledgment);

}

public interface BatchConsumerAwareMessageListener<K, V> extends
BatchMessageListener<K, V> { ⑦

    void onMessage(List<ConsumerRecord<K, V>> data, Consumer<?, ?> consumer);

}

public interface BatchAcknowledgingConsumerAwareMessageListener<K, V> extends
BatchMessageListener<K, V> { ⑧

    void onMessage(List<ConsumerRecord<K, V>> data, Acknowledgment acknowledgment,
Consumer<?, ?> consumer);

}

```

- ① Use this interface for processing individual `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using auto-commit or one of the container-managed `commit methods`.
- ② Use this interface for processing individual `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using one of the manual `commit methods`.
- ③ Use this interface for processing individual `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using auto-commit or one of the container-managed `commit methods`. Access to the `Consumer` object is provided.
- ④ Use this interface for processing individual `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using one of the manual `commit methods`. Access to the `Consumer` object is provided.
- ⑤ Use this interface for processing all `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using auto-commit or one of the container-managed `commit methods`. `AckMode.RECORD` is not supported when you use this interface, since the listener is given the complete batch.
- ⑥ Use this interface for processing all `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using one of the manual `commit methods`.
- ⑦ Use this interface for processing all `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using auto-commit or one of the container-managed `commit methods`. `AckMode.RECORD` is not supported when you use this interface, since the listener is given the complete batch. Access to the `Consumer` object is provided.
- ⑧ Use this interface for processing all `ConsumerRecord` instances received from the Kafka consumer `poll()` operation when using one of the manual `commit methods`. Access to the `Consumer` object is provided.



The `Consumer` object is not thread-safe. You must only invoke its methods on the thread that calls the listener.

Message Listener Containers

Two `MessageListenerContainer` implementations are provided:

- `KafkaMessageListenerContainer`
- `ConcurrentMessageListenerContainer`

The `KafkaMessageListenerContainer` receives all message from all topics or partitions on a single thread. The `ConcurrentMessageListenerContainer` delegates to one or more `KafkaMessageListenerContainer` instances to provide multi-threaded consumption.

Using `KafkaMessageListenerContainer`

The following constructors are available:

```

public KafkaMessageListenerContainer(ConsumerFactory<K, V> consumerFactory,
                                     ContainerProperties containerProperties)

public KafkaMessageListenerContainer(ConsumerFactory<K, V> consumerFactory,
                                     ContainerProperties containerProperties,
                                     TopicPartitionInitialOffset... topicPartitions)

```

Each takes a `ConsumerFactory` and information about topics and partitions, as well as other configuration in a `ContainerProperties` object. The second constructor is used by the `ConcurrentMessageListenerContainer` (described later) to distribute `TopicPartitionInitialOffset` across the consumer instances. `ContainerProperties` has the following constructors:

```

public ContainerProperties(TopicPartitionInitialOffset... topicPartitions)

public ContainerProperties(String... topics)

public ContainerProperties(Pattern topicPattern)

```

The first constructor takes an array of `TopicPartitionInitialOffset` arguments to explicitly instruct the container about which partitions to use (using the consumer `assign()` method) and with an optional initial offset. A positive value is an absolute offset by default. A negative value is relative to the current last offset within a partition by default. A constructor for `TopicPartitionInitialOffset` that takes an additional `boolean` argument is provided. If this is `true`, the initial offsets (positive or negative) are relative to the current position for this consumer. The offsets are applied when the container is started. The second takes an array of topics, and Kafka allocates the partitions based on the `group.id` property — distributing partitions across the group. The third uses a regex `Pattern` to select the topics.

To assign a `MessageListener` to a container, you can use the `ContainerProps.setMessageListener` method when creating the Container. The following example shows how to do so:

```

ContainerProperties containerProps = new ContainerProperties("topic1", "topic2");
containerProps.setMessageListener(new MessageListener<Integer, String>() {
    ...
});
DefaultKafkaConsumerFactory<Integer, String> cf =
    new DefaultKafkaConsumerFactory<Integer,
String>(consumerProps());
KafkaMessageListenerContainer<Integer, String> container =
    new KafkaMessageListenerContainer<>(cf, containerProps);
return container;

```

Refer to the [Javadoc](#) for `ContainerProperties` for more information about the various properties that you can set.

Since version 2.1.1, a new property called `logContainerConfig` is available. When `true` and `INFO` logging is enabled each listener container writes a log message summarizing its configuration properties.

By default, logging of topic offset commits is performed at the `DEBUG` logging level. Starting with version 2.1.2, a property in `ContainerProperties` called `commitLogLevel` lets you specify the log level for these messages. For example, to change the log level to `INFO`, you can use `containerProperties.setCommitLogLevel(LogIfLevelEnabled.Level.INFO);`.

Starting with version 2.2, a new container property called `missingTopicsFatal` has been added (default: `true`). This prevents the container from starting if any of the configured topics are not present on the broker. It does not apply if the container is configured to listen to a topic pattern (regex). Previously, the container threads looped within the `consumer.poll()` method waiting for the topic to appear while logging many messages. Aside from the logs, there was no indication that there was a problem. To restore the previous behavior, you can set the property to `false`.

Using `ConcurrentMessageListenerContainer`

The single constructor is similar to the first `KafkaListenerContainer` constructor. The following listing shows the constructor's signature:

```
public ConcurrentMessageListenerContainer(ConsumerFactory<K, V> consumerFactory,
                                         ContainerProperties containerProperties)
```

It also has a `concurrency` property. For example, `container.setConcurrency(3)` creates three `KafkaMessageListenerContainer` instances.

For the first constructor, Kafka distributes the partitions across the consumers using its group management capabilities.



When listening to multiple topics, the default partition distribution may not be what you expect. For example, if you have three topics with five partitions each and you want to use `concurrency=15`, you see only five active consumers, each assigned one partition from each topic, with the other 10 consumers being idle. This is because the default Kafka `PartitionAssignor` is the `RangeAssignor` (see its Javadoc). For this scenario, you may want to consider using the `RoundRobinAssignor` instead, which distributes the partitions across all of the consumers. Then, each consumer is assigned one topic or partition. To change the `PartitionAssignor`, you can set the `partition.assignment.strategy` consumer property (`ConsumerConfigs.PARTITION_ASSIGNMENT_STRATEGY_CONFIG`) in the properties provided to the `DefaultKafkaConsumerFactory`.

When using Spring Boot, you can assign set the strategy as follows:

```
spring.kafka.consumer.properties.partition.assignment.strategy=\norg.apache.kafka.clients.consumer.RoundRobinAssignor
```

For the second constructor, the `ConcurrentMessageListenerContainer` distributes the `TopicPartition` instances across the delegate `KafkaMessageListenerContainer` instances.

If, say, six `TopicPartition` instances are provided and the `concurrency` is 3; each container gets two partitions. For five `TopicPartition` instances, two containers get two partitions, and the third gets one. If the `concurrency` is greater than the number of `TopicPartitions`, the `concurrency` is adjusted down such that each container gets one partition.



The `client.id` property (if set) is appended with `-n` where `n` is the consumer instance that corresponds to the concurrency. This is required to provide unique names for MBeans when JMX is enabled.

Starting with version 1.3, the `MessageListenerContainer` provides access to the metrics of the underlying `KafkaConsumer`. In the case of `ConcurrentMessageListenerContainer`, the `metrics()` method returns the metrics for all the target `KafkaMessageListenerContainer` instances. The metrics are grouped into the `Map<MetricName, ? extends Metric>` by the `client-id` provided for the underlying `KafkaConsumer`.

Committing Offsets

Several options are provided for committing offsets. If the `enable.auto.commit` consumer property is `true`, Kafka auto-commits the offsets according to its configuration. If it is `false`, the containers support several `AckMode` settings (described in the next list).

The consumer `poll()` method returns one or more `ConsumerRecords`. The `MessageListener` is called for each record. The following lists describes the action taken by the container for each `AckMode`:

- **RECORD**: Commit the offset when the listener returns after processing the record.
- **BATCH**: Commit the offset when all the records returned by the `poll()` have been processed.

- **TIME**: Commit the offset when all the records returned by the `poll()` have been processed, as long as the `ackTime` since the last commit has been exceeded.
- **COUNT**: Commit the offset when all the records returned by the `poll()` have been processed, as long as `ackCount` records have been received since the last commit.
- **COUNT_TIME**: Similar to **TIME** and **COUNT**, but the commit is performed if either condition is `true`.
- **MANUAL**: The message listener is responsible to `acknowledge()` the `Acknowledgment`. After that, the same semantics as **BATCH** are applied.
- **MANUAL_IMMEDIATE**: Commit the offset immediately when the `Acknowledgment.acknowledge()` method is called by the listener.



MANUAL, and **MANUAL_IMMEDIATE** require the listener to be an `AcknowledgingMessageListener` or a `BatchAcknowledgingMessageListener`. See [Message Listeners](#).

Depending on the `syncCommits` container property, the `commitSync()` or `commitAsync()` method on the consumer is used.

The `Acknowledgment` has the following method:

```
public interface Acknowledgment {

    void acknowledge();

}
```

This method gives the listener control over when offsets are committed.

Listener Container Auto Startup

The listener containers implement `SmartLifecycle`, and `autoStartup` is `true` by default. The containers are started in a late phase (`Integer.MAX_VALUE - 100`). Other components that implement `SmartLifecycle`, to handle data from listeners, should be started in an earlier phase. The `- 100` leaves room for later phases to enable components to be auto-started after the containers.

@KafkaListener Annotation

The `@KafkaListener` annotation is used to designate a bean method as a listener for a listener container. The bean is wrapped in a `MessagingMessageListenerAdapter` configured with various features, such as converters to convert the data, if necessary, to match the method parameters.

You can configure most attributes on the annotation with SpEL by using `#{...}` or property placeholders (`${...}`). See the [Javadoc](#) for more information.

Record Listeners

The `@KafkaListener` annotation provides a mechanism for simple POJO listeners. The following example shows how to use it:

```
public class Listener {

    @KafkaListener(id = "foo", topics = "myTopic", clientIdPrefix = "myClientId")
    public void listen(String data) {
        ...
    }
}
```

This mechanism requires an `@EnableKafka` annotation on one of your `@Configuration` classes and a listener container factory, which is used to configure the underlying `ConcurrentMessageListenerContainer`. By default, a bean with name `kafkaListenerContainerFactory` is expected. The following example shows how to use `ConcurrentMessageListenerContainer`:

```

@Configuration
@EnableKafka
public class KafkaConfig {

    @Bean
    KafkaListenerContainerFactory<ConcurrentMessageListenerContainer<Integer,
String>>
        kafkaListenerContainerFactory() {
        ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
            new ConcurrentKafkaListenerContainerFactory<>();
        factory.setConsumerFactory(consumerFactory());
        factory.setConcurrency(3);
        factory.getContainerProperties().setPollTimeout(3000);
        return factory;
    }

    @Bean
    public ConsumerFactory<Integer, String> consumerFactory() {
        return new DefaultKafkaConsumerFactory<>(consumerConfigs());
    }

    @Bean
    public Map<String, Object> consumerConfigs() {
        Map<String, Object> props = new HashMap<>();
        props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG,
embeddedKafka.getBrokersAsString());
        ...
        return props;
    }
}

```

Notice that, to set container properties, you must use the `getContainerProperties()` method on the factory. It is used as a template for the actual properties injected into the container.

Starting with version 2.1.1, you can now set the `client.id` property for consumers created by the annotation. The `clientIdPrefix` is suffixed with `-n`, where `n` is an integer representing the container number when using concurrency.

Starting with version 2.2, you can now override the container factory's `concurrency` and `autoStartup` properties by using properties on the annotation itself. The properties can be simple values, property placeholders, or SpEL expressions. The following example shows how to do so:

```
@KafkaListener(id = "myListener", topics = "myTopic",
    autoStartup = "${listen.auto.start:true}", concurrency =
"${listen.concurrency:3}")
public void listen(String data) {
    ...
}
```

You can also configure POJO listeners with explicit topics and partitions (and, optionally, their initial offsets). The following example shows how to do so:

```
@KafkaListener(id = "thing2", topicPartitions =
    { @TopicPartition(topic = "topic1", partitions = { "0", "1" }),
      @TopicPartition(topic = "topic2", partitions = "0",
        partitionOffsets = @PartitionOffset(partition = "1", initialOffset =
"100"))
    })
public void listen(ConsumerRecord<?, ?> record) {
    ...
}
```

You can specify each partition in the `partitions` or `partitionOffsets` attribute but not both.

When using manual `AckMode`, you can also provide the listener with the `Acknowledgment`. The following example also shows how to use a different container factory.

```
@KafkaListener(id = "cat", topics = "myTopic",
    containerFactory = "kafkaManualAckListenerContainerFactory")
public void listen(String data, Acknowledgment ack) {
    ...
    ack.acknowledge();
}
```

Finally, metadata about the message is available from message headers. You can use the following header names to retrieve the headers of the message:

- `KafkaHeaders.RECEIVED_MESSAGE_KEY`
- `KafkaHeaders.RECEIVED_TOPIC`
- `KafkaHeaders.RECEIVED_PARTITION_ID`
- `KafkaHeaders.RECEIVED_TIMESTAMP`
- `KafkaHeaders.TIMESTAMP_TYPE`

The following example shows how to use the headers:

```
@KafkaListener(id = "qux", topicPattern = "myTopic1")
public void listen(@Payload String foo,
    @Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) Integer key,
    @Header(KafkaHeaders.RECEIVED_PARTITION_ID) int partition,
    @Header(KafkaHeaders.RECEIVED_TOPIC) String topic,
    @Header(KafkaHeaders.RECEIVED_TIMESTAMP) long ts
    ) {
    ...
}
```

Batch listeners

Starting with version 1.1, you can configure `@KafkaListener` methods to receive the entire batch of consumer records received from the consumer poll. To configure the listener container factory to create batch listeners, you can set the `batchListener` property. The following example shows how to do so:

[illegible]

The following example shows how to receive a list of payloads:

```
@KafkaListener(id = "list", topics = "myTopic", containerFactory = "batchFactory")
public void listen(List<String> list) {
    ...
}
```

The topic, partition, offset, and so on are available in headers that parallel the payloads. The following example shows how to use the headers:

```
@KafkaListener(id = "list", topics = "myTopic", containerFactory = "batchFactory")
public void listen(List<String> list,
    @Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) List<Integer> keys,
    @Header(KafkaHeaders.RECEIVED_PARTITION_ID) List<Integer> partitions,
    @Header(KafkaHeaders.RECEIVED_TOPIC) List<String> topics,
    @Header(KafkaHeaders.OFFSET) List<Long> offsets) {
    ...
}
```

Alternatively, you can receive a `List` of `Message<?>` objects with each offset and other details in each message, but it must be the only parameter (aside from optional `Acknowledgment`, when using manual commits, and/or `Consumer<?, ?>` parameters) defined on the method. The following example shows how to do so:

```
@KafkaListener(id = "listMsg", topics = "myTopic", containerFactory =
"batchFactory")
public void listen14(List<Message<?>> list) {
    ...
}

@KafkaListener(id = "listMsgAck", topics = "myTopic", containerFactory =
"batchFactory")
public void listen15(List<Message<?>> list, Acknowledgment ack) {
    ...
}

@KafkaListener(id = "listMsgAckConsumer", topics = "myTopic", containerFactory =
"batchFactory")
public void listen16(List<Message<?>> list, Acknowledgment ack, Consumer<?, ?>
consumer) {
    ...
}
```

No conversion is performed on the payloads in this case.

If the `BatchMessagingMessageConverter` is configured with a `RecordMessageConverter`, you can also add a generic type to the `Message` parameter and the payloads are converted. See [Payload Conversion with Batch Listeners](#) for more information.

You can also receive a list of `ConsumerRecord<?, ?>` objects, but it must be the only parameter (aside from optional `Acknowledgment`, when using manual commits and `Consumer<?, ?>` parameters) defined on the method. The following example shows how to do so:

```

@KafkaListener(id = "listCRs", topics = "myTopic", containerFactory =
"batchFactory")
public void listen(List<ConsumerRecord<Integer, String>> list) {
    ...
}

@KafkaListener(id = "listCRsAck", topics = "myTopic", containerFactory =
"batchFactory")
public void listen(List<ConsumerRecord<Integer, String>> list, Acknowledgment ack)
{
    ...
}

```

Starting with version 2.2, the listener can receive the complete `ConsumerRecords<?, ?>` object returned by the `poll()` method, letting the listener access additional methods, such as `partitions()` (which returns the `TopicPartition` instances in the list) and `records(TopicPartition)` (which gets selective records). Again, this must be the only parameter (aside from optional `Acknowledgment`, when using manual commits or `Consumer<?, ?>` parameters) on the method. The following example shows how to do so:

```

@KafkaListener(id = "pollResults", topics = "myTopic", containerFactory =
"batchFactory")
public void pollResults(ConsumerRecords<?, ?> records) {
    ...
}

```



If the container factory has a `RecordFilterStrategy` configured, it is ignored for `ConsumerRecords<?, ?>` listeners, with a `WARN` log message emitted. Records can only be filtered with a batch listener if the `<List?>>` form of listener is used.

Annotation Properties

Starting with version 2.0, the `id` property (if present) is used as the Kafka consumer `group.id` property, overriding the configured property in the consumer factory, if present. You can also set `groupId` explicitly or set `idIsGroup` to false to restore the previous behavior of using the consumer factory `group.id`.

You can use property placeholders or SpEL expressions within most annotation properties, as the following example shows:


```
@KafkaListener(topics = "${some.property}")

@KafkaListener(topics = "#{someBean.someProperty}",
    groupId = "#{someBean.someProperty}.group")
```

Starting with version 2.1.2, the SpEL expressions support a special token: `__listener`. It is a pseudo bean name that represents the current bean instance within which this annotation exists.

Consider the following example:

```
@Bean
public Listener listener1() {
    return new Listener("topic1");
}

@Bean
public Listener listener2() {
    return new Listener("topic2");
}
```

Given the beans in the previous example, we can then use the following:

```
public class Listener {

    private final String topic;

    public Listener(String topic) {
        this.topic = topic;
    }

    @KafkaListener(topics = "#{__listener.topic}",
        groupId = "#{__listener.topic}.group")
    public void listen(...) {
        ...
    }

    public String getTopic() {
        return this.topic;
    }

}
```

If, in the unlikely event that you have an actual bean called `__listener`, you can change the expression token by using the `beanRef` attribute. The following example shows how to do so:

```
@KafkaListener(beanRef = "__x", topics = "#{__x.topic}",
    groupId = "#{__x.topic}.group")
```

Starting with version 2.2.4, you can specify Kafka consumer properties directly on the annotation, these will override any properties with the same name configured in the consumer factory. You **cannot** specify the `group.id` and `client.id` properties this way; they will be ignored; use the `groupId` and `clientIdPrefix` annotation properties for those.

The properties are specified as individual strings with the normal Java `Properties` file format: `foo:bar`, `foo=bar`, or `foo bar`.

```
@KafkaListener(topics = "myTopic", groupId="group", properties= {
    "max.poll.interval.ms:60000",
    ConsumerConfig.MAX_POLL_RECORDS_CONFIG + "=100"
})
```

Container Thread Naming

Listener containers currently use two task executors, one to invoke the consumer and another that is used to invoke the listener when the kafka consumer property `enable.auto.commit` is `false`. You can provide custom executors by setting the `consumerExecutor` and `listenerExecutor` properties of the container's `ContainerProperties`. When using pooled executors, be sure that enough threads are available to handle the concurrency across all the containers in which they are used. When using the `ConcurrentMessageListenerContainer`, a thread from each is used for each consumer (concurrency).

If you do not provide a consumer executor, a `SimpleAsyncTaskExecutor` is used. This executor creates threads with names similar to `<beanName>-C-1` (consumer thread). For the `ConcurrentMessageListenerContainer`, the `<beanName>` part of the thread name becomes `<beanName>-m`, where `m` represents the consumer instance. `n` increments each time the container is started. So, with a bean name of `container`, threads in this container will be named `container-0-C-1`, `container-1-C-1` etc., after the container is started the first time; `container-0-C-2`, `container-1-C-2` etc., after a stop and subsequent start.

@KafkaListener as a Meta Annotation

Starting with version 2.2, you can now use `@KafkaListener` as a meta annotation. The following example shows how to do so:

```

@Target(ElementType.METHOD)
@Retention(RetentionPolicy.RUNTIME)
@KafkaListener
public @interface MyThreeConsumersListener {

    @AliasFor(annotation = KafkaListener.class, attribute = "id")
    String id();

    @AliasFor(annotation = KafkaListener.class, attribute = "topics")
    String[] topics();

    @AliasFor(annotation = KafkaListener.class, attribute = "concurrency")
    String concurrency() default "3";

}

```

You must alias at least one of `topics`, `topicPattern`, or `topicPartitions` (and, usually, `id` or `groupId` unless you have specified a `group.id` in the consumer factory configuration). The following example shows how to do so:

```

@MyThreeConsumersListener(id = "my.group", topics = "my.topic")
public void listen1(String in) {
    ...
}

```

`@KafkaListener` on a Class

When you use `@KafkaListener` at the class-level, you must specify `@KafkaHandler` at the method level. When messages are delivered, the converted message payload type is used to determine which method to call. The following example shows how to do so:

```

@KafkaListener(id = "multi", topics = "myTopic")
static class MultiListenerBean {

    @KafkaHandler
    public void listen(String foo) {
        ...
    }

    @KafkaHandler
    public void listen(Integer bar) {
        ...
    }

    @KafkaHandler(isDefault = true)
    public void listenDefault(Object object) {
        ...
    }
}

```

Starting with version 2.1.3, you can designate a `@KafkaHandler` method as the default method that is invoked if there is no match on other methods. At most, one method can be so designated. When using `@KafkaHandler` methods, the payload must have already been converted to the domain object (so the match can be performed). Use a custom deserializer, the `JsonDeserializer`, or the `(String|Bytes)JsonMessageConverter` with its `TypePrecedence` set to `TYPE_ID`. See [Serialization, Deserialization, and Message Conversion](#) for more information.

`@KafkaListener` Lifecycle Management

The listener containers created for `@KafkaListener` annotations are not beans in the application context. Instead, they are registered with an infrastructure bean of type `KafkaListenerEndpointRegistry`. This bean is automatically declared by the framework and manages the containers' lifecycles; it will auto-start any containers that have `autoStartup` set to `true`. All containers created by all container factories must be in the same `phase`. See [Listener Container Auto Startup](#) for more information. You can manage the lifecycle programmatically by using the registry. Starting or stopping the registry will start or stop all the registered containers. Alternatively, you can get a reference to an individual container by using its `id` attribute. You can set `autoStartup` on the annotation, which overrides the default setting configured into the container factory. You can get a reference to the bean from the application context, such as auto-wiring, to manage its registered containers. The following examples show how to do so:

```
@KafkaListener(id = "myContainer", topics = "myTopic", autoStartup = "false")
public void listen(...) { ... }
```

```
@Autowired
private KafkaListenerEndpointRegistry registry;

...

this.registry.getListenerContainer("myContainer").start();

...
```

@KafkaListener @Payload Validation

Starting with version 2.2, it is now easier to add a `Validator` to validate `@KafkaListener @Payload` arguments. Previously, you had to configure a custom `DefaultMessageHandlerMethodFactory` and add it to the registrar. Now, you can add the validator to the registrar itself. The following code shows how to do so:

```
@Configuration
@EnableKafka
public class Config implements KafkaListenerConfigurer {

    ...

    @Override
    public void configureKafkaListeners(KafkaListenerEndpointRegistrar registrar)
    {
        registrar.setValidator(new MyValidator());
    }
}
```



When you use Spring Boot with the validation starter, a `LocalValidatorFactoryBean` is auto-configured, as the following example shows:

```
@Configuration
@EnableKafka
public class Config implements KafkaListenerConfigurer {

    @Autowired
    private LocalValidatorFactoryBean validator;
    ...

    @Override
    public void configureKafkaListeners(KafkaListenerEndpointRegistrar registrar)
    {
        registrar.setValidator(this.validator);
    }
}
```

The following examples show how to validate:

```

public static class ValidatedClass {

    @Max(10)
    private int bar;

    public int getBar() {
        return this.bar;
    }

    public void setBar(int bar) {
        this.bar = bar;
    }

}

```

```

@KafkaListener(id="validated", topics = "annotated35", errorHandler =
"validationErrorHandler",
    containerFactory = "kafkaJsonListenerContainerFactory")
public void validatedListener(@Payload @Valid ValidatedClass val) {
    ...
}

@Bean
public KafkaListenerErrorHandler validationErrorHandler() {
    return (m, e) -> {
        ...
    };
}

```

Rebalancing Listeners

`ContainerProperties` has a property called `consumerRebalanceListener`, which takes an implementation of the Kafka client's `ConsumerRebalanceListener` interface. If this property is not provided, the container configures a logging listener that logs rebalance events at the `INFO` level. The framework also adds a sub-interface `ConsumerAwareRebalanceListener`. The following listing shows the `ConsumerAwareRebalanceListener` interface definition:

```

public interface ConsumerAwareRebalanceListener extends ConsumerRebalanceListener
{
    void onPartitionsRevokedBeforeCommit(Consumer<?, ?> consumer,
        Collection<TopicPartition> partitions);

    void onPartitionsRevokedAfterCommit(Consumer<?, ?> consumer,
        Collection<TopicPartition> partitions);

    void onPartitionsAssigned(Consumer<?, ?> consumer, Collection<TopicPartition>
        partitions);
}

```

Notice that there are two callbacks when partitions are revoked. The first is called immediately. The second is called after any pending offsets are committed. This is useful if you wish to maintain offsets in some external repository, as the following example shows:

```

containerProperties.setConsumerRebalanceListener(new
ConsumerAwareRebalanceListener() {

    @Override
    public void onPartitionsRevokedBeforeCommit(Consumer<?, ?> consumer,
        Collection<TopicPartition> partitions) {
        // acknowledge any pending Acknowledgments (if using manual acks)
    }

    @Override
    public void onPartitionsRevokedAfterCommit(Consumer<?, ?> consumer,
        Collection<TopicPartition> partitions) {
        // ...
        store(consumer.position(partition));
        // ...
    }

    @Override
    public void onPartitionsAssigned(Collection<TopicPartition> partitions) {
        // ...
        consumer.seek(partition, offsetTracker.getOffset() + 1);
        // ...
    }
});

```


Forwarding Listener Results using `@SendTo`

Starting with version 2.0, if you also annotate a `@KafkaListener` with a `@SendTo` annotation and the method invocation returns a result, the result is forwarded to the topic specified by the `@SendTo`.

The `@SendTo` value can have several forms:

- `@SendTo("someTopic")` routes to the literal topic
- `@SendTo("#{someExpression}")` routes to the topic determined by evaluating the expression once during application context initialization.
- `@SendTo("!{someExpression}")` routes to the topic determined by evaluating the expression at runtime. The `#root` object for the evaluation has three properties:
 - `request`: The inbound `ConsumerRecord` (or `ConsumerRecords` object for a batch listener))
 - `source`: The `org.springframework.messaging.Message<?>` converted from the `request`.
 - `result`: The method return result.
- `@SendTo` (no properties): This is treated as `!{source.headers['kafka_replyTopic']}` (since version 2.1.3).

Starting with versions 2.1.11 and 2.2.1, property placeholders are resolved within `@SendTo` values.

The result of the expression evaluation must be a `String` that represents the topic name. The following examples show the various ways to use `@SendTo`:

```

@KafkaListener(topics = "annotated21")
@SendTo("!{request.value()}") // runtime SpEL
public String replyingListener(String in) {
    ...
}

@KafkaListener(topics = "${some.property:annotated22}")
@SendTo("#{myBean.replyTopic}") // config time SpEL
public Collection<String> replyingBatchListener(List<String> in) {
    ...
}

@KafkaListener(topics = "annotated23", errorHandler = "replyErrorHandler")
@SendTo("annotated23reply") // static reply topic definition
public String replyingListenerWithErrorHandler(String in) {
    ...
}
...
@KafkaListener(topics = "annotated25")
@SendTo("annotated25reply1")
public class MultiListenerSendTo {

    @KafkaHandler
    public String foo(String in) {
        ...
    }

    @KafkaHandler
    @SendTo("!{'annotated25reply2'}")
    public String bar(@Payload(required = false) KafkaNull nul,
                     @Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) int key) {
        ...
    }
}
}

```

Starting with version 2.2, you can add a [ReplyHeadersConfigurer](#) to the listener container factory. This is consulted to determine which headers you want to set in the reply message. The following example shows how to add a [ReplyHeadersConfigurer](#):

```

@Bean
public ConcurrentKafkaListenerContainerFactory<Integer, String>
kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    factory.setConsumerFactory(cf());
    factory.setReplyTemplate(template());
    factory.setReplyHeadersConfigurer((k, v) -> k.equals("cat"));
    return factory;
}

```

You can also add more headers if you wish. The following example shows how to do so:

```

@Bean
public ConcurrentKafkaListenerContainerFactory<Integer, String>
kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    factory.setConsumerFactory(cf());
    factory.setReplyTemplate(template());
    factory.setReplyHeadersConfigurer(new ReplyHeadersConfigurer() {

        @Override
        public boolean shouldCopy(String headerName, Object headerValue) {
            return false;
        }

        @Override
        public Map<String, Object> additionalHeaders() {
            return Collections.singletonMap("qux", "fiz");
        }

    });
    return factory;
}

```

When you use `@SendTo`, you must configure the `ConcurrentKafkaListenerContainerFactory` with a `KafkaTemplate` in its `replyTemplate` property to perform the send.



Unless you use [request/reply semantics](#) only the simple `send(topic, value)` method is used, so you may wish to create a subclass to generate the partition or key. The following example shows how to do so:

```

@Bean
public KafkaTemplate<String, String> myReplyingTemplate() {
    return new KafkaTemplate<Integer, String>(producerFactory()) {

        @Override
        public ListenableFuture<SendResult<String, String>> send(String topic,
String data) {
            return super.send(topic, partitionForData(data), keyForData(data),
data);
        }

        ...

    };
}

```

If the listener method returns `Message<?>` or `Collection<Message<?>>`, the listener method is responsible for setting up the message headers for the reply. For example, when handling a request from a `ReplyingKafkaTemplate`, you might do the following:



```

@KafkaListener(id = "messageReturned", topics = "someTopic")
public Message<?> listen(String in,
    @Header(KafkaHeaders.REPLY_TOPIC) byte[] replyTo,
    @Header(KafkaHeaders.CORRELATION_ID) byte[] correlation) {
    return MessageBuilder.withPayload(in.toUpperCase())
        .setHeader(KafkaHeaders.TOPIC, replyTo)
        .setHeader(KafkaHeaders.MESSAGE_KEY, 42)
        .setHeader(KafkaHeaders.CORRELATION_ID, correlation)
        .setHeader("someOtherHeader", "someValue")
        .build();
}

```

When using request/reply semantics, the target partition can be requested by the sender.

You can annotate a `@KafkaListener` method with `@SendTo` even if no result is returned. This is to allow the configuration of an `errorHandler` that can forward information about a failed message delivery to some topic. The following example shows how to do so:



```
@KafkaListener(id = "voidListenerWithReplyingErrorHandler", topics
= "someTopic",
    errorHandler = "voidSendToErrorHandler")
@SendTo("failures")
public void voidListenerWithReplyingErrorHandler(String in) {
    throw new RuntimeException("fail");
}

@Bean
public KafkaListenerErrorHandler voidSendToErrorHandler() {
    return (m, e) -> {
        return ... // some information about the failure and input
        data
    };
}
```

See [Handling Exceptions](#) for more information.

Filtering Messages

In certain scenarios, such as rebalancing, a message that has already been processed may be redelivered. The framework cannot know whether such a message has been processed or not. That is an application-level function. This is known as the [Idempotent Receiver](#) pattern and Spring Integration provides an [implementation of it](#).

The Spring for Apache Kafka project also provides some assistance by means of the `FilteringMessageListenerAdapter` class, which can wrap your `MessageListener`. This class takes an implementation of `RecordFilterStrategy` in which you implement the `filter` method to signal that a message is a duplicate and should be discarded. This has an additional property called `ackDiscarded`, which indicates whether the adapter should acknowledge the discarded record. It is `false` by default.

When you use `@KafkaListener`, set the `RecordFilterStrategy` (and optionally `ackDiscarded`) on the container factory so that the listener is wrapped in the appropriate filtering adapter.

In addition, a `FilteringBatchMessageListenerAdapter` is provided, for when you use a batch [message listener](#).



The `FilteringBatchMessageListenerAdapter` is ignored if your `@KafkaListener` receives a `ConsumerRecords<?, ?>` instead of `List<ConsumerRecord<?, ?>>`, because `ConsumerRecords` is immutable.

Retrying Deliveries

If your listener throws an exception, the default behavior is to invoke the `ErrorHandler`, if configured, or logged otherwise.



Two error handler interfaces (`ErrorHandler` and `BatchErrorHandler`) are provided. You must configure the appropriate type to match the `message listener`.

To retry deliveries, a convenient listener adapter `RetryingMessageListenerAdapter` is provided.

You can configure it with a `RetryTemplate` and `RecoveryCallback<Void>` - see the [spring-retry](#) project for information about these components. If a recovery callback is not provided, the exception is thrown to the container after retries are exhausted. In that case, the `ErrorHandler` is invoked, if configured, or logged otherwise.

When you use `@KafkaListener`, you can set the `RetryTemplate` (and optionally `recoveryCallback`) on the container factory. When you do so, the listener is wrapped in the appropriate retrying adapter.

The contents of the `RetryContext` passed into the `RecoveryCallback` depend on the type of listener. The context always has a `record` attribute, which is the record for which the failure occurred. If your listener is acknowledging or consumer aware, additional `acknowledgment` or `consumer` attributes are available. For convenience, the `RetryingMessageListenerAdapter` provides static constants for these keys. See its [Javadoc](#) for more information.

A retry adapter is not provided for any of the batch `message listeners`, because the framework has no knowledge of where in a batch the failure occurred. If you need retry capabilities when you use a batch listener, we recommend that you use a `RetryTemplate` within the listener itself.

Stateful Retry

You should understand that the retry discussed in the [preceding section](#) suspends the consumer thread (if a `BackOffPolicy` is used). There are no calls to `Consumer.poll()` during the retries. Kafka has two properties to determine consumer health. The `session.timeout.ms` is used to determine if the consumer is active. Since version `0.10.1.0`, heartbeats are sent on a background thread, so a slow consumer no longer affects that. `max.poll.interval.ms` (default: five minutes) is used to determine if a consumer appears to be hung (taking too long to process records from the last poll). If the time between `poll()` calls exceeds this, the broker revokes the assigned partitions and performs a rebalance. For lengthy retry sequences, with back off, this can easily happen.

Since version 2.1.3, you can avoid this problem by using stateful retry in conjunction with a `SeekToCurrentErrorHandler`. In this case, each delivery attempt throws the exception back to the container, the error handler re-seeks the unprocessed offsets, and the same message is redelivered by the next `poll()`. This avoids the problem of exceeding the `max.poll.interval.ms` property (as long as an individual delay between attempts does not exceed it). So, when you use an `ExponentialBackOffPolicy`, you must ensure that the `maxInterval` is less than the `max.poll.interval.ms` property. To enable stateful retry, you can use the `RetryingMessageListenerAdapter` constructor that takes a `stateful boolean` argument (set it to `true`). When you configure the listener container factory (for `@KafkaListener`), set the factory's `statefulRetry` property to `true`.

Detecting Idle and Non-Responsive Consumers

While efficient, one problem with asynchronous consumers is detecting when they are idle. You might want to take some action if no messages arrive for some period of time.

You can configure the listener container to publish a `ListenerContainerIdleEvent` when some time passes with no message delivery. While the container is idle, an event is published every `idleEventInterval` milliseconds.

To configure this feature, set the `idleEventInterval` on the container. The following example shows how to do so:

```
@Bean
public KafkaMessageListenerContainer(ConsumerFactory<String, String>
consumerFactory) {
    ContainerProperties containerProps = new ContainerProperties("topic1",
"topic2");
    ...
    containerProps.setIdleEventInterval(60000L);
    ...
    KafkaMessageListenerContainer<String, String> container = new
KafkaMessageListenerContainer<>(...);
    return container;
}
```

The following example shows how to set the `idleEventInterval` for a `@KafkaListener`:

```
@Bean
public ConcurrentKafkaListenerContainerFactory kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<String, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    ...
    factory.getContainerProperties().setIdleEventInterval(60000L);
    ...
    return factory;
}
```

In each of these cases, an event is published once per minute while the container is idle.

In addition, if the broker is unreachable, the consumer `poll()` method does not exit, so no messages are received and idle events cannot be generated. To solve this issue, the container publishes a `NonResponsiveConsumerEvent` if a poll does not return within 3x the `pollInterval` property. By default, this check is performed once every 30 seconds in each container. You can modify this behavior by setting the `monitorInterval` and `noPollThreshold` properties in the `ContainerProperties` when configuring the listener container. Receiving such an event lets you stop the containers, thus

waking the consumer so that it can terminate.

Event Consumption

You can capture these events by implementing `ApplicationListener` — either a general listener or one narrowed to only receive this specific event. You can also use `@EventListener`, introduced in Spring Framework 4.2.

The next example combines `@KafkaListener` and `@EventListener` into a single class. You should understand that the application listener gets events for all containers, so you may need to check the listener ID if you want to take specific action based on which container is idle. You can also use the `@EventListener condition` for this purpose.

See [Events](#) for information about event properties.

The event is normally published on the consumer thread, so it is safe to interact with the `Consumer` object.

The following example uses both `@KafkaListener` and `@EventListener`:

```
public class Listener {

    @KafkaListener(id = "qux", topics = "annotated")
    public void listen4(@Payload String foo, Acknowledgment ack) {
        ...
    }

    @EventListener(condition = "event.listenerId.startsWith('qux-')")
    public void eventHandler(ListenerContainerIdleEvent event) {
        ...
    }

}
```



Event listeners see events for all containers. Consequently, in the preceding example, we narrow the events received based on the listener ID. Since containers created for the `@KafkaListener` support concurrency, the actual containers are named `id-n` where the `n` is a unique value for each instance to support the concurrency. That is why we use `startsWith` in the condition.



If you wish to use the idle event to stop the listener container, you should not call `container.stop()` on the thread that calls the listener. Doing so causes delays and unnecessary log messages. Instead, you should hand off the event to a different thread that can then stop the container. Also, you should not `stop()` the container instance if it is a child container. You should stop the concurrent container instead.

Current Positions when Idle

Note that you can obtain the current positions when idle is detected by implementing `ConsumerSeekAware` in your listener. See `onIdleContainer()` in [Seeking to a Specific Offset](#).

Topic/Partition Initial Offset

There are several ways to set the initial offset for a partition.

When manually assigning partitions, you can set the initial offset (if desired) in the configured `TopicPartitionInitialOffset` arguments (see [Message Listener Containers](#)). You can also seek to a specific offset at any time.

When you use group management where the broker assigns partitions:

- For a new `group.id`, the initial offset is determined by the `auto.offset.reset` consumer property (`earliest` or `latest`).
- For an existing group ID, the initial offset is the current offset for that group ID. You can, however, seek to a specific offset during initialization (or at any time thereafter).

Seeking to a Specific Offset

In order to seek, your listener must implement `ConsumerSeekAware`, which has the following methods:

```
void registerSeekCallback(ConsumerSeekCallback callback);

void onPartitionsAssigned(Map<TopicPartition, Long> assignments,
    ConsumerSeekCallback callback);

void onIdleContainer(Map<TopicPartition, Long> assignments, ConsumerSeekCallback
    callback);
```

The first method is called when the container is started. You should use this callback when seeking at some arbitrary time after initialization. You should save a reference to the callback. If you use the same listener in multiple containers (or in a `ConcurrentMessageListenerContainer`), you should store the callback in a `ThreadLocal` or some other structure keyed by the listener `Thread`.

When using group management, the second method is called when assignments change. You can use this method, for example, for setting initial offsets for the partitions, by calling the callback. You must use the callback argument, not the one passed into `registerSeekCallback`. This method is never called if you explicitly assign partitions yourself. Use the `TopicPartitionInitialOffset` in that case.

The callback has the following methods:

```
void seek(String topic, int partition, long offset);

void seekToBeginning(String topic, int partition);

void seekToEnd(String topic, int partition);
```

You can also perform seek operations from `onIdleContainer()` when an idle container is detected. See [Detecting Idle and Non-Responsive Consumers](#) for how to enable idle container detection.

To arbitrarily seek at runtime, use the callback reference from the `registerSeekCallback` for the appropriate thread.

Container factory

As discussed in [@KafkaListener Annotation](#), a `ConcurrentKafkaListenerContainerFactory` is used to create containers for annotated methods.

Starting with version 2.2, you can use the same factory to create any `ConcurrentMessageListenerContainer`. This might be useful if you want to create several containers with similar properties or you wish to use some externally configured factory, such as the one provided by Spring Boot auto-configuration. Once the container is created, you can further modify its properties, many of which are set by using `container.getContainerProperties()`. The following example configures a `ConcurrentMessageListenerContainer`:

```
@Bean
public ConcurrentMessageListenerContainer<String, String>(
    ConcurrentKafkaListenerContainerFactory<String, String> factory) {

    ConcurrentMessageListenerContainer<String, String> container =
        factory.createContainer("topic1", "topic2");
    container.setMessageListener(m -> { ... } );
    return container;
}
```



Containers created this way are not added to the endpoint registry. They should be created as `@Bean` definitions so that they are registered with the application context.

Thread Safety

When using a concurrent message listener container, a single listener instance is invoked on all consumer threads. Listeners, therefore, need to be thread-safe, and it is preferable to use stateless listeners. If it is not possible to make your listener thread-safe or adding synchronization would significantly reduce the benefit of adding concurrency, you can use one of a few techniques:

- Use `n` containers with `concurrency=1` with a prototype scoped `MessageListener` bean so that each container gets its own instance (this is not possible when using `@KafkaListener`).
- Keep the state in `ThreadLocal<?>` instances.
- Have the singleton listener delegate to a bean that is declared in `SimpleThreadScope` (or a similar scope).

To facilitate cleaning up thread state (for the second and third items in the preceding list), starting with version 2.2, the listener container publishes a `ConsumerStoppedEvent` when each thread exits. You can consume these events with an `ApplicationListener` or `@EventListener` method to remove `ThreadLocal<?>` instances or `remove()` thread-scoped beans from the scope. Note that `SimpleThreadScope` does not destroy beans that have a destruction interface (such as `DisposableBean`), so you should `destroy()` the instance yourself.



By default, the application context's event multicaster invokes event listeners on the calling thread. If you change the multicaster to use an async executor, thread cleanup is not effective.

4.1.4. Pausing and Resuming Listener Containers

Version 2.1.3 added `pause()` and `resume()` methods to listener containers. Previously, you could pause a consumer within a `ConsumerAwareMessageListener` and resume it by listening for a `ListenerContainerIdleEvent`, which provides access to the `Consumer` object. While you could pause a consumer in an idle container by using an event listener, in some cases, this was not thread-safe, since there is no guarantee that the event listener is invoked on the consumer thread. To safely pause and resume consumers, you should use the `pause` and `resume` methods on the listener containers. A `pause()` takes effect just before the next `poll()`; a `resume()` takes effect just after the current `poll()` returns. When a container is paused, it continues to `poll()` the consumer, avoiding a rebalance if group management is being used, but it does not retrieve any records. See the Kafka documentation for more information.

Starting with version 2.1.5, you can call `isPauseRequested()` to see if `pause()` has been called. However, the consumers might not have actually paused yet. `isConsumerPaused()` returns true if all `Consumer` instances have actually paused.

In addition (also since 2.1.5), `ConsumerPausedEvent` and `ConsumerResumedEvent` instances are published with the container as the `source` property and the `TopicPartition` instances involved in the `partitions` property.

The following simple Spring Boot application demonstrates by using the container registry to get a reference to a `@KafkaListener` method's container and pausing or resuming its consumers as well as receiving the corresponding events:

```

@SpringBootApplication
public class Application implements ApplicationListener<KafkaEvent> {

    public static void main(String[] args) {
        SpringApplication.run(Application.class, args).close();
    }

    @Override
    public void onApplicationEvent(KafkaEvent event) {
        System.out.println(event);
    }

    @Bean
    public ApplicationRunner runner(KafkaListenerEndpointRegistry registry,
        KafkaTemplate<String, String> template) {
        return args -> {
            template.send("pause.resume.topic", "thing1");
            Thread.sleep(10_000);
            System.out.println("pausing");
            registry.getListenerContainer("pause.resume").pause();
            Thread.sleep(10_000);
            template.send("pause.resume.topic", "thing2");
            Thread.sleep(10_000);
            System.out.println("resuming");
            registry.getListenerContainer("pause.resume").resume();
            Thread.sleep(10_000);
        };
    }

    @KafkaListener(id = "pause.resume", topics = "pause.resume.topic")
    public void listen(String in) {
        System.out.println(in);
    }

    @Bean
    public NewTopic topic() {
        return new NewTopic("pause.resume.topic", 2, (short) 1);
    }
}

```

The following listing shows the results of the preceding example:

```
partitions assigned: [pause.resume.topic-1, pause.resume.topic-0]
thing1
pausing
ConsumerPausedEvent [partitions=[pause.resume.topic-1, pause.resume.topic-0]]
resuming
ConsumerResumedEvent [partitions=[pause.resume.topic-1, pause.resume.topic-0]]
thing2
```

4.1.5. Events

The following events are published by listener containers and their consumers:

- **ContainerIdleEvent**: Issued when no messages have been received in **idleInterval** (if configured).
- **NonResponsiveConsumerEvent**: Issued when the consumer appears to be blocked in the **poll** method.
- **ConsumerPausedEvent**: Issued by each consumer when the container is paused.
- **ConsumerResumedEvent**: Issued by each consumer when the container is resumed.
- **ConsumerStoppingEvent**: Issued by each consumer just before stopping.
- **ConsumerStoppedEvent**: Issued after the consumer is closed. See [Thread Safety](#).
- **ContainerStoppedEvent**: Issued when all consumers have terminated.



By default, the application context's event multicaster invokes event listeners on the calling thread. If you change the multicaster to use an async executor, you must not invoke any **Consumer** methods when the event contains a reference to the consumer.

The **ContainerIdleEvent** has the following properties:

- **source**: The listener container instance that published the event.
- **container**: The listener container or the parent listener container, if the source container is a child.
- **id**: The listener ID (or container bean name).
- **idleTime**: The time the container had been idle when the event was published.
- **topicPartitions**: The topics and partitions that the container was assigned at the time the event was generated.
- **consumer**: A reference to the Kafka **Consumer** object. For example, if the consumer's **pause()** method was previously called, it can **resume()** when the event is received.
- **paused**: Whether the container is currently paused. See [Pausing and Resuming Listener Containers](#) for more information.

The `NonResponsiveConsumerEvent` has the following properties:

- `source`: The listener container instance that published the event.
- `container`: The listener container or the parent listener container, if the source container is a child.
- `id`: The listener ID (or container bean name).
- `timeSinceLastPoll`: The time just before the container last called `poll()`.
- `topicPartitions`: The topics and partitions that the container was assigned at the time the event was generated.
- `consumer`: A reference to the Kafka `Consumer` object. For example, if the consumer's `pause()` method was previously called, it can `resume()` when the event is received.
- `paused`: Whether the container is currently paused. See [Pausing and Resuming Listener Containers](#) for more information.

The `ConsumerPausedEvent`, `ConsumerResumedEvent`, and `ConsumerStopping` events have the following properties:

- `source`: The listener container instance that published the event.
- `container`: The listener container or the parent listener container, if the source container is a child.
- `partitions`: The `TopicPartition` instances involved.

The `ConsumerStoppedEvent` and `ContainerStoppedEvent` events have the following properties:

- `source`: The listener container instance that published the event.
- `container`: The listener container or the parent listener container, if the source container is a child.

All containers (whether a child or a parent) publish `ContainerStoppedEvent`. For a parent container, the source and container properties are identical.

4.1.6. Serialization, Deserialization, and Message Conversion

Apache Kafka provides a high-level API for serializing and deserializing record values as well as their keys. It is present with the `org.apache.kafka.common.serialization.Serializer<T>` and `org.apache.kafka.common.serialization.Deserializer<T>` abstractions with some built-in implementations. Meanwhile, we can specify serializer and deserializer classes by using `Producer` or `Consumer` configuration properties. The following example shows how to do so:

```

props.put(ConsumerConfig.KEY_DESERIALIZER_CLASS_CONFIG,
IntegerDeserializer.class);
props.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
StringDeserializer.class);
...
props.put(ProducerConfig.KEY_SERIALIZER_CLASS_CONFIG, IntegerSerializer.class);
props.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG, StringSerializer.class);

```

For more complex or particular cases, the `KafkaConsumer` (and, therefore, `KafkaProducer`) provides overloaded constructors to accept `Serializer` and `Deserializer` instances for `keys` and `values`, respectively.

When you use this API, the `DefaultKafkaProducerFactory` and `DefaultKafkaConsumerFactory` also provide properties (through constructors or setter methods) to inject custom `Serializer` and `Deserializer` instances into the target `Producer` or `Consumer`.

Spring for Apache Kafka also provides `JsonSerializer` and `JsonDeserializer` implementations that are based on the Jackson JSON object mapper. The `JsonSerializer` allows writing any Java object as a JSON `byte[]`. The `JsonDeserializer` requires an additional `Class<?> targetType` argument to allow the deserialization of a consumed `byte[]` to the proper target object. The following example shows how to create a `JsonDeserializer`:

```

JsonDeserializer<Thing> thingDeserializer = new JsonDeserializer<>(Thing.class);

```

You can customize both `JsonSerializer` and `JsonDeserializer` with an `ObjectMapper`. You can also extend them to implement some particular configuration logic in the `configure(Map<String, ?> configs, boolean isKey)` method.

Starting with version 2.1, you can convey type information in record `Headers`, allowing the handling of multiple types. In addition, you can configure the serializer and deserializer by using the following Kafka properties:

- `JsonSerializer.ADD_TYPE_INFO_HEADERS` (default `true`): You can set it to `false` to disable this feature on the `JsonSerializer` (sets the `addTypeInfo` property).
- `JsonSerializer.TYPE_MAPPINGS` (default `empty`): See [Mapping Types](#).
- `JsonDeserializer.USE_TYPE_INFO_HEADERS` (default `true`): You can set it to `false` to ignore headers set by the serializer.
- `JsonDeserializer.REMOVE_TYPE_INFO_HEADERS` (default `true`): You can set it to `false` to retain headers set by the serializer.
- `JsonDeserializer.KEY_DEFAULT_TYPE`: Fallback type for deserialization of keys if no header information is present.
- `JsonDeserializer.VALUE_DEFAULT_TYPE`: Fallback type for deserialization of values if no header

information is present.

- `JsonDeserializer.TRUSTED_PACKAGES` (default `java.util, java.lang`): Comma-delimited list of package patterns allowed for deserialization. `*` means deserialize all.
- `JsonDeserializer.TYPE_MAPPINGS` (default `empty`): See [Mapping Types](#).

Starting with version 2.2, the type information headers (if added by the serializer) are removed by the deserializer. You can revert to the previous behavior by setting the `removeTypeHeaders` property to `false`, either directly on the deserializer or with the configuration property described earlier.

Mapping Types

Starting with version 2.2, you can now provide type mappings by using the properties in the preceding list. Previously, you had to customize the type mapper within the serializer and deserializer. Mappings consist of a comma-delimited list of `token:className` pairs. On outbound, the payload's class name is mapped to the corresponding token. On inbound, the token in the type header is mapped to the corresponding class name.

The following example creates a set of mappings:

```
senderProps.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG,
JsonSerializer.class);
senderProps.put(JsonSerializer.TYPE_MAPPINGS, "cat:com.mycat.Cat,
hat:com.myhat.hat");
...
consumerProps.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
JsonDeserializer.class);
consumerProps.put(JsonDeSerializer.TYPE_MAPPINGS, "cat:com.yourcat.Cat,
hat:com.yourhat.hat");
```



The corresponding objects must be compatible.

If you use [Spring Boot](#), you can provide these properties in the `application.properties` (or `yaml`) file. The following example shows how to do so:

```
spring.kafka.producer.value-
serializer=org.springframework.kafka.support.serializer.JsonSerializer
spring.kafka.producer.properties.spring.json.type.mapping=cat:com.mycat.Cat,hat:co
m.myhat.Hat
```


You can perform only simple configuration with properties. For more advanced configuration (such as using a custom `ObjectMapper` in the serializer and deserializer), you should use the producer and consumer factory constructors that accept a pre-built serializer and deserializer. The following Spring Boot example overrides the default factories:



```
@Bean
public ConsumerFactory<Foo, Bar>
kafkaConsumerFactory(KafkaProperties properties,
    JsonSerializer customDeserializer) {

    return new
DefaultKafkaConsumerFactory<>(properties.buildConsumerProperties(),
    customDeserializer, customDeserializer);
}

@Bean
public ProducerFactory<Foo, Bar>
kafkaProducerFactory(KafkaProperties properties,
    JsonSerializer customSerializer) {

    return new
DefaultKafkaConsumerFactory<>(properties.buildProducerProperties(),
    customSerializer, customSerializer);
}
```

Setters are also provided, as an alternative to using these constructors.

Starting with version 2.2, you can explicitly configure the deserializer to use the supplied target type and ignore type information in headers by using one of the overloaded constructors that have a boolean `useHeadersIfPresent` (which is `true` by default). The following example shows how to do so:

```
DefaultKafkaConsumerFactory<Integer, Cat1> cf = new
DefaultKafkaConsumerFactory<>(props,
    new IntegerDeserializer(), new JsonSerializer<>(Cat1.class, false));
```

Spring Messaging Message Conversion

Although the `Serializer` and `Deserializer` API is quite simple and flexible from the low-level Kafka `Consumer` and `Producer` perspective, you might need more flexibility at the Spring Messaging level, when using either `@KafkaListener` or `Spring Integration`. To let you easily convert to and from `org.springframework.messaging.Message`, Spring for Apache Kafka provides a `MessageConverter` abstraction with the `MessagingMessageConverter` implementation and its `StringJsonMessageConverter`

and `BytesJsonMessageConverter` customization. You can inject the `MessageConverter` into a `KafkaTemplate` instance directly and by using `AbstractKafkaListenerContainerFactory` bean definition for the `@KafkaListener.containerFactory()` property. The following example shows how to do so:

```
@Bean
public KafkaListenerContainerFactory<?> kafkaJsonListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    factory.setConsumerFactory(consumerFactory());
    factory.setMessageConverter(new StringJsonMessageConverter());
    return factory;
}
...
@KafkaListener(topics = "jsonData",
               containerFactory = "kafkaJsonListenerContainerFactory")
public void jsonListener(Cat cat) {
    ...
}
```

When you use a `@KafkaListener`, the parameter type is provided to the message converter to assist with the conversion.



This type inference can be achieved only when the `@KafkaListener` annotation is declared at the method level. With a class-level `@KafkaListener`, the payload type is used to select which `@KafkaHandler` method to invoke, so it must already have been converted before the method can be chosen.



When you use the `StringJsonMessageConverter`, you should use a `StringDeserializer` in the Kafka consumer configuration and a `StringSerializer` in the Kafka producer configuration when you use Spring Integration or the `KafkaTemplate.send(Message<?> message)` method. When you use the `BytesJsonMessageConverter`, you should use a `BytesDeserializer` in the Kafka consumer configuration and `BytesSerializer` in the Kafka producer configuration when you use Spring Integration or the `KafkaTemplate.send(Message<?> message)` method (see [Using KafkaTemplate](#)). Generally, the `BytesJsonMessageConverter` is more efficient because it avoids a `String` to and from `byte[]` conversion.

Using `ErrorHandlingDeserializer`

When a deserializer fails to deserialize a message, Spring has no way to handle the problem, because it occurs before the `poll()` returns. To solve this problem, version 2.2 introduced the `ErrorHandlingDeserializer2`. This deserializer delegates to a real deserializer (key or value). If the delegate fails to deserialize the record content, the `ErrorHandlingDeserializer2` returns a `null` value and a `DeserializationException` in a header that contains the cause and the raw bytes. When you use a record-level `MessageListener`, if the `ConsumerRecord` contains a `DeserializationException` header for either the key or value, the container's `ErrorHandler` is called with the failed `ConsumerRecord`. The

record is not passed to the listener.

Alternatively, you can configure the `ErrorHandlingDeserializer2` to create a custom value by providing a `failedDeserializationFunction`, which is a `BiConsumer<byte[], Headers, T>`. This function is invoked to create an instance of `T`, which is passed to the listener in the usual fashion. The raw record value and headers are provided to the function. You can find the `DeserializationException` (as a serialized Java object) in headers. See the [Javadoc](#) for the `ErrorHandlingDeserializer2` for more information.



When you use a `BatchMessageListener`, you must provide a `failedDeserializationFunction`. Otherwise, the batch of records are not type safe.

You can use the `DefaultKafkaConsumerFactory` constructor that takes key and value `Deserializer` objects and wire in appropriate `ErrorHandlingDeserializer2` instances that you have configured with the proper delegates. Alternatively, you can use consumer configuration properties (which are used by the `ErrorHandlingDeserializer`) to instantiate the delegates. The property names are `ErrorHandlingDeserializer2.KEY_DESERIALIZER_CLASS` and `ErrorHandlingDeserializer2.VALUE_DESERIALIZER_CLASS`. The property value can be a class or class name. The following example shows how to set these properties:

```
... // other props
props.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
ErrorHandlingDeserializer2.class);
props.put(ConsumerConfig.KEY_DESERIALIZER_CLASS_CONFIG,
ErrorHandlingDeserializer2.class);
props.put(ErrorHandlingDeserializer.KEY_DESERIALIZER_CLASS,
JsonDeserializer.class);
props.put(JsonDeserializer.KEY_DEFAULT_TYPE, "com.example.MyKey")
props.put(ErrorHandlingDeserializer.VALUE_DESERIALIZER_CLASS,
JsonDeserializer.class.getName());
props.put(JsonDeserializer.VALUE_DEFAULT_TYPE, "com.example.MyValue")
props.put(JsonDeserializer.TRUSTED_PACKAGES, "com.example")
return new DefaultKafkaConsumerFactory<>(props);
```

The following example uses a `failedDeserializationFunction`.

```

public class BadFoo extends Foo {

    private final byte[] failedDecode;

    public BadFoo(byte[] failedDecode) {
        this.failedDecode = failedDecode;
    }

    public byte[] getFailedDecode() {
        return this.failedDecode;
    }

}

public class FailedFooProvider implements BiFunction<byte[], Headers, Foo> {

    @Override
    public Foo apply(byte[] t, Headers u) {
        return new BadFoo(t);
    }

}

```

The preceding example uses the following configuration:

```

...
consumerProps.put(ConsumerConfig.VALUE_DESERIALIZER_CLASS_CONFIG,
    ErrorHandlingDeserializer2.class);
consumerProps.put(ErrorHandlingDeserializer2.VALUE_DESERIALIZER_CLASS,
    JsonSerializer.class);
consumerProps.put(ErrorHandlingDeserializer2.VALUE_FUNCTION,
    FailedFooProvider.class);
...

```

Payload Conversion with Batch Listeners

Starting with version 1.3.2, you can also use a `StringJsonMessageConverter` or `BytesJsonMessageConverter` within a `BatchMessagingMessageConverter` to convert batch messages when you use a batch listener container factory. See [Serialization, Deserialization, and Message Conversion](#) for more information.

By default, the type for the conversion is inferred from the listener argument. If you configure the `(Bytes|String)JsonMessageConverter` with a `DefaultJackson2TypeMapper` that has its `TypePrecedence` set to `TYPE_ID` (instead of the default `INFERRED`), the converter uses the type information in headers (if present) instead. This allows, for example, listener methods to be declared with interfaces instead

of concrete classes. Also, the type converter supports mapping, so the deserialization can be to a different type than the source (as long as the data is compatible). This is also useful when you use [class-level @KafkaListener instances](#) where the payload must have already been converted to determine which method to invoke. The following example creates beans that use this method:

```
@Bean
public KafkaListenerContainerFactory<?> kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    factory.setConsumerFactory(consumerFactory());
    factory.setBatchListener(true);
    factory.setMessageConverter(new BatchMessagingMessageConverter(converter()));
    return factory;
}

@Bean
public StringJsonMessageConverter converter() {
    return new StringJsonMessageConverter();
}
```

Note that, for this to work, the method signature for the conversion target must be a container object with a single generic parameter type, such as the following:

```
@KafkaListener(topics = "blc1")
public void listen(List<Foo> foos, @Header(KafkaHeaders.OFFSET) List<Long>
offsets) {
    ...
}
```

Note that you can still access the batch headers.

If the batch converter has a record converter that supports it, you can also receive a list of messages where the payloads are converted according to the generic type. The following example shows how to do so:

```
@KafkaListener(topics = "blc3", groupId = "blc3")
public void listen1(List<Message<Foo>> fooMessages) {
    ...
}
```

ConversionService Customization

Starting with version 2.1.1, the `org.springframework.core.convert.ConversionService` used by the default `o.s.messaging.handler.annotation.support.MessageHandlerMethodFactory` to resolve parameters for the invocation of a listener method is supplied with all beans that implement any of the following interfaces:

- `org.springframework.core.convert.converter.Converter`
- `org.springframework.core.convert.converter.GenericConverter`
- `org.springframework.format.Formatter`

This lets you further customize listener deserialization without changing the default configuration for `ConsumerFactory` and `KafkaListenerContainerFactory`.



Setting a custom `MessageHandlerMethodFactory` on the `KafkaListenerEndpointRegistrar` through a `KafkaListenerConfigurer` bean disables this feature.

4.1.7. Message Headers

The 0.11.0.0 client introduced support for headers in messages. As of version 2.0, Spring for Apache Kafka now supports mapping these headers to and from `spring-messaging MessageHeaders`.



Previous versions mapped `ConsumerRecord` and `ProducerRecord` to `spring-messaging Message<?>`, where the value property is mapped to and from the `payload` and other properties (`topic`, `partition`, and so on) were mapped to headers. This is still the case, but additional (arbitrary) headers can now be mapped.

Apache Kafka headers have a simple API, shown in the following interface definition:

```
public interface Header {  
  
    String key();  
  
    byte[] value();  
  
}
```

The `KafkaHeaderMapper` strategy is provided to map header entries between Kafka `Headers` and `MessageHeaders`. Its interface definition is as follows:

```
public interface KafkaHeaderMapper {  
  
    void fromHeaders(MessageHeaders headers, Headers target);  
  
    void toHeaders(Headers source, Map<String, Object> target);  
  
}
```

The `DefaultKafkaHeaderMapper` maps the key to the `MessageHeaders` header name and, in order to support rich header types for outbound messages, JSON conversion is performed. A “special” header (with a key of `spring_json_header_types`) contains a JSON map of `<key>:<type>`. This header is used on the inbound side to provide appropriate conversion of each header value to the original type.

On the inbound side, all Kafka `Header` instances are mapped to `MessageHeaders`. On the outbound side, by default, all `MessageHeaders` are mapped, except `id`, `timestamp`, and the headers that map to `ConsumerRecord` properties.

You can specify which headers are to be mapped for outbound messages, by providing patterns to the mapper. The following listing shows a number of example mappings:

```

public DefaultKafkaHeaderMapper() { ❶
    ...
}

public DefaultKafkaHeaderMapper(ObjectMapper objectMapper) { ❷
    ...
}

public DefaultKafkaHeaderMapper(String... patterns) { ❸
    ...
}

public DefaultKafkaHeaderMapper(ObjectMapper objectMapper, String... patterns) {
❹
    ...
}

```

- ❶ Uses a default Jackson `ObjectMapper` and maps most headers, as discussed before the example.
- ❷ Uses the provided Jackson `ObjectMapper` and maps most headers, as discussed before the example.
- ❸ Uses a default Jackson `ObjectMapper` and maps headers according to the provided patterns.
- ❹ Uses the provided Jackson `ObjectMapper` and maps headers according to the provided patterns.

Patterns are rather simple and can contain a leading wildcard (`()`), a **trailing wildcard**, or **both** (for example, `.cat.*`). You can negate patterns with a leading `!`. The first pattern that matches a header name (whether positive or negative) wins.

When you provide your own patterns, we recommend including `!id` and `!timestamp`, since these headers are read-only on the inbound side.



By default, the mapper deserializes only classes in `java.lang` and `java.util`. You can trust other (or all) packages by adding trusted packages with the `addTrustedPackages` method. If you receive messages from untrusted sources, you may wish to add only those packages you trust. To trust all packages, you can use `mapper.addTrustedPackages("*")`.

By default, the `DefaultKafkaHeaderMapper` is used in the `MessagingMessageConverter` and `BatchMessagingMessageConverter`, as long as Jackson is on the class path.

With the batch converter, the converted headers are available in the `KafkaHeaders.BATCH_CONVERTED_HEADERS` as a `List<Map<String, Object>>` where the map in a position of the list corresponds to the data position in the payload.

If there is no converter (either because Jackson is not present or it is explicitly set to `null`), the

headers from the consumer record are provided unconverted in the `KafkaHeaders.NATIVE_HEADERS` header. This header is a `Headers` object (or a `List<Headers>` in the case of the batch converter), where the position in the list corresponds to the data position in the payload).



Certain types are not suitable for JSON serialization, and a simple `toString()` serialization might be preferred for these types. The `DefaultKafkaHeaderMapper` has a method called `addToStringClasses()` that lets you supply the names of classes that should be treated this way for outbound mapping. During inbound mapping, they are mapped as `String`. By default, only `org.springframework.util.MimeType` and `org.springframework.http.MediaType` are mapped this way.

4.1.8. Null Payloads and Log Compaction of 'Tombstone' Records

When you use [Log Compaction](#), you can send and receive messages with `null` payloads to identify the deletion of a key.

You can also receive `null` values for other reasons, such as a `Deserializer` that might return `null` when it cannot deserialize a value.

To send a `null` payload by using the `KafkaTemplate`, you can pass `null` into the value argument of the `send()` methods. One exception to this is the `send(Message<?> message)` variant. Since `spring-messaging Message<?>` cannot have a `null` payload, you can use a special payload type called `KafkaNull`, and the framework sends `null`. For convenience, the static `KafkaNull.INSTANCE` is provided.

When you use a message listener container, the received `ConsumerRecord` has a `null value()`.

To configure the `@KafkaListener` to handle `null` payloads, you must use the `@Payload` annotation with `required = false`. If it is a tombstone message for a compacted log, you usually also need the key so that your application can determine which key was “deleted”. The following example shows such a configuration:

```
@KafkaListener(id = "deletableListener", topics = "myTopic")
public void listen(@Payload(required = false) String value,
    @Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) String key) {
    // value == null represents key deletion
}
```

When you use a class-level `@KafkaListener` with multiple `@KafkaHandler` methods, some additional configuration is needed. Specifically, you need a `@KafkaHandler` method with a `KafkaNull` payload. The following example shows how to configure one:

```

@KafkaListener(id = "multi", topics = "myTopic")
static class MultiListenerBean {

    @KafkaHandler
    public void listen(String cat) {
        ...
    }

    @KafkaHandler
    public void listen(Integer hat) {
        ...
    }

    @KafkaHandler
    public void delete(@Payload(required = false) KafkaNull nul,
@Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) int key) {
        ...
    }
}

```

Note that the argument is `null`, not `KafkaNull`.

4.1.9. Handling Exceptions

This section describes how to handle various exceptions that may arise when you use Spring for Apache Kafka.

Listener Error Handlers

Starting with version 2.0, the `@KafkaListener` annotation has a new attribute: `errorHandler`.

By default, this attribute is not configured.

You can use the `errorHandler` to provide the bean name of a `KafkaListenerErrorHandler` implementation. This functional interface has one method, as the following listing shows:

```

@FunctionalInterface
public interface KafkaListenerErrorHandler {

    Object handleError(Message<?> message, ListenerExecutionFailedException
exception) throws Exception;

}

```

You have access to the spring-messaging `Message<?>` object produced by the message converter and the exception that was thrown by the listener, which is wrapped in a `ListenerExecutionFailedException`. The error handler can throw the original or a new exception, which is thrown to the container. Anything returned by the error handler is ignored.

It has a sub-interface (`ConsumerAwareListenerErrorHandler`) that has access to the consumer object, through the following method:

```
Object handleError(Message<?> message, ListenerExecutionFailedException exception,
Consumer<?, ?> consumer);
```

If your error handler implements this interface, you can, for example, adjust the offsets accordingly. For example, to reset the offset to replay the failed message, you could do something like the following:

```
@Bean
public ConsumerAwareListenerErrorHandler listen3ErrorHandler() {
    return (m, e, c) -> {
        this.listen3Exception = e;
        MessageHeaders headers = m.getHeaders();
        c.seek(new org.apache.kafka.common.TopicPartition(
            headers.get(KafkaHeaders.RECEIVED_TOPIC, String.class),
            headers.get(KafkaHeaders.RECEIVED_PARTITION_ID, Integer.class)),
            headers.get(KafkaHeaders.OFFSET, Long.class));
        return null;
    };
}
```

Similarly, you could do something like the following for a batch listener:

```

@Bean
public ConsumerAwareListenerErrorHandler listen10ErrorHandler() {
    return (m, e, c) -> {
        this.listen10Exception = e;
        MessageHeaders headers = m.getHeaders();
        List<String> topics = headers.get(KafkaHeaders.RECEIVED_TOPIC,
List.class);
        List<Integer> partitions = headers.get(KafkaHeaders.RECEIVED_PARTITION_ID,
List.class);
        List<Long> offsets = headers.get(KafkaHeaders.OFFSET, List.class);
        Map<TopicPartition, Long> offsetsToReset = new HashMap<>();
        for (int i = 0; i < topics.size(); i++) {
            int index = i;
            offsetsToReset.compute(new TopicPartition(topics.get(i),
partitions.get(i)),
(k, v) -> v == null ? offsets.get(index) : Math.min(v,
offsets.get(index)));
        }
        offsetsToReset.forEach((k, v) -> c.seek(k, v));
        return null;
    };
}

```

This resets each topic/partition in the batch to the lowest offset in the batch.



The preceding two examples are simplistic implementations, and you would probably want more checking in the error handler.

Container Error Handlers

You can specify a global error handler to be used for all listeners in the container factory. The following example shows how to do so:

```

@Bean
public KafkaListenerContainerFactory<ConcurrentMessageListenerContainer<Integer,
String>>
    kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    ...
    factory.setErrorHandler(myErrorHandler);
    ...
    return factory;
}

```

Similarly, you can set a global batch error handler:

```
@Bean
public KafkaListenerContainerFactory<ConcurrentMessageListenerContainer<Integer,
String>>
    kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<Integer, String> factory =
        new ConcurrentKafkaListenerContainerFactory<>();
    ...
    factory.getContainerProperties().setBatchErrorHandler(myBatchErrorHandler);
    ...
    return factory;
}
```

By default, if an annotated listener method throws an exception, it is thrown to the container, and the message is handled according to the container configuration.

Consumer-Aware Container Error Handlers

The container-level error handlers (`ErrorHandler` and `BatchErrorHandler`) have sub-interfaces called `ConsumerAwareErrorHandler` and `ConsumerAwareBatchErrorHandler`. The `handle` method of the `ConsumerAwareErrorHandler` has the following signature:

```
void handle(Exception thrownException, ConsumerRecord<?, ?> data, Consumer<?, ?>
consumer);
```

The `handle` method of the `ConsumerAwareBatchErrorHandler` has the following signature:

```
void handle(Exception thrownException, ConsumerRecords<?, ?> data, Consumer<?, ?>
consumer);
```

Similar to the `@KafkaListener` error handlers, you can reset the offsets as needed, based on the data that failed.



Unlike the listener-level error handlers, however, you should set the `ackOnError` container property to `false` when making adjustments. Otherwise, any pending acks are applied after your repositioning.

Seek To Current Container Error Handlers

If an `ErrorHandler` implements `RemainingRecordsErrorHandler`, the error handler is provided with the failed record and any unprocessed records retrieved by the previous `poll()`. Those records are not

passed to the listener after the handler exits. The following listing shows the `RemainingRecordsErrorHandler` interface definition:

```
@FunctionalInterface
public interface RemainingRecordsErrorHandler extends ConsumerAwareErrorHandler {

    void handle(Exception thrownException, List<ConsumerRecord<?, ?>> records,
        Consumer<?, ?> consumer);

}
```

This interface lets implementations seek all unprocessed topics and partitions so that the current record (and the others remaining) are retrieved by the next poll. `SeekToCurrentErrorHandler` does exactly this.

The container commits any pending offset commits before calling the error handler.

To configure the listener container with this handler, add it to the `ContainerProperties`.

For example, with the `@KafkaListener` container factory, you can add `SeekToCurrentErrorHandler` as follows:

```
@Bean
public ConcurrentKafkaListenerContainerFactory<String, String>
kafkaListenerContainerFactory() {
    ConcurrentKafkaListenerContainerFactory<String, String> factory = new
    ConcurrentKafkaListenerContainerFactory();
    factory.setConsumerFactory(consumerFactory());
    factory.getContainerProperties().setAckOnError(false);
    factory.getContainerProperties().setAckMode(AckMode.RECORD);
    factory.setErrorHandler(new SeekToCurrentErrorHandler());
    return factory;
}
```

As an example; if the `poll` returns six records (two from each partition 0, 1, 2) and the listener throws an exception on the fourth record, the container acknowledges the first three messages by committing their offsets. The `SeekToCurrentErrorHandler` seeks to offset 1 for partition 1 and offset 0 for partition 2. The next `poll()` returns the three unprocessed records.

If the `AckMode` was `BATCH`, the container commits the offsets for the first two partitions before calling the error handler.

Starting with version 2.2, the `SeekToCurrentErrorHandler` can now recover (skip) a record that keeps failing. By default, after ten failures, the failed record is logged (at the `ERROR` level). You can configure the handler with a custom recoverer (`BiConsumer`) and maximum failures. Setting the

`maxFailures` property to a negative number causes infinite retries. The following example configures recovery after three tries:

```
SeekToCurrentErrorHandler errorHandler =
    new SeekToCurrentErrorHandler((record, exception) -> {
        // recover after 3 failures - e.g. send to a dead-letter topic
    }, 3);
```

Starting with version 2.2.4, when the container is configured with `AckMode.MANUAL_IMMEDIATE`, the error handler can be configured to commit the offset of recovered records; set the `commitRecovered` property to `true`.

See also [Publishing Dead-letter Records](#).

When using transactions, similar functionality is provided by the `DefaultAfterRollbackProcessor`. See [After-rollback Processor](#).

The `SeekToCurrentBatchErrorHandler` seeks each partition to the first record in each partition in the batch, so the whole batch is replayed. This error handler does not support recovery, because the framework cannot know which message in the batch is failing.

After seeking, an exception that wraps the `ListenerExecutionFailedException` is thrown. This is to cause the transaction to roll back (if transactions are enabled).

Container Stopping Error Handlers

The `ContainerStoppingErrorHandler` (used with record listeners) stops the container if the listener throws an exception. When the `AckMode` is `RECORD`, offsets for already processed records are committed. When the `AckMode` is any manual value, offsets for already acknowledged records are committed. When the `AckMode` is `BATCH`, the entire batch is replayed when the container is restarted (unless transactions are enabled — in which case, only the unprocessed records are re-fetched).

The `ContainerStoppingBatchErrorHandler` (used with batch listeners) stops the container, and the entire batch is replayed when the container is restarted.

After the container stops, an exception that wraps the `ListenerExecutionFailedException` is thrown. This is to cause the transaction to roll back (if transactions are enabled).

After-rollback Processor

When using transactions, if the listener throws an exception (and an error handler, if present, throws an exception), the transaction is rolled back. By default, any unprocessed records (including the failed record) are re-fetched on the next poll. This is achieved by performing `seek` operations in the `DefaultAfterRollbackProcessor`. With a batch listener, the entire batch of records is reprocessed (the container has no knowledge of which record in the batch failed). To modify this behavior, you can configure the listener container with a custom `AfterRollbackProcessor`. For example, with a record-based listener, you might want to keep track of the failed record and give up after some number of attempts, perhaps by publishing it to a dead-letter topic.

Starting with version 2.2, the `DefaultAfterRollbackProcessor` can now recover (skip) a record that keeps failing. By default, after ten failures, the failed record is logged (at the `ERROR` level). You can configure the processor with a custom recoverer (`BiConsumer`) and maximum failures. Setting the `maxFailures` property to a negative number causes infinite retries. The following example configures recovery after three tries:

```
AfterRollbackProcessor<String, String> processor =
    new DefaultAfterRollbackProcessor((record, exception) -> {
        // recover after 3 failures - e.g. send to a dead-letter topic
    }, 3);
```

When you do not use transactions, you can achieve similar functionality by configuring a `SeekToCurrentErrorHandler`. See [Seek To Current Container Error Handlers](#).



Recovery is not possible with a batch listener, since the framework has no knowledge about which record in the batch keeps failing. In such cases, the application listener must handle a record that keeps failing.

See also [Publishing Dead-letter Records](#).

Publishing Dead-letter Records

As [discussed earlier](#), you can configure the `SeekToCurrentErrorHandler` and `DefaultAfterRollbackProcessor` with a record recoverer when the maximum number of failures is reached for a record. The framework provides the `DeadLetterPublishingRecoverer`, which publishes the failed message to another topic. The recoverer requires a `KafkaTemplate<Object, Object>`, which is used to send the record. You can also, optionally, configure it with a `BiFunction<ConsumerRecord<?, >, Exception, TopicPartition>`, which is called to resolve the destination topic and partition. By default, the dead-letter record is sent to a topic named `<originalTopic>.DLT` (the original topic name suffixed with `.DLT`) and to the same partition as the original record. Therefore, when you use the default resolver, the dead-letter topic must have at least as many partitions as the original topic. If the returned `TopicPartition` has a negative partition, the partition is not set in the `ProducerRecord`, so the partition is selected by Kafka. Starting with version 2.2.4, any `ListenerExecutionFailedException` (thrown, for example, when an exception is detected in a `@KafkaListener` method) is enhanced with the `groupId` property. This allows the destination resolver to use this, in addition to the information in the `ConsumerRecord` to select the dead letter topic.

The following example shows how to wire a custom destination resolver:


```

DeadLetterPublishingRecoverer recoverer = new
DeadLetterPublishingRecoverer(template,
    (r, e) -> {
        if (e instanceof FooException) {
            return new TopicPartition(r.topic() + ".Foo.failures",
r.partition());
        }
        else {
            return new TopicPartition(r.topic() + ".other.failures",
r.partition());
        }
    });
ErrorHandler errorHandler = new SeekToCurrentErrorHandler(recoverer, 3);

```

The record sent to the dead-letter topic is enhanced with the following headers:

- `KafkaHeaders.DLT_EXCEPTION_FQCN`: The Exception class name.
- `KafkaHeaders.DLT_EXCEPTION_STACKTRACE`: The Exception stack trace.
- `KafkaHeaders.DLT_EXCEPTION_MESSAGE`: The Exception message.
- `KafkaHeaders.DLT_ORIGINAL_TOPIC`: The original topic.
- `KafkaHeaders.DLT_ORIGINAL_PARTITION`: The original partition.
- `KafkaHeaders.DLT_ORIGINAL_OFFSET`: The original offset.
- `KafkaHeaders.DLT_ORIGINAL_TIMESTAMP`: The original timestamp.
- `KafkaHeaders.DLT_ORIGINAL_TIMESTAMP_TYPE`: The original timestamp type.

4.1.10. Kerberos

Starting with version 2.0, a `KafkaJaasLoginModuleInitializer` class has been added to assist with Kerberos configuration. You can add this bean, with the desired configuration, to your application context. The following example configures such a bean:

```

@Bean
public KafkaJaasLoginModuleInitializer jaasConfig() throws IOException {
    KafkaJaasLoginModuleInitializer jaasConfig = new
    KafkaJaasLoginModuleInitializer();
    jaasConfig.setControlFlag("REQUIRED");
    Map<String, String> options = new HashMap<>();
    options.put("useKeyTab", "true");
    options.put("storeKey", "true");
    options.put("keyTab", "/etc/security/keytabs/kafka_client.keytab");
    options.put("principal", "kafka-client-1@EXAMPLE.COM");
    jaasConfig.setOptions(options);
    return jaasConfig;
}

```

4.2. Kafka Streams Support

Starting with version 1.1.4, Spring for Apache Kafka provides first-class support for [Kafka Streams](#). To use it from a Spring application, the `kafka-streams` jar must be present on classpath. It is an optional dependency of the `spring-kafka` project and is not downloaded transitively.

4.2.1. Basics

The reference Apache Kafka Streams documentation suggests the following way of using the API:

```

// Use the builders to define the actual processing topology, e.g. to specify
// from which input topics to read, which stream operations (filter, map, etc.)
// should be called, and so on.

StreamsBuilder builder = ...; // when using the Kafka Streams DSL

// Use the configuration to tell your application where the Kafka cluster is,
// which serializers/deserializers to use by default, to specify security
// settings,
// and so on.
StreamsConfig config = ...;

KafkaStreams streams = new KafkaStreams(builder, config);

// Start the Kafka Streams instance
streams.start();

// Stop the Kafka Streams instance
streams.close();

```

So, we have two main components:

- **StreamsBuilder**: With an API to build **KStream** (or **KTable**) instances.
- **KafkaStreams**: To manage the lifecycle of those instances.



All **KStream** instances exposed to a **KafkaStreams** instance by a single **StreamsBuilder** are started and stopped at the same time, even if they have different logic. In other words, all streams defined by a **StreamsBuilder** are tied with a single lifecycle control. Once a **KafkaStreams** instance has been closed by `streams.close()`, it cannot be restarted. Instead, a new **KafkaStreams** instance to restart stream processing must be created.

4.2.2. Spring Management

To simplify using Kafka Streams from the Spring application context perspective and use the lifecycle management through a container, the Spring for Apache Kafka introduces **StreamsBuilderFactoryBean**. This is an **AbstractFactoryBean** implementation to expose a **StreamsBuilder** singleton instance as a bean. The following example creates such a bean:

```
@Bean
public FactoryBean<StreamsBuilderFactoryBean>
myKStreamBuilder(KafkaStreamsConfiguration streamsConfig) {
    return new StreamsBuilderFactoryBean(streamsConfig);
}
```



Starting with version 2.2, the stream configuration is now provided as a **KafkaStreamsConfiguration** object rather than a **StreamsConfig**.

The **StreamsBuilderFactoryBean** also implements **SmartLifecycle** to manage the lifecycle of an internal **KafkaStreams** instance. Similar to the Kafka Streams API, you must define the **KStream** instances before you start the **KafkaStreams**. That also applies for the Spring API for Kafka Streams. Therefore, when you use default `autoStartup = true` on the **StreamsBuilderFactoryBean**, you must declare **KStream** instances on the **StreamsBuilder** before the application context is refreshed. For example, **KStream** can be a regular bean definition, while the Kafka Streams API is used without any impacts. The following example shows how to do so:

```
@Bean
public KStream<?, ?> kStream(StreamsBuilder kStreamBuilder) {
    KStream<Integer, String> stream = kStreamBuilder.stream(STREAMING_TOPIC1);
    // Fluent KStream API
    return stream;
}
```

If you would like to control the lifecycle manually (for example, stopping and starting by some condition), you can reference the `StreamsBuilderFactoryBean` bean directly by using the factory bean (`@`) `prefix`. Since `StreamsBuilderFactoryBean` use its internal `KafkaStreams` instance, it is safe to stop and restart it again. A new `KafkaStreams` is created on each `start()`. You might also consider using different `StreamsBuilderFactoryBean` instances, if you would like to control the lifecycles for `KStream` instances separately.

You also can specify `KafkaStreams.StateListener`, `Thread.UncaughtExceptionHandler`, and `StateRestoreListener` options on the `StreamsBuilderFactoryBean`, which are delegated to the internal `KafkaStreams` instance. Also, apart from setting those options indirectly on `StreamsBuilderFactoryBean`, starting with version 2.1.5, you can use a `KafkaStreamsCustomizer` callback interface to configure an inner `KafkaStreams` instance. Note that `KafkaStreamsCustomizer` overrides the options provided by `StreamsBuilderFactoryBean`. If you need to perform some `KafkaStreams` operations directly, you can access that internal `KafkaStreams` instance by using `StreamsBuilderFactoryBean.getKafkaStreams()`. You can autowire `StreamsBuilderFactoryBean` bean by type, but you should be sure to use the full type in the bean definition, as the following example shows:

```
@Bean
public StreamsBuilderFactoryBean myKStreamBuilder(KafkaStreamsConfiguration
streamsConfig) {
    return new StreamsBuilderFactoryBean(streamsConfig);
}
...
@Autowired
private StreamsBuilderFactoryBean myKStreamBuilderFactoryBean;
```

Alternatively, you can add `@Qualifier` for injection by name if you use interface bean definition. The following example shows how to do so:

```
@Bean
public FactoryBean<StreamsBuilder> myKStreamBuilder(KafkaStreamsConfiguration
streamsConfig) {
    return new StreamsBuilderFactoryBean(streamsConfig);
}
...
@Autowired
@Qualifier("&myKStreamBuilder")
private StreamsBuilderFactoryBean myKStreamBuilderFactoryBean;
```

4.2.3. JSON Serialization and Deserialization

For serializing and deserializing data when reading or writing to topics or state stores in JSON format, Spring Kafka provides a `JsonSerde` implementation that uses JSON, delegating to the

`JsonSerializer` and `JsonDeserializer` described in [Serialization, Deserialization, and Message Conversion](#). The `JsonSerde` implementation provides the same configuration options through its constructor (target type or `ObjectMapper`). In the following example, we use the `JsonSerde` to serialize and deserialize the `Cat` payload of a Kafka stream (the `JsonSerde` can be used in a similar fashion wherever an instance is required):

```
stream.through(Serdes.Integer(), new JsonSerde<>(Cat.class), "cats");
```



Since Kafka Streams do not support headers, the `addTypeInfo` property on the `JsonSerializer` is ignored.

4.2.4. Using `KafkaStreamsBrancher`

The `KafkaStreamBrancher` class introduces a more convenient way to build conditional branches on top of `KStream`.

Consider the following example that does not use `KafkaStreamBrancher`:

```
KStream<String, String>[] branches = builder.stream("source").branch(
    (key, value) -> value.contains("A"),
    (key, value) -> value.contains("B"),
    (key, value) -> true
);
branches[0].to("A");
branches[1].to("B");
branches[2].to("C");
```

The following example uses `KafkaStreamBrancher`:

```
new KafkaStreamsBrancher<String, String>()
    .branch((key, value) -> value.contains("A"), ks -> ks.to("A"))
    .branch((key, value) -> value.contains("B"), ks -> ks.to("B"))
    //default branch should not necessarily be defined in the end of the chain!
    .defaultBranch(ks -> ks.to("C"))
    .onTopOf(builder.stream("source"));
//onTopOf method returns the provided stream so we can continue with method
chaining
```

4.2.5. Configuration

To configure the Kafka Streams environment, the `StreamsBuilderFactoryBean` requires a

`KafkaStreamsConfiguration` instance. See the Apache Kafka [documentation](#) for all possible options.



Starting with version 2.2, the stream configuration is now provided as a `KafkaStreamsConfiguration` object, rather than as a `StreamsConfig`.

To avoid boilerplate code for most cases, especially when you develop microservices, Spring for Apache Kafka provides the `@EnableKafkaStreams` annotation, which you should place on a `@Configuration` class. All you need is to declare a `KafkaStreamsConfiguration` bean named `defaultKafkaStreamsConfig`. A `StreamsBuilder` bean, named `defaultKafkaStreamsBuilder`, is automatically declared in the application context. You can declare and use any additional `StreamsBuilderFactoryBean` beans as well.

By default, when the factory bean is stopped, the `KafkaStreams.cleanup()` method is called. Starting with version 2.1.2, the factory bean has additional constructors, taking a `CleanupConfig` object that has properties to let you control whether the `cleanup()` method is called during `start()` or `stop()` or neither.

4.2.6. Kafka Streams Example

The following example combines all the topics we have covered in this chapter:

```

@Configuration
@EnableKafka
@EnableKafkaStreams
public static class KafkaStreamsConfig {

    @Bean(name =
KafkaStreamsDefaultConfiguration.DEFAULT_STREAMS_CONFIG_BEAN_NAME)
    public KafkaStreamsConfiguration kStreamsConfigs() {
        Map<String, Object> props = new HashMap<>();
        props.put(StreamsConfig.APPLICATION_ID_CONFIG, "testStreams");
        props.put(StreamsConfig.KEY_SERDE_CLASS_CONFIG,
Serdes.Integer().getClass().getName());
        props.put(StreamsConfig.VALUE_SERDE_CLASS_CONFIG,
Serdes.String().getClass().getName());
        props.put(StreamsConfig.TIMESTAMP_EXTRACTOR_CLASS_CONFIG,
WallclockTimestampExtractor.class.getName());
        return new KafkaStreamsConfiguration(props);
    }

    @Bean
    public KStream<Integer, String> kStream(StreamsBuilder kStreamBuilder) {
        KStream<Integer, String> stream =
kStreamBuilder.stream("streamingTopic1");
        stream
            .mapValues(String::toUpperCase)
            .groupByKey()
            .reduce((String value1, String value2) -> value1 + value2,
                TimeWindows.of(1000),
                "windowStore")
            .toStream()
            .map((windowedId, value) -> new KeyValue<>(windowedId.key(),
value))
            .filter((i, s) -> s.length() > 40)
            .to("streamingTopic2");

        stream.print();

        return stream;
    }
}

```

4.3. Testing Applications

The `spring-kafka-test` jar contains some useful utilities to assist with testing your applications.

4.3.1. JUnit

`o.s.kafka.test.utils.KafkaTestUtils` provides some static methods to set up producer and consumer properties. The following listing shows those method signatures:

```
/**
 * Set up test properties for an {@code <Integer, String>} consumer.
 * @param group the group id.
 * @param autoCommit the auto commit.
 * @param embeddedKafka a {@link EmbeddedKafkaBroker} instance.
 * @return the properties.
 */
public static Map<String, Object> consumerProps(String group, String autoCommit,
                                                EmbeddedKafkaBroker embeddedKafka) { ... }

/**
 * Set up test properties for an {@code <Integer, String>} producer.
 * @param embeddedKafka a {@link EmbeddedKafkaBroker} instance.
 * @return the properties.
 */
public static Map<String, Object> senderProps(EmbeddedKafkaBroker embeddedKafka) {
... }
```

A JUnit 4 `@Rule` wrapper for the `EmbeddedKafkaBroker` is provided to create an embedded Kafka and an embedded Zookeeper server. (See [@EmbeddedKafka Annotation](#) for information about using `@EmbeddedKafka` with JUnit 5). The following listing shows the signatures of those methods:


```

/**
 * Create embedded Kafka brokers.
 * @param count the number of brokers.
 * @param controlledShutdown passed into TestUtils.createBrokerConfig.
 * @param topics the topics to create (2 partitions per).
 */
public EmbeddedKafkaRule(int count, boolean controlledShutdown, String... topics)
{ ... }

/**
 *
 * Create embedded Kafka brokers.
 * @param count the number of brokers.
 * @param controlledShutdown passed into TestUtils.createBrokerConfig.
 * @param partitions partitions per topic.
 * @param topics the topics to create.
 */
public EmbeddedKafkaRule(int count, boolean controlledShutdown, int partitions,
String... topics) { ... }

```

The `EmbeddedKafkaBroker` class has a utility method that lets you consume for all the topics it created. The following example shows how to use it:

```

Map<String, Object> consumerProps = KafkaTestUtils.consumerProps("testT", "false",
embeddedKafka);
DefaultKafkaConsumerFactory<Integer, String> cf = new
DefaultKafkaConsumerFactory<Integer, String>(
    consumerProps);
Consumer<Integer, String> consumer = cf.createConsumer();
embeddedKafka.consumeFromAllEmbeddedTopics(consumer);

```

The `KafkaTestUtils` has some utility methods to fetch results from the consumer. The following listing shows those method signatures:

```

/**
 * Poll the consumer, expecting a single record for the specified topic.
 * @param consumer the consumer.
 * @param topic the topic.
 * @return the record.
 * @throws org.junit.ComparisonFailure if exactly one record is not received.
 */
public static <K, V> ConsumerRecord<K, V> getSingleRecord(Consumer<K, V> consumer,
String topic) { ... }

/**
 * Poll the consumer for records.
 * @param consumer the consumer.
 * @return the records.
 */
public static <K, V> ConsumerRecords<K, V> getRecords(Consumer<K, V> consumer) {
... }

```

The following example shows how to use `KafkaTestUtils`:

```

...
template.sendDefault(0, 2, "bar");
ConsumerRecord<Integer, String> received =
KafkaTestUtils.getSingleRecord(consumer, "topic");
...

```

When the embedded Kafka and embedded Zookeeper server are started by the `EmbeddedKafkaBroker`, a system property named `spring.embedded.kafka.brokers` is set to the address of the Kafka brokers and a system property named `spring.embedded.zookeeper.connect` is set to the address of Zookeeper. Convenient constants (`EmbeddedKafkaBroker.SPRING_EMBEDDED_KAFKA_BROKERS` and `EmbeddedKafkaBroker.SPRING_EMBEDDED_ZOOKEEPER_CONNECT`) are provided for this property.

With the `EmbeddedKafkaBroker.brokerProperties(Map<String, String>)`, you can provide additional properties for the Kafka servers. See [Kafka Config](#) for more information about possible broker properties.

4.3.2. Configuring Topics

The following example configuration creates topics called `cat` and `hat` with five partitions, a topic called `thing1` with 10 partitions, and a topic called `thing2` with 15 partitions:

```
public class MyTests {

    @ClassRule
    private static EmbeddedKafkaRule embeddedKafka = new EmbeddedKafkaRule(1,
false, 5, "cat", "hat");

    @Test
    public void test() {
        embeddedKafkaRule.getEmbeddedKafka()
            .addTopics(new NewTopic("thing1", 10, (short) 1), new
NewTopic("thing2", 15, (short) 1));
        ...
    }

}
```

4.3.3. Using the Same Brokers for Multiple Test Classes

There is no built-in support for doing so, but you can use the same broker for multiple test classes with something similar to the following:

```

public final class EmbeddedKafkaHolder {

    private static EmbeddedKafkaRule embeddedKafka = new EmbeddedKafkaRule(1,
false);

    private static boolean started;

    public static EmbeddedKafkaRule getEmbeddedKafka() {
        if (!started) {
            try {
                embeddedKafka.before();
            }
            catch (Exception e) {
                throw new KafkaException(e);
            }
            started = true;
        }
        return embeddedKafka;
    }

    private EmbeddedKafkaHolder() {
        super();
    }

}

```

Then, in each test class, you can use something similar to the following:

```

static {
    EmbeddedKafkaHolder.getEmbeddedKafka().addTopics(topic1, topic2);
}

private static EmbeddedKafkaRule embeddedKafka =
EmbeddedKafkaHolder.getEmbeddedKafka();

```



The preceding example provides no mechanism for shutting down the brokers when all tests are complete. This could be a problem if, say, you run your tests in a Gradle daemon. You should not use this technique in such a situation, or you should use something to call `destroy()` on the `EmbeddedKafkaBroker` when your tests are complete.

4.3.4. @EmbeddedKafka Annotation

We generally recommend that you use the rule as a `@ClassRule` to avoid starting and stopping the

broker between tests (and use a different topic for each test). Starting with version 2.0, if you use Spring's test application context caching, you can also declare a `EmbeddedKafkaBroker` bean, so a single broker can be used across multiple test classes. For convenience, we provide a test class-level annotation called `@EmbeddedKafka` to register the `EmbeddedKafkaBroker` bean. The following example shows how to use it:

```

@RunWith(SpringRunner.class)
@DirtiesContext
@EmbeddedKafka(partitions = 1,
    topics = {
        KafkaStreamsTests.STREAMING_TOPIC1,
        KafkaStreamsTests.STREAMING_TOPIC2 })
public class KafkaStreamsTests {

    @Autowired
    private EmbeddedKafkaBroker embeddedKafka;

    @Test
    public void someTest() {
        Map<String, Object> consumerProps =
            KafkaTestUtils.consumerProps("testGroup", "true", this.embeddedKafka);
        consumerProps.put(ConsumerConfig.AUTO_OFFSET_RESET_CONFIG, "earliest");
        ConsumerFactory<Integer, String> cf = new
            DefaultKafkaConsumerFactory<>(consumerProps);
        Consumer<Integer, String> consumer = cf.createConsumer();
        this.embeddedKafka.consumeFromAnEmbeddedTopic(consumer,
            KafkaStreamsTests.STREAMING_TOPIC2);
        ConsumerRecords<Integer, String> replies =
            KafkaTestUtils.getRecords(consumer);
        assertThat(replies.count()).isGreaterThanOrEqualTo(1);
    }

    @Configuration
    @EnableKafkaStreams
    public static class KafkaStreamsConfiguration {

        @Value("${" + EmbeddedKafkaBroker.SPRING_EMBEDDED_KAFKA_BROKERS + "}")
        private String brokerAddresses;

        @Bean(name =
            KafkaStreamsDefaultConfiguration.DEFAULT_STREAMS_CONFIG_BEAN_NAME)
        public KafkaStreamsConfiguration kStreamsConfigs() {
            Map<String, Object> props = new HashMap<>();
            props.put(StreamsConfig.APPLICATION_ID_CONFIG, "testStreams");
            props.put(StreamsConfig.BootstrapServersConfig,
                this.brokerAddresses);
            return new KafkaStreamsConfiguration(props);
        }
    }
}

```

Starting with version 2.2.4, you can also use the `@EmbeddedKafka` annotation to specify the Kafka

ports property.

The following example sets the `topics`, `brokerProperties`, and `brokerPropertiesLocation` attributes of `@EmbeddedKafka` support property placeholder resolutions:

```
@TestPropertySource(locations = "classpath:/test.properties")
@EmbeddedKafka(topics = { "any-topic", "${kafka.topics.another-topic}" },
    brokerProperties = { "log.dir=${kafka.broker.logs-dir}",

    "listeners=PLAINTEXT://localhost:${kafka.broker.port}",
                        "auto.create.topics.enable=${kafka.broker.topics-
enable:true}" }
    brokerPropertiesLocation = "classpath:/broker.properties")
```

In the preceding example, the property placeholders `${kafka.topics.another-topic}`, `${kafka.broker.logs-dir}`, and `${kafka.broker.port}` are resolved from the Spring `Environment`. In addition, the broker properties are loaded from the `broker.properties` classpath resource specified by the `brokerPropertiesLocation`. Property placeholders are resolved for the `brokerPropertiesLocation` URL and for any property placeholders found in the resource. Properties defined by `brokerProperties` override properties found in `brokerPropertiesLocation`.

You can use the `@EmbeddedKafka` annotation with JUnit 4 or JUnit 5.

4.3.5. Embedded Broker in `@SpringBootTest` Annotations

`Spring Initializr` now automatically adds the `spring-kafka-test` dependency in test scope to the project configuration.

If your application uses the Kafka binder in `spring-cloud-stream` and if you want to use an embedded broker for tests, you must remove the `spring-cloud-stream-test-support` dependency, because it replaces the real binder with a test binder for test cases. If you wish some tests to use the test binder and some to use the embedded broker, tests that use the real binder need to disable the test binder by excluding the binder auto configuration in the test class. The following example shows how to do so:



```
@RunWith(SpringRunner.class)
@SpringBootTest(properties = "spring.autoconfigure.exclude="
    +
    "org.springframework.cloud.stream.test.binder.TestSupportBinderAuto
    Configuration")
public class MyApplicationTests {
    ...
}
```

There are several ways to use an embedded broker in a Spring Boot application test.

They include:

- [JUnit4 Class Rule](#)
- [@EmbeddedKafka Annotation](#) or [EmbeddedKafkaBroker Bean](#)

JUnit4 Class Rule

The following example shows how to use a JUnit4 class rule to create an embedded broker:

```
@RunWith(SpringRunner.class)
@SpringBootTest
public class MyApplicationTests {

    @ClassRule
    public static EmbeddedKafkaRule broker = new EmbeddedKafkaRule(1,
        false, "someTopic");

    @BeforeClass
    public static void setup() {
        System.setProperty("spring.kafka.bootstrap-servers",
            broker.getEmbeddedKafka().getBrokersAsString());
    }

    @Autowired
    private KafkaTemplate<String, String> template;

    @Test
    public void test() {
        ...
    }
}
```

[@EmbeddedKafka Annotation](#) or [EmbeddedKafkaBroker Bean](#)

The following example shows how to use an [@EmbeddedKafka](#) Annotation to create an embedded broker:


```
@RunWith(SpringRunner.class)
@EmbeddedKafka(topics = "someTopic")
public class MyApplicationTests {

    static {
        System.setProperty(EmbeddedKafkaBroker.BROKER_LIST_PROPERTY,
            "spring.kafka.bootstrap-servers");
    }

    @Autowired
    private KafkaTemplate<String, String> template;

    @Test
    public void test() {
        ...
    }
}
```

4.3.6. Hamcrest Matchers

The `o.s.kafka.test.hamcrest.KafkaMatchers` provides the following matchers:

```

/**
 * @param key the key
 * @param <K> the type.
 * @return a Matcher that matches the key in a consumer record.
 */
public static <K> Matcher<ConsumerRecord<K, ?>> hasKey(K key) { ... }

/**
 * @param value the value.
 * @param <V> the type.
 * @return a Matcher that matches the value in a consumer record.
 */
public static <V> Matcher<ConsumerRecord<?, V>> hasValue(V value) { ... }

/**
 * @param partition the partition.
 * @return a Matcher that matches the partition in a consumer record.
 */
public static Matcher<ConsumerRecord<?, ?>> hasPartition(int partition) { ... }

/**
 * Matcher testing the timestamp of a {@link ConsumerRecord} assuming the topic
 * has been set with
 * {@link org.apache.kafka.common.record.TimestampType#CREATE_TIME CreateTime}.
 *
 * @param ts timestamp of the consumer record.
 * @return a Matcher that matches the timestamp in a consumer record.
 */
public static Matcher<ConsumerRecord<?, ?>> hasTimestamp(long ts) {
    return hasTimestamp(TimestampType.CREATE_TIME, ts);
}

/**
 * Matcher testing the timestamp of a {@link ConsumerRecord}
 * @param type timestamp type of the record
 * @param ts timestamp of the consumer record.
 * @return a Matcher that matches the timestamp in a consumer record.
 */
public static Matcher<ConsumerRecord<?, ?>> hasTimestamp(TimestampType type, long
ts) {
    return new ConsumerRecordTimestampMatcher(type, ts);
}

```

4.3.7. AssertJ Conditions

You can use the following AssertJ conditions:

```

/**
 * @param key the key
 * @param <K> the type.
 * @return a Condition that matches the key in a consumer record.
 */
public static <K> Condition<ConsumerRecord<K, ?>> key(K key) { ... }

/**
 * @param value the value.
 * @param <V> the type.
 * @return a Condition that matches the value in a consumer record.
 */
public static <V> Condition<ConsumerRecord<?, V>> value(V value) { ... }

/**
 * @param partition the partition.
 * @return a Condition that matches the partition in a consumer record.
 */
public static Condition<ConsumerRecord<?, ?>> partition(int partition) { ... }

/**
 * @param value the timestamp.
 * @return a Condition that matches the timestamp value in a consumer record.
 */
public static Condition<ConsumerRecord<?, ?>> timestamp(long value) {
    return new ConsumerRecordTimestampCondition(TimestampType.CREATE_TIME, value);
}

/**
 * @param type the type of timestamp
 * @param value the timestamp.
 * @return a Condition that matches the timestamp value in a consumer record.
 */
public static Condition<ConsumerRecord<?, ?>> timestamp(TimestampType type, long
value) {
    return new ConsumerRecordTimestampCondition(type, value);
}

```

4.3.8. Example

The following example brings together most of the topics covered in this chapter:

```

public class KafkaTemplateTests {

    private static final String TEMPLATE_TOPIC = "templateTopic";

```

```

    @ClassRule
    public static EmbeddedKafkaRule embeddedKafka = new EmbeddedKafkaRule(1, true,
    TEMPLATE_TOPIC);

    @Test
    public void testTemplate() throws Exception {
        Map<String, Object> consumerProps = KafkaTestUtils.consumerProps("testT",
    "false",
        embeddedKafka);
        DefaultKafkaConsumerFactory<Integer, String> cf =
            new DefaultKafkaConsumerFactory<Integer,
    String>(consumerProps);
        ContainerProperties containerProperties = new
    ContainerProperties(TEMPLATE_TOPIC);
        KafkaMessageListenerContainer<Integer, String> container =
            new KafkaMessageListenerContainer<>(cf,
    containerProperties);
        final BlockingQueue<ConsumerRecord<Integer, String>> records = new
    LinkedBlockingQueue<>();
        container.setupMessageListener(new MessageListener<Integer, String>() {

            @Override
            public void onMessage(ConsumerRecord<Integer, String> record) {
                System.out.println(record);
                records.add(record);
            }

        });
        container.setBeanName("templateTests");
        container.start();
        ContainerTestUtils.waitForAssignment(container,
    embeddedKafka.getEmbeddedKafka().getPartitionsPerTopic());
        Map<String, Object> senderProps =
    KafkaTestUtils.senderProps(embeddedKafka.getEmbeddedKafka().getBrokersAsString());
        ProducerFactory<Integer, String> pf =
            new DefaultKafkaProducerFactory<Integer,
    String>(senderProps);
        KafkaTemplate<Integer, String> template = new KafkaTemplate<>(pf);
        template.setDefaultTopic(TEMPLATE_TOPIC);
        template.sendDefault("foo");
        assertThat(records.poll(10, TimeUnit.SECONDS), hasValue("foo"));
        template.sendDefault(0, 2, "bar");
        ConsumerRecord<Integer, String> received = records.poll(10,
    TimeUnit.SECONDS);
        assertThat(received, hasKey(2));
        assertThat(received, hasPartition(0));
        assertThat(received, hasValue("bar"));
        template.send(TEMPLATE_TOPIC, 0, 2, "baz");
        received = records.poll(10, TimeUnit.SECONDS);
        assertThat(received, hasKey(2));
    }

```

```

        assertThat(received, hasPartition(0));
        assertThat(received, hasValue("baz"));
    }
}

```

The preceding example uses the Hamcrest matchers. With **AssertJ**, the final part looks like the following code:

```

assertThat(records.poll(10, TimeUnit.SECONDS)).has(value("foo"));
template.sendDefault(0, 2, "bar");
ConsumerRecord<Integer, String> received = records.poll(10, TimeUnit.SECONDS);
assertThat(received).has(key(2));
assertThat(received).has(partition(0));
assertThat(received).has(value("bar"));
template.send(TEMPLATE_TOPIC, 0, 2, "baz");
received = records.poll(10, TimeUnit.SECONDS);
assertThat(received).has(key(2));
assertThat(received).has(partition(0));
assertThat(received).has(value("baz"));

```

Chapter 5. Spring Integration

This part of the reference guide shows how to use the `spring-integration-kafka` module of Spring Integration.

5.1. Spring Integration for Apache Kafka

This documentation pertains to versions 2.0.0 and above. For documentation for earlier releases, see the [1.3.x README](#).

Spring Integration Kafka is now based on the [Spring for Apache Kafka project](#). It provides the following components:

- [Outbound Channel Adapter](#)
- [Message-driven Channel Adapter](#)

5.1.1. Outbound Channel Adapter

The Outbound channel adapter is used to publish messages from a Spring Integration channel to Kafka topics. The channel is defined in the application context and then wired into the application that sends messages to Kafka. Sender applications can publish to Kafka by using Spring Integration messages, which are internally converted to Kafka messages by the outbound channel adapter, as follows:

- The payload of the Spring Integration message is used to populate the payload of the Kafka message.
- By default, the `kafka_messageKey` header of the Spring Integration message is used to populate the key of the Kafka message.

You can customize the target topic and partition for publishing the message through the `kafka_topic` and `kafka_partitionId` headers, respectively.

In addition, the `<int-kafka:outbound-channel-adapter>` provides the ability to extract the key, target topic, and target partition by applying SpEL expressions on the outbound message. To that end, it supports three mutually exclusive pairs of attributes:

- `topic` and `topic-expression`
- `message-key` and `message-key-expression`
- `partition-id` and `partition-id-expression`

These let you specify `topic`, `message-key`, and `partition-id`, respectively, as static values on the adapter or to dynamically evaluate their values at runtime against the request message.



The `KafkaHeaders` interface (provided by `spring-kafka`) contains constants used for interacting with headers. The `messageKey` and `topic` default headers now require a `kafka_` prefix. When migrating from an earlier version that used the old headers, you need to specify `message-key-expression="headers['messageKey']"` and `topic-expression="headers['topic']"` on the `<int-kafka:outbound-channel-adapter>`. Alternatively, you can change the headers upstream to the new headers from `KafkaHeaders` by using a `<header-enricher>` or a `MessageBuilder`. If you use constant values, you can also configure them on the adapter by using `topic` and `message-key`.

NOTE : If the adapter is configured with a topic or message key (either with a constant or expression), those are used and the corresponding header is ignored. If you wish the header to override the configuration, you need to configure it in an expression, such as the following:

```
topic-expression="headers['topic'] != null ? headers['topic'] : 'myTopic'"
```

The adapter requires a `KafkaTemplate`.

The following example shows how to configure the Kafka outbound channel adapter with XML:

```
<int-kafka:outbound-channel-adapter id="kafkaOutboundChannelAdapter"
    kafka-template="template"
    auto-startup="false"
    channel="inputToKafka"
    topic="foo"
    sync="false"
    message-key-expression="'bar'"
    send-failure-channel="failures"
    send-success-channel="successes"
    error-message-strategy="ems"
    partition-id-expression="2">
</int-kafka:outbound-channel-adapter>

<bean id="template" class="org.springframework.kafka.core.KafkaTemplate">
    <constructor-arg>
        <bean class="org.springframework.kafka.core.DefaultKafkaProducerFactory">
            <constructor-arg>
                <map>
                    <entry key="bootstrap.servers" value="localhost:9092" />
                    ... <!-- more producer properties -->
                </map>
            </constructor-arg>
        </bean>
    </constructor-arg>
</bean>
```

The adapter requires a `KafkaTemplate`, which, in turn, requires a suitably configured `KafkaProducerFactory`.

The following example shows how to configure the Kafka outbound channel adapter with Java:

```
@Bean
@ServiceActivator(inputChannel = "toKafka")
public MessageHandler handler() throws Exception {
    KafkaProducerMessageHandler<String, String> handler =
        new KafkaProducerMessageHandler<>(kafkaTemplate());
    handler.setTopicExpression(new LiteralExpression("someTopic"));
    handler.setMessageKeyExpression(new LiteralExpression("someKey"));
    handler.setSuccessChannel(successes());
    handler.setFailureChannel(failures());
    return handler;
}

@Bean
public KafkaTemplate<String, String> kafkaTemplate() {
    return new KafkaTemplate<>(producerFactory());
}

@Bean
public ProducerFactory<String, String> producerFactory() {
    Map<String, Object> props = new HashMap<>();
    props.put(ProducerConfig.BOOTSTRAP_SERVERS_CONFIG, this.brokerAddress);
    // set more properties
    return new DefaultKafkaProducerFactory<>(props);
}
```

The following example shows how to configure the Kafka outbound channel adapter Spring Integration Java DSL:


```

@Bean
public ProducerFactory<Integer, String> producerFactory() {
    return new
DefaultKafkaProducerFactory<>(KafkaTestUtils.producerProps(embeddedKafka));
}

@Bean
public IntegrationFlow sendToKafkaFlow() {
    return f -> f
        .<String>split(p -> Stream.generate(() -> p).limit(101).iterator(),
null)
        .publishSubscribeChannel(c -> c
            .subscribe(sf -> sf.handle(
                kafkaMessageHandler(producerFactory(), TEST_TOPIC1)

.timestampExpression("T(Long).valueOf('1487694048633')"),
                e -> e.id("kafkaProducer1")))
            .subscribe(sf -> sf.handle(
                kafkaMessageHandler(producerFactory(), TEST_TOPIC2)
                    .timestamp(m -> 1487694048644L),
                e -> e.id("kafkaProducer2")))
        );
}

@Bean
public DefaultKafkaHeaderMapper mapper() {
    return new DefaultKafkaHeaderMapper();
}

private KafkaProducerMessageHandlerSpec<Integer, String, ?> kafkaMessageHandler(
    ProducerFactory<Integer, String> producerFactory, String topic) {
    return Kafka
        .outboundChannelAdapter(producerFactory)
        .messageKey(m -> m
            .getHeaders()
            .get(IntegrationMessageHeaderAccessor.SEQUENCE_NUMBER))
        .headerMapper(mapper())
        .partitionId(m -> 10)
        .topicExpression("headers[kafka_topic] ?: '' + topic + ''")
        .configureKafkaTemplate(t -> t.id("kafkaTemplate:" + topic));
}

```

If a `send-failure-channel` (`sendFailureChannel`) is provided and a send failure (sync or async) is received, an `ErrorMessage` is sent to the channel. The payload is a `KafkaSendFailureException` with `failedMessage`, `record` (the `ProducerRecord`) and `cause` properties. You can override the `DefaultErrorMessageStrategy` by setting the `error-message-strategy` property.

If a `send-success-channel` (`sendSuccessChannel`) is provided, a message with a payload of type

`org.apache.kafka.clients.producer.RecordMetadata` is sent after a successful send.

5.1.2. Message-driven Channel Adapter

The `KafkaMessageDrivenChannelAdapter` (<int-kafka:message-driven-channel-adapter>) uses a `spring-kafka KafkaMessageListenerContainer` or `ConcurrentListenerContainer`.

Starting with `spring-integration-kafka` version 2.1, the `mode` attribute is available. It can accept values of `record` or `batch` (default: `record`). For `record` mode, each message payload is converted from a single `ConsumerRecord`. For `batch` mode, the payload is a list of objects that are converted from all the `ConsumerRecord` instances returned by the consumer poll. As with the batched `@KafkaListener`, the `KafkaHeaders.RECEIVED_MESSAGE_KEY`, `KafkaHeaders.RECEIVED_PARTITION_ID`, `KafkaHeaders.RECEIVED_TOPIC`, and `KafkaHeaders.OFFSET` headers are also lists, with positions corresponding to the position in the payload.

The following example shows how to configure a message-driven channel adapter with XML:

```

<int-kafka:message-driven-channel-adapter
    id="kafkaListener"
    listener-container="container1"
    auto-startup="false"
    phase="100"
    send-timeout="5000"
    mode="record"
    retry-template="template"
    recovery-callback="callback"
    error-message-strategy="ems"
    channel="someChannel"
    error-channel="errorChannel" />

<bean id="container1"
class="org.springframework.kafka.listener.KafkaMessageListenerContainer">
    <constructor-arg>
        <bean class="org.springframework.kafka.core.DefaultKafkaConsumerFactory">
            <constructor-arg>
                <map>
                    <entry key="bootstrap.servers" value="localhost:9092" />
                    ...
                </map>
            </constructor-arg>
        </bean>
    </constructor-arg>
    <constructor-arg>
        <bean
class="org.springframework.kafka.listener.config.ContainerProperties">
            <constructor-arg name="topics" value="foo" />
        </bean>
    </constructor-arg>
</bean>

```

The following example shows how to configure a message-driven channel adapter with Java:

```

@Bean
public KafkaMessageDrivenChannelAdapter<String, String>
    adapter(KafkaMessageListenerContainer<String, String> container) {
    KafkaMessageDrivenChannelAdapter<String, String>
kafkaMessageDrivenChannelAdapter =
        new KafkaMessageDrivenChannelAdapter<>(container,
ListenerMode.record);
    kafkaMessageDrivenChannelAdapter.setOutputChannel(received());
    return kafkaMessageDrivenChannelAdapter;
}

@Bean
public KafkaMessageListenerContainer<String, String> container() throws Exception
{
    ContainerProperties properties = new ContainerProperties(this.topic);
    // set more properties
    return new KafkaMessageListenerContainer<>(consumerFactory(), properties);
}

@Bean
public ConsumerFactory<String, String> consumerFactory() {
    Map<String, Object> props = new HashMap<>();
    props.put(ConsumerConfig.BOOTSTRAP_SERVERS_CONFIG, this.brokerAddress);
    // set more properties
    return new DefaultKafkaConsumerFactory<>(props);
}

```

The following example shows how to configure a message-driven channel adapter with the Spring Integration Java DSL:

```

@Bean
public IntegrationFlow topic1ListenerFromKafkaFlow() {
    return IntegrationFlows
        .from(Kafka.messageDrivenChannelAdapter(consumerFactory(),
            KafkaMessageDrivenChannelAdapter.ListenerMode.record,
            TEST_TOPIC1)
            .configureListenerContainer(c ->

c.ackMode(AbstractMessageListenerContainer.AckMode.MANUAL)
            .id("topic1ListenerContainer"))
            .recoveryCallback(new
ErrorMessageSendingRecoverer(errorChannel(),
            new RawRecordHeaderErrorMessageStrategy()))
            .retryTemplate(new RetryTemplate())
            .filterInRetry(true))
            .filter(Message.class, m ->
            m.getHeaders().get(KafkaHeaders.RECEIVED_MESSAGE_KEY,
Integer.class) < 101,
            f -> f.throwExceptionOnRejection(true))
            .<String, String>transform(String::toUpperCase)
            .channel(c -> c.queue("listeningFromKafkaResults1"))
            .get();
}

```

Received messages have certain headers populated. See the [KafkaHeaders](#) class for more information.



The `Consumer` object (in the `kafka_consumer` header) is not thread-safe. You must invoke its methods only on the thread that calls the listener within the adapter. If you hand off the message to another thread, you must not call its methods.

When a `retry-template` is provided, delivery failures are retried according to its retry policy. An `error-channel` is not allowed in this case. You can use the `recovery-callback` to handle the error when retries are exhausted. In most cases, this is an `ErrorMessageSendingRecoverer` that sends the `ErrorMessage` to a channel.

When building an `ErrorMessage` (for use in the `error-channel` or `recovery-callback`), you can customize the error message by setting the `error-message-strategy` property. By default, a `RawRecordHeaderErrorMessageStrategy` is used, to provide access to the converted message as well as the raw `ConsumerRecord`.

Starting with Spring for Apache Kafka version 2.2 (Spring Integration Kafka 3.1), you can also use the container factory that is used for `@KafkaListener` annotations to create `ConcurrentMessageListenerContainer` instances for other purposes. See [Container factory](#) for an example.

With the Java DSL, the container does not have to be configured as a `@Bean`, because the DSL

registers the container as a bean. The following example shows how to do so:

```
@Bean
public IntegrationFlow topic2ListenerFromKafkaFlow() {
    return IntegrationFlows

        .from(Kafka.messageDrivenChannelAdapter(kafkaListenerContainerFactory().createContainer(
            TEST_TOPIC2),
            KafkaMessageDrivenChannelAdapter.ListenerMode.record)
            .id("topic2Adapter"))
            ...
            get();
}
```

Notice that, in this case, the adapter is given an `id` (`topic2Adapter`). The container is registered in the application context with a name of `topic2Adapter.container`. If the adapter does not have an `id` property, the container's bean name is the container's fully qualified class name plus `#n`, where `n` is incremented for each container.

5.1.3. Outbound Gateway

The outbound gateway is for request/reply operations. It differs from most Spring Integration gateways in that the sending thread does not block in the gateway and the reply is processed on the reply listener container thread. If your code invokes the gateway behind a synchronous [Messaging Gateway](#), the user thread blocks there until the reply is received (or a timeout occurs).



The gateway does not accept requests until the reply container has been assigned its topics and partitions. It is suggested that you add a `ConsumerRebalanceListener` to the template's reply container properties and wait for the `onPartitionsAssigned` call before sending messages to the gateway.

The following example shows how to configure a gateway with Java:

```
@Bean
@ServiceActivator(inputChannel = "kafkaRequests", outputChannel = "kafkaReplies")
public KafkaProducerMessageHandler<String, String> outGateway(
    ReplyingKafkaTemplate<String, String, String> kafkaTemplate) {
    return new KafkaProducerMessageHandler<>(kafkaTemplate);
}
```

Notice that the same class as the [outbound channel adapter](#) is used, the only difference being that the Kafka template passed into the constructor is a `ReplyingKafkaTemplate`. See [Using ReplyingKafkaTemplate](#) for more information.

The outbound topic, partition, key, and so on are determined in the same way as the outbound adapter. The reply topic is determined as follows:

1. A message header named `KafkaHeaders.REPLY_TOPIC` (if present, it must have a `String` or `byte[]` value) is validated against the template's reply container's subscribed topics.
2. If the template's `replyContainer` is subscribed to only one topic, it is used.

You can also specify a `KafkaHeaders.REPLY_PARTITION` header to determine a specific partition to be used for replies. Again, this is validated against the template's reply container's subscriptions.

The following example shows how to configure an outbound gateway with the Java DSL:

```
@Bean
public IntegrationFlow outboundGateFlow(
    ReplyingKafkaTemplate<String, String, String> kafkaTemplate) {
    return IntegrationFlows.from("kafkaRequests")
        .handle(Kafka.outboundGateway(kafkaTemplate))
        .channel("kafkaReplies")
        .get();
}
```

Alternatively, you can also use a configuration similar to the following bean:

```
@Bean
public IntegrationFlow outboundGateFlow() {
    return IntegrationFlows.from("kafkaRequests")
        .handle(Kafka.outboundGateway(producerFactory(), replyContainer())
            .configureKafkaTemplate(t -> t.replyTimeout(30_000)))
        .channel("kafkaReplies")
        .get();
}
```



XML configuration is not currently available for this component.

5.1.4. Inbound Gateway

The inbound gateway is for request/reply operations.

The following example shows how to configure an inbound gateway with Java:

```

@Bean
public KafkaInboundGateway<Integer, String, String> inboundGateway(
    AbstractMessageListenerContainer<Integer, String> container,
    KafkaTemplate<Integer, String> replyTemplate) {

    KafkaInboundGateway<Integer, String, String> gateway =
        new KafkaInboundGateway<>(container, replyTemplate);
    gateway.setRequestChannel(requests);
    gateway.setReplyChannel(replies);
    gateway.setReplyTimeout(30_000);
    return gateway;
}

```

The following example shows how to configure a simple upper case converter with the Java DSL:

```

@Bean
public IntegrationFlow serverGateway(
    ConcurrentMessageListenerContainer<Integer, String> container,
    KafkaTemplate<Integer, String> replyTemplate) {
    return IntegrationFlows
        .from(Kafka.inboundGateway(container, template)
            .replyTimeout(30_000))
        .<String, String>transform(String::toUpperCase)
        .get();
}

```

Alternatively, you could configure an upper-case converter by using code similar to the following:

```

@Bean
public IntegrationFlow serverGateway() {
    return IntegrationFlows
        .from(Kafka.inboundGateway(consumerFactory(), containerProperties(),
            producerFactory())
            .replyTimeout(30_000))
        .<String, String>transform(String::toUpperCase)
        .get();
}

```



XML configuration is not currently available for this component.

Starting with Spring for Apache Kafka version 2.2 (Spring Integration Kafka 3.1), you can also use the container factory that is used for `@KafkaListener` annotations to create

`ConcurrentMessageListenerContainer` instances for other purposes. See [Container factory](#) and [Message-driven Channel Adapter](#) for examples.

5.1.5. Message Conversion

A `StringJsonMessageConverter` is provided. See [Serialization](#), [Deserialization](#), and [Message Conversion](#) for more information.

When using this converter with a message-driven channel adapter, you can specify the type to which you want the incoming payload to be converted. This is achieved by setting the `payload-type` attribute (`payloadType` property) on the adapter. The following example shows how to do so in XML configuration:

```
<int-kafka:message-driven-channel-adapter
    id="kafkaListener"
    listener-container="container1"
    auto-startup="false"
    phase="100"
    send-timeout="5000"
    channel="nullChannel"
    message-converter="messageConverter"
    payload-type="com.example.Foo"
    error-channel="errorChannel" />

<bean id="messageConverter"
    class="org.springframework.kafka.support.converter.MessagingMessageConverter"/>
```

The following example shows how to set the `payload-type` attribute (`payloadType` property) on the adapter in Java configuration:

```
@Bean
public KafkaMessageDrivenChannelAdapter<String, String>
    adapter(KafkaMessageListenerContainer<String, String> container) {
    KafkaMessageDrivenChannelAdapter<String, String>
    kafkaMessageDrivenChannelAdapter =
        new KafkaMessageDrivenChannelAdapter<>(container,
        ListenerMode.record);
    kafkaMessageDrivenChannelAdapter.setOutputChannel(received());
    kafkaMessageDrivenChannelAdapter.setMessageConverter(converter());
    kafkaMessageDrivenChannelAdapter.setPayloadType(Foo.class);
    return kafkaMessageDrivenChannelAdapter;
}
```

5.1.6. Null Payloads and Log Compaction 'Tombstone' Records

Spring Messaging `Message<?>` objects cannot have `null` payloads. When you use the Kafka endpoints, `null` payloads (also known as tombstone records) are represented by a payload of type `KafkaNull`. See [Null Payloads and Log Compaction of 'Tombstone' Records](#) for more information.

Starting with version 3.1 of Spring Integration Kafka, such records can now be received by Spring Integration POJO methods with a true `null` value instead. To do so, mark the parameter with `@Payload(required = false)`. The following example shows how to do so:

```
@ServiceActivator(inputChannel = "fromSomeKafkaInboundEndpoint")
public void in(@Header(KafkaHeaders.RECEIVED_MESSAGE_KEY) String key,
               @Payload(required = false) Customer customer) {
    // customer is null if a tombstone record
    ...
}
```

5.1.7. What's New in Spring Integration for Apache Kafka

See the [Spring for Apache Kafka Project Page](#) for a matrix of compatible `spring-kafka` and `kafka-clients` versions.

2.1.x

The 2.1.x branch introduced the following changes:

- Update to `spring-kafka` 1.1.x, including support of batch payloads
- Support `sync` outbound requests in XML configuration
- Support `payload-type` for inbound channel adapters
- Support for enhanced error handling for the inbound channel adapter (2.1.1)
- Support for send success and failure messages (2.1.2)

2.2.x

The 2.2.x branch introduced the following changes:

- Update to `spring-kafka` 1.2.x

2.3.x

The 2.3.x branch introduced the following changes:

- Update to `spring-kafka` 1.3.x, including support for transactions and header mapping provided by `kafka-clients` 0.11.0.0
- Support for record timestamps

3.0.x

- Update to `spring-kafka` 2.1.x and `kafka-clients` 1.0.0
- Support `ConsumerAwareMessageListener` (`Consumer` is available in a message header)
- Update to Spring Integration 5.0 and Java 8
- Moved Java DSL to the main project
- Added inbound and outbound gateways (3.0.2)

3.1.x

- Update to `spring-kafka` 2.2.x and `kafka-clients` 2.0.0
- Support tombstones in EIP POJO Methods

Chapter 6. Other Resources

In addition to this reference documentation, we recommend a number of other resources that may help you learn about Spring and Apache Kafka.

- [Apache Kafka Project Home Page](#)
- [Spring for Apache Kafka Home Page](#)
- [Spring for Apache Kafka GitHub Repository](#)
- [Spring Integration Kafka Extension GitHub Repository](#)

Appendix A: Override Dependencies to use the 2.1.x kafka-clients with an Embedded Broker

When you use `spring-kafka-test` (version 2.2.x) with the 2.1.x `kafka-clients` jar, you need to override certain transitive dependencies, as follows:

```
<dependency>
  <groupId>org.springframework.kafka</groupId>
  <artifactId>spring-kafka</artifactId>
  <version>${spring.kafka.version}</version>
</dependency>
```

```
<dependency>
  <groupId>org.springframework.kafka</groupId>
  <artifactId>spring-kafka-test</artifactId>
  <version>${spring.kafka.version}</version>
  <scope>test</scope>
</dependency>
```

```
<dependency>
  <groupId>org.apache.kafka</groupId>
  <artifactId>kafka-clients</artifactId>
  <version>2.1.0</version>
</dependency>
```

```
<dependency>
  <groupId>org.apache.kafka</groupId>
  <artifactId>kafka-clients</artifactId>
  <version>2.1.0</version>
  <classifier>test</classifier>
</dependency>
```

```
<dependency>
  <groupId>org.apache.kafka</groupId>
  <artifactId>kafka_2.11</artifactId>
  <version>2.1.0</version>
  <scope>test</scope>
</dependency>
```

```
<dependency>
  <groupId>org.apache.kafka</groupId>
  <artifactId>kafka_2.11</artifactId>
  <version>2.1.0</version>
  <classifier>test</classifier>
  <scope>test</scope>
</dependency>
```

Appendix B: Change History

B.1. Changes between 2.0 and 2.1

B.1.1. Kafka Client Version

This version requires the 1.0.0 `kafka-clients` or higher.



The 1.1.x client is supported with version 2.1.5, but you need to override dependencies as described in [\[deps-for-11x\]](#).

The 1.1.x client is supported natively in version 2.2.

B.1.2. JSON Improvements

The `StringJsonMessageConverter` and `JsonSerializer` now add type information in `Headers`, letting the converter and `JsonDeserializer` create specific types on reception, based on the message itself rather than a fixed configured type. See [Serialization](#), [Deserialization](#), and [Message Conversion](#) for more information.

B.1.3. Container Stopping Error Handlers

Container error handlers are now provided for both record and batch listeners that treat any exceptions thrown by the listener as fatal/ They stop the container. See [Handling Exceptions](#) for more information.

B.1.4. Pausing and Resuming Containers

The listener containers now have `pause()` and `resume()` methods (since version 2.1.3). See [Pausing and Resuming Listener Containers](#) for more information.

B.1.5. Stateful Retry

Starting with version 2.1.3, you can configure stateful retry. See [Stateful Retry](#) for more information.

B.1.6. Client ID

Starting with version 2.1.1, you can now set the `client.id` prefix on `@KafkaListener`. Previously, to customize the client ID, you needed a separate consumer factory (and container factory) per listener. The prefix is suffixed with `-n` to provide unique client IDs when you use concurrency.

B.1.7. Logging Offset Commits

By default, logging of topic offset commits is performed with the `DEBUG` logging level. Starting with version 2.1.2, a new property in `ContainerProperties` called `commitLogLevel` lets you specify the log level for these messages. See [Using KafkaMessageListenerContainer](#) for more information.

B.1.8. Default `@KafkaHandler`

Starting with version 2.1.3, you can designate one of the `@KafkaHandler` annotations on a class-level `@KafkaListener` as the default. See [@KafkaListener on a Class](#) for more information.

B.1.9. `ReplyingKafkaTemplate`

Starting with version 2.1.3, a subclass of `KafkaTemplate` is provided to support request/reply semantics. See [Using `ReplyingKafkaTemplate`](#) for more information.

B.1.10. `ChainedKafkaTransactionManager`

Version 2.1.3 introduced the `ChainedKafkaTransactionManager`. See [Using `ChainedKafkaTransactionManager`](#) for more information.

B.1.11. Migration Guide from 2.0

See the [2.0 to 2.1 Migration](#) guide.

B.2. Changes Between 1.3 and 2.0

B.2.1. Spring Framework and Java Versions

The Spring for Apache Kafka project now requires Spring Framework 5.0 and Java 8.

B.2.2. `@KafkaListener` Changes

You can now annotate `@KafkaListener` methods (and classes and `@KafkaHandler` methods) with `@SendTo`. If the method returns a result, it is forwarded to the specified topic. See [Forwarding Listener Results using `@SendTo`](#) for more information.

B.2.3. Message Listeners

Message listeners can now be aware of the `Consumer` object. See [Message Listeners](#) for more information.

B.2.4. Using `ConsumerAwareRebalanceListener`

Rebalance listeners can now access the `Consumer` object during rebalance notifications. See [Rebalancing Listeners](#) for more information.

B.3. Changes Between 1.2 and 1.3

B.3.1. Support for Transactions

The 0.11.0.0 client library added support for transactions. The `KafkaTransactionManager` and other support for transactions have been added. See [Transactions](#) for more information.

B.3.2. Support for Headers

The 0.11.0.0 client library added support for message headers. These can now be mapped to and from `spring-messaging MessageHeaders`. See [Message Headers](#) for more information.

B.3.3. Creating Topics

The 0.11.0.0 client library provides an `AdminClient`, which you can use to create topics. The `KafkaAdmin` uses this client to automatically add topics defined as `@Bean` instances.

B.3.4. Support for Kafka Timestamps

`KafkaTemplate` now supports an API to add records with timestamps. New `KafkaHeaders` have been introduced regarding `timestamp` support. Also, new `KafkaConditions.timestamp()` and `KafkaMatchers.hasTimestamp()` testing utilities have been added. See [Using KafkaTemplate](#), [@KafkaListener Annotation](#), and [Testing Applications](#) for more details.

B.3.5. @KafkaListener Changes

You can now configure a `KafkaListenerErrorHandler` to handle exceptions. See [Handling Exceptions](#) for more information.

By default, the `@KafkaListener id` property is now used as the `group.id` property, overriding the property configured in the consumer factory (if present). Further, you can explicitly configure the `groupId` on the annotation. Previously, you would have needed a separate container factory (and consumer factory) to use different `group.id` values for listeners. To restore the previous behavior of using the factory configured `group.id`, set the `idIsGroup` property on the annotation to `false`.

B.3.6. @EmbeddedKafka Annotation

For convenience, a test class-level `@EmbeddedKafka` annotation is provided, to register `KafkaEmbedded` as a bean. See [Testing Applications](#) for more information.

B.3.7. Kerberos Configuration

Support for configuring Kerberos is now provided. See [Kerberos](#) for more information.

B.4. Changes between 1.1 and 1.2

This version uses the 0.10.2.x client.

B.5. Changes between 1.0 and 1.1

B.5.1. Kafka Client

This version uses the Apache Kafka 0.10.x.x client.

B.5.2. Batch Listeners

Listeners can be configured to receive the entire batch of messages returned by the `consumer.poll()` operation, rather than one at a time.

B.5.3. Null Payloads

Null payloads are used to “delete” keys when you use log compaction.

B.5.4. Initial Offset

When explicitly assigning partitions, you can now configure the initial offset relative to the current position for the consumer group, rather than absolute or relative to the current end.

B.5.5. Seek

You can now seek the position of each topic or partition. You can use this to set the initial position during initialization when group management is in use and Kafka assigns the partitions. You can also seek when an idle container is detected or at any arbitrary point in your application’s execution. See [Seeking to a Specific Offset](#) for more information.