



## Red Hat Process Automation Manager 7.13

Getting started with Red Hat build of Kogito in  
Red Hat Process Automation Manager





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## Abstract

This document describes how to get started with Red Hat build of Kogito in Red Hat Process Automation Manager to build cloud-native business applications.

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## PREFACE

As a developer of business decisions, you can use Red Hat build of Kogito to build cloud-native applications that adapt your business domain and tooling.



## MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see [our CTO Chris Wright's message](#).

## PART I. GETTING STARTED WITH RED HAT BUILD OF KOGITO MICROSERVICES

As a developer of business decisions, you can use Red Hat build of Kogito business automation to develop decision services using Decision Model and Notation (DMN) models, Drools Rule Language (DRL) rules, Predictive Model Markup Language (PMML) or a combination of all three methods.

### Prerequisites

- JDK 11 or later is installed.
- Apache Maven 3.6.2 or later is installed.

# CHAPTER 1. RED HAT BUILD OF KOGITO MICROSERVICES IN RED HAT PROCESS AUTOMATION MANAGER

Red Hat build of Kogito is a cloud-native business automation technology for building cloud-ready business applications. The name *Kogito* derives from the Latin "Cogito", as in "Cogito, ergo sum" ("I think, therefore I am"), and is pronounced [**'ko:ɔ̃ʒi.to**] (KO-jee-to). The letter *K* refers to Kubernetes, the base for Red Hat OpenShift Container Platform as the target cloud platform for Red Hat Process Automation Manager, and to the Knowledge Is Everything (KIE) open source business automation project from which Red Hat build of Kogito originates.

Red Hat build of Kogito in Red Hat Process Automation Manager is optimized for a hybrid cloud environment and adapts to your domain and tooling needs. The core objective of Red Hat build of Kogito microservices is to help you mold a set of decisions into your own domain-specific cloud-native set of services.



## IMPORTANT

In Red Hat Process Automation Manager 7.13 version, Red Hat build of Kogito support is limited to decision services, including Decision Model and Notation (DMN), Drools Rule Language (DRL), and Predictive Model Markup Language (PMML). This support will be improved and extended to Business Process Modeling Notation (BPMN) in a future release.

When you use Red Hat build of Kogito, you are building a cloud-native application as a set of independent domain-specific microservices to achieve some business value. The decisions that you use to describe the target behavior are executed as part of the microservices that you create. The resulting microservices are highly distributed and scalable with no centralized orchestration service, and the runtime that your microservice uses is optimized for what is required.

As a business rules developer, you can use Red Hat build of Kogito microservices in Red Hat Process Automation Manager to build cloud-native applications that adapt to your business domain and tooling.

## 1.1. CLOUD-FIRST PRIORITY

Red Hat build of Kogito microservices are designed to run and scale on a cloud infrastructure. You can use Red Hat build of Kogito microservices in Red Hat Process Automation Manager with the latest cloud-based technologies, such as Red Hat build of Quarkus, to increase start times and instant scaling on container application platforms, such as Red Hat OpenShift Container Platform.

For example, Red Hat build of Kogito microservices are compatible with the following technologies:

- **Red Hat OpenShift Container Platform** is based on Kubernetes, and is the target platform for building and managing containerized applications.
- **Red Hat build of Quarkus** is a native Java stack for Kubernetes that you can use to build applications, using the Red Hat build of Kogito microservices.
- **Spring Boot** is an application framework that you can use to configure Spring Framework with Red Hat Process Automation Manager.

## 1.2. RED HAT BUILD OF KOGITO MICROSERVICES ON RED HAT BUILD OF QUARKUS AND SPRING BOOT

The primary Java frameworks that Red Hat build of Kogito microservices support are Red Hat build of Quarkus and Spring Boot.

[Red Hat build of Quarkus](#) is a Kubernetes-native Java framework with a container-first approach to building Java applications, especially for Java virtual machines (JVMs) such as OpenJDK HotSpot. Red Hat build of Quarkus optimizes Java specifically for Kubernetes by reducing the size of both the Java application and container image footprint, eliminating some of the Java programming workload from previous generations, and reducing the amount of memory required to run those images.

For Red Hat build of Kogito microservices, Red Hat build of Quarkus is the preferred framework for optimal Kubernetes compatibility and enhanced developer features, such as live reload in development mode for advanced debugging.

[Spring Boot](#) is a Java-based framework for building standalone production-ready Spring applications. Spring Boot enables you to develop Spring applications with minimal configurations and without an entire Spring configuration setup.

For Red Hat build of Kogito microservices, Spring Boot is supported for developers who need to use Red Hat Process Automation Manager in an existing Spring Framework environment.

## CHAPTER 2. DMN MODELERS FOR RED HAT BUILD OF KOGITO MICROSERVICES

Red Hat Process Automation Manager provides extensions or applications that you can use to design Decision Model and Notation (DMN) decision models for your Red Hat build of Kogito microservices using graphical modelers.

The following DMN modelers are supported:

- **VS Code extension:** Enables you to view and design DMN models in Visual Studio Code (VS Code). The VS Code extension requires VS Code 1.46.0 or later. To install the VS Code extension directly in VS Code, select the **Extensions** menu option in VS Code and search for and install the **Red Hat Business Automation Bundle** extension.
- **Business Modeler standalone editors** Enable you to view and design DMN models embedded in your web applications. To download the necessary files, you can either use the NPM artifacts from the [Kogito tooling repository](#) or download the JavaScript files directly for the DMN standalone editor library at <https://kiegroup.github.io/kogito-online/standalone/dmn/index.js>.

### 2.1. INSTALLING THE RED HAT PROCESS AUTOMATION MANAGER VS CODE EXTENSION BUNDLE

Red Hat Process Automation Manager provides a **Red Hat Business Automation Bundle** VS Code extension that enables you to design Decision Model and Notation (DMN) decision models, Business Process Model and Notation (BPMN) 2.0 business processes, and test scenarios directly in VS Code. VS Code is the preferred integrated development environment (IDE) for developing new business applications. Red Hat Process Automation Manager also provides individual **DMN Editor** and **BPMN Editor** VS Code extensions for DMN or BPMN support only, if needed.



#### IMPORTANT

The editors in the VS Code are partially compatible with the editors in the Business Central, and several Business Central features are not supported in the VS Code.

#### Prerequisites

- The latest stable version of [VS Code](#) is installed.

#### Procedure

1. In your VS Code IDE, select the **Extensions** menu option and search for **Red Hat Business Automation Bundle** for DMN, BPMN, and test scenario file support. For DMN or BPMN file support only, you can also search for the individual **DMN Editor** or **BPMN Editor** extensions.
2. When the **Red Hat Business Automation Bundle** extension appears in VS Code, select it and click **Install**.
3. For optimal VS Code editor behavior, after the extension installation is complete, reload or close and re-launch your instance of VS Code.

After you install the VS Code extension bundle, any **.dmn**, **.bpmn**, or **.bpmn2** files that you open or create in VS Code are automatically displayed as graphical models. Additionally, any **.scsim** files that

you open or create are automatically displayed as tabular test scenario models for testing the functionality of your business decisions.

If the DMN, BPMN, or test scenario modelers open only the XML source of a DMN, BPMN, or test scenario file and displays an error message, review the reported errors and the model file to ensure that all elements are correctly defined.



## NOTE

For new DMN or BPMN models, you can also enter **dmn.new** or **bpmn.new** in a web browser to design your DMN or BPMN model in the online modeler. When you finish creating your model, you can click **Download** in the online modeler page to import your DMN or BPMN file into your Red Hat Process Automation Manager project in VS Code.

## 2.2. CONFIGURING THE RED HAT PROCESS AUTOMATION MANAGER STANDALONE EDITORS

Red Hat Process Automation Manager provides standalone editors that are distributed in a self-contained library providing an all-in-one JavaScript file for each editor. The JavaScript file uses a comprehensive API to set and control the editor.

You can install the standalone editors using the following methods:

- Download each JavaScript file manually
- Use the NPM package

### Procedure

1. Install the standalone editors using one of the following methods:
  - Download each JavaScript file manually** For this method, follow these steps:
    - a. Download the JavaScript files.
    - b. Add the downloaded Javascript files to your hosted application.
    - c. Add the following **<script>** tag to your HTML page:

#### Script tag for your HTML page for the DMN editor

```
<script src="https://<YOUR_PAGE>/dmn/index.js"></script>
```

#### Script tag for your HTML page for the BPMN editor

```
<script src="https://<YOUR_PAGE>/bpmn/index.js"></script>
```

**Use the NPM package:** For this method, follow these steps:

- a. Add the NPM package to your **package.json** file:

#### Adding the NPM package

```
npm install @kie-tools/kie-editors-standalone
```

- b. Import each editor library to your **TypeScript** file:

### Importing each editor

```
import * as DmnEditor from "@kie-tools/kie-editors-standalone/dist/dmn"
import * as BpmnEditor from "@kie-tools/kie-editors-standalone/dist/bpmn"
```

2. After you install the standalone editors, open the required editor by using the provided editor API, as shown in the following example for opening a DMN editor. The API is the same for each editor.

### Opening the DMN standalone editor

```
const editor = DmnEditor.open({
  container: document.getElementById("dmn-editor-container"),
  initialContent: Promise.resolve(""),
  readOnly: false,
  origin: "",
  resources: new Map([
    [
      "MyIncludedModel.dmn",
      {
        contentType: "text",
        content: Promise.resolve("")
      }
    ]
  ])
});
```

Use the following parameters with the editor API:

**Table 2.1. Example parameters**

Parameter	Description
<b>container</b>	HTML element in which the editor is appended.
<b>initialContent</b>	Promise to a DMN model content. This parameter can be empty, as shown in the following examples: <ul style="list-style-type: none"> <li>● <b>Promise.resolve("")</b></li> <li>● <b>Promise.resolve("&lt;DIAGRAM_CONTENT_DIRECTLY_HERE&gt;")</b></li> <li>● <b>fetch("MyDmnModel.dmn").then(content =&gt; content.text())</b></li> </ul>
<b>readOnly</b> (Optional)	Enables you to allow changes in the editor. Set to <b>false</b> (default) to allow content editing and <b>true</b> for read-only mode in editor.

Parameter	Description
<b>origin</b> (Optional)	Origin of the repository. The default value is <b>window.location.origin</b> .
<b>resources</b> (Optional)	Map of resources for the editor. For example, this parameter is used to provide included models for the DMN editor or work item definitions for the BPMN editor. Each entry in the map contains a resource name and an object that consists of <b>content-type</b> ( <b>text</b> or <b>binary</b> ) and <b>content</b> (similar to the <b>initialContent</b> parameter).

The returned object contains the methods that are required to manipulate the editor.

Table 2.2. Returned object methods

Method	Description
<b>getContent(): Promise&lt;string&gt;</b>	Returns a promise containing the editor content.
<b>setContent(path: string, content: string): void</b>	Sets the content of the editor.
<b>getPreview(): Promise&lt;string&gt;</b>	Returns a promise containing an SVG string of the current diagram.
<b>subscribeToContentChanges(callback: (isDirty: boolean) ⇒ void): (isDirty: boolean) ⇒ void</b>	Sets a callback to be called when the content changes in the editor and returns the same callback to be used for unsubscription.
<b>unsubscribeToContentChanges(callback: (isDirty: boolean) ⇒ void): void</b>	Unsubscribes the passed callback when the content changes in the editor.
<b>markAsSaved(): void</b>	Resets the editor state that indicates that the content in the editor is saved. Also, it activates the subscribed callbacks related to content change.
<b>undo(): void</b>	Undoes the last change in the editor. Also, it activates the subscribed callbacks related to content change.
<b>redo(): void</b>	Redoes the last undone change in the editor. Also, it activates the subscribed callbacks related to content change.
<b>close(): void</b>	Closes the editor.



Method	Description
<b>getElementPosition(selector: string): Promise&lt;Rect&gt;</b>	Provides an alternative to extend the standard query selector when an element lives inside a canvas or a video component. The <b>selector</b> parameter must follow the <b>&lt;PROVIDER&gt;::<b>SELECT</b></b> format, such as <b>Canvas::<b>MySquare</b></b> or <b>Video::<b>PresenterHand</b></b> . This method returns a <b>Rect</b> representing the element position.
<b>envelopeApi: MessageBusClientApi&lt;KogitoEditorEnvelopeApi&gt;</b>	This is an advanced editor API. For more information about advanced editor API, see <a href="#">MessageBusClientApi</a> and <a href="#">KogitoEditorEnvelopeApi</a> .

## CHAPTER 3. CREATING A MAVEN PROJECT FOR A RED HAT BUILD OF KOGITO MICROSERVICE

Before you can begin developing Red Hat build of Kogito microservices, you need to create a Maven project where you can build your assets and any other related resources for your application.

### Procedure

1. In a command terminal, navigate to a local folder where you want to store the new project.
2. Enter the following command to generate a project within a defined folder:

#### On Red Hat build of Quarkus

```
$ mvn io.quarkus:quarkus-maven-plugin:create \
  -DprojectId=org.acme -DprojectArtifactId=sample-kogito \
  -DprojectVersion=1.0.0-SNAPSHOT -Dextensions=kogito-quarkus
```

#### On Spring Boot

```
$ mvn archetype:generate \
  -DarchetypeGroupId=org.kie.kogito \
  -DarchetypeArtifactId=kogito-spring-boot-archetype \
  -DgroupId=org.acme -DartifactId=sample-kogito \
  -DarchetypeVersion=1.11.0.Final \
  -Dversion=1.0-SNAPSHOT
```

This command generates a **sample-kogito** Maven project and imports the extension for all required dependencies and configurations to prepare your application for business automation.

If you want to enable PMML execution for your project, add the following dependency to the **pom.xml** file in the Maven project that contains your Red Hat build of Kogito microservices:

#### Dependency to enable PMML execution

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>kogito-pmml</artifactId>
</dependency>
<dependency>
  <groupId>org.jpmmml</groupId>
  <artifactId>pmml-model</artifactId>
</dependency>
```

On Red Hat build of Quarkus, if you plan to run your application on OpenShift, you must also import the **smallrye-health** extension for the [liveness and readiness probes](#), as shown in the following example:

#### SmallRye Health extension for Red Hat build of Quarkus applications on OpenShift

```
$ mvn quarkus:add-extension -Dextensions="smallrye-health"
```

This command generates the following dependency in the **pom.xml** file of your Red Hat Process Automation Manager project on Red Hat build of Quarkus:

### SmallRye Health dependency for Red Hat build of Quarkus applications on OpenShift

```
<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-smallrye-health</artifactId>
</dependency>
```

3. Open or import the project in your VS Code IDE to view the contents.

## 3.1. CREATING A CUSTOM SPRING BOOT PROJECT FOR RED HAT BUILD OF KOGITO MICROSERVICES

You can create custom Maven projects using the Spring Boot archetype for your Red Hat build of Kogito microservices. The Spring Boot archetype enables you to add Spring Boot starters or add-ons to your project.

A Spring Boot starter is an all-in-one descriptor for your project and requires business automation engines provided by Red Hat build of Kogito. The Spring Boot starters include decisions, rules, and predictions.

When your project contains all the assets and you want a quick way to get started with Red Hat build of Kogito, you can use the **kogito-spring-boot-starter** starter. For a more granular approach, you can use a specific starter, such as **kogito-decisions-spring-boot-starter** for decisions, or a combination of starters.

Red Hat build of Kogito supports the following Spring Boot starters:

### Decisions Spring Boot starter

Starter for providing DMN support to your Spring Boot project. The following is an example of adding a decisions Spring boot starter to your project:

```
<dependencies>
  <dependency>
    <groupId>org.kie.kogito</groupId>
    <artifactId>kogito-decisions-spring-boot-starter</artifactId>
  </dependency>
</dependencies>
```

### Predictions Spring Boot starter

Starter for providing PMML support to your Spring Boot project. The following is an example of adding a predictions Spring boot starter to your project:

```
<dependencies>
  <dependency>
    <groupId>org.kie.kogito</groupId>
    <artifactId>kogito-predictions-spring-boot-starter</artifactId>
  </dependency>
</dependencies>
```

## Rules Spring Boot starter

Starter for providing DRL support to your Spring Boot project. The following is an example of adding a rules Spring boot starter to your project:

```
<dependencies>
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>kogito-rules-spring-boot-starter</artifactId>
</dependency>
</dependencies>
```

## Procedure

1. In a command terminal, navigate to a local folder where you want to store the new project.
2. Enter one of the following commands to generate a project using the **starters** or **addons** property:
  - To generate a project using the **starters** property, enter the following command:

```
$ mvn archetype:generate \
  -DarchetypeGroupId=org.kie.kogito \
  -DarchetypeArtifactId=kogito-springboot-archetype \
  -DgroupId=org.acme -DartifactId=sample-kogito \
  -DarchetypeVersion=1.11.0.Final \
  -Dversion=1.0-SNAPSHOT
  -Dstarters=decisions
```

The new project includes the dependencies required to run the decision microservices. You can combine multiple Spring Boot starters using a comma-separated list, such as **starters=decisions,rules**.

- To generate a project containing Prometheus monitoring using the **addons** property, enter the following command:

```
$ mvn archetype:generate \
  -DarchetypeGroupId=org.kie.kogito \
  -DarchetypeArtifactId=kogito-springboot-archetype \
  -DgroupId=org.acme -DartifactId=sample-kogito \
  -DarchetypeVersion=1.11.0.Final \
  -Dversion=1.0-SNAPSHOT
  -Dstarters=descisions
  -Daddons=monitoring-prometheus,persistence-infinispan
```



### NOTE

When you pass an add-on to the property, the add-on name does not require the **kogito-addons-springboot** prefix. Also, you can combine the **add-ons** and **starters** properties to customize the project.

3. Open or import the project in your IDE to view the contents.

## CHAPTER 4. EXAMPLE APPLICATIONS WITH RED HAT BUILD OF KOGITO MICROSERVICES

Red Hat build of Kogito microservices include example applications in the **rhpan-7.13.5-kogito-and-optaplanner-quickstarts.zip** file. These example applications contain various types of services on Red Hat build of Quarkus or Spring Boot to help you develop your own applications. The services use one or more Decision Model and Notation (DMN) decision models, Drools Rule Language (DRL) rule units, Predictive Model Markup Language (PMML) models, or Java classes to define the service logic.

For information about each example application and instructions for using them, see the **README** file in the relevant application folder.



### NOTE

When you run examples in a local environment, ensure that the environment matches the requirements that are listed in the **README** file of the relevant application folder. Also, this might require making the necessary network ports available, as configured for Red Hat build of Quarkus, Spring Boot, and docker-compose where applicable.

The following list describes some of the examples provided with Red Hat build of Kogito microservices:



### NOTE

These quick start examples showcase a supported setup. Other quickstarts not listed might use technology that is provided by the upstream community only and therefore not fully supported by Red Hat.

### Decision services

- **dmn-quarkus-example** and **dmn-springboot-example**: A decision service (on Red Hat build of Quarkus or Spring Boot) that uses DMN to determine driver penalty and suspension based on traffic violations.
- **rules-quarkus-helloworld**: A Hello World decision service on Red Hat build of Quarkus with a single DRL rule unit.
- **ruleunit-quarkus-example** and **ruleunit-springboot-example**: A decision service (on Red Hat build of Quarkus or Spring Boot) that uses DRL with rule units to validate a loan application and that exposes REST operations to view application status.
- **dmn-pmml-quarkus-example** and **dmn-pmml-springboot-example**: A decision service (on Red Hat build of Quarkus or Spring Boot) that uses DMN and PMML to determine driver penalty and suspension based on traffic violations.
- **dmn-drools-quarkus-metrics** and **dmn-drools-springboot-metrics**: A decision service (on Red Hat build of Quarkus or Spring Boot) that enables and consumes the runtime metrics monitoring feature in Red Hat build of Kogito.
- **pmml-quarkus-example** and **pmml-springboot-example**: A decision service (on Red Hat build of Quarkus or Spring Boot) that uses PMML.

For more information, see [Designing a decision service using DMN models](#) , [Designing a decision service using DRL rules](#), and [Designing a decision service using PMML models](#) .

## CHAPTER 5. DESIGNING THE APPLICATION LOGIC FOR A RED HAT BUILD OF KOGITO MICROSERVICE USING DMN

After you create your project, you can create or import Decision Model and Notation (DMN) decision models and Drools Rule Language (DRL) business rules in the **src/main/resources** folder of your project. You can also include Java classes in the **src/main/java** folder of your project that act as Java services or provide implementations that you call from your decisions.

The example for this procedure is a basic Red Hat build of Kogito microservice that provides a REST endpoint **/persons**. This endpoint is automatically generated based on an example **PersonDecisions.dmn** DMN model to make decisions based on the data being processed.

The business decision contains the decision logic of the Red Hat Process Automation Manager service. You can define business rules and decisions in different ways, such as with DMN models or DRL rules. The example for this procedure uses a DMN model.

### Prerequisites

- You have created a project. For more information about creating a Maven project, see [Chapter 3, Creating a Maven project for a Red Hat build of Kogito microservice](#) .

### Procedure

1. In the Maven project that you generated for your Red Hat Process Automation Manager service, navigate to the **src/main/java/org/acme** folder and add the following **Person.java** file:

#### Example person Java object

```
package org.acme;

import java.io.Serializable;

public class Person {

    private String name;
    private int age;
    private boolean adult;

    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }

    public int getAge() {
        return age;
    }

    public void setAge(int age) {
        this.age = age;
    }

    public boolean isAdult() {
```

```
return adult;
}

public void setAdult(boolean adult) {
    this.adult = adult;
}

@Override
public String toString() {
    return "Person [name=" + name + ", age=" + age + ", adult=" + adult + "];"
}

}
```

This example Java object sets and retrieves a person's name, age, and adult status.

2. Navigate to the **src/main/resources** folder and add the following **PersonDecisions.dmn** DMN decision model:

Figure 5.1. Example **PersonDecisions** DMN decision requirements diagram (DRD)

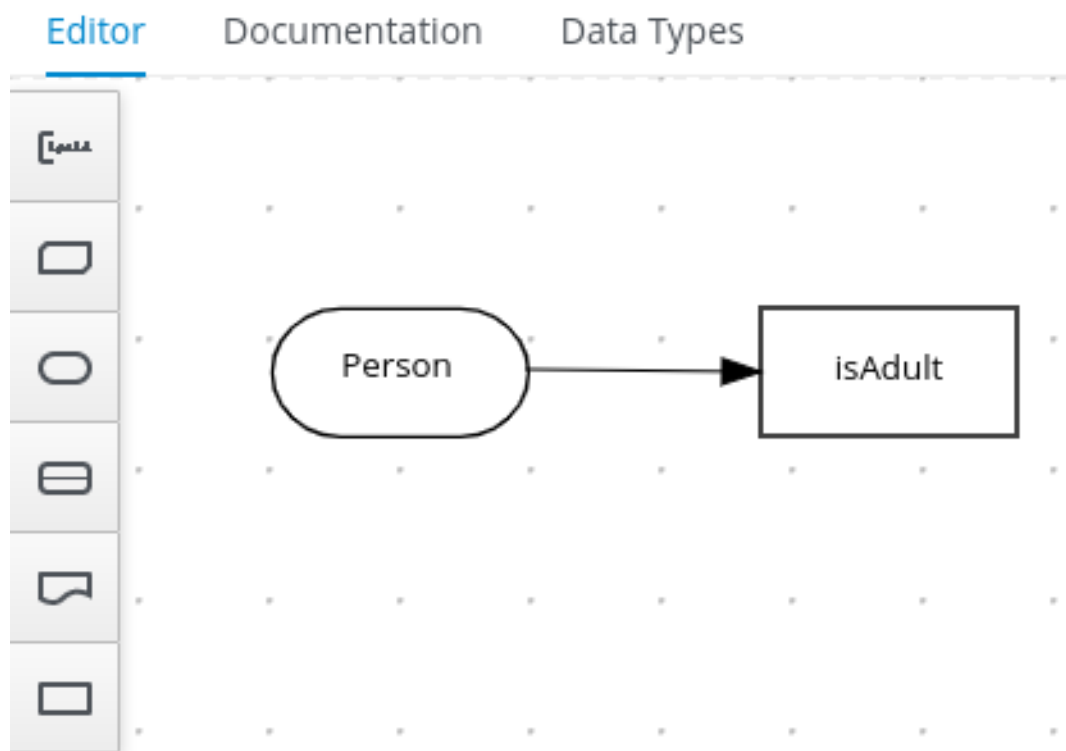


Figure 5.2. Example DMN boxed expression for **isAdult** decision

Editor Documentation Data Types

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**isAdult** (*Decision Table*)













U	Person.Age (number)	isAdult (boolean)	Description
1	> 18	true	
2	<= 18	false	

Figure 5.3. Example DMN data types

Editor Documentation Data Types Q

Custom Data Types

Expand all | Collapse all

▼ <b>tPerson</b> (Structure)	  
Age (number)	  
Name (string)	  
Adult (boolean)	  

This example DMN model consists of a basic DMN input node and a decision node defined by a DMN decision table with a custom structured data type.

In VS Code, you can add the **Red Hat Business Automation Bundle** VS Code extension to design the decision requirements diagram (DRD), boxed expression, and data types with the DMN modeler.

To create this example DMN model quickly, you can copy the following **PersonDecisions.dmn** file content:

### Example DMN file



```

<dmn:definitions xmlns:dmn="http://www.omg.org/spec/DMN/20180521/MODEL/"
xmlns="https://kiegroup.org/dmn/_52CEF9FD-9943-4A89-96D5-6F66810CA4C1"
xmlns:di="http://www.omg.org/spec/DMN/20180521/DI/"
xmlns:kie="http://www.drools.org/kie/dmn/1.2"
xmlns:dmndi="http://www.omg.org/spec/DMN/20180521/DMNDI/"
xmlns:dc="http://www.omg.org/spec/DMN/20180521/DC/"
xmlns:feel="http://www.omg.org/spec/DMN/20180521/FEEL/" id="_84B432F5-87E7-43B1-
9101-1BAFE3D18FC5" name="PersonDecisions"
typeLanguage="http://www.omg.org/spec/DMN/20180521/FEEL/"
namespace="https://kiegroup.org/dmn/_52CEF9FD-9943-4A89-96D5-6F66810CA4C1">
  <dmn:extensionElements/>
  <dmn:itemDefinition id="_DEF2C3A7-F3A9-4ABA-8D0A-C823E4EB43AB" name="tPerson"
isCollection="false">
    <dmn:itemComponent id="_DB46DB27-0752-433F-ABE3-FC9E3BDECC97" name="Age"
isCollection="false">
      <dmn:typeRef>number</dmn:typeRef>
    </dmn:itemComponent>
    <dmn:itemComponent id="_8C6D865F-E9C8-43B0-AB4D-3F2075A4ECA6" name="Name"
isCollection="false">
      <dmn:typeRef>string</dmn:typeRef>
    </dmn:itemComponent>
    <dmn:itemComponent id="_9033704B-4E1C-42D3-AC5E-0D94107303A1" name="Adult"
isCollection="false">
      <dmn:typeRef>boolean</dmn:typeRef>
    </dmn:itemComponent>
  </dmn:itemDefinition>
  <dmn:inputData id="_F9685B74-0C69-4982-B3B6-B04A14D79EDB" name="Person">
    <dmn:extensionElements/>
    <dmn:variable id="_0E345A3C-BB1F-4FB2-B00F-C5691FD1D36C" name="Person"
typeRef="tPerson"/>
  </dmn:inputData>
  <dmn:decision id="_0D2BD7A9-ACA1-49BE-97AD-19699E0C9852" name="isAdult">
    <dmn:extensionElements/>
    <dmn:variable id="_54CD509F-452F-40E5-941C-AFB2667D4D45" name="isAdult"
typeRef="boolean"/>
    <dmn:informationRequirement id="_2F819B03-36B7-4DEB-AED6-2B46AE3ADB75">
      <dmn:requiredInput href="#_F9685B74-0C69-4982-B3B6-B04A14D79EDB"/>
    </dmn:informationRequirement>
    <dmn:decisionTable id="_58370567-05DE-4EC0-AC2D-A23803C1EAAE"
hitPolicy="UNIQUE" preferredOrientation="Rule-as-Row">
      <dmn:input id="_ADEF36CD-286A-454A-ABD8-9CF96014021B">
        <dmn:inputExpression id="_4930C2E5-7401-46DD-8329-EAC523BFA492"
typeRef="number">
          <dmn:text>Person.Age</dmn:text>
        </dmn:inputExpression>
      </dmn:input>
      <dmn:output id="_9867E9A3-CBF6-4D66-9804-D2206F6B4F86" typeRef="boolean"/>
      <dmn:rule id="_59D6BFF0-35B4-4B7E-8D7B-E31CB0DB8242">
        <dmn:inputEntry id="_7DC55D63-234F-497B-A12A-93DA358C0136">
          <dmn:text>&gt; 18</dmn:text>
        </dmn:inputEntry>
        <dmn:outputEntry id="_B3BB5B97-05B9-464A-AB39-58A33A9C7C00">
          <dmn:text>>true</dmn:text>
        </dmn:outputEntry>
      </dmn:rule>
    </dmn:decisionTable>
  </dmn:decision>
  <dmn:rule id="_8FCD63FE-8AD8-4F56-AD12-923E87AFD1B1">

```

```

    <dmn:inputEntry id="_B4EF7F13-E486-46CB-B14E-1D21647258D9">
      <dmn:text>&lt;= 18</dmn:text>
    </dmn:inputEntry>
    <dmn:outputEntry id="_F3A9EC8E-A96B-42A0-BF87-9FB1F2FDB15A">
      <dmn:text>>false</dmn:text>
    </dmn:outputEntry>
  </dmn:rule>
</dmn:decisionTable>
</dmn:decision>
<dmndi:DMNDI>
  <dmndi:DMNDiagram>
    <di:extension>
      <kie:ComponentsWidthsExtension>
        <kie:ComponentWidths dmnElementRef="_58370567-05DE-4EC0-AC2D-A23803C1EAAE">
          <kie:width>50</kie:width>
          <kie:width>100</kie:width>
          <kie:width>100</kie:width>
          <kie:width>100</kie:width>
        </kie:ComponentWidths>
      </kie:ComponentsWidthsExtension>
    </di:extension>
    <dmndi:DMNShape id="dmnshape-_F9685B74-0C69-4982-B3B6-B04A14D79EDB"
dmnElementRef="_F9685B74-0C69-4982-B3B6-B04A14D79EDB" isCollapsed="false">
      <dmndi:DMNStyle>
        <dmndi:FillColor red="255" green="255" blue="255"/>
        <dmndi:StrokeColor red="0" green="0" blue="0"/>
        <dmndi:FontColor red="0" green="0" blue="0"/>
      </dmndi:DMNStyle>
      <dc:Bounds x="404" y="464" width="100" height="50"/>
      <dmndi:DMNLabel/>
    </dmndi:DMNShape>
    <dmndi:DMNShape id="dmnshape-_0D2BD7A9-ACA1-49BE-97AD-19699E0C9852"
dmnElementRef="_0D2BD7A9-ACA1-49BE-97AD-19699E0C9852" isCollapsed="false">
      <dmndi:DMNStyle>
        <dmndi:FillColor red="255" green="255" blue="255"/>
        <dmndi:StrokeColor red="0" green="0" blue="0"/>
        <dmndi:FontColor red="0" green="0" blue="0"/>
      </dmndi:DMNStyle>
      <dc:Bounds x="404" y="311" width="100" height="50"/>
      <dmndi:DMNLabel/>
    </dmndi:DMNShape>
    <dmndi:DMNEdge id="dmnedge-_2F819B03-36B7-4DEB-AED6-2B46AE3ADB75"
dmnElementRef="_2F819B03-36B7-4DEB-AED6-2B46AE3ADB75">
      <di:waypoint x="504" y="489"/>
      <di:waypoint x="404" y="336"/>
    </dmndi:DMNEdge>
  </dmndi:DMNDiagram>
</dmndi:DMNDI>
</dmn:definitions>

```

To create this example DMN model in VS Code using the DMN modeler, follow these steps:

- a. Open the empty **PersonDecisions.dmn** file, click the **Properties** icon in the upper-right corner of the DMN modeler, and confirm that the DMN model **Name** is set to **PersonDecisions**.

- b. In the left palette, select **DMN Input Data**, drag the node to the canvas, and double-click the node to name it **Person**.
- c. In the left palette, drag the **DMN Decision** node to the canvas, double-click the node to name it **isAdult**, and link to it from the input node.
- d. Select the decision node to display the node options and click the **Edit** icon to open the DMN boxed expression editor to define the decision logic for the node.
- e. Click the *undefined expression* field and select **Decision Table**.
- f. Click the upper-left corner of the decision table to set the hit policy to **Unique**.
- g. Set the input and output columns so that the input source **Person.Age** with type **number** determines the age limit and the output target **isAdult** with type **boolean** determines adult status:

Figure 5.4. Example DMN decision table for **isAdult** decision

[Editor](#)   [Documentation](#)   [Data Types](#)

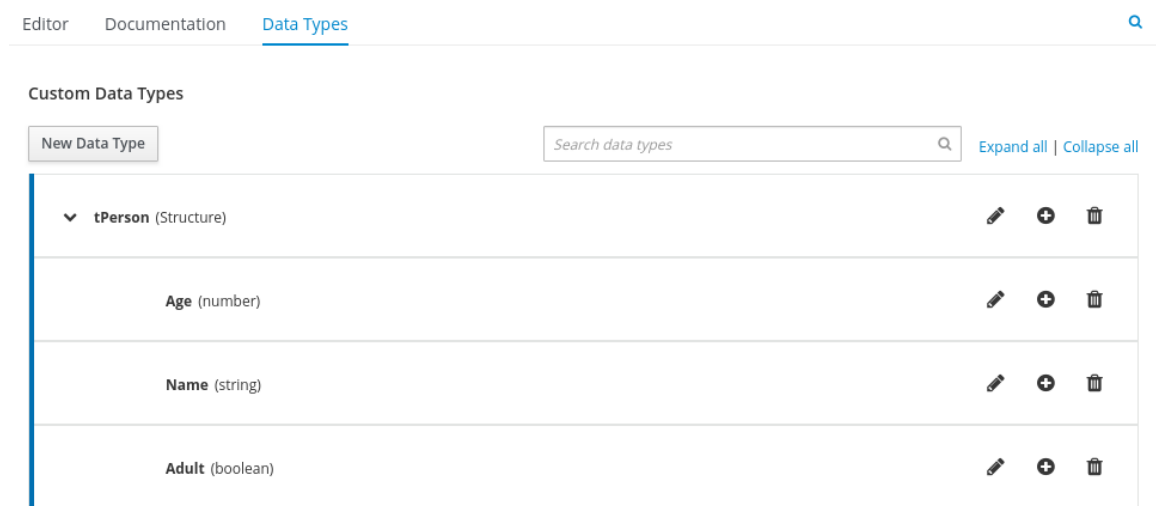
« [Back to PersonDecisions](#)

**isAdult** (*Decision Table*)

U	Person.Age ( <i>number</i> )	isAdult ( <i>boolean</i> )	Description
1	> 18	true	
2	<= 18	false	

- h. In the upper tab options, select the **Data Types** tab and add the following **tPerson** structured data type and nested data types:

Figure 5.5. Example DMN data types



- i. After you define the data types, select the **Editor** tab to return to the DMN modeler canvas.
- j. Select the **Person** input node, click the **Properties** icon, and under **Information item**, set the **Data type** to **tPerson**.
- k. Select the **isAdult** decision node, click the **Properties** icon, and under **Information item**, confirm that the **Data type** is still set to **boolean**. You previously set this data type when you created the decision table.
- l. Save the DMN decision file.

## 5.1. USING DRL RULE UNITS AS AN ALTERNATIVE DECISION SERVICE

You can also use a Drools Rule Language (DRL) file implemented as a rule unit to define this example decision service, as an alternative to using Decision Model and Notation (DMN).

A DRL rule unit is a module for rules and a unit of execution. A rule unit collects a set of rules with the declaration of the type of facts that the rules act on. A rule unit also serves as a unique namespace for each group of rules. A single rule base can contain multiple rule units. You typically store all the rules for a unit in the same file as the unit declaration so that the unit is self-contained. For more information about rule units, see [Designing a decision service using DRL rules](#).

### Prerequisites

- You have created a project. For more information about creating a Maven project, see [Chapter 3, Creating a Maven project for a Red Hat build of Kogito microservice](#).

### Procedure

1. In the **src/main/resources** folder of your example project, instead of using a DMN file, add the following **PersonRules.drl** file:

#### Example PersonRules DRL file

```
package org.acme
unit PersonRules;

import org.acme.Person;
```

```
rule isAdult
when
  $person: /person[ age > 18 ]
then
  modify($person) {
    setAdult(true)
  };
end

query persons
  $p : /person[ adult ]
end
```

This example rule determines that any person who is older than 18 is classified as an adult. The rule file also declares that the rule belongs to the rule unit **PersonRules**. When you build the project, the rule unit is generated and associated with the DRL file.

The rule also defines the condition using OOPath notation. OOPath is an object-oriented syntax extension to XPath for navigating through related elements while handling collections and filtering constraints.

You can also rewrite the same rule condition in a more explicit form using the traditional rule pattern syntax, as shown in the following example:

#### Example **PersonRules** DRL file using traditional notation

```
package org.acme
unit PersonRules;

import org.acme.Person;

rule isAdult
when
  $person: Person(age > 18) from person
then
  modify($person) {
    setAdult(true)
  };
end

query persons
  $p : /person[ adult ]
end
```

## CHAPTER 6. RED HAT BUILD OF KOGITO EVENTS ADD-ON

The events add-on provides a default implementation in supported target platforms for **EventEmitter** and **EventReceiver** interfaces. You can use **EventEmitter** and **EventReceiver** interfaces to enable messaging by process, serverless workflow events, and event decision handling.

### 6.1. IMPLEMENTING MESSAGE PAYLOAD DECORATOR FOR RED HAT BUILD OF KOGITO EVENTS ADD-ON

Any dependent add-on can implement the [MessagePayloadDecorator](#).

#### Prerequisites

- You have installed the Events add-on in Red Hat build of Kogito.

#### Procedure

- Create a file named **META-INF/services/org.kie.kogito.add-on.cloudevents.message.MessagePayloadDecorator** in your class path.
- Open the file.
- Enter the full name of your implementation class in the file.
- Save the file.

The **MessagePayloadDecoratorProvider** loads the file upon application start-up and adds the file to the decoration chain. When Red Hat build of Kogito calls the **MessagePayloadDecoratorProvider#decorate**, your implementation is part of the decoration algorithm.

- To use the events add-on, add the following code to the **pom.xml** file of your project:

#### Events smallrye add-on for {QAURKUS}

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>kogito-addons-quarkus-events-smallrye</artifactId>
  <version>1.15</version>
</dependency>
```

#### Events decisions add-on for {QAURKUS}

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>kogito-addons-events-decisions</artifactId>
  <version>1.15</version>
</dependency>
```

#### Events Kafka add-on for Spring Boot

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>kogito-addons-springboot-events-kafka</artifactId>
```

```
<version>1.15</version>  
</dependency>
```

### Events decisions add-on for Spring Boot

```
<dependency>  
  <groupId>org.kie.kogito</groupId>  
  <artifactId>kogito-addons-springboot-events-decisions</artifactId>  
  <version>1.15</version>  
</dependency>
```

## CHAPTER 7. RUNNING A RED HAT BUILD OF KOGITO MICROSERVICE

After you design the business decisions for your Red Hat build of Kogito microservice, you can run your Red Hat build of Quarkus or Spring Boot application in one of the following modes:

- **Development mode:** For local testing. On Red Hat build of Quarkus, development mode also offers live reload of your decisions in your running applications for advanced debugging.
- **JVM mode:** For compatibility with a Java virtual machine (JVM).

### Procedure

In a command terminal, navigate to the project that contains your Red Hat build of Kogito microservice and enter one of the following commands, depending on your preferred run mode and application environment:

- For development mode:

#### On Red Hat build of Quarkus

```
$ mvn clean compile quarkus:dev
```

#### On Sprint Boot

```
$ mvn clean compile spring-boot:run
```

- For JVM mode:

#### On Red Hat build of Quarkus and Spring Boot

```
$ mvn clean package  
$ java -jar target/sample-kogito-1.0-SNAPSHOT-runner.jar
```



## CHAPTER 8. INTERACTING WITH A RUNNING RED HAT BUILD OF KOGITO MICROSERVICE

After your Red Hat build of Kogito microservice is running, you can send REST API requests to interact with your application and execute your microservices according to how you set up the application.

This example tests the `/persons` REST API endpoint that is automatically generated the decisions in the `PersonDecisions.dmn` file (or the rules in the `PersonRules.drl` file if you used a DRL rule unit).

For this example, use a REST client, curl utility, or the Swagger UI configured for the application (such as `http://localhost:8080/q/swagger-ui` or `http://localhost:8080/swagger-ui.html`) to send API requests with the following components:

- URL: `http://localhost:8080/persons`
- HTTP headers: For **POST** requests only:
  - `accept: application/json`
  - `content-type: application/json`
- HTTP methods: **GET**, **POST**, or **DELETE**

### Example POST request body to add an adult (JSON)

```
{
  "person": {
    "name": "John Quark",
    "age": 20
  }
}
```

### Example curl command to add an adult

```
curl -X POST http://localhost:8080/persons -H 'content-type: application/json' -H 'accept: application/json' -d '{"person": {"name": "John Quark", "age": 20}}'
```

### Example response (JSON)

```
{
  "id": "3af806dd-8819-4734-a934-728f4c819682",
  "person": {
    "name": "John Quark",
    "age": 20,
    "adult": false
  },
  "isAdult": true
}
```

This example procedure uses curl commands for convenience.

### Procedure

In a command terminal window that is separate from your running application, navigate to the project that contains your Red Hat build of Kogito microservice and use any of the following curl commands with JSON requests to interact with your running microservice:



## NOTE

On Spring Boot, you might need to modify how your application exposes API endpoints in order for these example requests to function. For more information, see the **README** file included in the example Spring Boot project that you created for this tutorial.

- Add an adult person:

### Example request

```
curl -X POST http://localhost:8080/persons -H 'content-type: application/json' -H 'accept: application/json' -d '{"person": {"name": "John Quark", "age": 20}}'
```

### Example response

```
{"id": "3af806dd-8819-4734-a934-728f4c819682", "person": {"name": "John Quark", "age": 20, "adult": false}, "isAdult": true}
```

- Add an underage person:

### Example request

```
curl -X POST http://localhost:8080/persons -H 'content-type: application/json' -H 'accept: application/json' -d '{"person": {"name": "Jenny Quark", "age": 15}}'
```

### Example response

```
{"id": "8eef502b-012b-4628-acb7-73418a089c08", "person": {"name": "Jenny Quark", "age": 15, "adult": false}, "isAdult": false}
```

- Complete the evaluation using the returned UUIDs:

### Example request

```
curl -X POST http://localhost:8080/persons/8eef502b-012b-4628-acb7-73418a089c08/ChildrenHandling/cdec4241-d676-47de-8c55-4ee4f9598bac -H 'content-type: application/json' -H 'accept: application/json' -d '{}'
```

## PART II. DEPLOYING RED HAT BUILD OF KOGITO MICROSERVICES ON RED HAT OPENSIFT CONTAINER PLATFORM

As a developer of business decisions and processes, you can deploy Red Hat build of Kogito microservices on Red Hat OpenShift Container Platform for cloud implementation. The RHPAM Kogito Operator automates many of the deployment steps for you or guides you through the deployment process.

### Prerequisites

- Red Hat OpenShift Container Platform 4.6 or 4.7 is installed.
- The OpenShift project for the deployment is created.

## CHAPTER 9. RED HAT BUILD OF KOGITO ON RED HAT OPENSIFT CONTAINER PLATFORM

You can deploy Red Hat build of Kogito microservices on Red Hat OpenShift Container Platform for cloud implementation. In this architecture, Red Hat build of Kogito microservices are deployed as OpenShift pods that you can scale up and down individually to provide as few or as many containers as required for a particular service.

To help you deploy your Red Hat build of Kogito microservices on OpenShift, Red Hat Process Automation Manager provides **Red Hat Process Automation Manager Kogito Operator**. This operator guides you through the deployment process. The operator is based on the [Operator SDK](#) and automates many of the deployment steps for you. For example, when you provide the operator with a link to the Git repository that contains your application, the operator automatically configures the components required to build your project from source and deploys the resulting services.

To install the Red Hat Process Automation Manager Kogito Operator in OpenShift web console, go to **Operators → OperatorHub** in the left menu, search for and select **RHPAM Kogito Operator**, and follow the on-screen instructions to install the latest operator version.

## CHAPTER 10. OPENSIFT DEPLOYMENT OPTIONS WITH THE RHPAM KOGITO OPERATOR

After you create your Red Hat build of Kogito microservices as part of a business application, you can use the Red Hat OpenShift Container Platform web console to deploy your microservices. The RHPAM Kogito Operator page in the OpenShift web console guides you through the deployment process.

The RHPAM Kogito Operator supports the following options for building and deploying Red Hat build of Kogito microservices on Red Hat OpenShift Container Platform:

- Git source build and deployment
- Binary build and deployment
- Custom image build and deployment
- File build and deployment

### 10.1. DEPLOYING RED HAT BUILD OF KOGITO MICROSERVICES ON OPENSIFT USING GIT SOURCE BUILD AND OPENSIFT WEB CONSOLE

The RHPAM Kogito Operator uses the following custom resources to deploy domain-specific microservices (the microservices that you develop):

- **KogitoBuild** builds an application using the Git URL or other sources and produces a runtime image.
- **KogitoRuntime** starts the runtime image and configures it as per your requirements.

In most use cases, you can use the standard runtime build and deployment method to deploy Red Hat build of Kogito microservices on OpenShift from a Git repository source, as shown in the following procedure.



#### NOTE

If you are developing or testing your Red Hat build of Kogito microservice locally, you can use the binary build, custom image build, or file build option to build and deploy from a local source instead of from a Git repository.

#### Prerequisites

- The RHPAM Kogito Operator is installed.
- The application with your Red Hat build of Kogito microservices is in a Git repository that is reachable from your OpenShift environment.
- You have access to the OpenShift web console with the necessary permissions to create and edit **KogitoBuild** and **KogitoRuntime**.
- (Red Hat build of Quarkus only) The **pom.xml** file of your project contains the following dependency for the **quarkus-smallrye-health** extension. This extension enables the [liveness and readiness probes](#) that are required for Red Hat build of Quarkus projects on OpenShift.

## SmallRye Health dependency for Red Hat build of Quarkus applications on OpenShift

```
<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-smallrye-health</artifactId>
</dependency>
```

### Procedure

1. Go to **Operators** → **Installed Operators** and select **RHPAM Kogito Operator**.
2. To create the Red Hat build of Kogito build definition, on the operator page, select the **Kogito Build** tab and click **Create KogitoBuild**.
3. In the application window, use **Form View** or **YAML View** to configure the build definition. At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito build

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-quarkus # Application name
spec:
  type: RemoteSource
  gitSource:
    uri: 'https://github.com/kiegroup/kogito-examples' # Git repository containing application
    (uses default branch)
    contextDir: dmn-quarkus-example # Git folder location of application
```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito build

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
  type: RemoteSource
  gitSource:
    uri: 'https://github.com/kiegroup/kogito-examples' # Git repository containing application
    (uses default branch)
    contextDir: dmn-springboot-example # Git folder location of application
```

**NOTE**

If you configured an internal Maven repository, you can use it as a Maven mirror service and specify the Maven mirror URL in your Red Hat build of Kogito build definition to shorten build time substantially:

```
spec:
  mavenMirrorURL: http://nexus3-nexus.apps-crc.testing/repository/maven-
  public/
```

For more information about internal Maven repositories, see the [Apache Maven](#) documentation.

4. After you define your application data, click **Create** to generate the Red Hat build of Kogito build.  
Your application is listed in the **Red Hat build of Kogito Builds** page. You can select the application name to view or modify application settings and YAML details.
5. To create the Red Hat build of Kogito microservice definition, on the operator page, select the **Kogito Runtime** tab and click **Create KogitoRuntime**.
6. In the application window, use **Form View** or **YAML View** to configure the microservice definition.  
At a minimum, define the application configurations shown in the following example YAML file:

#### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-quarkus # Application name
```

#### Example YAML definition for a Spring Boot application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
```

**NOTE**

In this case, the application is built from Git and deployed using KogitoRuntime. You must ensure that the application name is same in **KogitoBuild** and **KogitoRuntime**.

7. After you define your application data, click **Create** to generate the Red Hat build of Kogito microservice.  
Your application is listed in the Red Hat build of Kogito microservice page. You can select the application name to view or modify application settings and the contents of the YAML file.

8. In the left menu of the web console, go to **Builds** → **Builds** to view the status of your application build.

You can select a specific build to view build details.



#### NOTE

For every Red Hat build of Kogito microservice that you create for OpenShift deployment, two builds are generated and listed in the **Builds** page in the web console: a traditional runtime build and a Source-to-Image (S2I) build with the suffix **-builder**. The S2I mechanism builds the application in an OpenShift build and then passes the built application to the next OpenShift build to be packaged into the runtime container image. The Red Hat build of Kogito S2I build configuration also enables you to build the project directly from a Git repository on the OpenShift platform.

9. After the application build is complete, go to **Workloads** → **Deployments** to view the application deployments, pod status, and other details.
10. After your Red Hat build of Kogito microservice is deployed, in the left menu of the web console, go to **Networking** → **Routes** to view the access link to the deployed application. You can select the application name to view or modify route settings.

With the application route, you can integrate your Red Hat build of Kogito microservices with your business automation solutions as needed.

## 10.2. DEPLOYING RED HAT BUILD OF KOGITO MICROSERVICES ON OPENSIFT USING BINARY BUILD AND OPENSIFT WEB CONSOLE

OpenShift builds can require extensive amounts of time. As a faster alternative for building and deploying your Red Hat build of Kogito microservices on OpenShift, you can use a binary build.

The operator uses the following custom resources to deploy domain-specific microservices (the microservices that you develop):

- **KogitoBuild** processes an uploaded application and produces a runtime image.
- **KogitoRuntime** starts the runtime image and configures it as per your requirements.

### Prerequisites

- The RHPAM Kogito Operator is installed.
- The **oc** OpenShift CLI is installed and you are logged in to the relevant OpenShift cluster. For **oc** installation and login instructions, see the [OpenShift documentation](#).
- You have access to the OpenShift web console with the necessary permissions to create and edit **KogitoBuild** and **KogitoRuntime**.
- (Red Hat build of Quarkus only) The **pom.xml** file of your project contains the following dependency for the **quarkus-smallrye-health** extension. This extension enables the [liveness and readiness probes](#) that are required for Red Hat build of Quarkus projects on OpenShift.

### SmallRye Health dependency for Red Hat build of Quarkus applications on OpenShift

■



```

<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-smallrye-health</artifactId>
</dependency>

```

## Procedure

1. Build an application locally.
2. Go to **Operators** → **Installed Operators** and select **RHPAM Kogito Operator**.
3. To create the Red Hat build of Kogito build definition, on the operator page, select the **Kogito Build** tab and click **Create KogitoBuild**.
4. In the application window, use **Form View** or **YAML View** to configure the build definition. At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito build

```

apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-quarkus # Application name
spec:
  type: Binary

```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito build

```

apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
  type: Binary

```

5. After you define your application data, click **Create** to generate the Red Hat build of Kogito build. Your application is listed in the **Red Hat build of KogitoBuilds** page. You can select the application name to view or modify application settings and YAML details.
6. Upload the built binary using the following command:

```
$ oc start-build example-quarkus --from-dir=target/ -n namespace
```

- **from-dir** is equals to the **target** folder path of the built application.
- **namespace** is the namespace where **KogitoBuild** is created.

7. To create the Red Hat build of Kogito microservice definition, on the operator page, select the **Kogito Runtime** tab and click **Create KogitoRuntime**.

- In the application window, use **Form View** or **YAML View** to configure the microservice definition.  
At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-quarkus # Application name
```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
```



#### NOTE

In this case, the application is built locally and deployed using KogitoRuntime. You must ensure that the application name is same in **KogitoBuild** and **KogitoRuntime**.

- After you define your application data, click **Create** to generate the Red Hat build of Kogito microservice.  
Your application is listed in the Red Hat build of Kogito microservice page. You can select the application name to view or modify application settings and the contents of the YAML file.
- In the left menu of the web console, go to **Builds** → **Builds** to view the status of your application build.  
You can select a specific build to view build details.
- After the application build is complete, go to **Workloads** → **Deployments** to view the application deployments, pod status, and other details.
- After your Red Hat build of Kogito microservice is deployed, in the left menu of the web console, go to **Networking** → **Routes** to view the access link to the deployed application.  
You can select the application name to view or modify route settings.

With the application route, you can integrate your Red Hat build of Kogito microservices with your business automation solutions as needed.

## 10.3. DEPLOYING RED HAT BUILD OF KOGITO MICROSERVICES ON OPENSIFT USING CUSTOM IMAGE BUILD AND OPENSIFT WEB CONSOLE

You can use custom image build as an alternative for building and deploying your Red Hat build of Kogito microservices on OpenShift.

The operator uses the following custom resources to deploy domain-specific microservices (the microservices that you develop):

- **KogitoRuntime** starts the runtime image and configures it as per your requirements.



## NOTE

The Red Hat Process Automation Manager builder image does not support native builds. However, you can perform a custom build and use **Containerfile** to build the container image as shown in the following example:

```
FROM registry.redhat.io/rhpam-7-tech-preview/rhpam-kogito-runtime-native-rhel8:7.13.5
```

```
ENV RUNTIME_TYPE quarkus
```

```
COPY --chown=1001:root target/*-runner $KOGITO_HOME/bin
```

This feature is Technology Preview only.

To build the native binary with Mandrel, see [Compiling your Quarkus applications to native executables](#).

## Prerequisites

- The RHPAM Kogito Operator is installed.
- You have access to the OpenShift web console with the necessary permissions to create and edit **KogitoRuntime**.
- (Red Hat build of Quarkus only) The **pom.xml** file of your project contains the following dependency for the **quarkus-smallrye-health** extension. This extension enables the [liveness and readiness probes](#) that are required for Red Hat build of Quarkus projects on OpenShift.

### SmallRye Health dependency for Red Hat build of Quarkus applications on OpenShift

```
<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-smallrye-health</artifactId>
</dependency>
```

## Procedure

1. Build an application locally.
2. Create **Containerfile** in the project root folder with the following content:

### Example Containerfile for a Red Hat build of Quarkus application

```
FROM registry.redhat.io/rhpam-7/rhpam-kogito-runtime-jvm-rhel8:7.13.5

ENV RUNTIME_TYPE quarkus

COPY target/quarkus-app/lib/ $KOGITO_HOME/bin/lib/
```

```
COPY target/quarkus-app/*.jar $KOGITO_HOME/bin
COPY target/quarkus-app/app/ $KOGITO_HOME/bin/app/
COPY target/quarkus-app/quarkus/ $KOGITO_HOME/bin/quarkus/
```

### Example Containerfile for a Spring Boot application

```
FROM registry.redhat.io/rhpam-7/rhpam-kogito-runtime-jvm-rhel8:7.13.5

ENV RUNTIME_TYPE springboot

COPY target/<application-jar-file> $KOGITO_HOME/bin
```

- **application-jar-file** is the name of the JAR file of the application.
3. Build the Red Hat build of Kogito image using the following command:

```
podman build --tag <final-image-name> -f <Container-file>
```

In the previous command, **final-image-name** is the name of the Red Hat build of Kogito image and **Container-file** is name of the **Containerfile** that you created in the previous step.

4. Optionally, test the built image using the following command:

```
podman run --rm -it -p 8080:8080 <final-image-name>
```

5. Push the built Red Hat build of Kogito image to an image registry using the following command:

```
podman push <final-image-name>
```

6. Go to **Operators** → **Installed Operators** and select **RHPAM Kogito Operator**.
7. To create the Red Hat build of Kogito microservice definition, on the operator page, select the **Kogito Runtime** tab and click **Create KogitoRuntime**.
8. In the application window, use **Form View** or **YAML View** to configure the microservice definition.

At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-quarkus # Application name
spec:
  image: <final-image-name> # Kogito image name
  insecureImageRegistry: true # Can be omitted when image is pushed into secured registry
  with valid certificate
```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito microservices

```

apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-springboot # Application name
spec:
  image: <final-image-name> # Kogito image name
  insecureImageRegistry: true # Can be omitted when image is pushed into secured registry
  with valid certificate
runtime: springboot

```

9. After you define your application data, click **Create** to generate the Red Hat build of Kogito microservice.  
Your application is listed in the Red Hat build of Kogito microservice page. You can select the application name to view or modify application settings and the contents of the YAML file.
10. After the application build is complete, go to **Workloads** → **Deployments** to view the application deployments, pod status, and other details.
11. After your Red Hat build of Kogito microservice is deployed, in the left menu of the web console, go to **Networking** → **Routes** to view the access link to the deployed application.  
You can select the application name to view or modify route settings.

With the application route, you can integrate your Red Hat build of Kogito microservices with your business automation solutions as needed.

## 10.4. DEPLOYING RED HAT BUILD OF KOGITO MICROSERVICES ON OPENSIFT USING FILE BUILD AND OPENSIFT WEB CONSOLE

You can build and deploy your Red Hat build of Kogito microservices from a single file, such as a Decision Model and Notation (DMN), Drools Rule Language (DRL), or properties file, or from a directory with multiple files. You can specify a single file from your local file system path or specify a file directory from a local file system path only. When you upload the file or directory to an OpenShift cluster, a new Source-to-Image (S2I) build is automatically triggered.

The operator uses the following custom resources to deploy domain-specific microservices (the microservices that you develop):

- **KogitoBuild** generates an application from a file and produces a runtime image.
- **KogitoRuntime** starts the runtime image and configures it as per your requirements.

### Prerequisites

- The RHPAM Kogito Operator is installed.
- The **oc** OpenShift CLI is installed and you are logged in to the relevant OpenShift cluster. For **oc** installation and login instructions, see the [OpenShift documentation](#).
- You have access to the OpenShift web console with the necessary permissions to create and edit **KogitoBuild** and **KogitoRuntime**.

### Procedure

1. Go to **Operators** → **Installed Operators** and select **RHPAM Kogito Operator**.

- To create the Red Hat build of Kogito build definition, on the operator page, select the **Kogito Build** tab and click **Create KogitoBuild**.
- In the application window, use **Form View** or **YAML View** to configure the build definition. At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito build

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-quarkus # Application name
spec:
  type: LocalSource
```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito build

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoBuild # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
  type: LocalSource
```



#### NOTE

If you configured an internal Maven repository, you can use it as a Maven mirror service and specify the Maven mirror URL in your Red Hat build of Kogito build definition to shorten build time substantially:

```
spec:
  mavenMirrorURL: http://nexus3-nexus.apps-crc.testing/repository/maven-public/
```

For more information about internal Maven repositories, see the [Apache Maven](#) documentation.

- After you define your application data, click **Create** to generate the Red Hat build of Kogito build. Your application is listed in the **Red Hat build of KogitoBuilds** page. You can select the application name to view or modify application settings and YAML details.
- Upload the file asset using the following command:

```
$ oc start-build example-quarkus-builder --from-file=<file-asset-path> -n namespace
```

- file-asset-path** is the path of the file asset that you want to upload.
- namespace** is the namespace where **KogitoBuild** is created.

- To create the Red Hat build of Kogito microservice definition, on the operator page, select the **Kogito Runtime** tab and click **Create KogitoRuntime**.
- In the application window, use **Form View** or **YAML View** to configure the microservice definition.  
At a minimum, define the application configurations shown in the following example YAML file:

### Example YAML definition for a Red Hat build of Quarkus application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-quarkus # Application name
```

### Example YAML definition for a Spring Boot application with Red Hat build of Kogito microservices

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-springboot # Application name
spec:
  runtime: springboot
```



#### NOTE

In this case, the application is built from a file and deployed using KogitoRuntime. You must ensure that the application name is same in **KogitoBuild** and **KogitoRuntime**.

- After you define your application data, click **Create** to generate the Red Hat build of Kogito microservice.  
Your application is listed in the Red Hat build of Kogito microservice page. You can select the application name to view or modify application settings and the contents of the YAML file.
- In the left menu of the web console, go to **Builds** → **Builds** to view the status of your application build.  
You can select a specific build to view build details.



#### NOTE

For every Red Hat build of Kogito microservice that you create for OpenShift deployment, two builds are generated and listed in the **Builds** page in the web console: a traditional runtime build and a Source-to-Image (S2I) build with the suffix **-builder**. The S2I mechanism builds the application in an OpenShift build and then passes the built application to the next OpenShift build to be packaged into the runtime container image.

- After the application build is complete, go to **Workloads** → **Deployments** to view the application deployments, pod status, and other details.

11. After your Red Hat build of Kogito microservice is deployed, in the left menu of the web console, go to **Networking** → **Routes** to view the access link to the deployed application. You can select the application name to view or modify route settings.

With the application route, you can integrate your Red Hat build of Kogito microservices with your business automation solutions as needed.



## CHAPTER 11. RED HAT BUILD OF KOGITO SERVICE PROPERTIES CONFIGURATION

When a Red Hat build of Kogito microservice is deployed, a **configMap** resource is created for the **application.properties** configuration of the Red Hat build of Kogito microservice.

The name of the **configMap** resource consists of the name of the Red Hat build of Kogito microservice and the suffix **-properties**, as shown in the following example:

### Example configMap resource generated during Red Hat build of Kogito microservice deployment

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: kogito-travel-agency-properties
data:
  application.properties : |-
    property1=value1
    property2=value2
```

The **application.properties** data of the **configMap** resource is mounted in a volume to the container of the Red Hat build of Kogito microservice. Any runtime properties that you add to the **application.properties** section override the default application configuration properties of the Red Hat build of Kogito microservice.

When the **application.properties** data of the **configMap** is changed, a rolling update modifies the deployment and configuration of the Red Hat build of Kogito microservice.

## CHAPTER 12. PROBES FOR RED HAT BUILD OF KOGITO MICROSERVICES ON RED HAT OPENSIFT CONTAINER PLATFORM

The probes in Red Hat OpenShift Container Platform verify that an application is working or it needs to be restarted. For Red Hat build of Kogito microservices on Red Hat build of Quarkus and Spring Boot, probes interact with the application using an HTTP request, defaulting to the endpoints that are exposed by an extension. Therefore, to run your Red Hat build of Kogito microservices on Red Hat OpenShift Container Platform, you must import the extensions to provide application availability information for the [liveness](#), [readiness](#), and [startup probes](#).

### 12.1. ADDING HEALTH CHECK EXTENSION FOR RED HAT BUILD OF QUARKUS APPLICATIONS ON RED HAT OPENSIFT CONTAINER PLATFORM

You can add the health check extension for the Red Hat build of Kogito services that are based on Red Hat build of Quarkus on Red Hat OpenShift Container Platform.

#### Procedure

In a command terminal, navigate to the **pom.xml** file of your project and add the following dependency for the **quarkus-smallrye-health** extension:

#### SmallRye Health dependency for Red Hat build of Quarkus applications on Red Hat OpenShift Container Platform

```
<dependencies>
  <dependency>
    <groupId>io.quarkus</groupId>
    <artifactId>quarkus-smallrye-health</artifactId>
  </dependency>
</dependencies>
```

### 12.2. ADDING HEALTH CHECK EXTENSION FOR SPRING BOOT APPLICATIONS ON RED HAT OPENSIFT CONTAINER PLATFORM

You can add the health check extension for the Red Hat build of Kogito microservices that are based on Spring Boot on Red Hat OpenShift Container Platform.

#### Procedure

In a command terminal, navigate to the **pom.xml** file of your project and add the following Spring Boot actuator dependency:

#### Spring Boot actuator dependency for Spring Boot applications on Red Hat OpenShift Container Platform

```
<dependencies>
  <dependency>
    <groupId>org.springframework.boot</groupId>
```

```
<artifactId>spring-boot-starter-actuator</artifactId>
</dependency>
</dependencies>
```

## 12.3. SETTING CUSTOM PROBES FOR RED HAT BUILD OF KOGITO MICROSERVICES ON RED HAT OPENSIFT CONTAINER PLATFORM

You can also configure the custom endpoints for the liveness, readiness, and startup probes.

### Procedure

1. Define the probes in the **KogitoRuntime** YAML file of your project, as shown in the following example:

### Example Red Hat build of Kogito microservice custom resource with custom probe endpoints

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this service
kind: KogitoRuntime
metadata:
  name: process-quarkus-example # Application name
spec:
  replicas: 1
  probes:
    livenessProbe:
      httpGet:
        path: /probes/live # Liveness endpoint
        port: 8080
    readinessProbe:
      httpGet:
        path: /probes/ready # Readiness endpoint
        port: 8080
    startupProbe:
      tcpSocket:
        port: 8080
```

## CHAPTER 13. RED HAT PROCESS AUTOMATION MANAGER KOGITO OPERATOR INTERACTION WITH PROMETHEUS AND GRAFANA

Red Hat build of Kogito in Red Hat Process Automation Manager provides a **monitoring-prometheus-addon** add-on that enables Prometheus metrics monitoring for Red Hat build of Kogito microservices and generates Grafana dashboards that consume the default metrics exported by the add-on. The RHPAM Kogito Operator uses the [Prometheus Operator](#) to expose the metrics from your project for Prometheus to scrape. Due to this dependency, the Prometheus Operator must be installed in the same namespace as your project.

If you want to enable the Prometheus metrics monitoring for your Red Hat build of Kogito microservices, add the following dependency to the **pom.xml** file in your project, depending on the framework you are using:

### Dependency for Prometheus Red Hat build of Quarkus add-on

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>monitoring-prometheus-quarkus-addon</artifactId>
</dependency>
```

### Dependency for Prometheus Spring Boot add-on

```
<dependency>
  <groupId>org.kie.kogito</groupId>
  <artifactId>monitoring-prometheus-springboot-addon</artifactId>
</dependency>
```

When you deploy a Red Hat build of Kogito microservice that uses the **monitoring-prometheus-addon** add-on and the Prometheus Operator is installed, the Red Hat Process Automation Manager Kogito Operator creates a **ServiceMonitor** custom resource to expose the metrics for Prometheus, as shown in the following example:

### Example ServiceMonitor resource for Prometheus

```
apiVersion: monitoring.coreos.com/v1
kind: ServiceMonitor
metadata:
  labels:
    app: onboarding-service
    name: onboarding-service
    namespace: kogito
spec:
  endpoints:
  - path: /metrics
    targetPort: 8080
    scheme: http
  namespaceSelector:
    matchNames:
    - kogito
```

```

selector:
  matchLabels:
    app: onboarding-service

```

You must manually configure your **Prometheus** custom resource that is managed by the Prometheus Operator to select the **ServiceMonitor** resource:

### Example Prometheus resource

```

apiVersion: monitoring.coreos.com/v1
kind: Prometheus
metadata:
  name: prometheus
spec:
  serviceAccountName: prometheus
  serviceMonitorSelector:
    matchLabels:
      app: dmn-drools-quarkus-metrics-service

```

After you configure your Prometheus resource with the **ServiceMonitor** resource, you can see the endpoint scraped by Prometheus in the **Targets** page in the Prometheus web console. The metrics exposed by the Red Hat Process Automation Manager service appear in the **Graph** view.

The RHPAM Kogito Operator also creates a **GrafanaDashboard** custom resource defined by the [Grafana Operator](#) for each of the Grafana dashboards generated by the add-on. The **app** label for the dashboards is the name of the deployed Red Hat build of Kogito microservice. You must set the **dashboardLabelSelector** property of the **Grafana** custom resource according to the relevant Red Hat build of Kogito microservice.

### Example Grafana resource

```

apiVersion: integreatly.org/v1alpha1
kind: Grafana
metadata:
  name: example-grafana
spec:
  ingress:
    enabled: true
  config:
    auth:
      disable_signout_menu: true
    auth.anonymous:
      enabled: true
  log:
    level: warn
    mode: console
  security:
    admin_password: secret
    admin_user: root
  dashboardLabelSelector:
    - matchExpressions:
      - key: app
        operator: In
        values:
          - my-kogito-application

```

## CHAPTER 14. RED HAT PROCESS AUTOMATION MANAGER RED HAT BUILD OF KOGITO OPERATOR INTERACTION WITH KAFKA

The Red Hat Process Automation Manager Red Hat build of Kogito Operator uses the AMQ Streams Operator to automatically configure the Red Hat build of Kogito microservice with Kafka.

When you enable an infrastructure mechanism through **KogitoInfra** deployment, the Red Hat Process Automation Manager Red Hat build of Kogito Operator uses the relevant third-party operator to configure the infrastructure.

You must define your custom infrastructure resource and link it in the **KogitoInfra** file. You can specify your custom infrastructure resource in the **spec.resource.name** and **spec.resource.namespace** configurations.

### Example Red Hat Process Automation Manager Red Hat build of Kogito infrastructure resource for custom messaging

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoInfra # Application type
metadata:
  name: my-kafka-infra
spec:
  resource:
    apiVersion: kafka.strimzi.io/v1beta2 # AMQ Streams API
    kind: Kafka # AMQ Streams Application Type
    name: my-kafka-instance
    namespace: my-namespace
```

In this example, the **KogitoInfra** custom resource connects to the Kafka cluster **my-kafka-instance** from **my-namespace** for event messaging.

To connect Red Hat build of Kogito microservice to Kafka, you need to define the **infra** configuration to use the corresponding infrastructure.

### Example of Red Hat build of Kogito microservice resource configuration with messaging

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example-quarkus # Application name
spec:
  image: <final-image-name> # Kogito image name
  insecureImageRegistry: true # Can be omitted when image is pushed into secured registry with valid certificate
  infra:
    - my-kafka-infra
```

The Red Hat Process Automation Manager Red Hat build of Kogito Operator configures the necessary properties so that your application can connect to the Kafka instance.

## CHAPTER 15. RED HAT BUILD OF KOGITO MICROSERVICE DEPLOYMENT TROUBLESHOOTING

Use the information in this section to troubleshoot issues that you might encounter when using the operator to deploy Red Hat build of Kogito microservices. The following information is updated as new issues and workarounds are discovered.

### No builds are running

If you do not see any builds running nor any resources created in the relevant namespace, enter the following commands to retrieve running pods and to view the operator log for the pod:

### View RHPAM Kogito Operator log for a specified pod

```
// Retrieves running pods
$ oc get pods

NAME                                READY STATUS  RESTARTS AGE
kogito-operator-6d7b6d4466-9ng8t  1/1   Running    0      26m

// Opens RHPAM Kogito Operator log for the pod
$ oc logs -f kogito-operator-6d7b6d4466-9ng8t
```

### Verify KogitoRuntime status

If you create, for example, **KogitoRuntime** application with a non-existing image using the following YAML definition:

### Example YAML definition for a KogitoRuntime application

```
apiVersion: rhpam.kiegroup.org/v1 # Red Hat build of Kogito API for this microservice
kind: KogitoRuntime # Application type
metadata:
  name: example # Application name
spec:
  image: 'not-existing-image:latest'
  replicas: 1
```

You can verify the status of the **KogitoRuntime** application using the **oc describe KogitoRuntime example** command in the bash console. When you run the **oc describe KogitoRuntime example** command in the bash console, you receive the following output:

### Example KogitoRuntime status

```
[user@localhost ~]$ oc describe KogitoRuntime example
Name:         example
Namespace:    username-test
Labels:       <none>
Annotations:  <none>
API Version:  rhpam.kiegroup.org/v1
Kind:         KogitoRuntime
Metadata:
  Creation Timestamp: 2021-05-20T07:19:41Z
  Generation:        1
  Managed Fields:
```

```

API Version: rhpam.kiegroup.org/v1
Fields Type: FieldsV1
fieldsV1:
  f:spec:
    ..:
    f:image:
    f:replicas:
Manager:   Mozilla
Operation: Update
Time:     2021-05-20T07:19:41Z
API Version: rhpam.kiegroup.org/v1
Fields Type: FieldsV1
fieldsV1:
  f:spec:
    f:monitoring:
    f:probes:
      ..:
      f:livenessProbe:
      f:readinessProbe:
    f:resources:
    f:runtime:
  f:status:
    ..:
    f:cloudEvents:
    f:conditions:
Manager:   main
Operation: Update
Time:     2021-05-20T07:19:45Z
Resource Version: 272185
Self Link: /apis/rhpam.kiegroup.org/v1/namespaces/ksuta-test/kogitoruntimes/example
UID:      edbe0bf1-554e-4523-9421-d074070df982
Spec:
Image:   not-existing-image:latest
Replicas: 1
Status:
Cloud Events:
Conditions:
  Last Transition Time: 2021-05-20T07:19:44Z
  Message:
  Reason:      NoPodAvailable
  Status:      False
  Type:        Deployed
  Last Transition Time: 2021-05-20T07:19:44Z
  Message:
  Reason:      RequestedReplicasNotEqualToAvailableReplicas
  Status:      True
  Type:        Provisioning
  Last Transition Time: 2021-05-20T07:19:45Z
  Message:      you may not have access to the container image "quay.io/kiegroup/not-existing-image:latest"
  Reason:      ImageStreamNotReadyReason
  Status:      True
  Type:        Failed

```

At the end of the output, you can see the **KogitoRuntime** status with a relevant message.



## PART III. MIGRATING TO RED HAT BUILD OF KOGITO MICROSERVICES

As a developer of business decisions and processes, you can migrate your decision services in Red Hat Process Automation Manager to Red Hat build of Kogito microservices. When performing migration, your existing business decisions become part of your own domain-specific cloud-native set of services. You can migrate Decision Model and Notation (DMN) models, Predictive Model Markup Language (PMML) models, or Drools Rule Language (DRL) rules.

### Prerequisites

- JDK 11 or later is installed.
- Apache Maven 3.6.2 or later is installed.

## CHAPTER 16. OVERVIEW OF MIGRATION TO RED HAT BUILD OF KOGITO MICROSERVICES

You can migrate the decision service artifacts that you developed in Business Central to Red Hat build of Kogito microservices. Red Hat build of Kogito currently supports migration for the following types of decision services:

- **Decision Model and Notation (DMN) models** You migrate DMN-based decision services by moving the DMN resources from KJAR artifacts to the respective Red Hat build of Kogito archetype.
- **Predictive Model Markup Language (PMML) models** You migrate PMML-based prediction and prediction services by moving the PMML resources from KJAR artifacts to the respective Red Hat build of Kogito archetype.
- **Drools Rule Language (DRL) rules** You migrate the DRL-based decision services by enclosing them in a Red Hat build of Quarkus REST endpoint. This approach of migration enables you to use major Quarkus features, such as hot reload and native compilation. The Quarkus features and the programming model of Red Hat build of Kogito enable the automatic generation of the Quarkus REST endpoints for implementation in your applications and services.

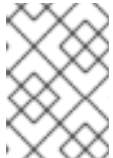
## CHAPTER 17. MIGRATION OF A DMN SERVICE TO A RED HAT BUILD OF KOGITO MICROSERVICE

You can migrate DMN-based decision services to Red Hat build of Kogito microservices by moving the DMN resources from KJAR artifacts to the respective Red Hat build of Kogito project. In the Red Hat build of Kogito microservices, some of the KIE v7 features are no longer required.

### 17.1. MAJOR CHANGES AND MIGRATION CONSIDERATIONS

The following table describes the major changes and features that affect migration from the KIE Server API and KJAR to Red Hat build of Kogito deployments:

**Table 17.1. DMN migration considerations**

Feature	In KIE Server API	In Red Hat build of Kogito artifact
DMN models	stored in <b>src/main/resources</b> of KJAR.	copy as is to <b>src/main/resources</b> .
Object models (POJOs) required for KIE Server generic marshalling	managed using Data Model object editor in Business Central.	object model editing is no longer required.
<b>DMNRuntimeListener</b>	configured using a system property or <b>kmodule.xml</b> file.	must be configured using CDI, by annotating the <b>DMNRuntimeEventListener</b> with CDI's <b>@ApplicationScope</b> annotation.
Other configuration options	configured using system property or <b>kmodule.xml</b> file.	except <b>DMNRuntimeEventListener</b> , only default values are considered and no override of configuration is supported.
KIE Server Client API	used in conjunction with object models to interact with a KJAR that is deployed on the KIE Server.	for object models, this feature is no longer required.   <b>NOTE</b> You can select your own choice of REST library.
REST API	when a KJAR is deployed on KIE Server, the applications interacting with specific DMN model endpoint, use the same API on Red Hat build of Kogito deployment.	advanced support for specific DMN model generation. For more information, see <a href="#">DMN model execution</a> .

Feature	In KIE Server API	In Red Hat build of Kogito artifact
Test scenarios	run with a JUnit activator.	analogous JUnit activator is available on Red Hat build of Kogito.



## NOTE

The features that are not mentioned in the previous table are either not supported or not required in a cloud-native Red Hat build of Kogito deployment.

## 17.2. MIGRATION STRATEGY

When migrating a DMN project to a Red Hat build of Kogito project, first you can migrate external applications that are interacting with decision services on the KIE Server. You can use the REST endpoints that are specific to DMN models. After using the REST endpoints, you can migrate the external applications from the KIE Server to a Red Hat build of Kogito deployment. For more information about specific REST endpoints to DMN models, see [REST endpoints for specific DMN models](#).

The migration strategy includes the following steps:

1. Migrate existing external applications from the generic KIE Server API to a specific DMN REST endpoint using the KIE Server.
2. Migrate a KJAR that is deployed on the KIE Server to a Red Hat build of Kogito microservice.
3. Deploy the Red Hat build of Kogito microservice using Red Hat OpenShift Container Platform.
4. Reconnect the external application and migrate the REST API consumption from the specific DMN REST endpoint to the Red Hat build of Kogito deployment.

## 17.3. MIGRATING EXTERNAL APPLICATIONS TO REST ENDPOINTS SPECIFIC TO DMN MODELS

To migrate a DMN project to a Red Hat build of Kogito deployment, first you can migrate external applications that use specific DMN REST endpoints to interact with decision services on the KIE Server.

### Procedure

1. If you are using the REST endpoints in your external application, retrieve the Swagger or OAS specification file of the KJAR using **GET /server/containers/{containerId}/dmn/openapi.json (.yaml)** endpoint.  
For more information about REST endpoints for specific DMN models, see [REST endpoints for specific DMN models](#).
2. In your external application, select the Java or JDK library to interact with the decision services. You can interact with the decision services using the REST endpoint for the specific KJAR.

**NOTE**

The KIE Server Client Java API is not supported in the migration to a Red Hat build of Kogito deployment.

## 17.4. MIGRATING A DMN MODEL KJAR TO A RED HAT BUILD OF KOGITO MICROSERVICE

After migrating your external application, you need to migrate a KJAR that is specific to a DMN model to a Red Hat build of Kogito microservice.

### Procedure

1. Create a Maven project for your Red Hat build of Kogito microservice.  
For the procedure about creating a Maven project, see [Creating a Maven project for a Red Hat build of Kogito microservice](#).

The Maven project creates Kogito artifacts.

2. Copy the DMN models from the **src/main/resources** folder of the KJAR to the **src/main/resources** folder of the Kogito artifact.
3. Copy the test scenarios from the **src/test/resources** folder of the KJAR to the **src/test/resources** folder of the Kogito artifact.

**IMPORTANT**

You need to import the Red Hat build of Kogito dependency of test scenarios in the **pom.xml** file of your project and create a JUnit activator using the KIE Server REST API. For more information, see [Testing a decision service using test scenarios](#).

4. Run the following command and ensure that the test scenario is running for the specified non-regression tests.

```
mvn clean install
```

After running the Red Hat build of Kogito application, you can retrieve the Swagger or OAS specification file. The Swagger or OAS specifications provide the same information as the REST endpoint along with the following implementation details:

- Base URL of the server where the API is available
- References Schemas names

You can use the provided implementation details when your external application is re-routed to the new URL.

After migrating a DMN model KJAR to a Red Hat build of Kogito microservice, you need to deploy the microservice using Red Hat OpenShift Container Platform. For deployment options with Openshift, see [OpenShift deployment options with the RHPAM Kogito Operator](#).

### 17.4.1. Example of migrating a DMN model KJAR to a Red Hat build of Kogito microservice

The following is an example of migrating a DMN model KJAR to a Red Hat build of Kogito microservice:

Figure 17.1. Example decision service implemented using DMN model

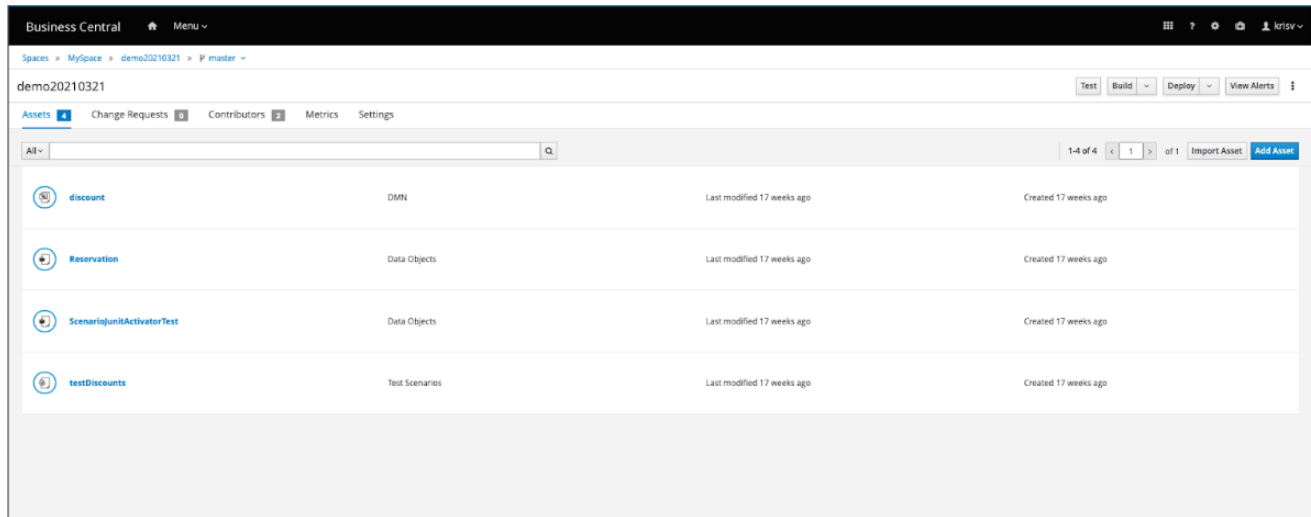
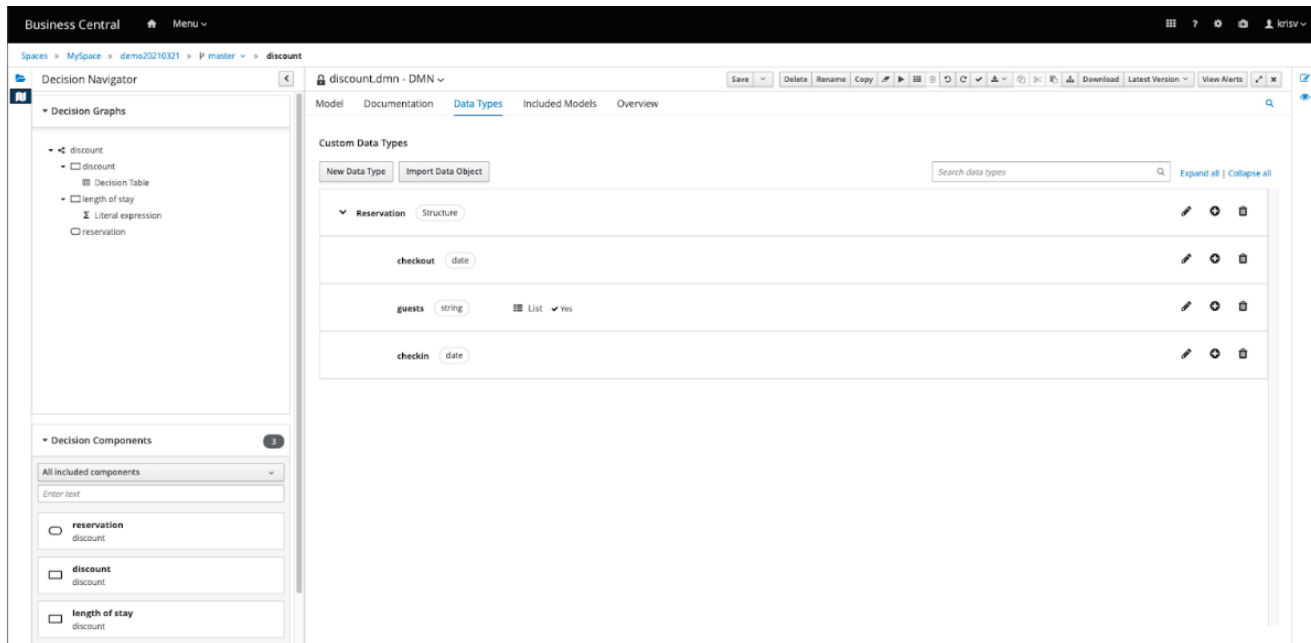


Figure 17.2. Example DMN model using specificItemDefinition structure



You need to define the object model (POJO) as a DTO in an existing KJAR that is developed in Business Central.

### Example of an object model defined as DTO in a KJAR

```
package com.myspace.demo20210321;

/**
 * This class was automatically generated by the data modeler tool.
 */

public class Reservation implements java.io.Serializable {

    static final long serialVersionUID = 1L;
    @com.fasterxml.jackson.annotation.JsonFormat(shape =
com.fasterxml.jackson.annotation.JsonFormat.Shape.STRING, pattern = "yyyy-MM-dd")
```

```

    @com.fasterxml.jackson.databind.annotation.JsonSerialize(using =
com.fasterxml.jackson.datatype.jsr310.ser.LocalDateSerializer.class)
    private java.time.LocalDate checkin;
    @com.fasterxml.jackson.annotation.JsonFormat(shape =
com.fasterxml.jackson.annotation.JsonFormat.Shape.STRING, pattern = "yyyy-MM-dd")
    @com.fasterxml.jackson.databind.annotation.JsonSerialize(using =
com.fasterxml.jackson.datatype.jsr310.ser.LocalDateSerializer.class)
    private java.time.LocalDate checkout;

    private java.util.List<java.lang.String> guests;

    public Reservation() {
    }

    public java.time.LocalDate getCheckin() {
        return this.checkin;
    }

    public void setCheckin(java.time.LocalDate checkin) {
        this.checkin = checkin;
    }

    public java.time.LocalDate getCheckout() {
        return this.checkout;
    }

    public void setCheckout(java.time.LocalDate checkout) {
        this.checkout = checkout;
    }

    public java.util.List<java.lang.String> getGuests() {
        return this.guests;
    }

    public void setGuests(java.util.List<java.lang.String> guests) {
        this.guests = guests;
    }

    public Reservation(java.time.LocalDate checkin,
        java.time.LocalDate checkout,
        java.util.List<java.lang.String> guests) {
        this.checkin = checkin;
        this.checkout = checkout;
        this.guests = guests;
    }
}

```

In the previous example, the defined DTO is used in conjunction with the KIE Server client Java API. Alternatively, you can specify the DTO in the payload, when a non-Java external application is interacting with the KJAR that is deployed on the KIE Server.

### Example of using KIE Server client Java API

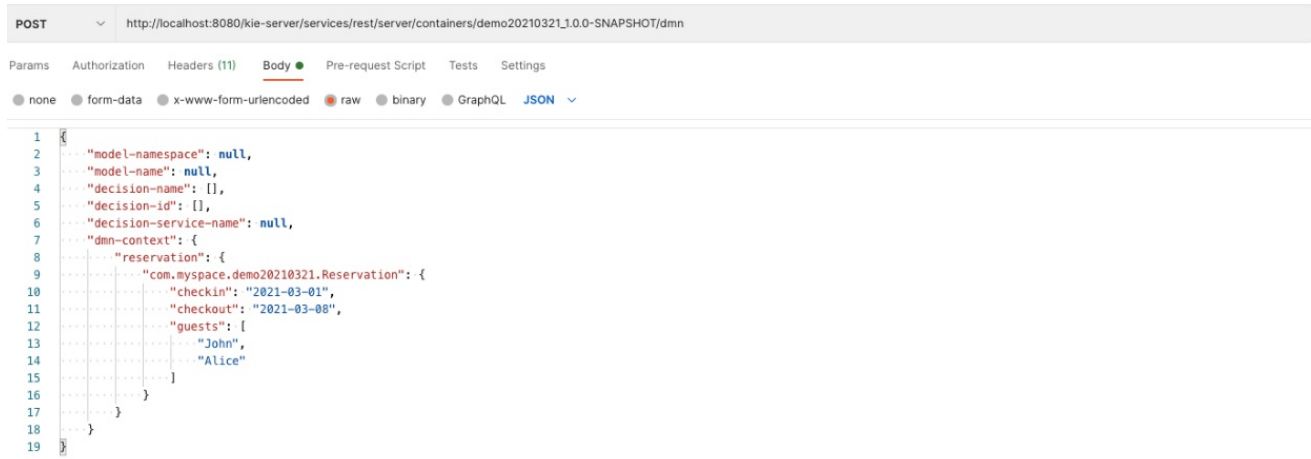
```

DMNServicesClient dmnClient = kieServicesClient.getServicesClient(DMNServicesClient.class);
DMNContext dmnContext = dmnClient.newContext();

```

```
dmnContext.set("reservation", new com.myspace.demo20210321.Reservation(LocalDate.of(2021, 3,
1),
LocalDate.of(2021, 3, 8),
Arrays.asList("John", "Alice")));
run(dmnClient, dmnContext);
```

Figure 17.3. Example of manually specifying DTO in the payload



```
POST http://localhost:8080/kie-server/services/rest/server/containers/demo20210321_1.0.0-SNAPSHOT/dmn

Params Authorization Headers (11) Body Pre-request Script Tests Settings
none form-data x-www-form-urlencoded raw binary GraphQL JSON

1 {
2   "model-namespace": null,
3   "model-name": null,
4   "decision-name": [],
5   "decision-id": [],
6   "decision-service-name": null,
7   "dmn-context": {
8     "reservation": {
9       "com.myspace.demo20210321.Reservation": {
10        "checkin": "2021-03-01",
11        "checkout": "2021-03-08",
12        "guests": [
13          "John",
14          "Alice"
15        ]
16      }
17    }
18  }
19 }
```



## NOTE

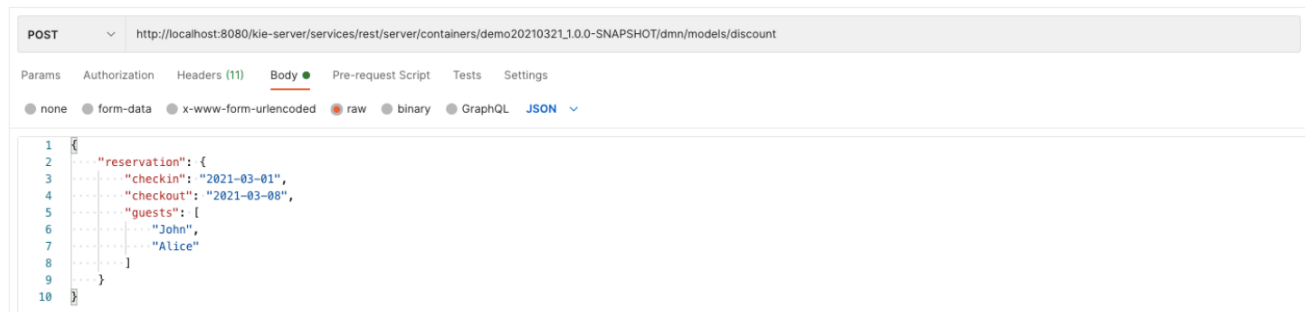
In the previous example, the FQCN of the object model in the REST API is used for the generic KIE Server marshalling.

## 17.5. EXAMPLE OF BINDING AN EXTERNAL APPLICATION TO A RED HAT BUILD OF KOGITO DEPLOYMENT

After deploying the Red Hat build of Kogito microservice, you need to bind your external application to the Red Hat build of Kogito microservice deployment.

Binding your external application includes re-routing the external application and binding the application to a new base URL of the server that is associated with the Red Hat build of Kogito application. For more information, see the following example:

Figure 17.4. Example /discount REST endpoint of KJAR on KIE Server

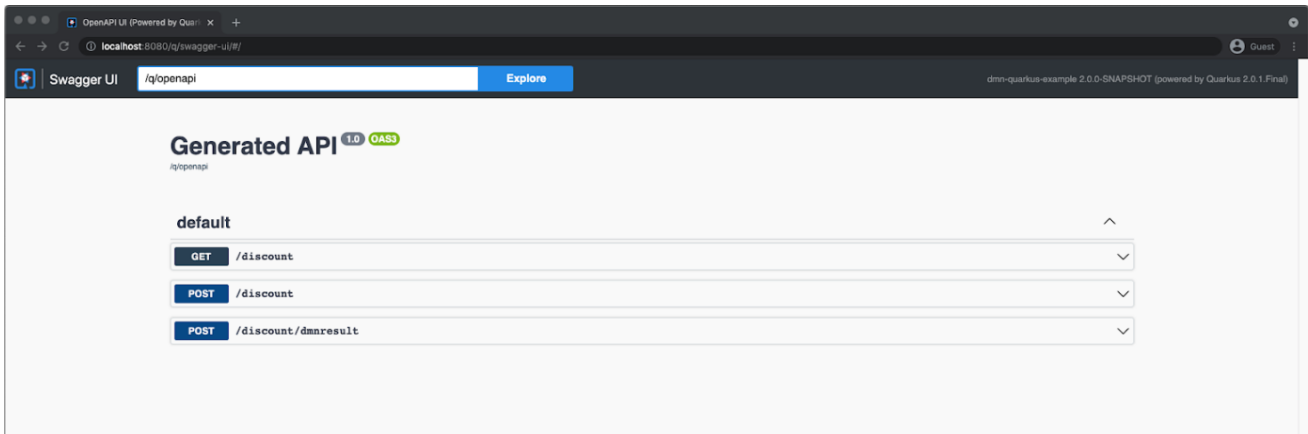
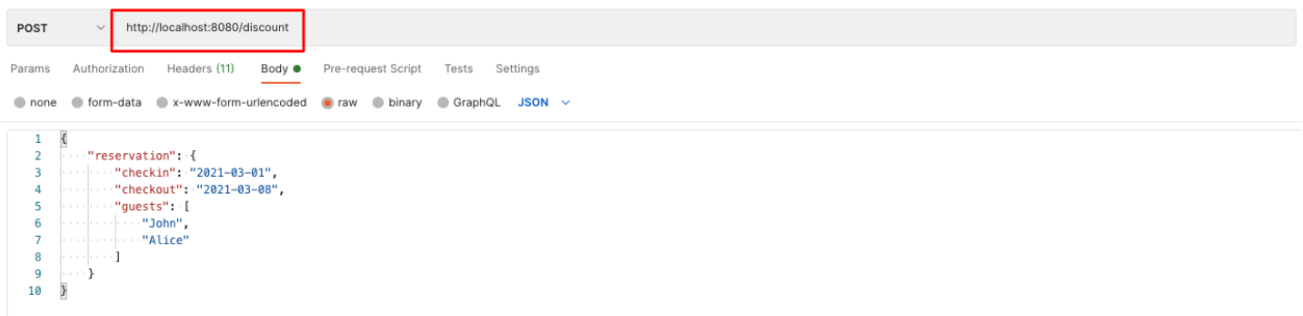


```
POST http://localhost:8080/kie-server/services/rest/server/containers/demo20210321_1.0.0-SNAPSHOT/dmn/models/discount

Params Authorization Headers (11) Body Pre-request Script Tests Settings
none form-data x-www-form-urlencoded raw binary GraphQL JSON

1 {
2   "reservation": {
3     "checkin": "2021-03-01",
4     "checkout": "2021-03-08",
5     "guests": [
6       "John",
7       "Alice"
8     ]
9   }
10 }
```



Figure 17.5. Example `/discount` REST endpoint on local Red Hat build of KogitoFigure 17.6. Example `/discount` REST endpoint bound to new base URL of Red Hat build of Kogito

## CHAPTER 18. MIGRATION OF A PMML SERVICE TO A RED HAT BUILD OF KOGITO MICROSERVICE

You can migrate PMML-based services to Red Hat build of Kogito microservices by moving the PMML resources from KJAR artifacts to the respective Red Hat build of Kogito project.

### 18.1. MAJOR CHANGES AND MIGRATION CONSIDERATIONS

The following table describes the major changes and features that affect migration from the KIE Server API and KJAR to Red Hat build of Kogito deployments:

**Table 18.1. PMML migration considerations**

Feature	In KIE Server API	In Red Hat build of Kogito artifact
PMML models	stored in <b>src/main/resources</b> of KJAR.	copy as is to <b>src/main/resources</b> .
Other configuration options	configured using a system property or <b>kmodule.xml</b> file.	only default values are considered and no override of configuration is supported.
Command-based REST API	use <b>ApplyPmmlModelCommand</b> to request PMML evaluation.	not supported.
Domain-driven REST API	not supported.	advanced support for PMML model-specific generation.



#### NOTE

The features that are not mentioned in the previous table are either not supported or not required in a cloud-native Red Hat build of Kogito deployment.

### 18.2. MIGRATION STRATEGY

The migration strategy includes the following steps:

1. Migrate a KJAR that is deployed on the KIE Server to a Red Hat build of Kogito microservice.
2. Deploy the Red Hat build of Kogito microservice using Red Hat OpenShift Container Platform.
3. Modify the external application from client PMML API on the KIE Server to the REST API of the Red Hat build of Kogito deployment.

### 18.3. MIGRATING A PMML MODEL KJAR TO A RED HAT BUILD OF KOGITO MICROSERVICE

You can migrate a KJAR that is implemented using PMML model to a Red Hat build of Kogito microservice.

## Procedure

1. Create a Maven project for your Red Hat build of Kogito microservice.  
For the procedure about creating a Maven project, see [Creating a Maven project for a Red Hat build of Kogito microservice](#).

The Maven project creates Kogito artifacts.

2. Copy the PMML models from the **src/main/resources** folder of the KJAR to the **src/main/resources** folder of the Kogito artifact.
3. Run the following command to execute the Red Hat build of Kogito application:

```
mvn clean install
```

After running the Red Hat build of Kogito application, you can retrieve the Swagger or OAS specification file. The Swagger or OAS specifications provide the same information as the REST endpoint along with the following implementation details:

- Base URL of the server where the API is available
- References Schemas names

You can use the provided implementation details when your external application is re-routed to the new URL.

After migrating a PMML model KJAR to a Red Hat build of Kogito microservice, you need to deploy the microservice using Red Hat OpenShift Container Platform. For deployment options with Openshift, see [OpenShift deployment options with the RHPAM Kogito Operator](#).

## 18.4. MODIFYING AN EXTERNAL APPLICATION TO A RED HAT BUILD OF KOGITO MICROSERVICE

After deploying the PMML microservice, you need to modify the external application to a Red Hat build of Kogito deployment.

### Prerequisites

- The original external application must be implemented on the KIE Server client API.

Figure 18.1. Example external application implementation on KIE Server

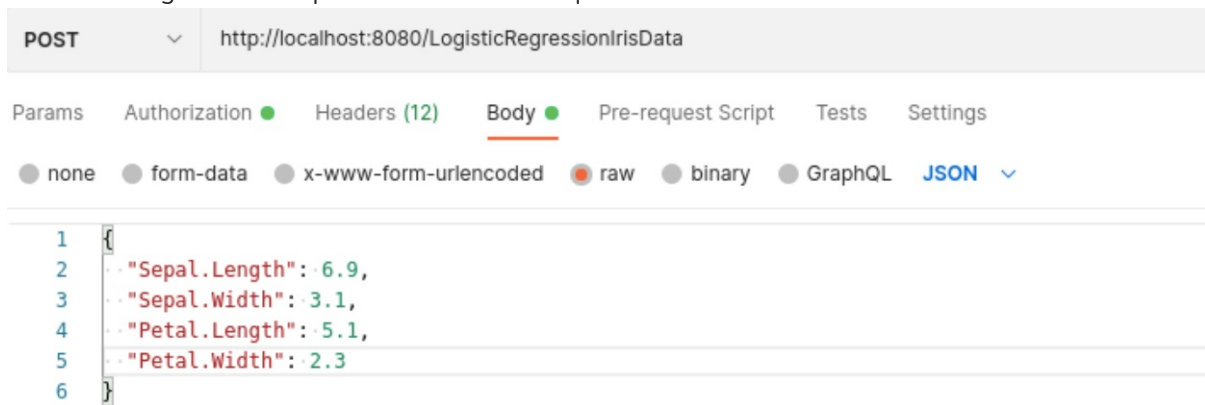
```
protected void execute(String correlationId,
    String containerId,
    String modelName,
    String fileName,
    String targetField,
    Object expectedResult,|
    Map<String, Object> inputData) {

    final PMMLRequestData request = new PMMLRequestData(correlationId, modelName);
    request.setSource(fileName);
    inputData.forEach(request::addRequestParam);

    final KieCommands commandsFactory = KieServices.Factory.get().getCommands();
    final ApplyPmmlModelCommand command = (ApplyPmmlModelCommand) commandsFactory.newApplyPmmlModel(request);
    final ServiceResponse<ExecutionResults> results = ruleClient.executeCommandsWithResults(containerId, command);
```

## Procedure

1. Remove all the usage of the KIE Server client API and replace it with the HTTP communication. The following is an example of a non-Java request:



The screenshot shows a REST client interface with the following details:

- Method:** POST
- URL:** http://localhost:8080/LogisticRegressionIrisData
- Body Type:** JSON (selected)
- Body Content:**

```

1 {
2   "Sepal.Length": 6.9,
3   "Sepal.Width": 3.1,
4   "Petal.Length": 5.1,
5   "Petal.Width": 2.3
6 }
```

2. Ensure that any HTTP client Java library is used inside the external application to create a similar invocation and parse the result.

The following is an example of Java 11 HTTP client and Gson to convert the input data to JSON:

```
protected void execute(Map<String, Object> inputData) throws IOException, InterruptedException {
    Gson gson = new Gson();
    String requestBody = gson.toJson(inputData);
    HttpRequest request = HttpRequest.newBuilder()
        .uri(URI.create("http://localhost:8080/LogisticRegressionIrisData"))
        .header("Content-Type", "application/json")
        .POST(HttpRequest.BodyPublishers.ofString(requestBody))
        .build();
    HttpClient client = HttpClient.newHttpClient();
    HttpResponse<String> response = client.send(request, HttpResponse.BodyHandlers.ofString());
}
```



## NOTE

All the parameters that are required as the values of the parameters are embedded in the URL that is called.

## CHAPTER 19. MIGRATION OF A DRL SERVICE TO A RED HAT BUILD OF KOGITO MICROSERVICE

You can build and deploy a sample project in Red Hat build of Kogito to expose a stateless rules evaluation of the decision engine in a Red Hat build of Quarkus REST endpoint, and migrate the REST endpoint to Red Hat build of Kogito.

The stateless rule evaluation is a single execution of a rule set in Red Hat Process Automation Manager and can be identified as a function invocation. In the invoked function, the output values are determined using the input values. Also, the invoked function uses the decision engine to perform the jobs. Therefore, in such cases, a function is exposed using a REST endpoint and converted into a microservice. After converting into a microservice, a function is deployed into a Function as a Service environment to eliminate the cost of JVM startup time.

### 19.1. MAJOR CHANGES AND MIGRATION CONSIDERATIONS

The following table describes the major changes and features that affect migration from the KIE Server API and KJAR to Red Hat build of Kogito deployments:

**Table 19.1. DRL migration considerations**

Feature	In KIE Server API	In Red Hat build of Kogito with legacy API support	In Red Hat build of Kogito artifact
DRL files	stored in <b>src/main/resources</b> folder of KJAR.	copy as is to <b>src/main/resources</b> folder.	rewrite using the rule units and OOPath.
<b>KieContainer</b>	configured using a system property or <b>kmodule.xml</b> file.	replaced by <b>KieRuntimeBuilder</b> .	not required.
<b>KieBase</b> or <b>KieSession</b>	configured using a system property or <b>kmodule.xml</b> file.	configured using a system property or <b>kmodule.xml</b> file.	replaced by rule units.

### 19.2. MIGRATION STRATEGY

In Red Hat Process Automation Manager, you can migrate a rule evaluation to a Red Hat build of Kogito deployment in the following two ways:

#### Using legacy API in Red Hat build of Kogito

In Red Hat build of Kogito, the **kogito-legacy-api** module makes the legacy API of Red Hat Process Automation Manager available; therefore, the DRL files remain unchanged. This approach of migrating rule evaluation requires minimal changes and enables you to use major Red Hat build of Quarkus features, such as hot reload and native image creation.

#### Migrating to Red Hat build of Kogito rule units

Migrating to Red Hat build of Kogito rule units include the programming model of Red Hat build of Kogito, which is based on the concept of rule units.

A rule unit in Red Hat build of Kogito includes both a set of rules and the facts, against which the

rules are matched. Rule units in Red Hat build of Kogito also come with data sources. A rule unit data source is a source of the data processed by a given rule unit and represents the entry point, which is used to evaluate the rule unit. Rule units use two types of data sources:

- **DataStream:** This is an append-only data source and the facts added into the **DataStream** cannot be updated or removed.
- **DataStore:** This data source is for modifiable data. You can update or remove an object using the **FactHandle** that is returned when the object is added into the **DataStore**.

Overall, a rule unit contains two parts: The definition of the fact to be evaluated and the set of rules evaluating the facts.

## 19.3. EXAMPLE LOAN APPLICATION PROJECT

In the following sections, a loan application project is used as an example to migrate a DRL project to Red Hat build of Kogito deployments. The domain model of the loan application project is made of two classes, the **LoanApplication** class and the **Applicant** class:

### Example LoanApplication class

```
public class LoanApplication {

    private String id;
    private Applicant applicant;
    private int amount;
    private int deposit;
    private boolean approved = false;

    public LoanApplication(String id, Applicant applicant,
                          int amount, int deposit) {
        this.id = id;
        this.applicant = applicant;
        this.amount = amount;
        this.deposit = deposit;
    }
}
```

### Example Applicant class

```
public class Applicant {

    private String name;
    private int age;

    public Applicant(String name, int age) {
        this.name = name;
        this.age = age;
    }
}
```

The rule set is created using business decisions to approve or reject an application, along with the last rule of collecting all the approved applications in a list.

## Example rule set in loan application

```

global Integer maxAmount;
global java.util.List approvedApplications;

rule LargeDepositApprove when
    $!: LoanApplication( applicant.age >= 20, deposit >= 1000, amount <= maxAmount )
then
    modify($!) { setApproved(true) }; // loan is approved
end

rule LargeDepositReject when
    $!: LoanApplication( applicant.age >= 20, deposit >= 1000, amount > maxAmount )
then
    modify($!) { setApproved(false) }; // loan is rejected
end

// ... more loans approval/rejections business rules ...

rule CollectApprovedApplication when
    $!: LoanApplication( approved )
then
    approvedApplications.add($!); // collect all approved loan applications
end

```

### 19.3.1. Exposing rule evaluation with a REST endpoint using Red Hat build of Quarkus

You can expose the rule evaluation that is developed in Business Central with a REST endpoint using Red Hat build of Quarkus.

#### Procedure

1. Create a new module based on the module that contains the rules and Quarkus libraries, providing the REST support:

#### Example dependencies for creating a new module

```

<dependencies>

<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-resteasy</artifactId>
</dependency>
<dependency>
  <groupId>io.quarkus</groupId>
  <artifactId>quarkus-resteasy-jackson</artifactId>
</dependency>

<dependency>
  <groupId>org.example</groupId>
  <artifactId>drools-project</artifactId>
  <version>1.0-SNAPSHOT</version>
</dependency>

<dependencies>

```

- 2. Create a REST endpoint.

The following is an example setup for creating a REST endpoint:

### Example FindApprovedLoansEndpoint endpoint setup

```
@Path("/find-approved")
public class FindApprovedLoansEndpoint {

    private static final KieContainer kContainer =
        KieServices.Factory.get().newKieClasspathContainer();

    @POST()
    @Produces(MediaType.APPLICATION_JSON)
    @Consumes(MediaType.APPLICATION_JSON)
    public List<LoanApplication> executeQuery(LoanAppDto loanAppDto) {
        KieSession session = kContainer.newKieSession();

        List<LoanApplication> approvedApplications = new ArrayList<>();
        session.setGlobal("approvedApplications", approvedApplications);
        session.setGlobal("maxAmount", loanAppDto.getMaxAmount());

        loanAppDto.getLoanApplications().forEach(session::insert);
        session.fireAllRules();
        session.dispose();

        return approvedApplications;
    }
}
```

In the previous example, a **KieContainer** containing the rules is created and added into a static field. The rules in the **KieContainer** are obtained from the other module in the class path. Using this approach, you can reuse the same **KieContainer** for subsequent invocations related to the **FindApprovedLoansEndpoint** endpoint without recompiling the rules.



#### NOTE

The two modules are consolidated in the next process of migrating rule units to a Red Hat build of Kogito microservice using legacy API. For more information, see [Migrating DRL rules units to Red Hat build of Kogito microservice using legacy API](#).

When the **FindApprovedLoansEndpoint** endpoint is invoked, a new **KieSession** is created from the **KieContainer**. The **KieSession** is populated with the objects from **LoanAppDto** resulting from the unmarshalling of a JSON request.

### Example LoanAppDto class

```
public class LoanAppDto {

    private int maxAmount;

    private List<LoanApplication> loanApplications;

    public int getMaxAmount() {
```



```

    return maxAmount;
}

public void setMaxAmount(int maxAmount) {
    this.maxAmount = maxAmount;
}

public List<LoanApplication> getLoanApplications() {
    return loanApplications;
}

public void setLoanApplications(List<LoanApplication> loanApplications) {
    this.loanApplications = loanApplications;
}
}

```

When the **fireAllRules()** method is called, **KieSession** is fired and the business logic is evaluated against the input data. After business logic evaluation, the last rule collects all the approved applications in a list and the same list is returned as an output.

3. Start the Red Hat build of Quarkus application.
4. Invoke the **FindApprovedLoansEndpoint** endpoint with a JSON request that contains the loan applications to be checked.

The value of the **maxAmount** is used in the rules as shown in the following example:

### Example curl request

```

curl -X POST -H 'Accept: application/json' -H 'Content-Type: application/json' -d
'{"maxAmount":5000,
"loanApplications":[
{"id":"ABC10001","amount":2000,"deposit":1000,"applicant":{"age":45,"name":"John"}},
{"id":"ABC10002","amount":5000,"deposit":100,"applicant":{"age":25,"name":"Paul"}},
{"id":"ABC10015","amount":1000,"deposit":100,"applicant":{"age":12,"name":"George"}}
]}' http://localhost:8080/find-approved

```

### Example JSON response

```

[
{
  "id": "ABC10001",
  "applicant": {
    "name": "John",
    "age": 45
  },
  "amount": 2000,
  "deposit": 1000,
  "approved": true
}
]

```



## NOTE

Using this approach, you cannot use the hot reload feature and cannot create a native image of the project. In the next steps, the missing Quarkus features are provided by the Kogito extension that enables Quarkus aware of the DRL files and implement the hot reload feature in a similar way.

### 19.3.2. Migrating a rule evaluation to a Red Hat build of Kogito microservice using legacy API

After exposing a rule evaluation with a REST endpoint, you can migrate the rule evaluation to a Red Hat build of Kogito microservice using legacy API.

#### Procedure

1. Add the following dependencies to the project **pom.xml** file to enable the use of Red Hat build of Quarkus and legacy API:

#### Example dependencies for using Quarkus and legacy API

```
<dependencies>
<dependency>
<groupId>org.kie.kogito</groupId>
<artifactId>kogito-quarkus-rules</artifactId>
</dependency>
<dependency>
<groupId>org.kie.kogito</groupId>
<artifactId>kogito-legacy-api</artifactId>
</dependency>
</dependencies>
```

2. Rewrite the REST endpoint implementation:

#### Example REST endpoint implementation

```
@Path("/find-approved")
public class FindApprovedLoansEndpoint {

    @Inject
    KieRuntimeBuilder kieRuntimeBuilder;

    @POST()
    @Produces(MediaType.APPLICATION_JSON)
    @Consumes(MediaType.APPLICATION_JSON)
    public List<LoanApplication> executeQuery(LoanAppDto loanAppDto) {
        KieSession session = kieRuntimeBuilder.newKieSession();

        List<LoanApplication> approvedApplications = new ArrayList<>();
        session.setGlobal("approvedApplications", approvedApplications);
        session.setGlobal("maxAmount", loanAppDto.getMaxAmount());

        loanAppDto.getLoanApplications().forEach(session::insert);
        session.fireAllRules();
        session.dispose();
    }
}
```

```

    return approvedApplications;
  }
}

```

In the rewritten REST endpoint implementation, instead of creating the **KieSession** from the **KieContainer**, the **KieSession** is created automatically using an integrated **KieRuntimeBuilder**.

The **KieRuntimeBuilder** is an interface provided by the **kogito-legacy-api** module that replaces the **KieContainer**. Using **KieRuntimeBuilder**, you can create **KieBases** and **KieSessions** in a similar way you create in **KieContainer**. Red Hat build of Kogito automatically generates an implementation of **KieRuntimeBuilder** interface at compile time and integrates the **KieRuntimeBuilder** into a class, which implements the **FindApprovedLoansEndpoint** REST endpoint.

3. Start your Red Hat build of Quarkus application in development mode.  
You can also use the hot reload to make the changes to the rules files that are applied to the running application. Also, you can create a native image of your rule based application.

### 19.3.3. Implementing rule units and automatic REST endpoint generation

After migrating rule units to a Red Hat build of Kogito microservice, you can implement the rule units and automatic generation of the REST endpoint.

In Red Hat build of Kogito, a rule unit contains a set of rules and the facts, against which the rules are matched. Rule units in Red Hat build of Kogito also come with data sources. A rule unit data source is a source of the data processed by a given rule unit and represents the entry point, which is used to evaluate the rule unit. Rule units use two types of data sources:

- **DataStream**: This is an append-only data source. In **DataStream**, subscribers receive new and past messages, stream can be hot or cold in the reactive streams. Also, the facts added into the **DataStream** cannot be updated or removed.
- **DataStore**: This data source is for modifiable data. You can update or remove an object using the **FactHandle** that is returned when the object is added into the **DataStore**.

Overall, a rule unit contains two parts: the definition of the fact to be evaluated and the set of rules evaluating the facts.

#### Procedure

1. Implement a fact definition using POJO:

#### Example implementation of a fact definition using POJO

```

package org.kie.kogito.queries;

import org.kie.kogito.rules.DataSource;
import org.kie.kogito.rules.DataStore;
import org.kie.kogito.rules.RuleUnitData;

public class LoanUnit implements RuleUnitData {

    private int maxAmount;
    private DataStore<LoanApplication> loanApplications;

```

```

public LoanUnit() {
    this(DataSource.createStore(), 0);
}

public LoanUnit(DataStore<LoanApplication> loanApplications, int maxAmount) {
    this.loanApplications = loanApplications;
    this.maxAmount = maxAmount;
}

public DataStore<LoanApplication> getLoanApplications() { return loanApplications; }

public void setLoanApplications(DataStore<LoanApplication> loanApplications) {
    this.loanApplications = loanApplications;
}

public int getMaxAmount() { return maxAmount; }
public void setMaxAmount(int maxAmount) { this.maxAmount = maxAmount; }
}

```

In the previous example, instead of using **LoanAppDto** the **LoanUnit** class is bound directly. **LoanAppDto** is used to marshal or unmarshal JSON requests. Also, the previous example implements the **org.kie.kogito.rules.RuleUnitData** interface and uses a **DataStore** to contain the loan applications to be approved.

The **org.kie.kogito.rules.RuleUnitData** is a marker interface to notify the decision engine that **LoanUnit** class is part of a rule unit definition. In addition, the **DataStore** is responsible to allow the rule engine to react on the changes by firing new rules and triggering other rules.

Additionally, the consequences of the rules modify the **approved** property in the previous example. On the contrary, the **maxAmount** value is considered as a configuration parameter for the rule unit, which is not modified. The **maxAmount** is processed automatically during the rules evaluation and automatically set from the value passed in the JSON requests.

2. Implement a DRL file:

### Example implementation of a DRL file

```

package org.kie.kogito.queries;
unit LoanUnit; // no need to using globals, all variables and facts are stored in the rule unit

rule LargeDepositApprove when
    $l: /loanApplications[ applicant.age >= 20, deposit >= 1000, amount <= maxAmount ] //
oopath style
then
    modify($l) { setApproved(true) };
end

rule LargeDepositReject when
    $l: /loanApplications[ applicant.age >= 20, deposit >= 1000, amount > maxAmount ]
then
    modify($l) { setApproved(false) };
end

// ... more loans approval/rejections business rules ...

```

```
// approved loan applications are now retrieved through a query
query FindApproved
  $!: /loanApplications[ approved ]
end
```

The DRL file that you create must declare the same package as fact definition implementation and a unit with the same name of the Java class. The Java class implements the **RuleUnitData** interface to state that the interface belongs to the same rule unit.

Also, the DRL file in the previous example is rewritten using the OOPath expressions. In the DRL file, the data source acts as an entry point and the OOPath expression contains the data source name as root. However, the constraints are added in square brackets as follows:

```
$!: /loanApplications[ applicant.age >= 20, deposit >= 1000, amount <= maxAmount ]
```

Alternatively, you can use the standard DRL syntax, in which you can specify the data source name as an entry point. However, you need to specify the type of the matched object again as shown in the following example, even if the decision engine can infer the type from the data source:

```
$!: LoanApplication( applicant.age >= 20, deposit >= 1000, amount <= maxAmount ) from entry-point loanApplications
```

In the previous example, the last rule that collects all the approved loan applications is replaced by a query that retrieves the list. A rule unit defines the facts to be passed in input to evaluate the rules, and the query defines the expected output from the rule evaluation. Using this approach, Red Hat build of Kogito can automatically generate a class that executes the query and returns the output as shown in the following example:

### Example LoanUnitQueryFindApproved class

```
public class LoanUnitQueryFindApproved implements
org.kie.kogito.rules.RuleUnitQuery<List<org.kie.kogito.queries.LoanApplication>> {

    private final RuleUnitInstance<org.kie.kogito.queries.LoanUnit> instance;

    public LoanUnitQueryFindApproved(RuleUnitInstance<org.kie.kogito.queries.LoanUnit>
instance) {
        this.instance = instance;
    }

    @Override
    public List<org.kie.kogito.queries.LoanApplication> execute() {
        return
instance.executeQuery("FindApproved").stream().map(this::toResult).collect(toList());
    }

    private org.kie.kogito.queries.LoanApplication toResult(Map<String, Object> tuple) {
        return (org.kie.kogito.queries.LoanApplication) tuple.get("$!");
    }
}
```

The following is an example of a REST endpoint that takes a rule unit as input and passing the input to a query executor to return the output:

### Example LoanUnitQueryFindApprovedEndpoint endpoint

```

@Path("/find-approved")
public class LoanUnitQueryFindApprovedEndpoint {

    @javax.inject.Inject
    RuleUnit<org.kie.kogito.queries.LoanUnit> ruleUnit;

    public LoanUnitQueryFindApprovedEndpoint() {
    }

    public LoanUnitQueryFindApprovedEndpoint(RuleUnit<org.kie.kogito.queries.LoanUnit>
ruleUnit) {
        this.ruleUnit = ruleUnit;
    }

    @POST()
    @Produces(MediaType.APPLICATION_JSON)
    @Consumes(MediaType.APPLICATION_JSON)
    public List<org.kie.kogito.queries.LoanApplication>
executeQuery(org.kie.kogito.queries.LoanUnit unit) {
        RuleUnitInstance<org.kie.kogito.queries.LoanUnit> instance =
ruleUnit.createInstance(unit);
        return instance.executeQuery(LoanUnitQueryFindApproved.class);
    }
}

```



#### NOTE

You can also add multiple queries and for each query, a different REST endpoint is generated. For example, the **FindApproved** REST endpoint is generated for find-approved.

## CHAPTER 20. ADDITIONAL RESOURCES

- *Designing a decision service using DMN models*
- *Designing a decision service using DRL rules*
- *Designing a decision service using PMML models*

## APPENDIX A. VERSIONING INFORMATION

Documentation last updated on Thursday, March 14th, 2024.



## APPENDIX B. CONTACT INFORMATION

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