

Setup Camel Message Integrations

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The Fedora Repository makes it possible to design custom event-driven application workflows. For instance, a common use case is sending content to an external search engine or triplestore. Other repositories may wish to generate derivative content such as creating a set of smaller images from a high-resolution master.

Because Fedora publishes modification events on a JMS topic using a local [ActiveMQ broker](#), one can write custom listener applications to handle these various workflows. By default, the repository's JMS broker supports both the [OpenWire](#) and [STOMP](#) protocols, which means that it is possible to write client listeners or consumers in a wide variety of languages, including PHP, Python, Ruby and Java, among others.

For simple message-consuming applications, writing special-purpose applications may be an excellent choice. In contrast, once a repository begins making use of more complex message-based workflows or when there are multiple listener applications to manage, many repositories use systems such as [Apache Camel](#) to simplify the handling of these messages.

Camel makes use of "[components](#)" to integrate various services using a terse, domain specific language (DSL) that can be expressed in Java, XML, Scala or Groovy. There exists an [fcrepo-camel](#) component designed to work specifically with a Fedora4 repository. This makes it possible to model Solr indexing in only a few lines of code like so:

Camel Route using the Java DSL

```
XPathBuilder xpath = new XPathBuilder("/rdf:RDF/rdf:Description/rdf:type[@rdf:resource='http://fedora.info/definitions/v4/indexing#Indexable']")
xpath.namespace("rdf", "http://www.w3.org/1999/02/22-rdf-syntax-ns#")

from("activemq:topic:fedora")
    .to("fcrepo:localhost:8080/fedora/rest")
    .filter(xpath)
        .to("fcrepo:localhost:8080/fedora/rest?transform=default")
        .to("http4:localhost:8080/solr/core/update");
```

In this specific case, the [XPath](#) filtering predicate is just an example; you can, of course, use many different [Predicate](#) languages, including [XQuery](#), [SQL](#) or various [Scripting Languages](#).

This same logic can also be expressed using the Spring XML extensions:

Camel Route using the Spring DSL

```
<route>
  <from uri="activemq:topic:fedora"/>
  <to uri="fcrepo:localhost:8080/fedora/rest"/>
  <filter>
    <xpath>/rdf:RDF/rdf:Description/rdf:type[@rdf:resource='http://fedora.info/definitions/v4/indexing#Indexable']</xpath>
    <to uri="fcrepo:localhost:8080/fedora/rest?transform=default"/>
    <to uri="http4:localhost:8080/solr/core/update"/>
  </filter>
</route>
```

Or, in Scala:

Camel Route using the Scala DSL

```
val xpath = new XPathBuilder("/rdf:RDF/rdf:Description/rdf:type[@rdf:resource='http://fedora.info/definitions/v4/indexing#Indexable']")
xpath.namespace("rdf", "http://www.w3.org/1999/02/22-rdf-syntax-ns#")

"activemq:topic:fedora" ==> {
  to("fcrepo:localhost:8080/fedora/rest")
  filter(xpath) {
    to("fcrepo:localhost:8080/fedora/rest?transform=default")
    to("http4:localhost:8080/solr/core/update")
  }
}
```

Please note that the hostnames used for Fedora and Solr in the snippets above are arbitrary. It is quite likely that these systems will be deployed on separate hosts and that the Camel routes will be deployed on yet another host. Camel makes it easy to distribute applications and replicate data asynchronously across an arbitrarily large number of independent systems.

Message Headers

By default, Fedora publishes events to a topic on a local broker. This topic is named "fedora". Each message will contain an empty body and up to five different header values. Those header values are namespaced so they look like this:

- org.fcrepo.jms.identifier
- org.fcrepo.jms.eventType
- org.fcrepo.jms.properties
- org.fcrepo.jms.timestamp
- org.fcrepo.jms.baseURL

Both `eventType` and `properties` are comma-delimited lists of events or properties. The eventTypes follow the JCR 2.0 specification and include:

- http://fedora.info/definitions/v4/repository#NODE_ADDED
- http://fedora.info/definitions/v4/repository#NODE_REMOVED
- http://fedora.info/definitions/v4/repository#PROPERTY_ADDED
- http://fedora.info/definitions/v4/repository#PROPERTY_CHANGED
- http://fedora.info/definitions/v4/repository#PROPERTY_REMOVED

The `properties` field will list the RDF properties that changed with that event. `NODE_REMOVED` events contain no properties. The fcrepo component for Camel is configured to recognize these headers and act appropriately.

Supporting Queues

The default configuration is fine for locally-deployed listeners, but it can be problematic in a distributed context. For instance, if the listener is restarted while a message is sent to the topic, that message may be missed. Furthermore, if there is a networking hiccup between Fedora's local broker and the remote listener, that too can result in lost messages. Instead, in this case, a queue may be better suited.

ActiveMQ supports "virtual destinations", allowing your broker to automatically forward messages from one location to another. If Fedora4 is deployed in Tomcat, the ActiveMQ configuration will be located in `WEB-INF/classes/config/activemq.xml`. That file can be edited to include the following block:

activemq.xml customization: supporting a queue/fedora endpoint

```
<destinationInterceptors>
  <virtualDestinationInterceptor>
    <virtualDestinations>
      <compositeTopic name="fedora">
        <forwardTo>
          <queue physicalName="fedora"/>
        </forwardTo>
      </compositeTopic>
    </virtualDestinations>
  </virtualDestinationInterceptor>
</destinationInterceptors>
```

Now a consumer can pull messages from a queue without risk of losing messages.

This configuration, however, will not allow any other applications to read from the original topic. If it is necessary to have /topic/fedora available to consumers, this configuration will be useful:

activemq.xml customization: supporting topic and queue endpoints

```
<destinationInterceptors>
  <virtualDestinationInterceptor>
    <virtualDestinations>
      <compositeTopic name="fedora" forwardOnly="false">
        <forwardTo>
          <queue physicalName="fedora"/>
        </forwardTo>
      </compositeTopic>
    </virtualDestinations>
  </virtualDestinationInterceptor>
</destinationInterceptors>
```

Now, both /topic/fedora and /queue/fedora will be available to consumers.

Distributed Brokers

The above example will allow you to distribute the message consumers across multiple machines without missing messages, but it can also be useful to distribute the message broker across multiple machines. This can be especially useful if you want to further decouple the message producers and consumers. It can also be useful for high-availability and failover support.

ActiveMQ supports a variety of distributed broker [topologies](#). To push messages from both the message queue and topic to a remote broker, this configuration can be used:

activemq.xml customization: distributed brokers

```
<networkConnectors>
  <networkConnector name="fedora_bridge" dynamicOnly="true" uri="static:(tcp://remote-host:61616)">
    <dynamicallyIncludedDestinations>
      <topic physicalName="fedora"/>
      <queue physicalName="fedora"/>
    </dynamicallyIncludedDestinations>
  </networkConnector>
</networkConnectors>
```

Protocol Support

ActiveMQ brokers support a wide variety of [protocols](#). If Fedora's internal broker is bridged to an external broker, please remember to enable the proper protocols on the remote broker. This can be done like so:

activemq.xml customization: protocol support

```
<transportConnectors>
  <transportConnector name="openwire" uri="tcp://0.0.0.0:61616"/>
  <transportConnector name="stomp" uri="stomp://0.0.0.0:61613"/>
</transportConnectors>
```

Each `transportConnector` supports many additional [options](#) that can be added to this configuration.

Deployment

Camel routes can be deployed in any JVM container. In order to deploy to Jetty or Tomcat, the route must be built as a WAR file. This command will get you started:

```
$> mvn archetype:generate \
  -DarchetypeGroupId=org.apache.camel.archetypes \
  -DarchetypeArtifactId=camel-archetype-war \
  -DarchetypeVersion=2.14.0 \
  -DgroupId=org.example.camel \
  -DartifactId=my-camel-route \
  -Dversion=1.0.0-SNAPSHOT \
  -Dpackage=org.example.camel
```

After the project has been built (`mvn install`), you will find the WAR file in `./target`. That file can simply be copied to the `webapps` directory of your Jetty/Tomcat server.

Another popular deployment option is [Karaf](#), which is a light-weight OSGi-based JVM container. Karaf has the advantage of supporting hot code swapping, which allows you to make sure that your routes are always running. It also allows you to deploy XML-based routes ([Spring](#) or [Blueprint](#)) by simply copying the files into a `$KARAF_HOME/deploy` directory. If deploying camel routes to Karaf, Blueprint-based routes have some advantages over the Spring-based DSL, particularly in terms of being able to use [property placeholders](#) within your routes.

Karaf can be set up by:

1. [downloading Karaf](#) 4.x or later from an [apache.org](#) mirror
2. running `./bin/karaf` to enter the shell
3. installing required bundles:

Karaf console

```
$> feature:repo-add camel 2.16.2
$> feature:repo-add activemq 5.11.1
$> feature:install camel
$> feature:install activemq-camel

# display available camel features
$> feature:list | grep camel

# install camel features, as needed
$> feature:install camel-http4

# install fcrepo-camel (as of v4.4.0)
$> feature:repo-add mvn:org.fcrepo.camel/fcrepo-camel/4.4.0/xml/features
$> feature:install fcrepo-camel
```

4. setting up a service wrapper (so that karaf runs as a system-level service)

Karaf console

```
$> feature:install wrapper
$> wrapper:install
```

5. following the directions provided by this command

Now, routes can be deployed (and re-deployed) by simply copying JAR files or XML documents to \$KARAF_HOME/deploy.

Fedora Camel Toolbox

The Fedora project distributes camel routes for several common repository tasks as part of the [fcrepo-camel-toolbox](#) project, for use with Karaf version 4.x. Additional information is available on the [Integration Services](#) page. Detailed installation instructions are available as part of the project [README](#) and follow this pattern:

Karaf Shell

```
# install fcrepo-camel-toolbox (as of v4.1.0)
$> feature:repo-add mvn:org.fcrepo.camel/fcrepo-camel-toolbox/4.1.0/xml/features

# install fcrepo-camel-toolbox (as of v4.5.0)
$> feature:repo-add mvn:org.fcrepo.camel/toolbox-features/4.5.0/xml/features

# display available features
$> feature:list | grep fcrepo

# install feature
$> feature:install fcrepo-indexing-triplestore
```

Monitoring Your Camel Routes

It is often useful to keep runtime statistics for your camel routes. [Hawtio](#) is a web console for monitoring your messaging infrastructure, and it can be deployed in any JVM container, including Karaf, Tomcat or Jetty.

In Karaf, hawtio can be installed like so:

Karaf console

```
$> feature:repo-add hawtio 1.4.29
$> feature:install hawtio
```

Once deployed, hawtio is available at <http://localhost:8181/hawtio/>

With Tomcat or Jetty, deploying hawtio is simply a matter of installing a WAR file. Please see the [hawtio website](#) for more information.