Learning IBM Business Automation Open Edition

None

IBM

None

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A great guide for users who are trying IBAMOE for the first time. Recommended getting started guide.

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In this hands-on workshop, users can learn about the DMN specification, author decisions, and deploy it using IBM Decision Manager with basic, intermediate and advanced exercises.

1.6.3 Event-driven processes

This hands-on workshop allows the user to validate the experience of creating loan approval workflow with decision automation. The user will also have an introduction to Fuse, develop an endpoint and consume it using the workflow.

1.6.4 Learn the tools

In this hands-on workshop, create new decision services using Kogito tooling and the VSCode extension , create unit tests and deploy them on KIE Server.

1.6.5 Learn how to deploy IBAMOE on OpenShift using Operators

Try out the business automation operator and learn how to manage your KIE Apps on OpenShift.

Check the Learn more section for more guides and references about business automation with the projects under the KIE umbrella.

Last update: 2023-12-06

2. Learn more

2.1 Videos

KIE Live events are live streams designed to facilitate knowledge sharing about the Business Automation topic, including business rules, decisions, processes, resource planning, tooling, and AI. They're community events and anyone is welcome to attend.

Check out all the KIE Lives at: https://red.ht/kielives

2.2 Red Hat Scholars

You can refer to Red Hat Scholars to find several up-to-date guides about business automation topics, including Kogito.

Check out all the great guides available at: https://redhat-scholars.github.io/cloud-native-business-automation/

2.3 Guides

There are several guided exercises and workshops that are not yet part of this guide. You can find them below:

Loan Approval Workshop with DMN

This workshop is aimed at providing hands on experience creating DMN assets. This lab will implement a Loan Approval workflow. Check out this guide here.

Loan Approval Workshop

This workshop is aimed at providing hands-on experience creating Decision and Process Assets. This lab will implement a Loan Approval workflow. Check out this guide here.

KIE Learning: IBAMOE and RHDM

This repository is a set of explanation and hands-on labs which you can try on your environment and follow at your own pace. The step-by-step guides covers different topics, since basics to more advanced and specific features. The content is not sequential and it covers Decision Manager, Business Optimizer, Process Automation Manager and Kogito.

DMN Handbook

This handbook is a vademecum for the FEEL expression language from the DMN specification, as implemented by the Drools DMN open source engine.

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3. Guided exercises

3.1 Get the tools for IBAMOE

3.1.1 1. Introduction

Before getting started with **IBM Business Automation Open Edition 9.0**, we must first explore and prepare the different tools we'll need in order to go beyond the basics on this Business Automation journey.

We'll be using different tools as we move through the guided exercises: - During development, we'll use IBM Business Automation Open Editions **Canvas**, which is known in the open-source as KIE Sandbox. - To set up the local workstation, we'll use VSCode Plugins, Maven, GraalVM and more. - Since our goal with this enablement is to move towards Kogito adoption and its cloud-native approach, we'll mostly use Canvas and VSCode. Although, you can also find extra exercises covering the usage of Business Central, supported on the 8.x version.

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3.1.2 2. Environment Setup

This section will cover the deployment of some of the tools locally that you will use in these exercises. **IBM Business Automation Open Edition 9.0**

In order to follow these guided labs, you should have IBAMOE 8.0+ in your local environment. IBAMOE is flexible in how you design. The developer runtime tools are predominantly focused in VSCode (download here) with Maven builds targeted at a more cloud native strategy. There are also runtime options available through the utilization of the KIE Server (Knowledge is Everything) to execute. This enablement session will go through both, but the evolution of the jBPM/Drools projects are definitely more towards the Kogito runtimes versus the Java EE-based KIE Server.

If you need to setup IBAMOE locally, you can use this repository to help you get up and running quickly: IBM Business Automation Open Edition 9.0 Environment Setup. This will provide the files as two different forms, a locally built environment that will persist, or the option to have an ephemeral container that will lose the data stored between sessions. Both forms will provide a Business Central and KIE Server environment for use.

2.1 VS Code

For running through the exercises, it is highly recommended that you get **Visual Studio Code** as this is the IDE that IBM Business Automation Open Edition 9.0 most supports for activities regarding both decisions and processes. To get Visual Studio Code go to the Visual Studio Code download page and download for your platform.

2.2 Git, Maven and Java

These labs are going to assume you are already running , a running version of git, Maven 3.6.2+ and OpenJDK 11+. To get these added to your environment, you can follow the steps in this section. IBM Business Automation Open Edition 9.0 is built around git source code control and Maven archetypes. You will need these tools to do most of the content in these quick walk throughs.

2.2.1 GIT

Git is the open-source solution for source code management. To get git, go to here to install it if you don't have it already. All of the major source code management systems work with the git command line and is ultimately platform-agnostic to those.

2.2.2 MAVEN

With IBM Business Automation Open Edition 9.0, the components are built around a Maven architecture predominantly. What this ultimately means is your workstation needs to be able to communicate with one to many different Maven Repositories. These labs will use two in particular, the Red Hat General Availability repository and Maven Central. You could easily replace the two repositories with a local environment one hosting the Maven dependencies as a mirror or based in a disconnected installation, but this is the easiest developer workflow for acquiring new dependencies. The reason we are pointing to the Red Hat Maven repository, at least in the short term, is that the builds for IBM Business Automation Open Edition 9.0 are being deployed there as they are the same binaries used within both the IBM and Red Hat products during the transition of Red Hat Process Automation Manager (RHPAM)/Red Hat Decision Manager (RHDM) from Red Hat into IBM Automation under the name of IBM Business Automation Open Edition 9.0 (IBAMOE). The settings.xml file included below will use the local Maven repository at your **USER_HOME**/.m2/repository, which when configuring Maven would be the default M2_HOME that's created.

ample settings.xml file

```
<?xml version="1.0" encoding="UTF-8"?>
<settings xmlns="http://maven.apache.org/SETTINGS/1.0.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/SETTINGS/1.0.0 http://maven.apache.org/xsd/settings-1.0.0.xsd">
  <localRepository>${user.home}/.m2/repository</localRepository>
  <interactiveMode>true</interactiveMode>
  <usePluginRegistry>false</usePluginRegistry>
  <offline>false</offline>
  <profiles>
    <!-- Profile with online repositories required by IBAMOE -->
    <profile>
      <id>brms-bpms-online-profile</id>
      <repositories>
        <repository>
        <!-- Red Hat Maven Repository-->
          <id>jboss-ga-repository</id>
          <url>https://maven.repository.redhat.com/ga/</url>
          <releases>
            <enabled>true</enabled>
          </releases>
          <snapshots>
            <enabled>false</enabled>
          </snapshots>
        </repository>
      </repositories>
      <pluginRepositories>
        <pluginRepository>
          <id>jboss-ga-plugin-repository</id>
          <url>https://maven.repository.redhat.com/ga/</url>
          <releases>
            <enabled>true</enabled>
          </releases>
          <snapshots>
            <enabled>true</enabled>
          </snapshots>
        </pluginRepository>
      </pluginRepositories>
    </profile>
    <profile>
      <id>maven-https</id>
      <activation>
        <activeByDefault>true</activeByDefault>
      </activation>
      <repositories>
        <repository>
        <!--Maven Central Repository-->
          <id>central</id>
          <url>https://repo1.maven.org/maven2</url>
          <snapshots>
            <enabled>true</enabled>
          </snapshots>
        </repository>
      </repositories>
      <pluginRepositories>
        <pluginRepository>
          <id>central</id>
          <url>https://repo1.maven.org/maven2</url>
          <snapshots>
            <enabled>false</enabled>
          </snapshots>
        </pluginRepository>
      </pluginRepositories>
    </profile>
  </profiles>
  <activeProfiles>
    <!-- Activation of the BRMS/BPMS profile -->
    <activeProfile>brms-bpms-online-profile</activeProfile>
    <activeProfile>maven-https</activeProfile>
  </activeProfiles>
</settings>
```

2.2.2.1 Linux/Windows/Mac

Follow the instructions at the Maven Community to download and update your path variables to incorporate it into your builds.

2.2.2.1.1 Example Linux installation

1. Download Maven 3.8.6 from here
2. If using the Skytap image, change to the downloads folder.

```
cd /home/pamadmin/Downloads
```

3. Now you need to extract the tar

```
tar xzvf apache-maven-3.8.6-bin.tar.gz
```

4. Now if there's an existing Maven in your stack, you can move it out with this command.

```
sudo mv /usr/share/maven /usr/share/maven-old
```

5. Now move the new download into your /usr/share with the following command.

```
sudo mv apache-maven-3.8.6 /usr/share/maven
```

6. With this, Maven should be updated, validate with running a Maven version command.

```
mvn -v
```

Your console should return a log similar to below

```
[pamadmin@host-1 maven]$ mvn -version
Apache Maven 3.8.6 (84538c9988a25aec085021c365c560670ad80f63)
Maven home: /usr/share/maven
Java version: 11.0.16.1, vendor: Red Hat, Inc., runtime: /usr/lib/jvm/java-11-openjdk-11.0.16.1.1-1.el8_6.x86_64
Default locale: en_US, platform encoding: UTF-8
OS name: "linux", version: "4.18.0-372.26.1.el8_6.x86_64", arch: "amd64", family: "unix"
```

2.2.2.2 Mac Alternative

The easiest way to acquire Maven is to use **homebrew** and run the command `brew install maven`, which at the time of writing will install Maven 3.8.6.

2.2.3 JAVA

The assumption in these exercises are that you will utilize a supported JDK. These were tested with `openjdk 11.0.11 2021-04-20`, but other ones are supported. You should be using at least Java 11 with IBM Business Automation Open Edition 9.0 to ensure your best experience with the tooling.

2.3 Kafka

The Kafka setup requires `docker-compose` to run locally, to get this capability, you can use either Docker or Podman for this capability. To see which is right for you, read this article. Coming later in 2022 will be the labs shifted to using an OpenShift deployment of AMQ Streams to minimize the local installations required.

Event-driven processes can react to the events that happens in the ecosystem. Kafka is an open-source even streaming platform, and currently, one of the most popular tools. In this type of architecture, we have the Kafka `topics` used as the communication layer in between the services. Each service can now be considered a `consumer` or a `producer`, in other words, each service can publish or consume events to/from the `topics`.

IBM supports the integration between IBAMOE and AMQ Streams (Kafka). To follow the labs, you should have an accessible Kafka server. The KIE Server (process engine) will communicate with the topics that we will create in the Kafka server.

If you don't have an environment available you can get a Kafka (Strimzi) server quickly running by using Docker. Let's clone the project to the enablement folder.

1. Create a new folder named `enablement` and access it:

```
mkdir ~/enablement && cd ~/enablement
```

2. Clone this repository to your local machine.

```
git clone https://github.com/hguerrero/amq-examples
```

The docker-compose file available in this quickstart should bootstrap everything you need to have your Strimzi up and running: Zookeeper, Kafka server v2.5.0, Apicurio Registry and a Kafka Bridge.

3. Access the `amq-examples/strimzi-all-in-one/` folder:

```
cd amq-examples/strimzi-all-in-one/
```

4. Start the Kafka environment:

```
docker-compose up
```

Docker will download the images and start the services for you. You now have a Kafka server running on localhost port 9092.

2.4 Creating the Kafka topics

In the upcoming labs we will need three topics: `incoming-requests`, `requests-approved` and `requests-denied`. Next, you need to create these topics in your Kafka server. If you are using the containerized option mentioned in this lab, you can create the topics using the `kafka-topics.sh` available in the kafka container.

1. Open a new terminal and let's using the kafka container we have just started. Enter the Kafka folder:

```
cd ~/enablement/amq-examples/strimzi-all-in-one /
```

2. Create the following three topics:

```
docker-compose exec kafka bin/kafka-topics.sh --create --bootstrap-server localhost:9092 --replication-factor 1 --partitions 1 --topic incoming-requests

docker-compose exec kafka bin/kafka-topics.sh --create --bootstrap-server localhost:9092 --replication-factor 1 --partitions 1 --topic requests-approved

docker-compose exec kafka bin/kafka-topics.sh --create --bootstrap-server localhost:9092 --replication-factor 1 --partitions 1 --topic requests-denied
```

2.5 Next steps

At this point you should have IBAMOE, and Kafka on your environment. Before proceeding to the next steps, make sure you have both IBAMOE and Kafka server up and running.

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3.2 Getting Started with Kogito

3.2.1 3. Introduction

This section will focus on how to setup your first Kogito projects from scratch. The method we're going to use for this is through the use of Maven to create it from an empty workspace, produce a DMN model and make it available both locally and how to use deploy it to OpenShift.

 Initial project setup and walk through

 Deploy locally

 Deploy to OpenShift

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3.2.2 4. Using Maven to create the project workspace

In the previous section, you setup Maven locally in your environment, so you should now have access to all of the `mvn` commands that are associated with running it. The first thing we're going to create is a project using the proceeding steps:

1. We're going to create the service in Quarkus with the Maven commands below, this will create a Quarkus project called `quick-kogito` that will be versioned `1.0.0-SNAPSHOT` including the extensions `kogito-quarkus, dmn, resteasy-reactive-jackson, quarkus-smallrye-openapi, quarkus-smallrye-health` which will create a Quarkus DMN project with the openapi components to get the OpenAPI end points easily with health checks when deploying to OpenShift.

```
mvn io.quarkus:quarkus-maven-plugin:2.16.7.Final:create \
    -DprojectGroupId=com.ibm.sample \
    -DprojectArtifactId=quick-kogito \
    -DprojectVersion=1.0.0-SNAPSHOT \
    -DplatformVersion=2.16.7.Final \
    -Dextensions=kogito-quarkus,dmn,resteasy-reactive-jackson,quarkus-smallrye-openapi,quarkus-smallrye-health
```

2. When you create this project you should get a bunch of Maven artifacts start to stream in your console that are being pulled and ultimately are left with a console message like the below:

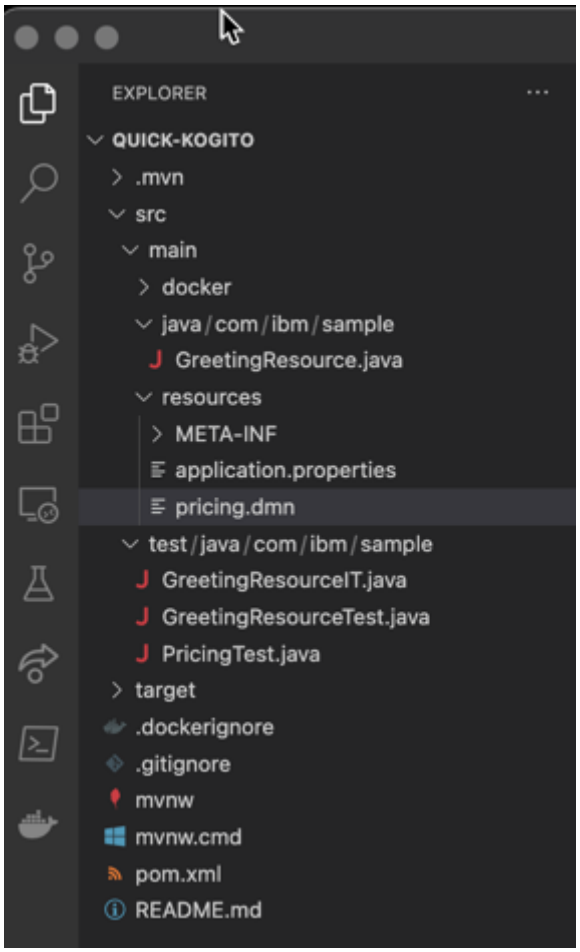
```
[INFO]
[INFO] ----------------------------------------------------------------------------
[INFO] Your new application has been created in /Users/timwuthenow/techxchange/quick-kogito
[INFO] Navigate into this directory and launch your application with mvn quarkus:dev
[INFO] Your application will be accessible on http://localhost:8080
[INFO] ----------------------------------------------------------------------------
[INFO]
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time:  8.555 s
[INFO] Finished at: 2023-07-17T13:35:03-04:00
[INFO] ------------------------------------------------------------------------
```

NOTE: If you are using an image provided by IBM for labs, the 8080 port location that is labeled here will not work immediately because another service is utilizing this port. We will show how to change this in the next steps.

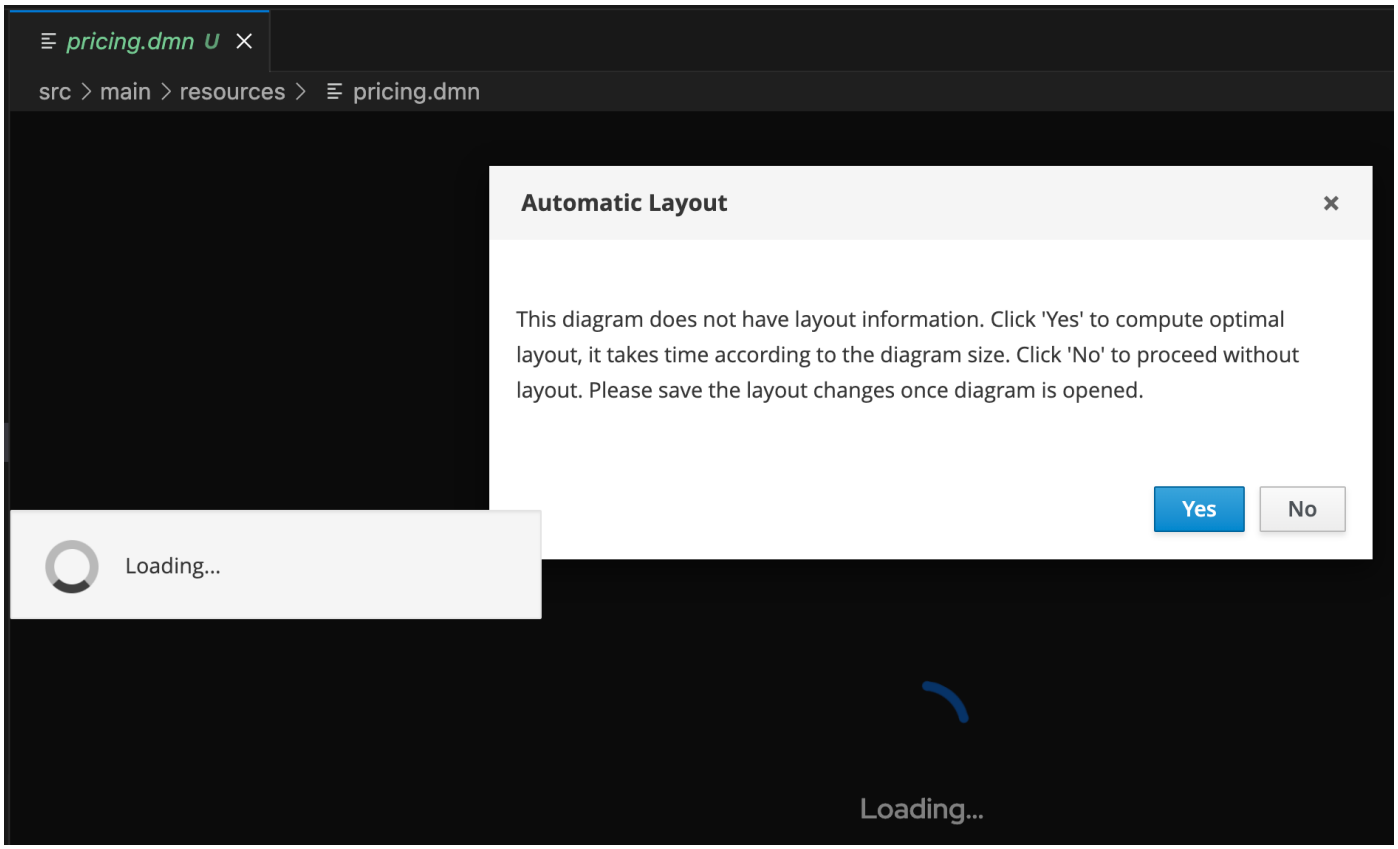
3. With VSCode installed to your PATH variables, you can open the workspace by doing the below command, otherwise open VSCode and navigate to where you ran the command for quick-kogito to be created at:

```
cd quick-kogito
code .
```

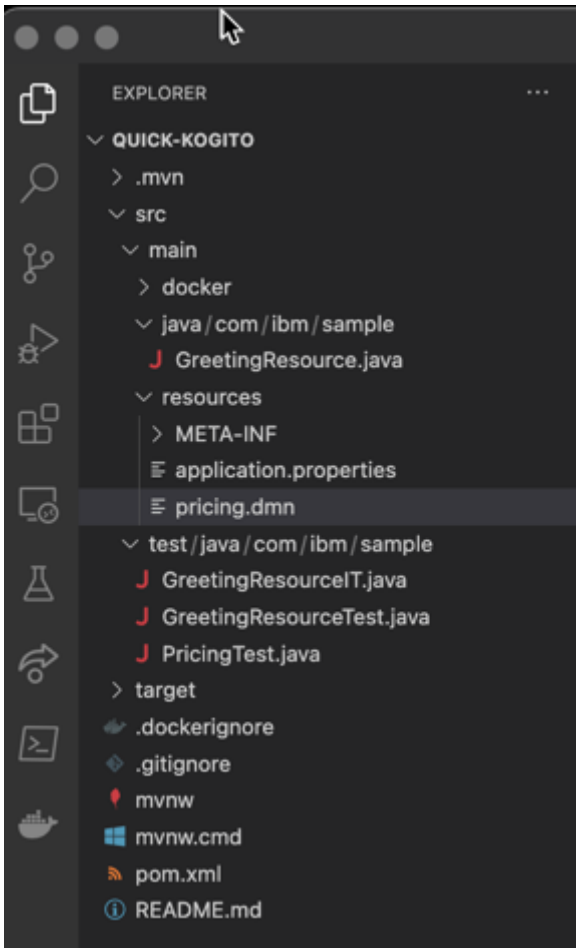
4. From here we can see the workspace's contents and if we expand the contents of `/src/main` you will see the creation of several artifacts. Within `java` you will have a `GreetingResource.java` and within `resources` you will have an `application.properties` and `pricing.dmn` file. These are sample files that can be later modified or deleted, but we will be explore them first in this section, but will do more in later labs around the various end points.



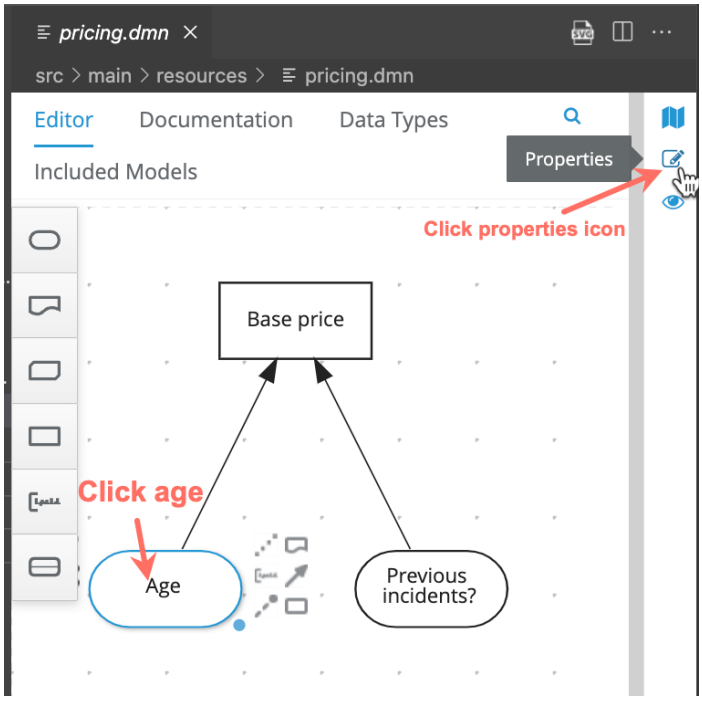
5. Let's first click the `pricing.dmn` file to open it. When you do so you may be greeted with a message similar to `This diagram does not have layout information. Click 'Yes' to compute optimal layout, it takes time according to the diagram size. Click 'No' to proceed without layout. Please save the layout changes once diagram is opened.` - if so click `Yes` to automap the DMN locations.



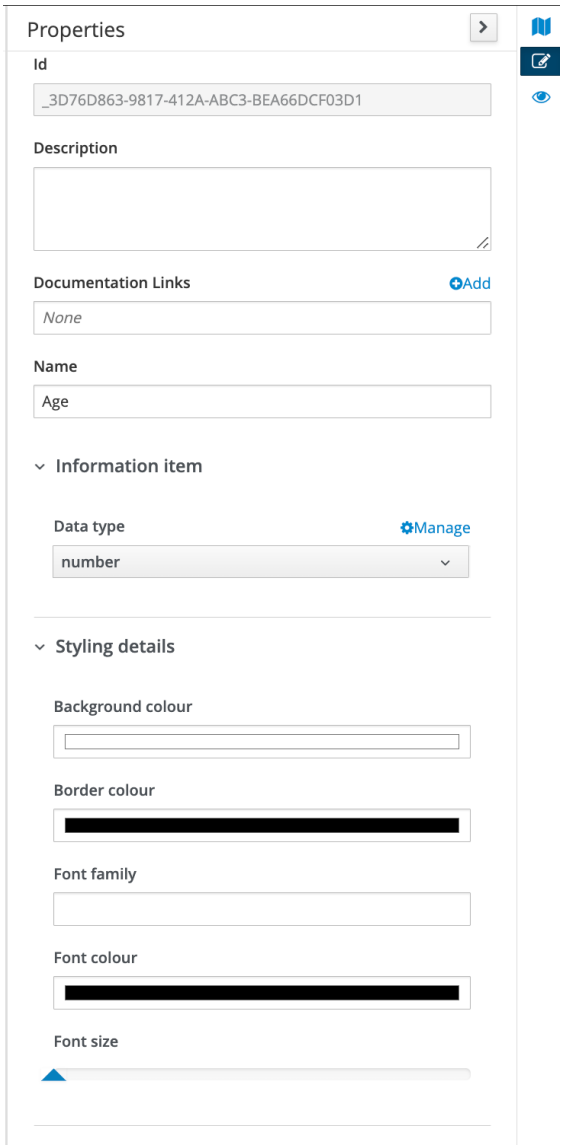
6. When the diagram opens you will see something similar to below, so we will start exploring it. The DMN is made up of two inputs *Age* and *Previous incidents?*, which are used to make the decision, *Base price*.



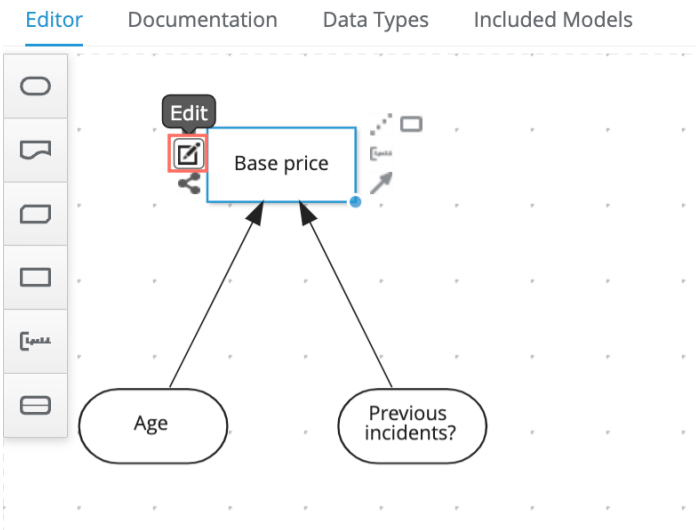
7. If you click *Age* and then click the *Properties* icon on the right, you will open a pane for the input.



8. Within this pane, you can see information about the input *Age*, this includes that it is a number and what the input name is. More can be changed around this object, including changing the color of the node, font size, etc.

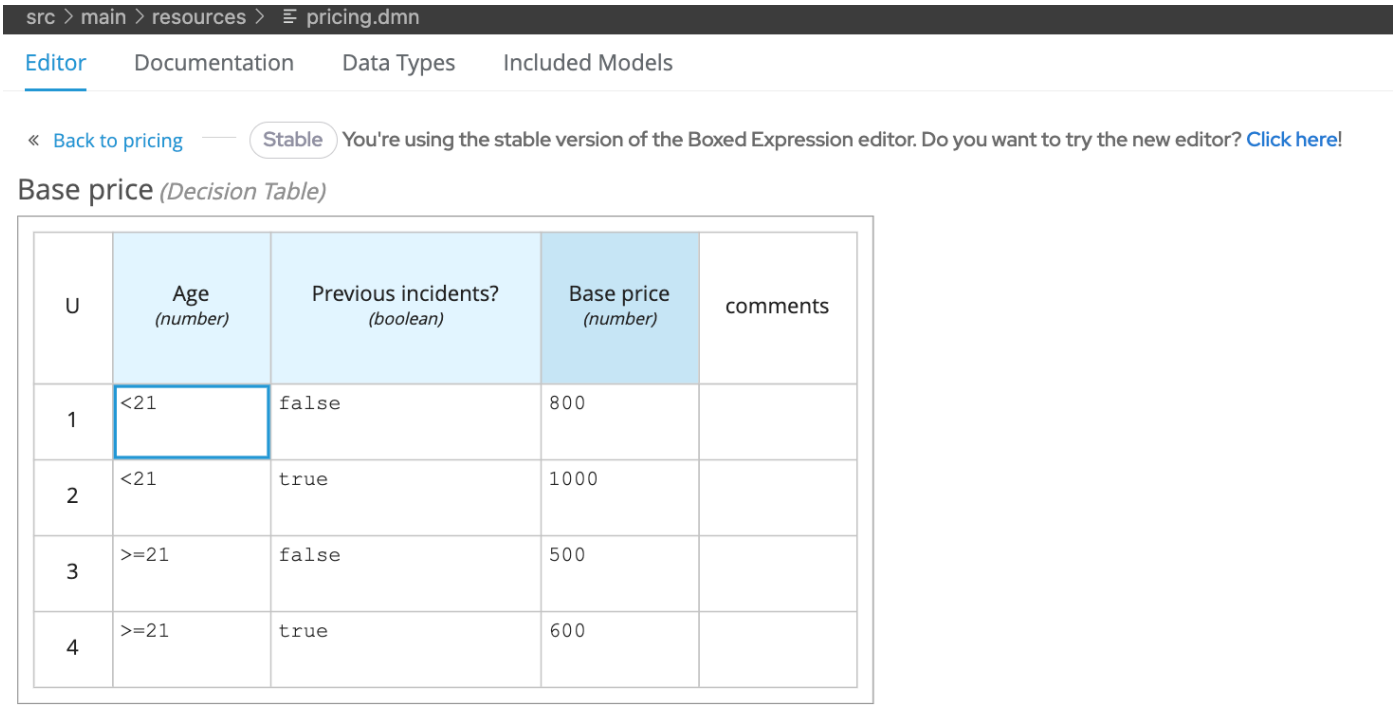


9. To view the Decision, click the square decision node and select the `Edit` button to enter the decision for *Base Price*.



10. From here you will see the Decision Table that is associated with the Base Price decision. From here you will see two (2) input columns (`Age` and `Previous Incidents`), as well as one output column (`Base price`) all with their types below them. These types are controlled from the properties panel similarly to how they were opened when looking at `Age` a few steps ago. This decision has 4

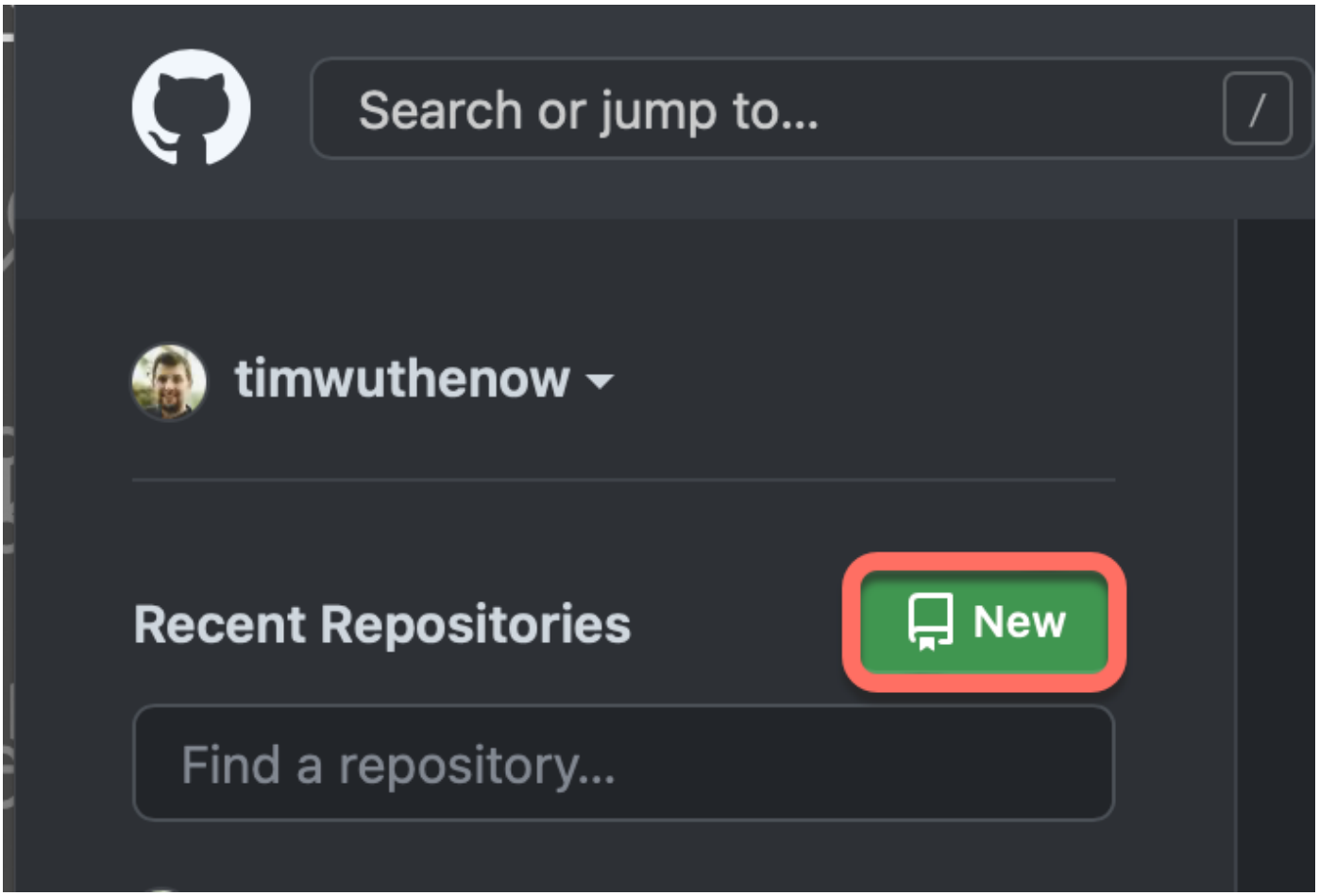
different rows that could fire, with a Hit Policy of `UNIQUE` signified by the **U** in the top left corner of the table. A decision writer could make any comments they want to the table and have them saved towards the decision here



4.1 Create a GitHub repository for the project

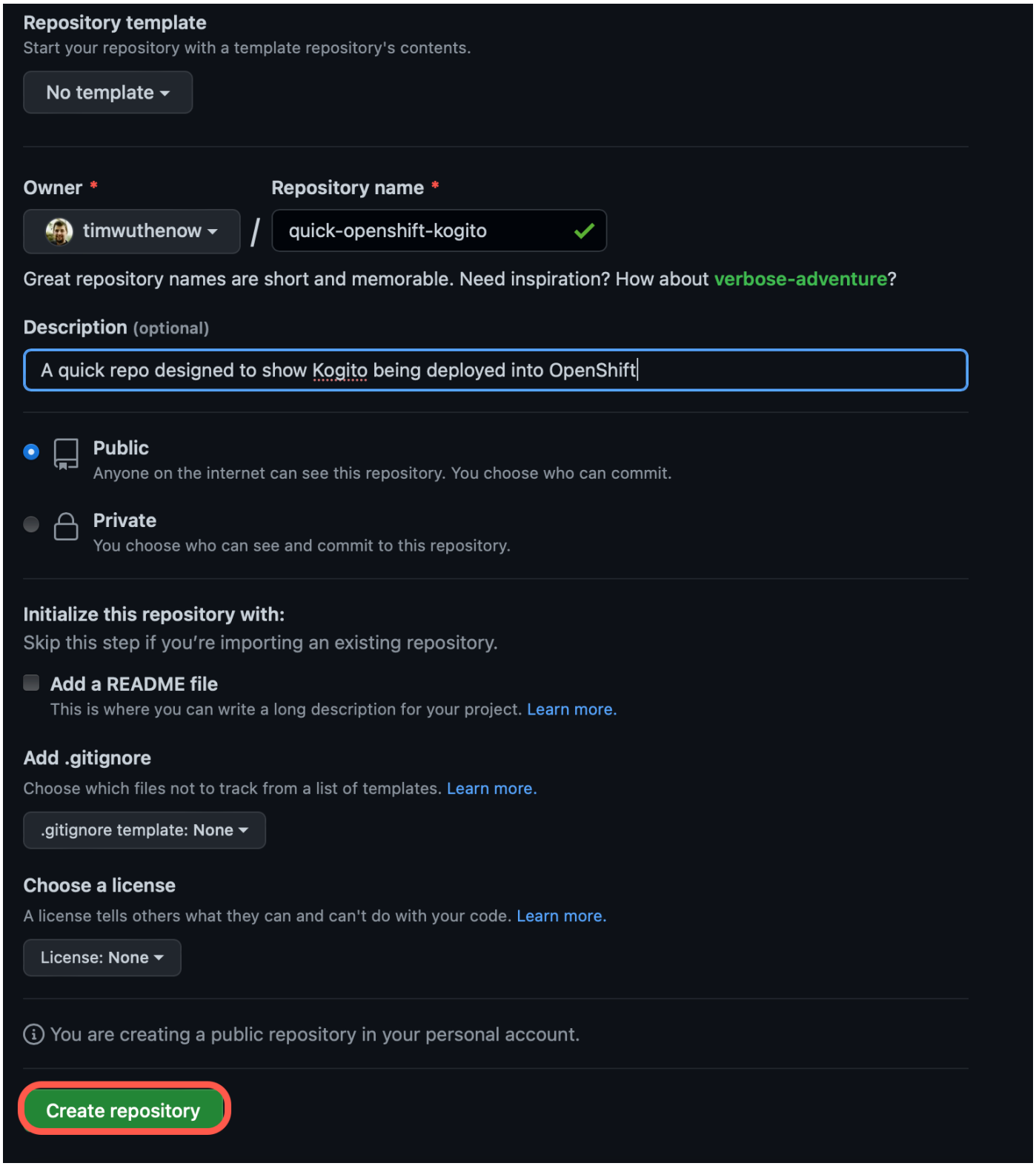
One last thing we're going to do is to create a GitHub repository for this service, so you have somewhere to store our changes and also take advantage of building it into a cloud service running on OpenShift.

1. You can create a repository on GitHub. To do this login to your GitHub username (or create one if you don't have one!) and from your home page and click the green `New` icon near the top left of the page (or you can navigate directly to here)

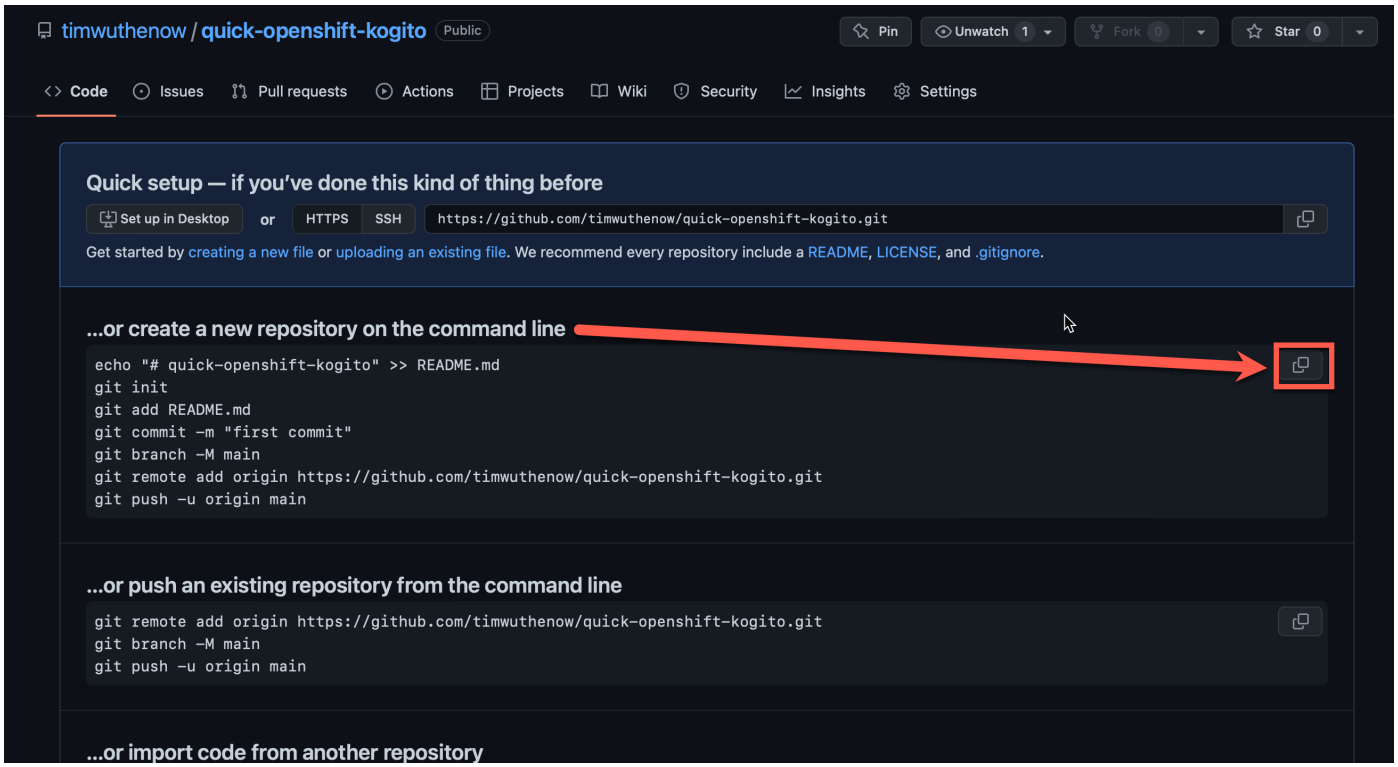


2. Fill out the form with your values

- **Repository Name**: quick-openshift-kogito
- Select **Public** for now
- Add a **Description** if you want
- Click **Create Repository**



3. Copy the command for **...or create a new repository on the command line** as we're going to take exactly what's in our repository add a mostly empty `README.md` and push those changes to GitHub. The below command is an example **and will not be the exact same as what you have on your repository**. Copy *yours*.



4. When this is done, you are finished with this section. Proceed to either deploying locally or deploying on OpenShift

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3.2.3 5. Deploying the Project locally as a Quarkus runtime

Now that we have seen a little of the DMN Decision, let's use the combined power of Quarkus (Learn more here about the Kubernetes-native Java Stack that is the best place for Kogito to run!) and Kogito to quickly build and deploy the service using Maven commands and also having the option to deploy it to OpenShift as well.

1. The first thing we're going to do is open a terminal (either in VSCode or whatever method you prefer) and validate that you have Maven and Java installed.

```
java -version
```

Expected output should be similar to

```
openjdk version "11.0.11" 2021-04-20
OpenJDK Runtime Environment AdoptOpenJDK-11.0.11+9 (build 11.0.11+9)
OpenJDK 64-Bit Server VM AdoptOpenJDK-11.0.11+9 (build 11.0.11+9, mixed mode)
```

```
mvn -version
```

Expected output should be similar to:

```
Apache Maven 3.8.6 (84538c9988a25aec085021c365c560670ad80f63)
Java version: 18.0.2, vendor: Homebrew, runtime: /opt/homebrew/Cellar/openjdk/18.0.2/libexec/openjdk.jdk/Contents/Home
Maven home: /opt/homebrew/Cellar/maven/3.8.6/libexec
Default locale: en_US, platform encoding: UTF-8
OS name: "mac os x", version: "12.6", arch: "aarch64", family: "mac"
```

2. Now that our environment has the appropriate resources, let's build and run the service locally. Quarkus does this very simply with the command `mvn quarkus:dev` which will operate the container in development mode. By default it will run on 2 ports when running this command, `8080` and `5005`. These ports can be maintained in the `application.properties` file in `src/main/resources/` or you can modify the `mvn quarkus:dev` command to load those properties from the command line. If you want to do the command line, you can do `mvn quarkus:dev -Dquarkus.http.port=8085 -Ddebug=7007` which would setup your application to run off of port `8085` and be able to attach a remote debugger at `7007`. To change the default host in application.properties add the following line.

```
quarkus.http.port=8085
```

3. After the project's application.properties has been updated, let's start the Quarkus service by running the following command. This command will run the remote debugger (which we are not using in these labs) on port 6006 so that if you already have another application running on 5005 (the default port) it won't give an error.

```
mvn quarkus:dev -Ddebug=6006
```

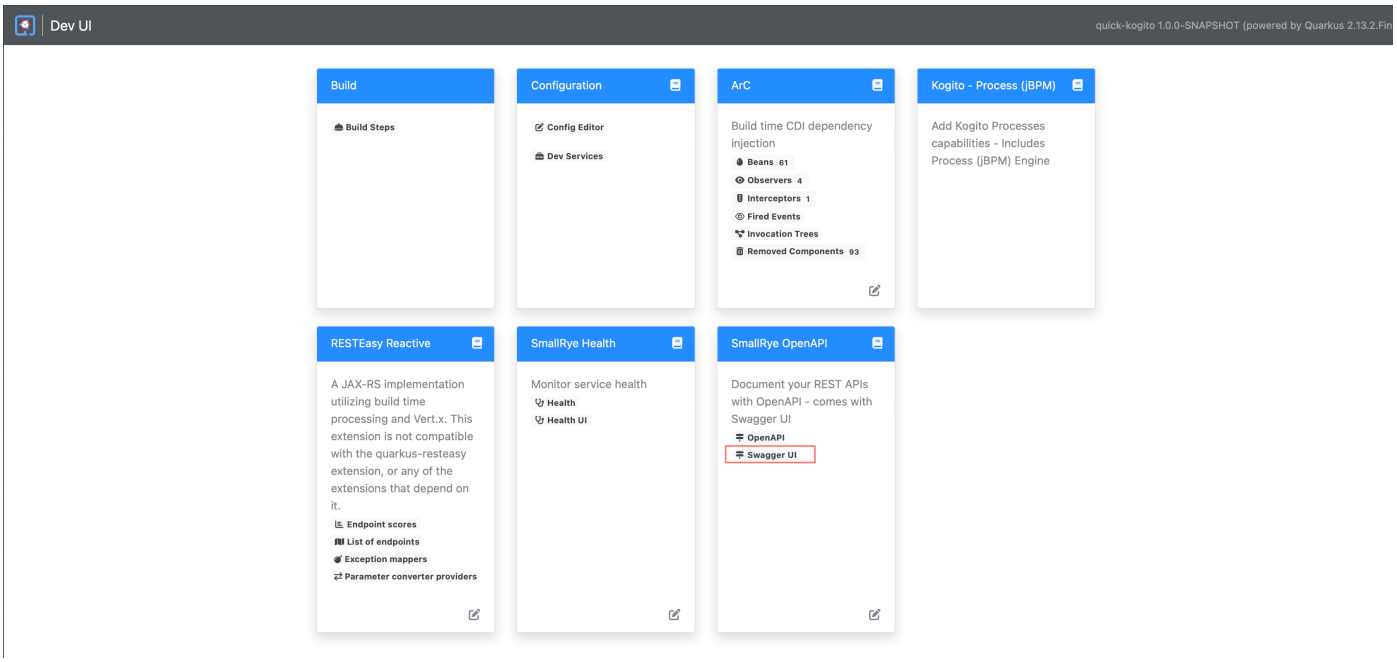
4. When the service is ready, it will produce a log similar to the below:

```
$ quick-kogito % mvn quarkus:dev -Ddebug=6006
[INFO] Scanning for projects...
[INFO]
[INFO] --------------------< com.ibm.sample:quick-kogito >---------------------
[INFO] Building quick-kogito 1.0.0-SNAPSHOT
[INFO] --------------------------------[ jar ]---------------------------------
...
2022-09-29 20:48:34,404 INFO  [org.kie.kog.cod.dec.DecisionValidation] (build-23) Initializing DMN DT Validator...
2022-09-29 20:48:34,405 INFO  [org.kie.kog.cod.dec.DecisionValidation] (build-23) DMN DT Validator initialized.
2022-09-29 20:48:34,405 INFO  [org.kie.kog.cod.dec.DecisionValidation] (build-23) Analysing decision tables in DMN Model 'pricing' ...
2022-09-29 20:48:34,410 INFO  [org.kie.kog.cod.dec.DecisionValidation] (build-23)  analysis for decision table 'Base price':
2022-09-29 20:48:34,412 INFO  [org.kie.kog.cod.dec.DecisionValidation] (build-23)   Decision Table Analysis of table 'Base price' finished with no messages to
be reported.
2022-09-29 20:48:34,494 INFO  [org.kie.kog.qua.com.dep.KogitoAssetsProcessor] (build-38) reflectiveEfestoGeneratedClassBuildItem
org.kie.kogito.quarkus.common.deployment.KogitoGeneratedSourcesBuildItem@415815e1
__  ____  __  _____   ___  __ ____  ______
 --/ __ \/ / / / _ | / _ \/ //_/ / / / __/
 -/ /_/ / /_/ / __ |/ , _/ ,< / /_/ /\ \
--\___\_\____/_/ |_/_/|_/_/|_|\____/___/
2022-09-29 20:48:35,728 INFO  quick-kogito 1.0.0-SNAPSHOT on JVM started in 2.432s.
2022-09-29 20:48:35,728 INFO  Listening on: http://localhost:8085
2022-09-29 20:48:35,728 INFO  Profile dev activated. Live Coding activated.
2022-09-29 20:48:35,728 INFO  Installed features: [cdi, kogito-decisions, kogito-predictions, kogito-processes, kogito-rules, resteasy-reactive, resteasy-
reactive-jackson, smallrye-context-propagation, smallrye-openapi, swagger-ui, vertx]
```

5.1 Using the project that is created

Now that your application is created, you can start using it more for live development and change as you go.

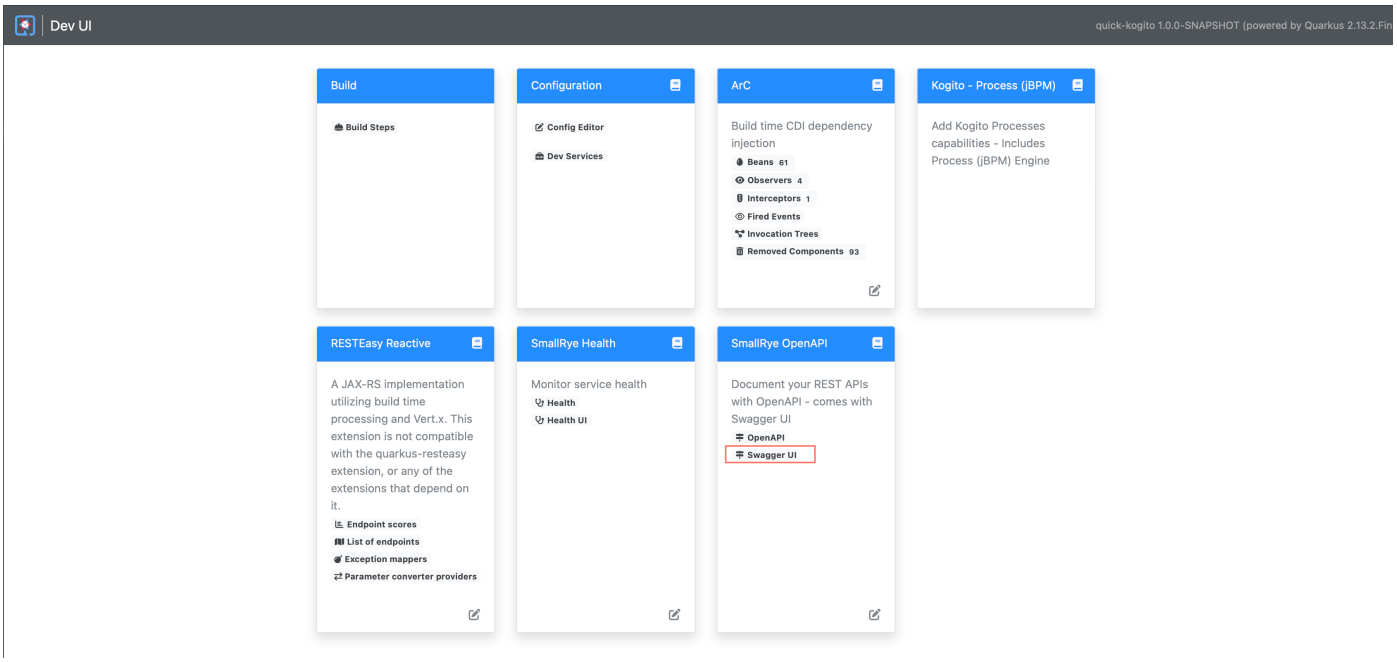
1. To access the Quarkus Development console, in the logs, you can `Command/Ctrl+click` the link in VSCode or go to ()[http://localhost:8085], directly.



2. The development console will show various aspects of your deployment. A quick highlight will be:

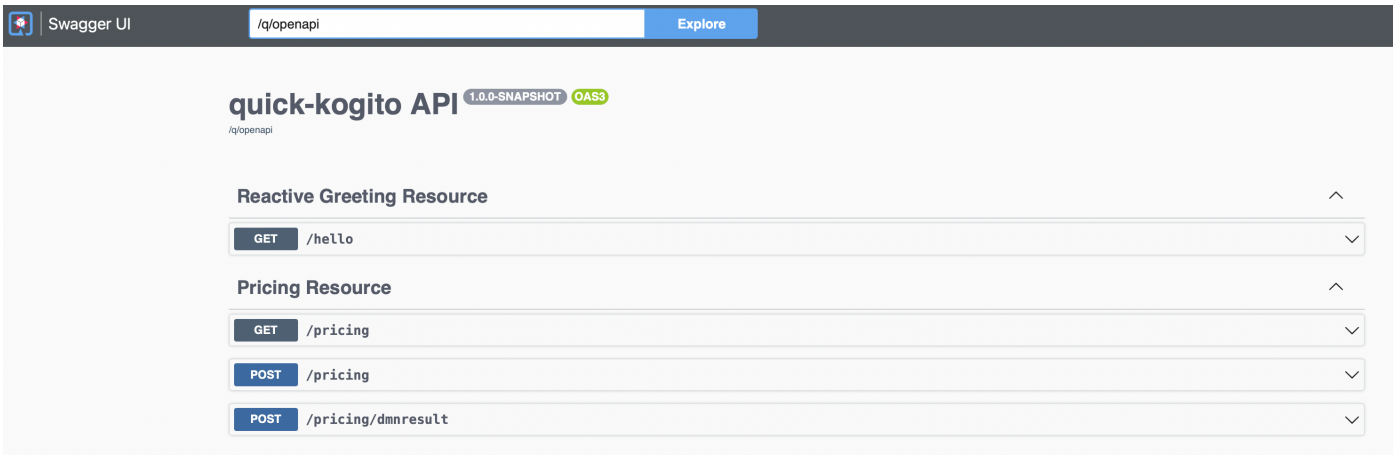
- The list of end points that are available
- The produced Maven artifact name (in this case quick-kogito 1.0.0-SNAPSHOT)
- You can modify configurations of your running application from here
- The Swagger UI and OpenAPI pages to get more information and test out your end points.

  We will be clicking the Swagger UI link to open the Swagger page to try out our sample DMN.



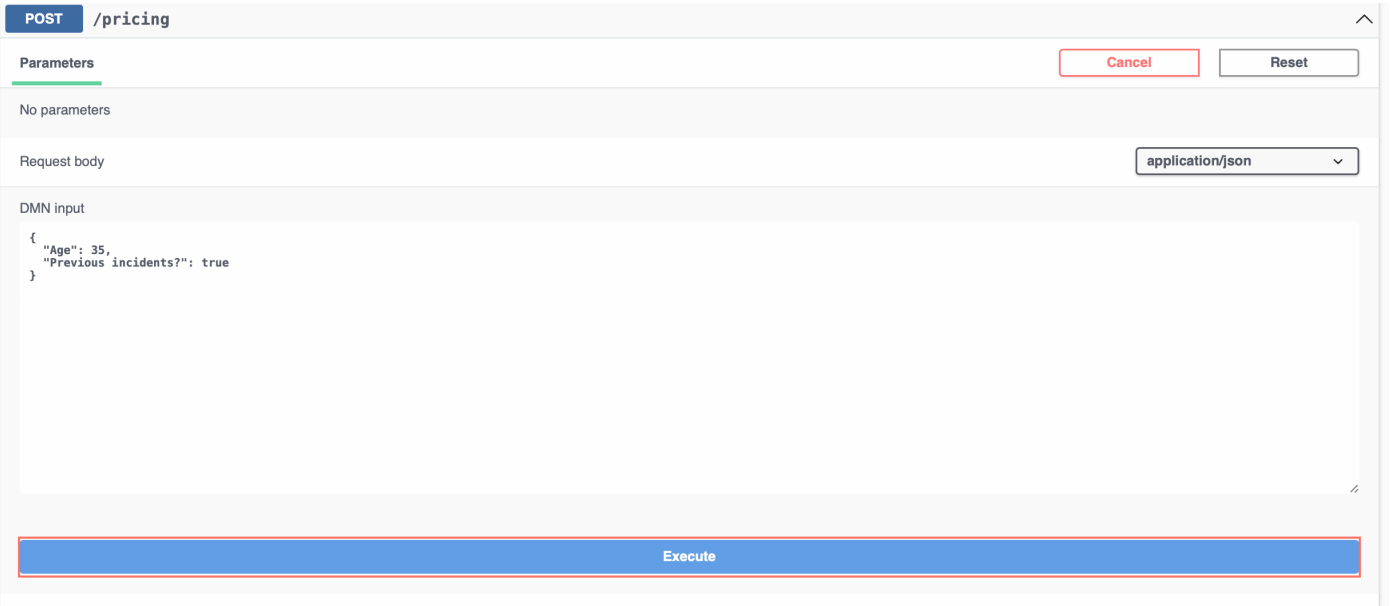
3. Here you can see your generated Quarkus endpoints that deal with the Decision model. When building a DMN Decision Service with IBM Business Automation Open Edition 9.0 in Kogito, it will be able to use the DMN Model, coupled with the data model created in it to generate the required end points and inputs. This creates a **Domain Specific Decision Service**, which is different than how KIE Server worked before in that you would interact with a generic API and insert the objects for execution. By going away from the classpath loading strategy in Kogito, Decision Services are ready to be deployed into a cloud native environment.

Your payloads are simpler and easy to reuse across any services as required without having to know exactly how the service is deployed, the objects associated with the deployment and more.

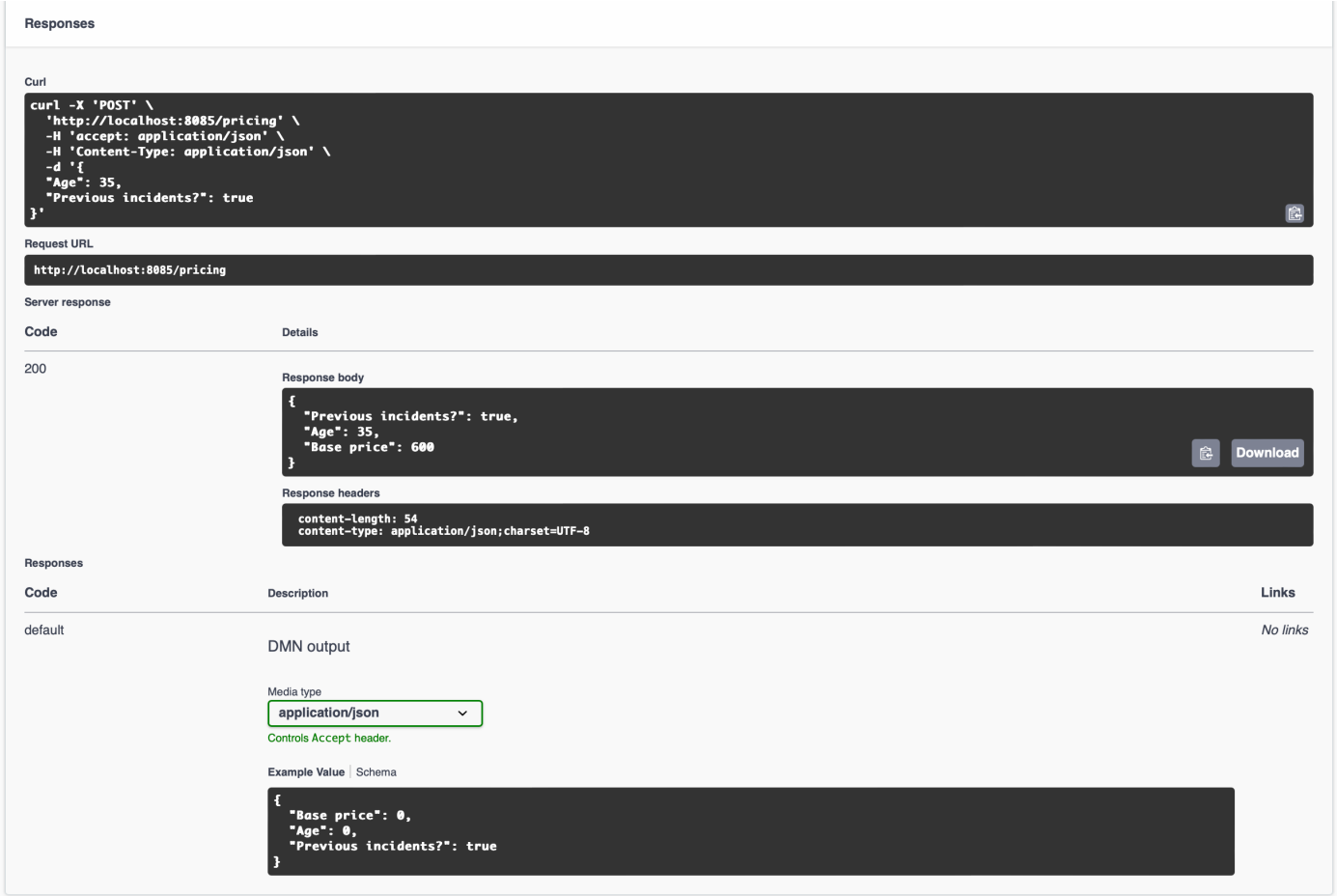


4. The service that was created for the Decision Service is called **Pricing Resource** and if you click any of the end points you will get more information on them. The first end point to look at is the `Post /pricing`. This endpoint can be used to execute a decision and return just the data associated with the decison (inputs and outputs).

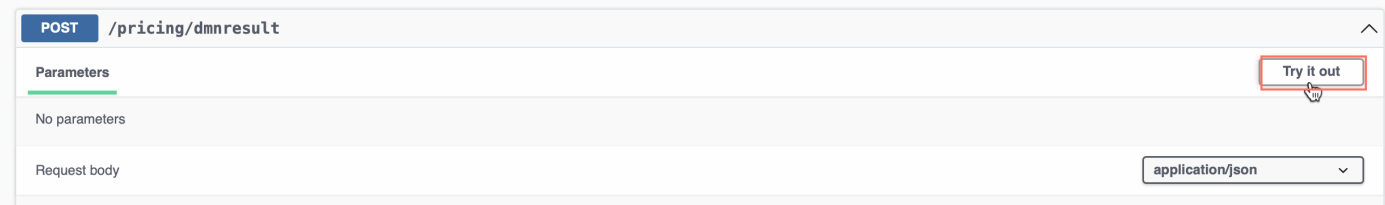
5. After clicking, you can edit the Domain Specific payload in input that matches your decision input nodes (`Age` and `Previous incidents`) with values you want to test. Notice that the endpoints use faces in the object names, this matches the expected values that were tied to the inputs in the model as opposed to camelCase or snake_case or PascalCase. This helps with a consistent view across the Kogito stack - from design to runtime.



6. Your result should look similar to the one below. As you can see, the Swagger-UI page produces a few things of note, the first being a Curl command to reproduce locally, the URL you called, and then ultimately the response from the service.

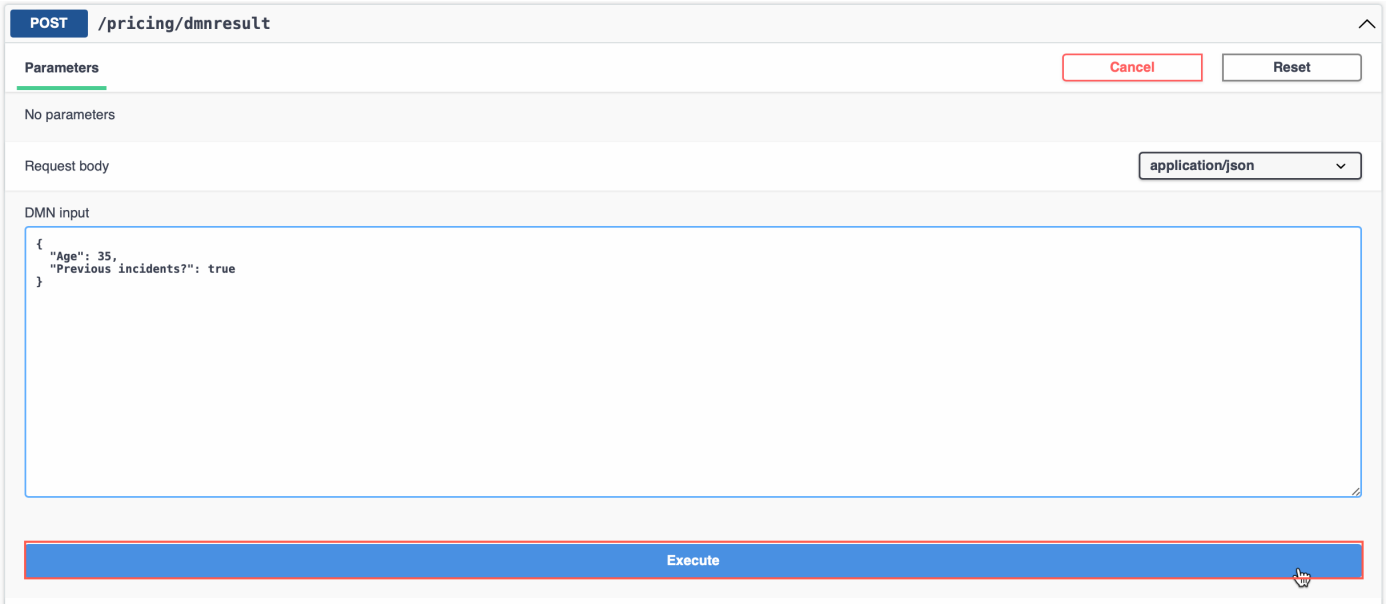


7. The next endpoint to evaluate is the `/pricing/dmnresult` endpoint which will tell you more about the decision that executed. You can use the same payload from the previous steps to show the differences of what is presented. That payload can be similar to the code below provided in JSON. Click `Try it out` and repeat the steps from above.
8. The input for the `Try it out` can be used from below.

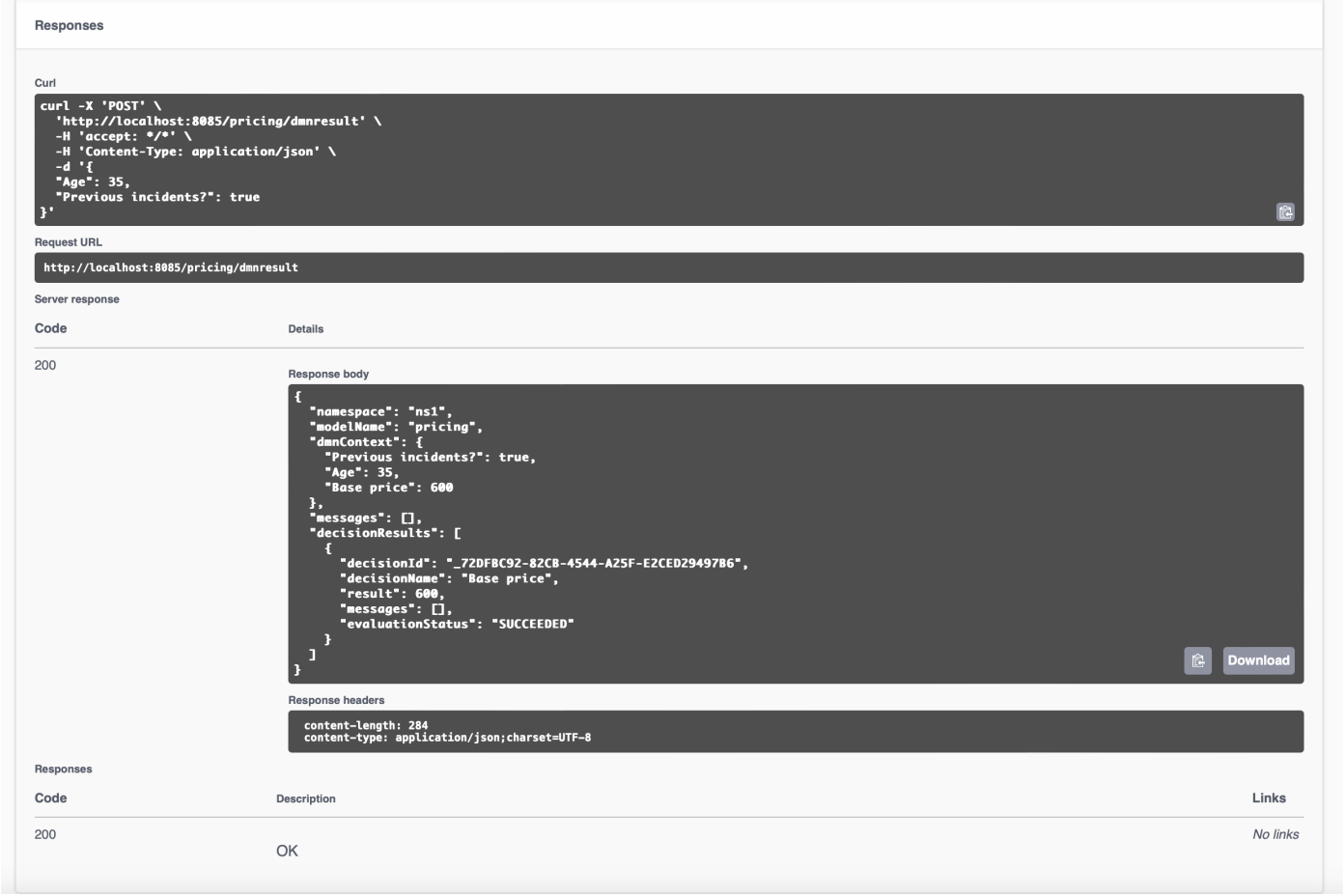



```
{
  "Age": 35,
  "Previous incidents?": true
}
```

9. Click `Execute` with the updated payload.



10. The result will go into more detail about which Decision Nodes were executed against and more. When there is more than one Decision Node available, you can see the results from each node.



Now you can play with the DMN model more and see how those changes impact your Quarkus service. Since you're in Dev mode, as you make changes, those changes should be available to you each time you save. Try it out!

Last update: 2023-12-06

3.2.4 6. Under construction

This content will be completed soon!

6.1 Deploying your service to OpenShift as a Kogito Quarkus Service

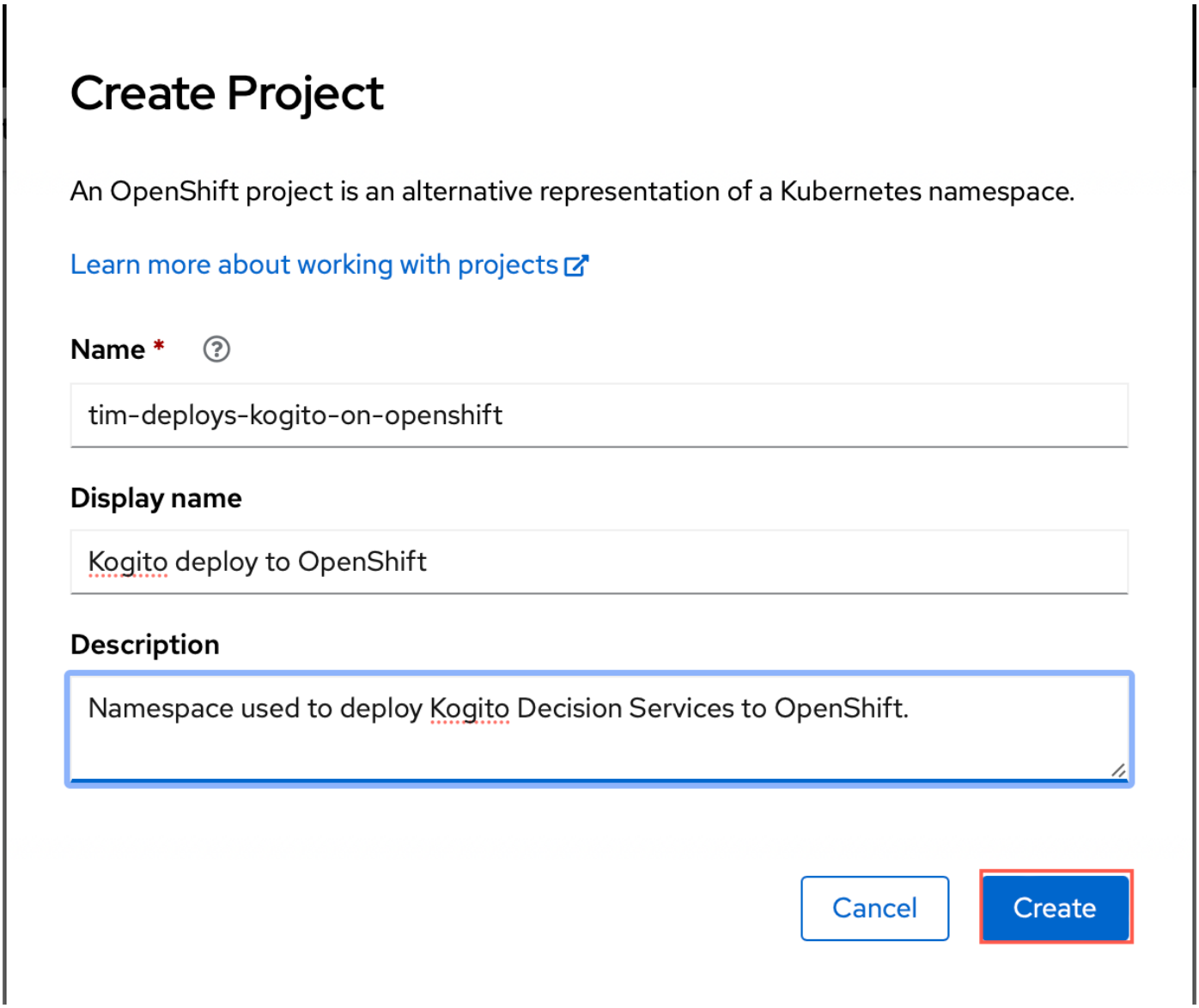
Now that we have seen a little of the DMN Decision, let's use the combined power of Quarkus (Learn more here about the Kubernetes-native Java Stack that is the best place for Kogito to run!) and Kogito to quickly build and deploy the service to OpenShift. If you have already done the deploy locally, you will be able to skip some of these steps and start at Getting Ready for OpenShift Deployment.

When deploying to OpenShift you will need to take the following things into account:

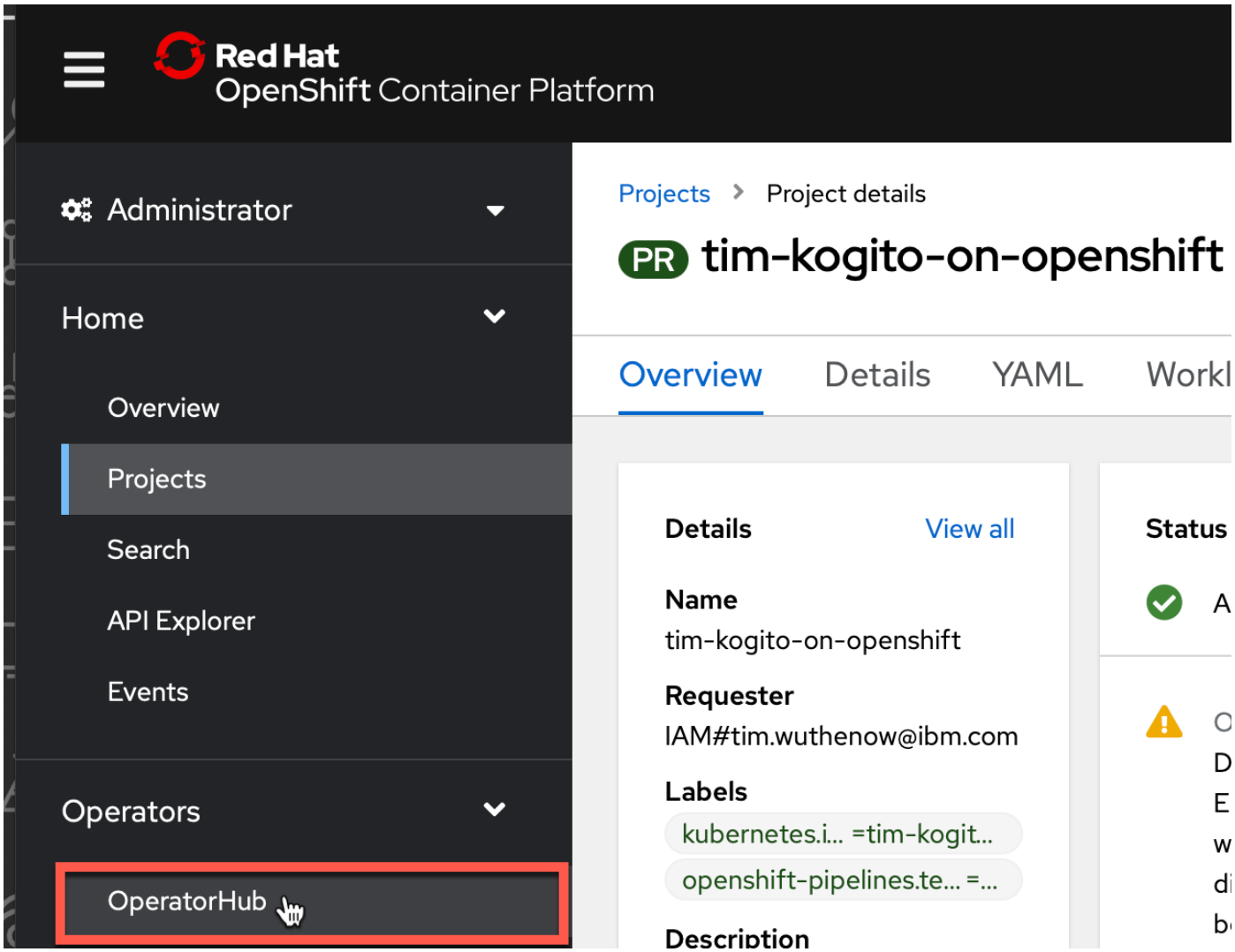
- The application with your Kogito microservices is in a Git repository that is reachable from your OpenShift environment.
- You have access to the OpenShift web console with the necessary permissions to create and edit KogitoBuild and KogitoRuntime.
- If implementing Quarkus, update the pom.xml file 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 Quarkus-based projects on OpenShift. If you created the project like in 01_walk_through.md, you will already have this extension added to your deployment.

6.2 Deploying the Kogito Operator

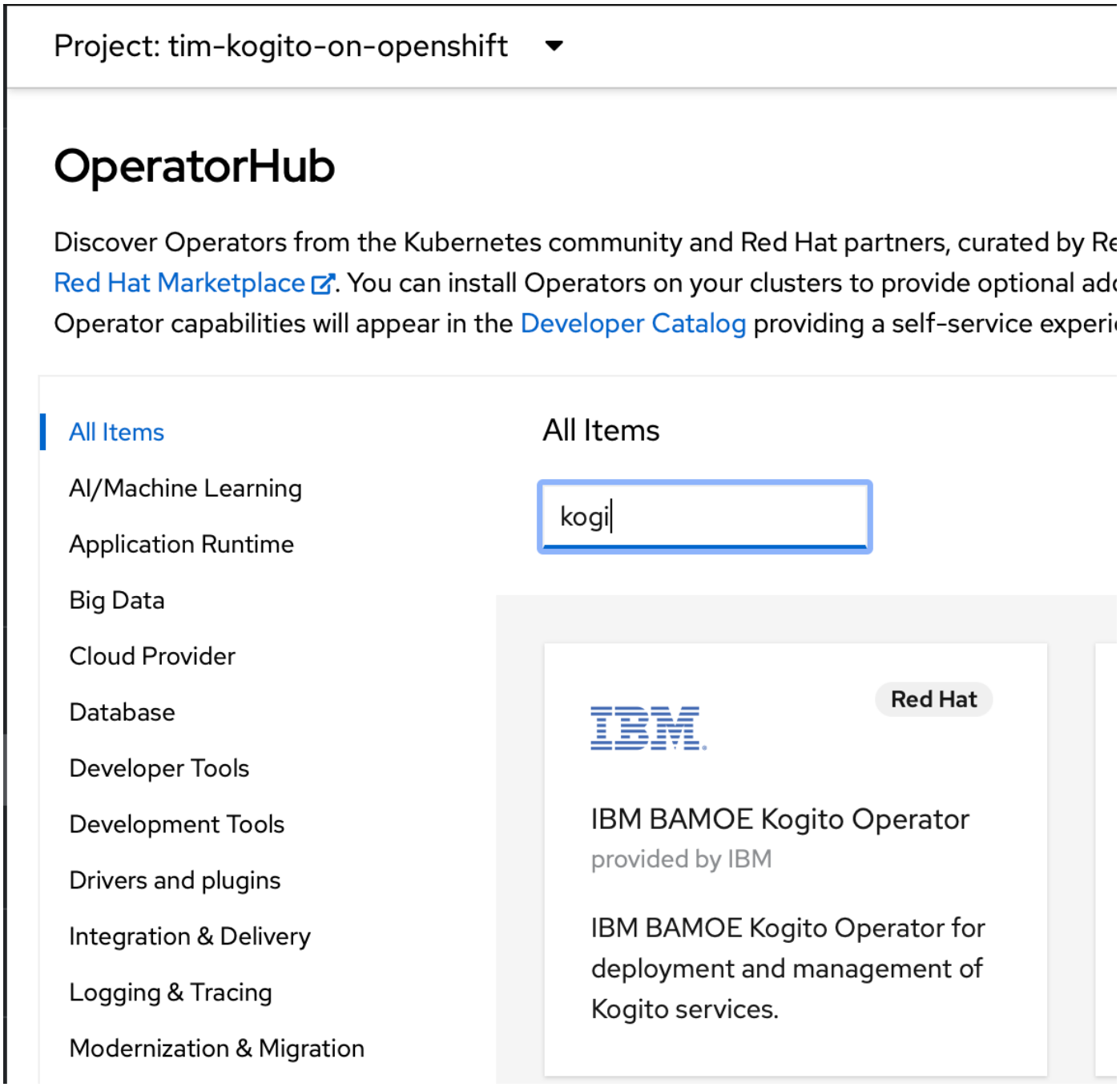
1. First create a namespace for this to deployed into from the OpenShift console. For example `tim-kogito-on-openshift`.



2. Next, we need to install the Kogito Operator from the OperatorHub. To do this, login to the OpenShift Cluster console and login as an admin. From here, go to `Operator` ==> `OperatorHub` to open the OperatorHub.



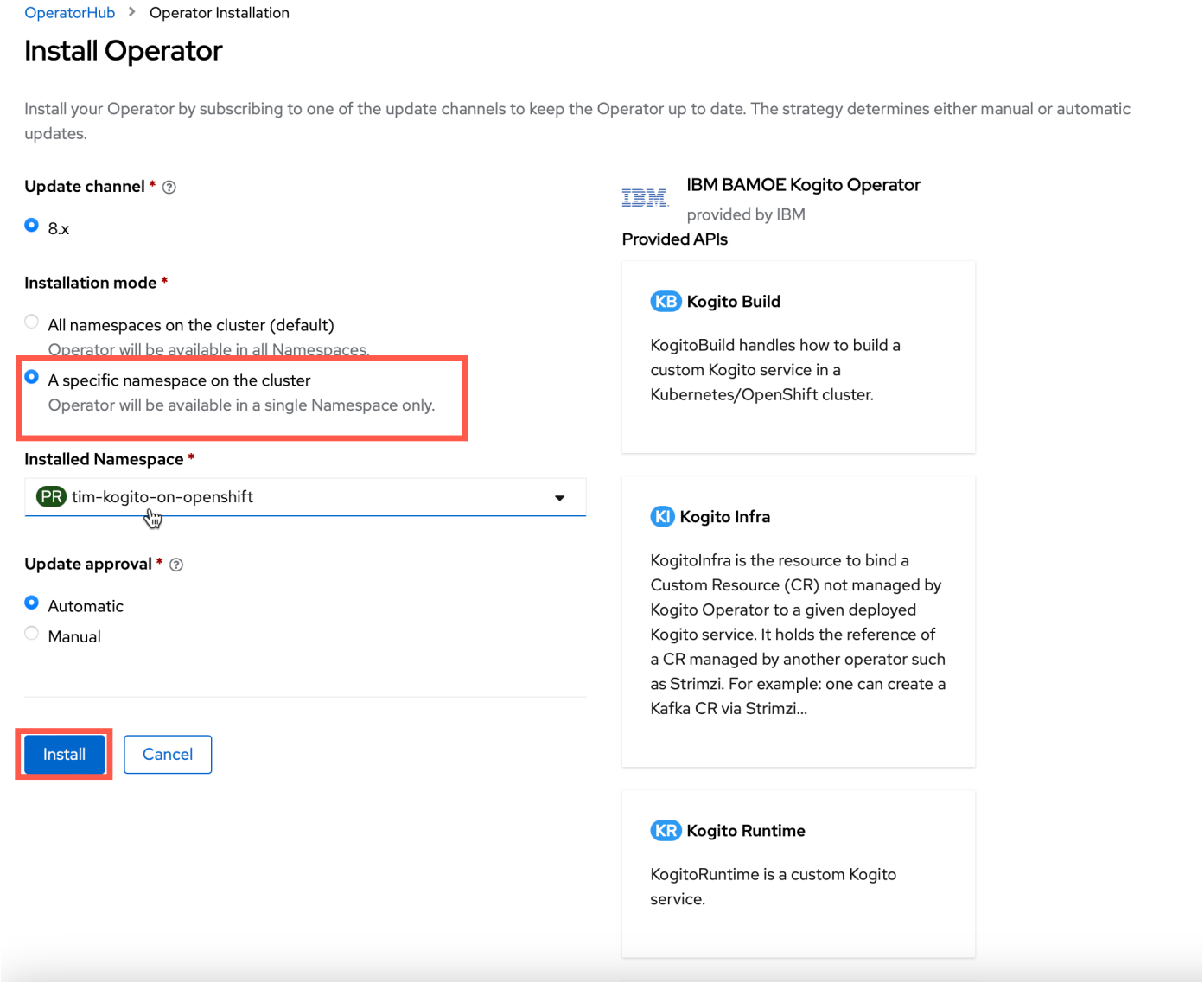
3. Search for Kogito and click the `IBM BAMOE Kogito Operator` tile.



4. From the Operator Form, click `Install` at the top left to install the Operator.

   Operator install

5. Install it to your namespace you created earlier. This way if there's a version already installed, you're not colliding with it and it is contained to just your namespace. The drawback is that it is limited to this namespace.



6. The installation may take a few minutes, but once it is completed, you will be ready to deploy your service. Click **View Operator**

Success

6.2.1 DEPLOYING YOUR FIRST KOGITO APPLICATION ON OPENSHIFT

Now that we've got the Operator installed, we're going to see how it works. This lab will walk through the deployment of a Quarkus deployment of the Kogito Service. There will be a collapsed section to refer to if the service was a Spring Boot service instead so there's a reference to it to show how easy it both types of deployments are utilizing the operator.

1. Once the operator is installed, you will click the Kebab icon and `Create KogitoBuild` to create the build.

   Create KogitoBuild

2. Since we're developing in Quarkus, our implemetation details handled in yaml are fairly minimal. We will point to a git repository where the service is deployed. In the previous section you created a repository, e.g. `github.com/timwuthenow/quick-openshift-kogito`.

Last update: 2023-12-06

3.3 TechXchange

3.3.1 7. IBM Business Automation Open Edition 9.0 labs at IBM TechXchange 2023

Welcome to the Session 1717, at IBM TechXchange 2023.

In this session you'll have a hands-on experience with cloud-native decision automation using IBM Business Automation Open Edition 9.0. As part of our learning journey, we'll explore many capabilities of IBAMOE, along with having a better understanding of its architecture, how its components work together and ultimately, allows to create cloud-native decision services that can be deployed on cloud platforms such as Red Hat OpenShift Container Platform (OCP).

To create our decision models, we'll use a new tool made available in 9.0, IBM Business Automation Manager Canvas, and we'll combine it with the developer joy brought by Quarkus, and how we can quickly deploy our automation solutions to a cloud environment.

We will focus predominantly on the IBAMOE 9.0 release, exploring how to automate a decision using Open Standards such as DMN, and running it with a Kogito-based Decision Service.

> **Note**
>
> If you want to go a step further, you'll also have available to you, labs focused on the 8.0.3 version of Open Editions, specially, on the Process Automation capabilities. Aligned with the evolution of the technology landscape and the future of this solution, the process automation capabilities are currently shifting towards a cloud-native architecture as we'll learn today. We hope to see you around in TechXchange 2024, to experience together all the exciting innovation we're building for this IBM's open source business automation solution!

Now, let's get started!

7.1 Create your first Decision Service using IBM Decision Manager Open Edition

Intro to DMN | **Explore DMN** | **Deeper Dive into DMN**

7.1.1 GO ONE STEP FURTHER (OPTIONAL)

7.1.1.1 Explore process automation with IBM Business Automation Open Edition 8.0

Getting started with Process | **Event-driven processes**

7.1.1.2 More Exercises

First Kogito Project Setup from Scratch

Implement a On-push CI/CD

Last update: 2023-12-06

3.4 DMN Exercises

3.4.1 8. Learn Decision Automation with DMN

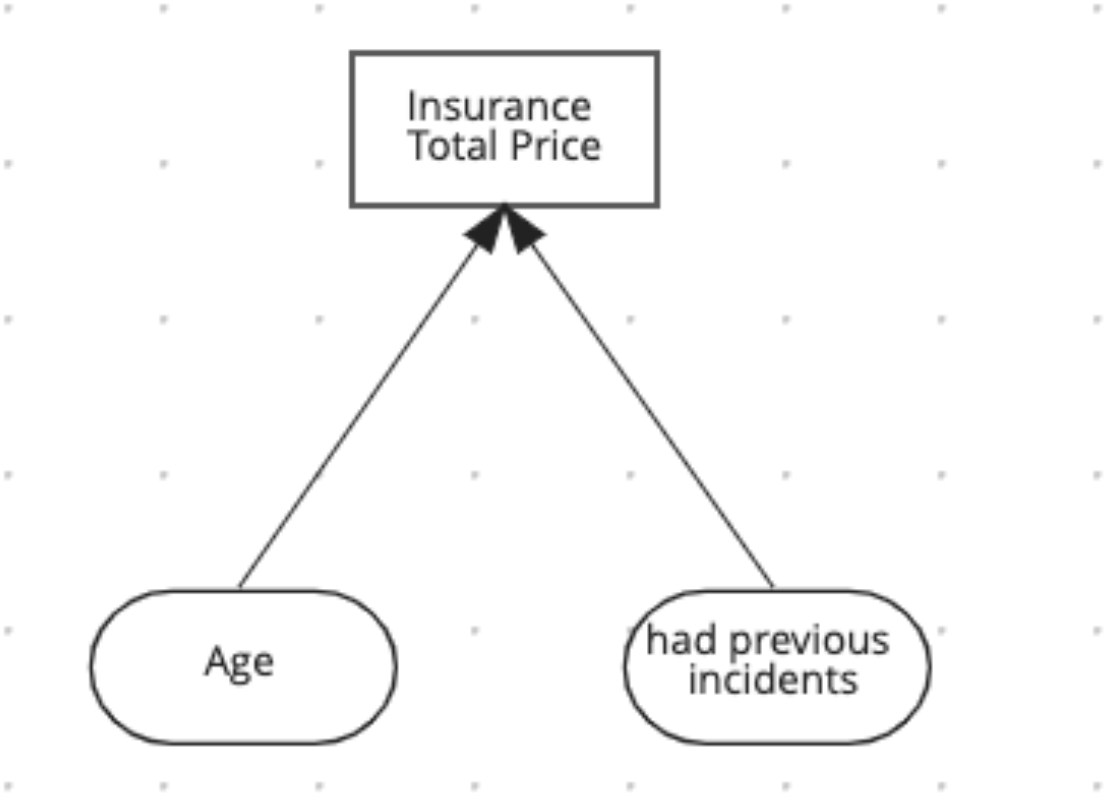
It's time to learn how Decision Automation can be made simple with Open Standards And Open Editions. Throughout these exercises, you'll experiment the development of decisions using Decision Model and Notation - DMN, and learn how to run, deploy and consume your decisions.

Before getting started, let's get familiar with the exercises you'll be working on and get introduced to the concepts of the DMN Standard, an increasingly adopted strategy for developing rules in the decision automation market.

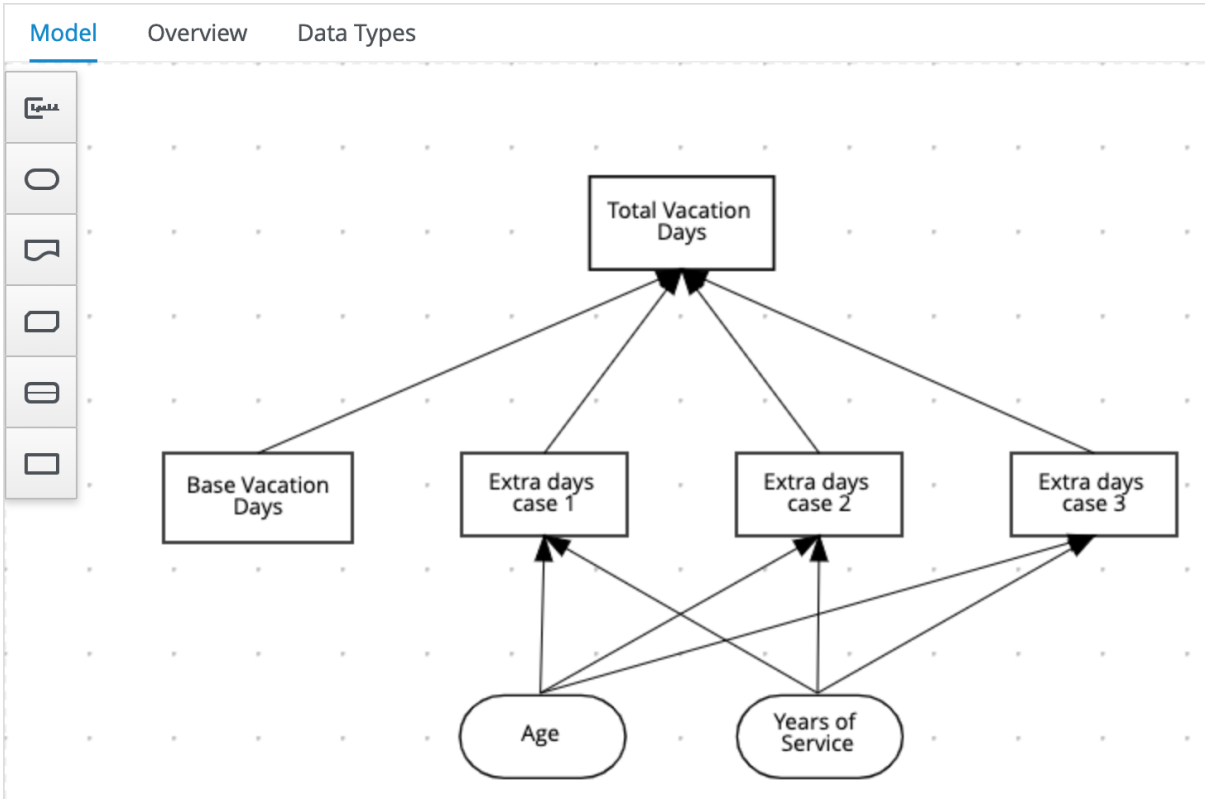
8.1 Goals of the Guided Exercises

These are the labs you have available in this workshop:

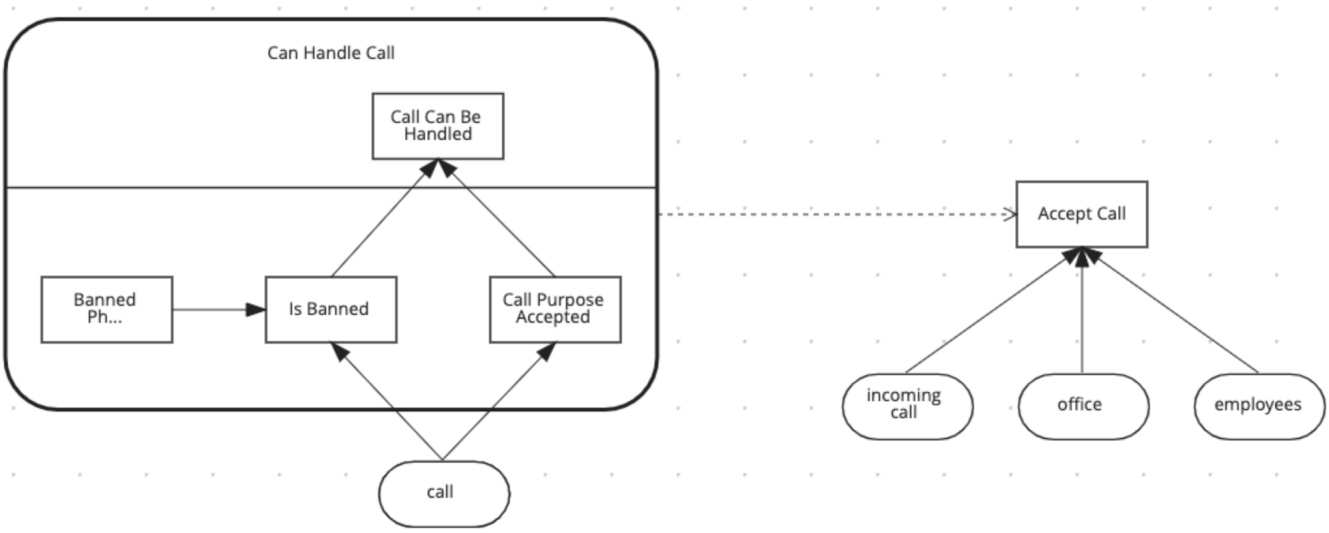
- Getting Started, Insurance Price calculation: Start by importing an existing module. Explore, deploy and test it using local development capabilities of Open Editions.



- Intermediate, Vacation Days: Author a model from scratch, use decision tables, work with different hit policies, different FEEL constructs and expressions. Finally, you will deploy it and test it, optionally running it on OpenShift.



- Advanced, Call Center: You will author a model from scratch, create data types, consume DMN decision services from within decision nodes, and more FEEL constructs and expressions. Finally, you will deploy and test it locally and optionally on OpenShift.



These are independent guided exercises and you don't need to implement the previous use case to implement the next one. If you are more comfortable with DMN, you can go to the more advanced labs immediately.

Before moving forward, get up to speed with what is DMN and explore the editor capabilities you'll be using.

8.2 Introduction to DMN

8.2.1 WHAT IS DMN

DMN, along with BPMN, is managed by the Object Management Group (OMG). Let's have a look at what OMG describes about the DMN standard, in their website:

> **OMG explanains what is DMN**
>
> "*DMN is a modeling language and notation for the precise specification of business decisions and business rules. DMN is easily readable by the different types of people involved in decision management. These include: business people who specify the rules and monitor their application; business analysts.*
>
> DMN is designed to work alongside BPMN and/or CMMN, providing a mechanism to model the decision-making associated with processes and cases. While BPMN, CMMN and DMN can be used independently, they were carefully designed to be complementary. Indeed, many organizations require a combination of process models for their prescriptive workflows, case models for their reactive activities, and decision models for their more complex, multi-criteria business rules. Those organizations will benefit from using the three standards in combination, selecting which one is most appropriate to each type of activity modeling. This is why BPMN, CMMN and DMN really constitute the “triple crown” of process improvement standards."_

IBM Business Automation Open Edition 9.0 brings a set of graphical tooling that allow you to author decisions using DMN and a lightweight engine that can execute these decisions. The engine and the authoring tooling set are decoupled and you can scale it independently.

8.2.2 TOOLING SET

With IBM Business Automation Open Edition 9.0 you can author decisions in multiple ways - and using the exact same editor across different environments:

- IBM Business Automation Manager Canvas brings a new experience for easily working with decisions and processes in IBM Business Automation Open Edition 9.0. This is a highly scalable and lightweight method for maintaining diagrams that the community has moved towards and which IBM has most recently embraced and been working hard on!
- Business Automation VSCode Extension
- A developer IDE (Visual Studio Code) extension that allows the visualization and editing of BPMN, DMN and Test Scenarios inside VSCode.
- If you are currently using IBM Business Automation Open Edition 8.0 and are utilizing things like KIE Server and Business Central, you can also build the DMN model within there. The preference for this lab is to focus on IBM Business Automation Open Edition 9.0, but this option is capable of being done. A core component of IBM Business Automation Open Edition 9.0 is intercompatability between versions and IBM's heavy emphasis on DMN is that the models produced for varying levels of the product are still compatible across releases. The walkthroughs are going to focus on IBM Business Automation Manager Canvas for the DMN labs.

Adding to the tools above, there are also other tools and knowledge sources you can leverage from the open source community. Listed below are you'll find resources developed in collaboration between IBM and Red Hat, for the community (not supported):

- DMN FEEL Handbook
- A handbook for the FEEL expression language from the DMN specification, as implemented by the Drools DMN open source engine.
- Learn DMN in 15 minutes
- A guided tour in a website through the elements of DMN
- Open Source Online Editors
- BPMN.new - A free online editor for business processes;
- DMN.new - A free online editor for decision models;
- PMML.new - A free online editor for scorecards;

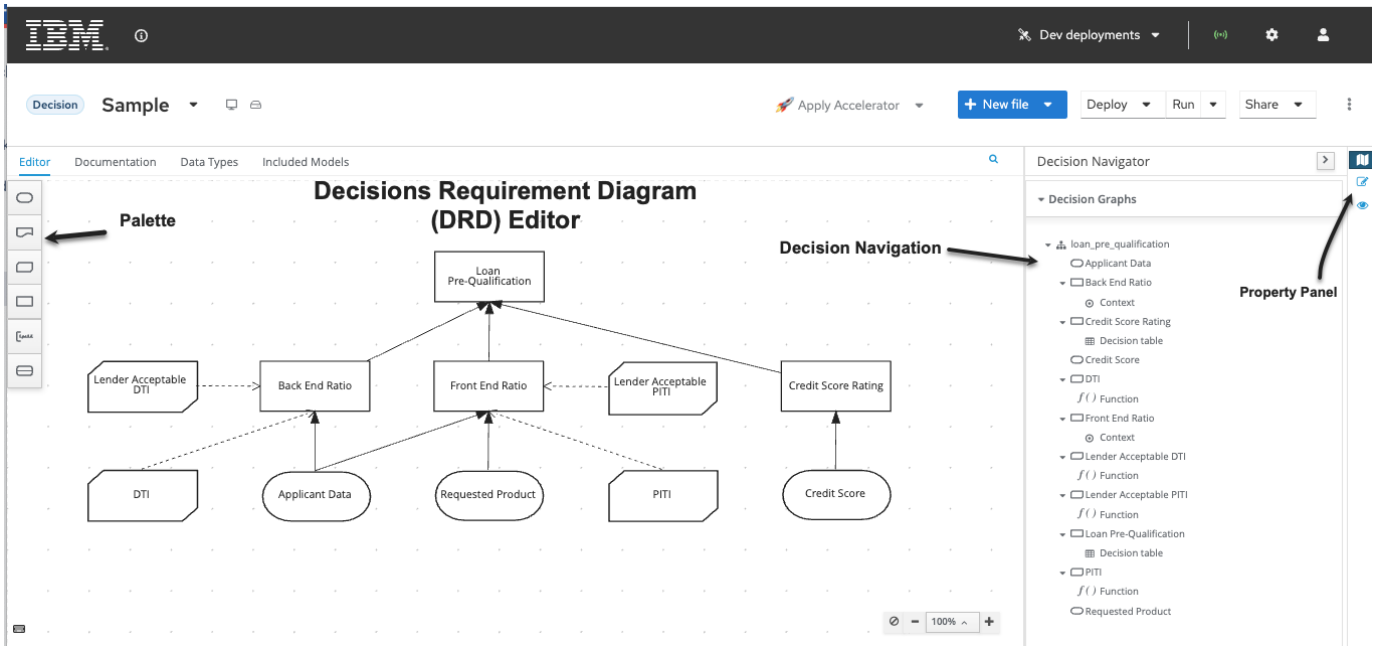
8.2.3 EXPLORING THE DECISIONS EDITOR

Both in Canvas and VSCode, you'll have the same components within the the DMN Editor. They consist of:

8.2.3.1 Editor Pane

From the Editor pane you can edit and view multiple areas including:

- **Decision Navigator**: shows the nodes used in the Decision Requirements Diagram (DRD, the diagram), and the decisions behind the nodes. Allows for quick navigation through the model.
- **Decision Requirements Diagram Editor**: the canvas in which the model can be created.
- **Palette**: Contains all the DMN constructs that can be used in a DRD, e.g. Input Node, Decision Node, etc.
- **Expression Editor**: Editor in which DMN boxed expressions, like decision tables and literal expressions, can be created.
- **Property Panel**: provides access to the properties of the model (name, namespace, etc), nodes, etc.



Editor Documentation Data Types Included Models

Back to loan_pre_qualification

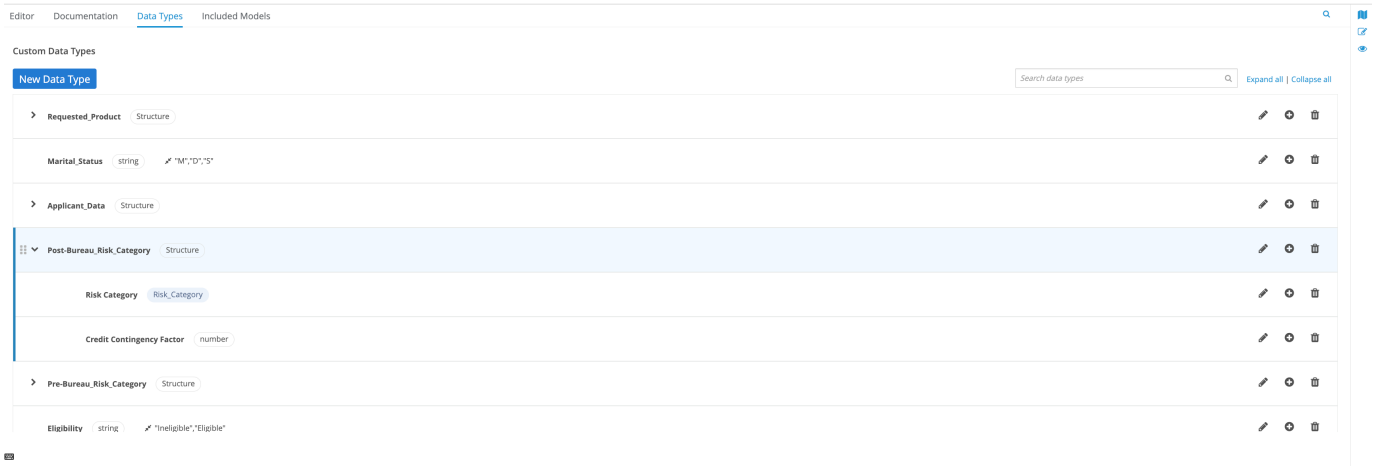
Credit Score Rating *(Decision table)*

Decision table

U	Credit Score.FICO *(number)*	Credit Score Rating *(Credit_Score_Rating)*	*Enter Text*
1	>= 750	"Excellent"	
2	[700..750)	"Good"	
3	[650..700)	"Fair"	
4	[600..650)	"Poor"	
5	< 600	"Bad"	

8.2.3.2 Data Types Pane

Within the Data Types pane you can define data types that are used for your decision, including complex types.



Last update: 2023-12-06

3.4.2 9. Getting Started with Decision Model and Notation

This lab introduces you to the deployment of an existing Decision Model and Notation (DMN) and validation of it's decisions.

- Explore an existing DMN file created using IBM Business Automation Manager Canvas
- Test the DMN using IBM Business Automation Manager Canvas's Extended Services
- Deploy the existing DMN project to OpenShift
- Test the deployed DMN

9.1 Examine Existing DMN Diagram

The following example describes an insurance price calculator based on an applicant’s age and accident history. This is a simple decision process based on the following decision table:

Insurance Total Price *(Decision Table)*

U	Age *(number)*	had previous incidents *(boolean)*	Insurance Total Price *(number)*	*Enter Text*
1	>25	false	1000	
2	>25	true	1250	
3	[18..25]	false	2000	
4	[18..25]	true	3000	

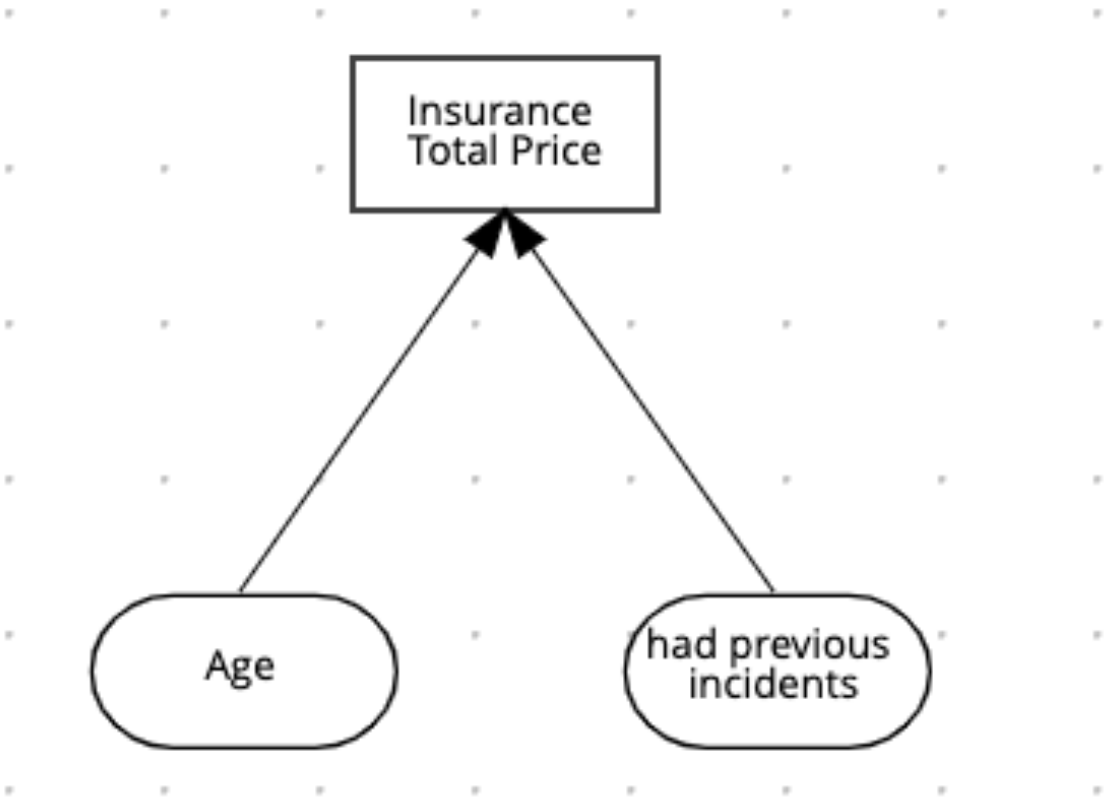
DMN Decision Table

The decision table was designed with using a DMN editor, this could be done in IBM Business Automation Manager Canvas, VSCode, Business Central or realistically any DMN compatible design tool. With how IBM Business Automation Open Edition 9.0 utilizes the DMN specification, we're easily able to import this diagram seamlessly in the tool that makes the most sense for our end user.

Notice that:

- The DMN decision table includes a *hit policy*, *inputs*, and *outputs*.
- Unlike the classic Drools Rules Language (DRL) based decision tables that can be created in Business Central, input and output names in DMN decision tables accept spaces. This allows for more clarity in your decisions aligning more to a business acumen.
- The conditions for the `Age` input is defined using the Friendly Enough Expression Language (FEEL).

The decision can also be represented by the following decision requirements diagram:



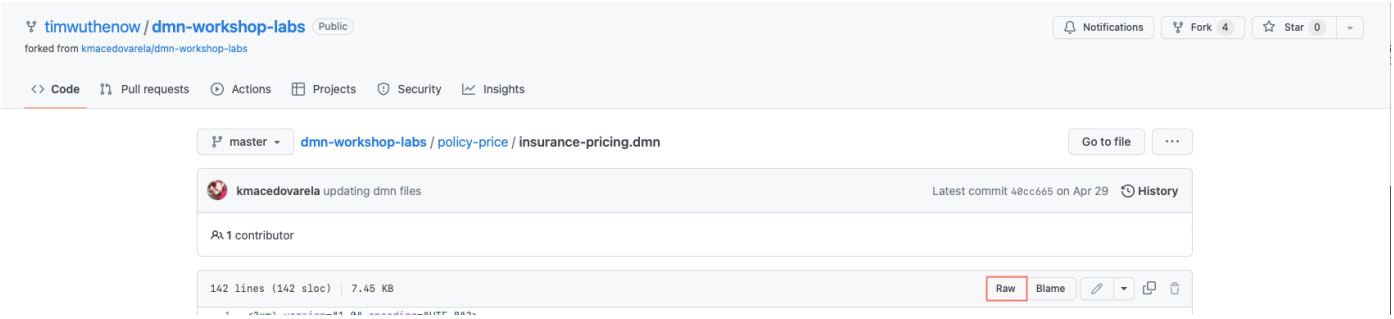
In this decision requirements diagram, you may note that the applicant’s age and accident history are found in squared ovals, these indicate that these are the required inputs for the decision table "Insurance Total Price".

You can find the DMN component in the DMN GitHub repository.

9.2 Import the DMN File into IBM Business Automation Manager Canvas

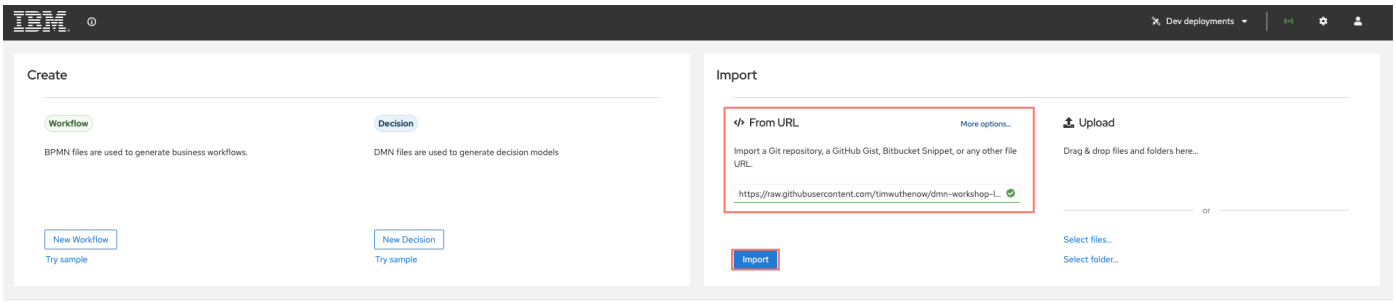
In this section, you can import the GitHub repository to IBM Business Automation Manager Canvas directly from the file or clone the repository, if you do the direct file.

1. Open IBM Business Automation Manager Canvas by navigating to your instance of it (within the lab environments these are at http://localhost:9090/#. From here, you will copy the URL to the gist of the *Insurance Pricing* DMN located at this repository location.

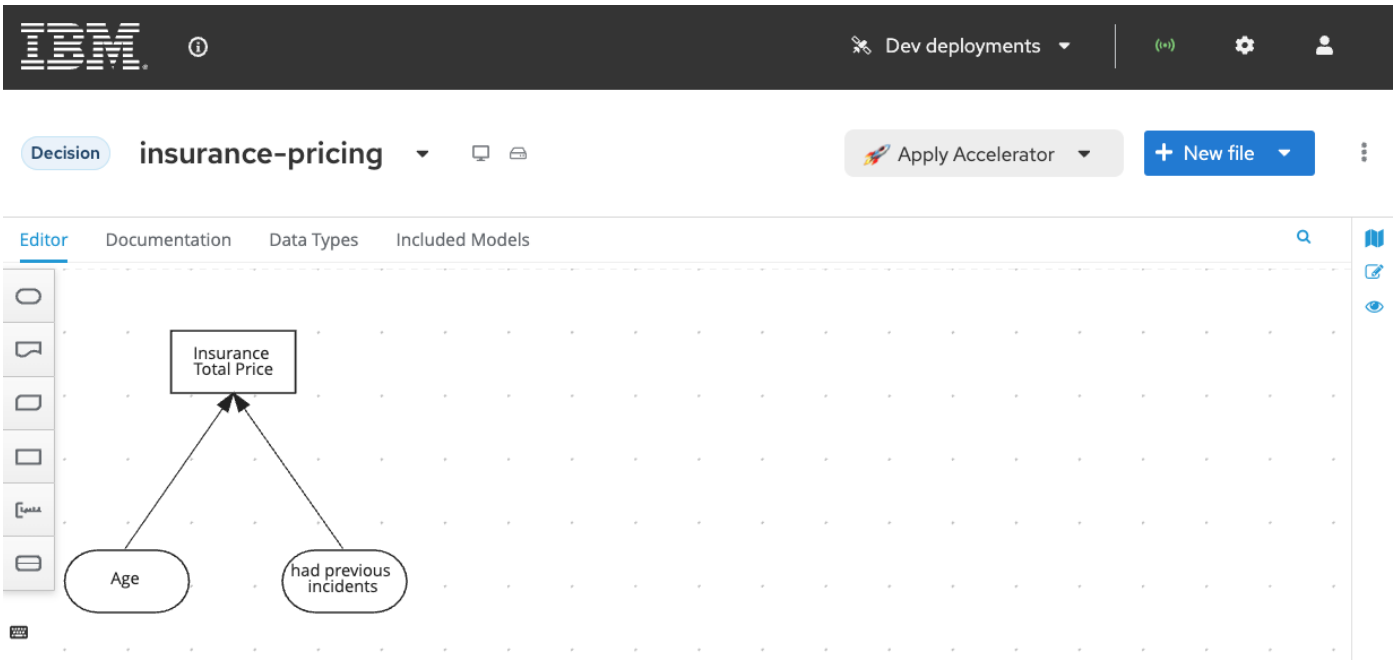



```
https://raw.githubusercontent.com/timwuthenow/dmn-workshop-labs/master/policy-price/insurance-pricing.dmn
```

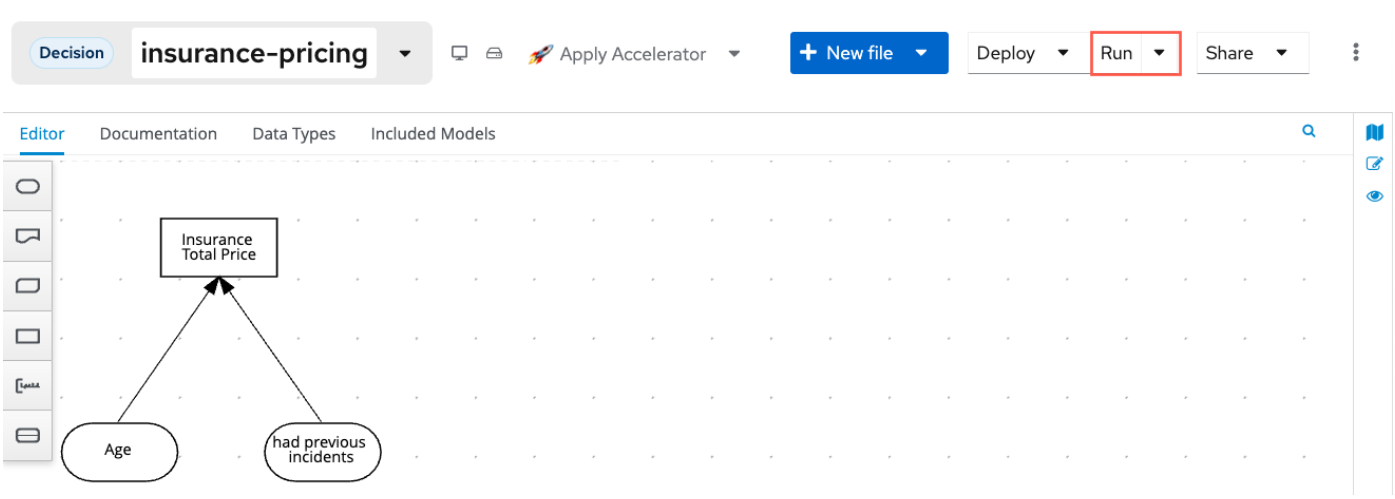
2. With this link navigate to the IBM Business Automation Manager Canvas and under **Import From URL** paste the link from the previous step and click **Import**.



3. When the project is imported, you will see the DMN Editor with the **insurance-pricing** DMN model displayed. If you instead of pointing to a particular DMN, pointed to an entire project, any DMN/BPMN models associated with it would be able to viewed/ edited within IBM Business Automation Manager Canvas.

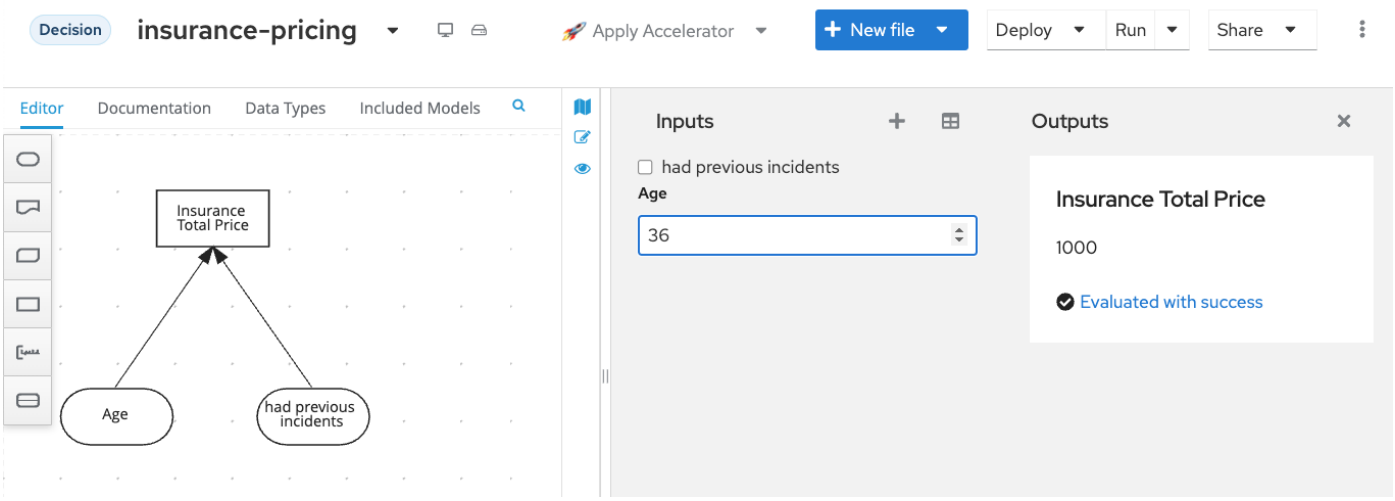


4. You can then click the **Run** button to get a local copy of this DMN running within the browser session itself. The best part about the DMN specification is that it is both a modeling specification, but also has an execution specification which allows for it to be as portable as it is.



5. This will have a section of the browser turn into a form and you can run the model right there. Modifying the checkbox based on the boolean of `had previous incidents` and set an `Age` based on the data type being a number.

> **Info**
>
> Within this form you may see that if you just put an age in that the result returns *(null)*. This is because the way that a typical form works when generated is that a non-checked box assumes *null*, which the rules by default do not check for null. To quickly get around this from the form you can check and uncheck the checkbox and move forward with your testing. This initializes the value, this is because the form when it sends it for initial execution has the boolean value as a null. How would you address this in the rules? *HINT*: since we're checking if the number of incidents has a checkbox or not, you can write it as `? = false or ? = null`. Why the `?`? This is a way that DMN through the Friendly Enough Expression Language uses the column header object that you're testing to simplify checking a variable against a condition!



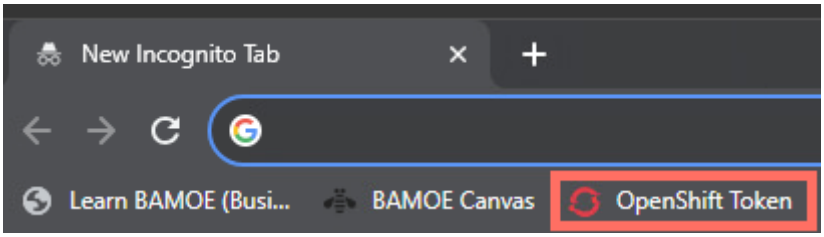
6. This service can be deployed as a sample Quarkus service to OpenShift right away as a sample service that you can invoke immediately. In the next section we will show how this is done from a development point of view.

9.3 Deploying this sample service to OpenShift

If you are using the provided lab environment for TechXchange, the environment itself provides access to a shared cluster for all attendees to login to OpenShift there is a bookmark in Chrome called `OpenShift Token` that will take you to a login page to create an OpenShift login token. Every user for the TechXchange environment has a created namespace to the student id that was given

to your workstation at the start of the lab (student01 through student20 with the namespace to that username with `-namespace`). The password for all of these instances is `Passw0rd`.

1. To create the OpenShift token to connect to the console at the bookmarked link **OpenShift Token** from Chrome.



2. From here you will login to OpenShift using your username and password created for the lab which is of the format `student01` through `student20` with password `Passw0rd`. If you get security issues with the link, accept them using the *Advanced* option in Chrome to proceed to the login screen.

9.4 Conclusion

Congratulations, you've finished the first part of the DMN exercise. Next, you will have an intermediate level exercise that will guide you through the implementation, deployment and testing of the Vacation Days use case.

Last update: 2023-12-06

3.4.3 10. Vacation Days - Use case and project creation

In this lab you'll try out the combination of DMN decision tables with literal expressions. You will also explore a number of different FEEL constructs and expressions like, for example, ranges. Finally, you'll learn how to deploy the solution as a sample to OpenShift.

10.1 Goal

- Implement a DMN model using the IBM Business Automation Manager Canvas DMN editor
- Deploy the existing DMN project to OpenShift
- Consume the DMN project using the REST API

10.2 Problem Statement

In this lab we will create a decision service that determines the number of vacation days assigned to a given employee. The number of vacation days depends on age and years of service.

- Every employee receives at least 22 days.
- Additional days are provided according to the following criteria which will be broken into separate decision nodes:

a. Only employees younger than 18 or at least 60 years, will receive 5 days of vacation or employees with at least 30 years of service will receive an 7 extra days;

b. Employees with at least 30 years of service get 3 more days and also employees of age 60 or more, receive 4 extra days, on top of possible additional days already given;

c. If an employee has at least 15 but less than 30 years of service, 3 extra days are given. These 3 days are also provided for employees of age 45 or more. These 2 extra days can not be combined with the 5 extra days.

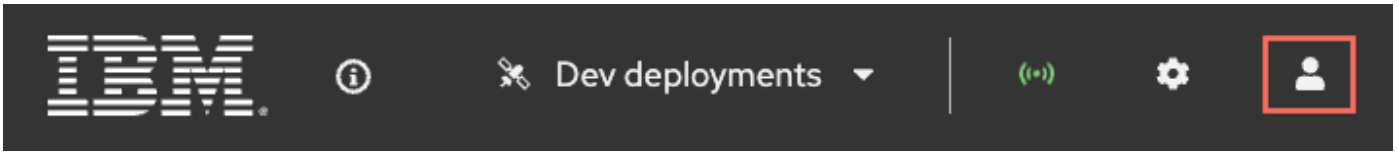
10.3 Link IBM Business Automation Manager Canvas to your GitHub account and create a project in GitHub using Extended Services

When using IBM Business Automation Manager Canvas you can start from the decision model creation and work top-down to deliver your decision model. This is a feature that will enable you to create the decision model and publish a sample project to your Git provider. From here the project can be deployed in your traditional means or you can also utilize a sample service that IBM Business Automation Manager Canvas can create if you desire for *testing* purposes. To do this, you need to make sure your connection to GitHub is active with the token and from there you can jump right in!

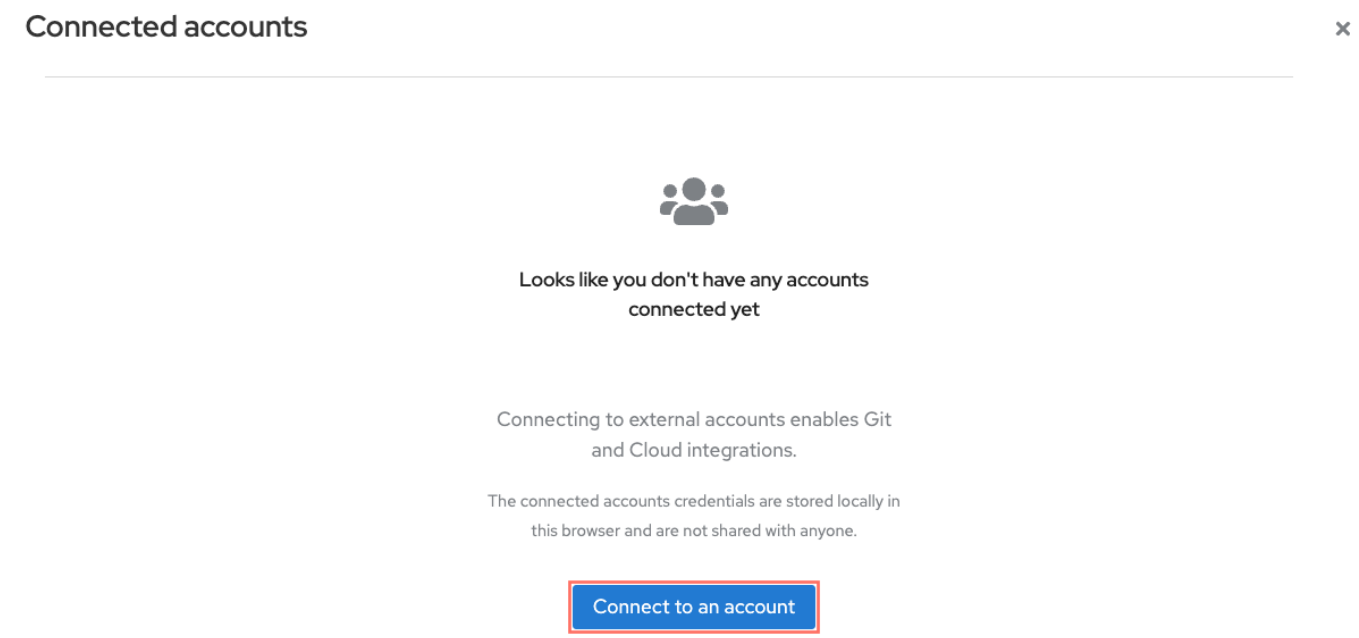
10.3.1 LINK GITHUB TO YOUR IBM BUSINESS AUTOMATION MANAGER CANVAS

In this section we will link your GitHub account to the IBM Business Automation Manager Canvas so we can easily synchronize changes in DMN with GitHub and our tooling, in this case IBM Business Automation Manager Canvas.

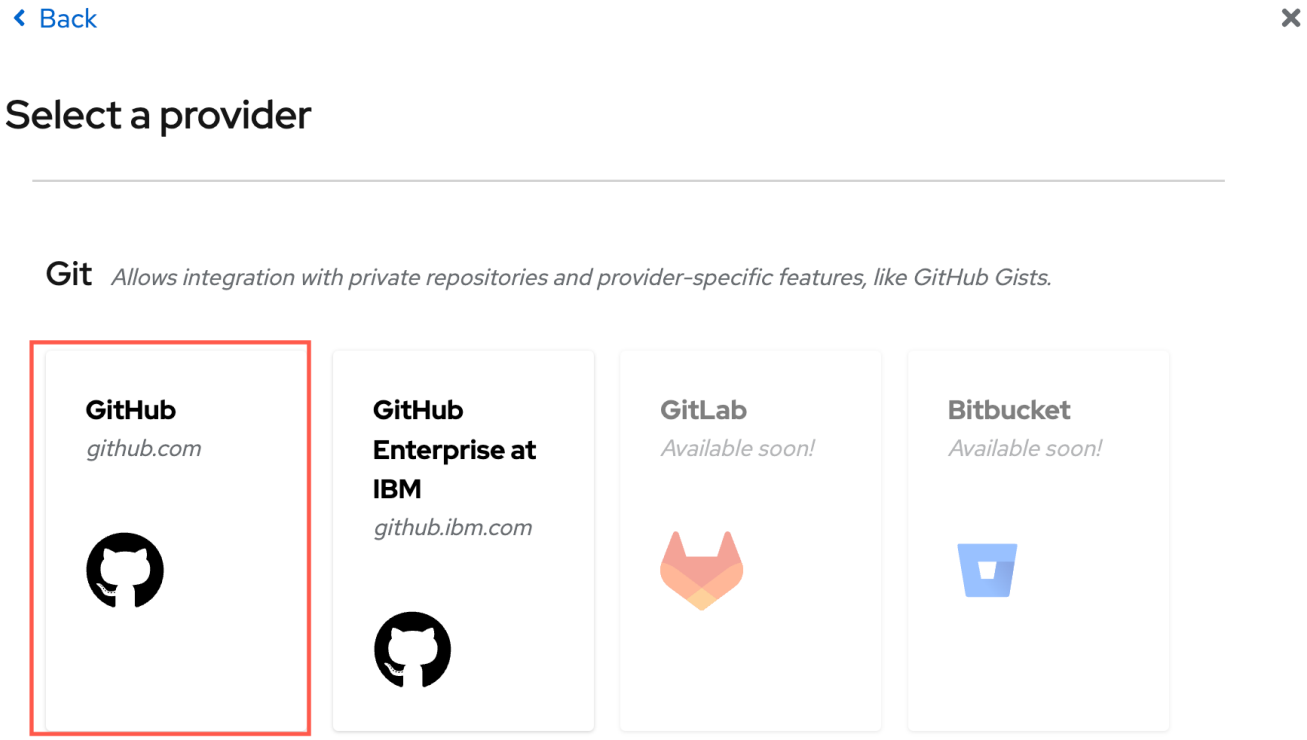
1. First click the User icon to connect your public GitHub account to the IBM Business Automation Manager Canvas.

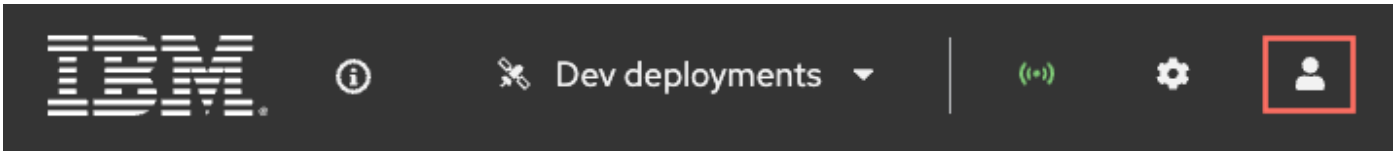


2. Click the **Connect to an account** button to add a new Git provider

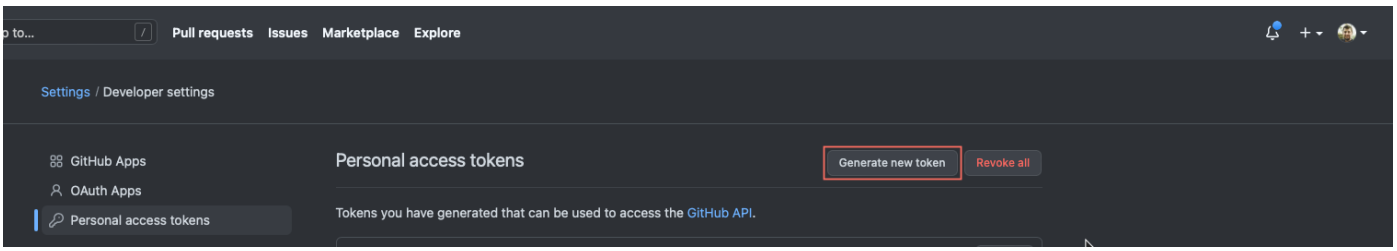


3. Select the card for GitHub



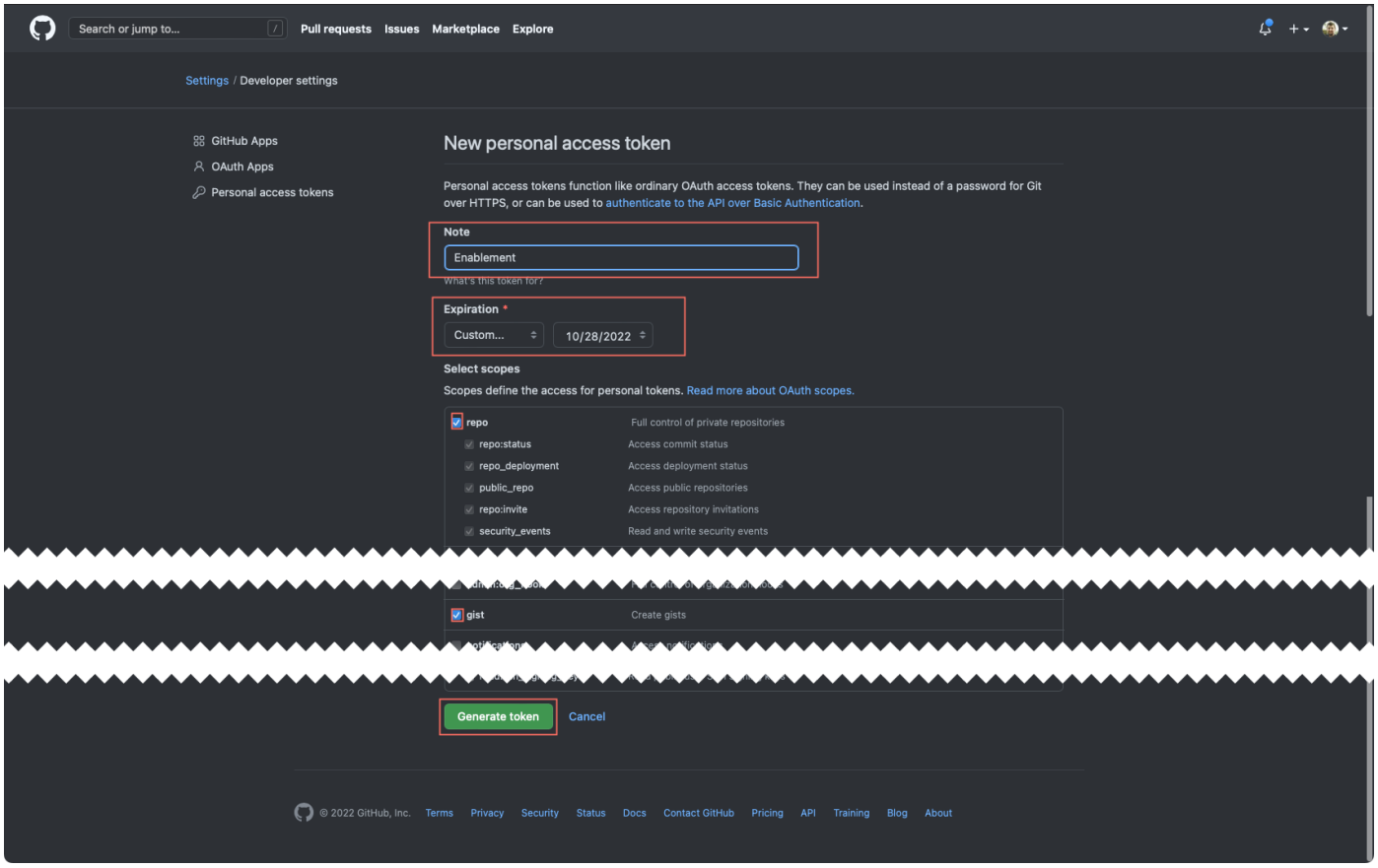


4. Click *Generate new token* to create a new token that will be used by IBM Business Automation Manager Canvas

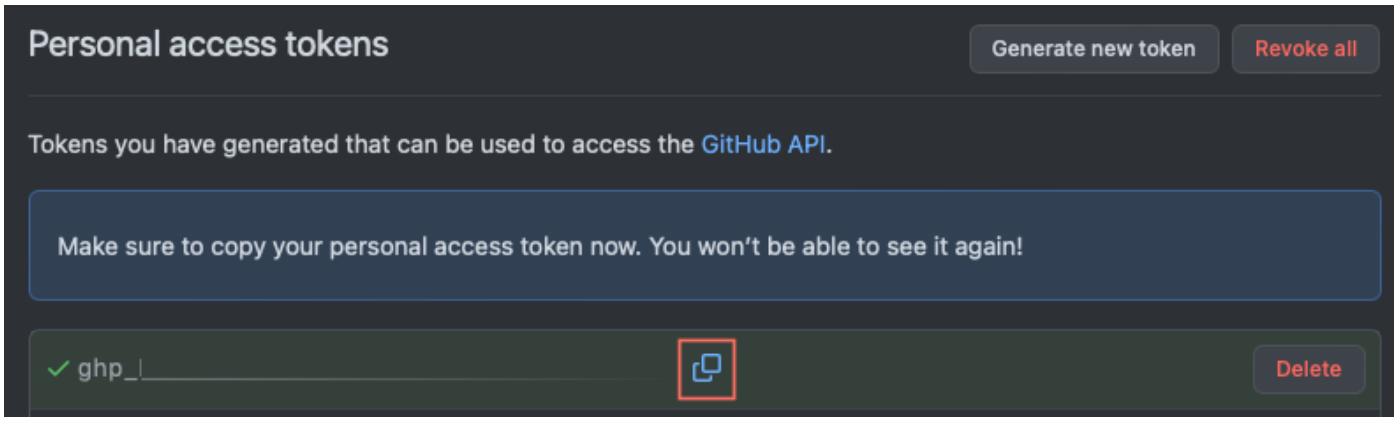


5. You can use similar properties to the token created below in the screenshot, but the main 2 to have right now are *repo* and *gist* - the others can be beneficial if you reuse this token for other purposes too, but are not required nor needed. You can change the date to never expiring or be as short as you want. Once the token is generated though, that is the only time you will see the actual token value.

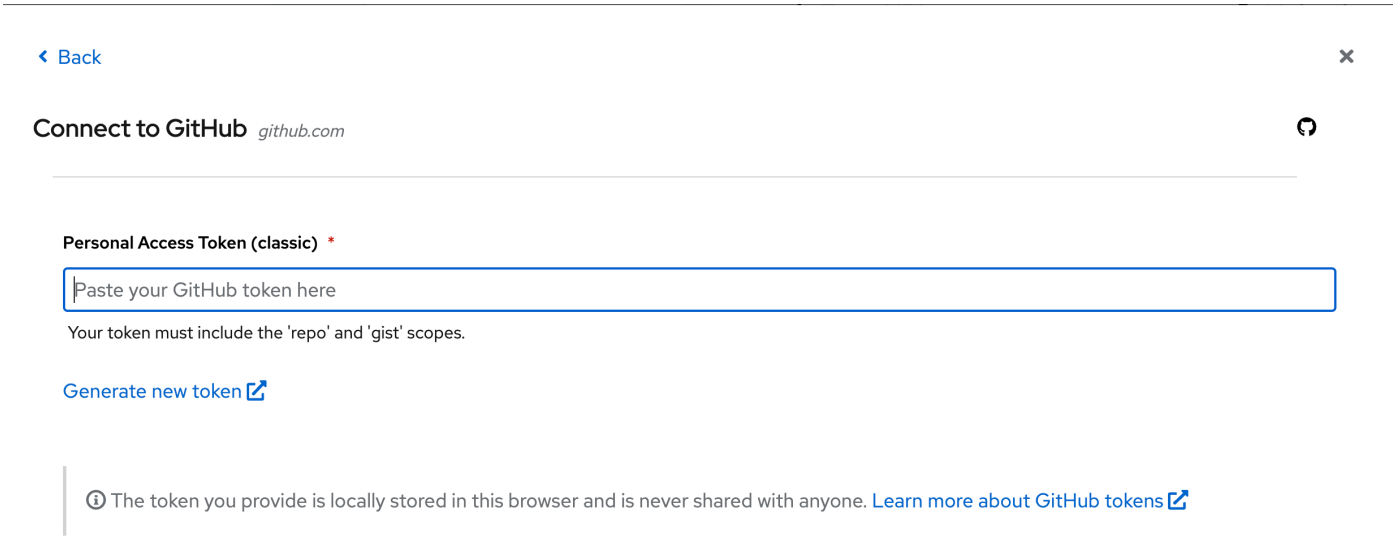
- *Name*: Name your token a unique name from any previously created
- *Expiration*: This can either be a set time period, up to 1 year or never expiring
- The checkboxes you need are **repo** and **gist** to get the full benefit of IBM Business Automation Manager Canvas



6. Use the copy button that's created with the Token to use in IBM Business Automation Manager Canvas.



7. Return to IBM Business Automation Manager Canvas and insert the Token into the wizard.



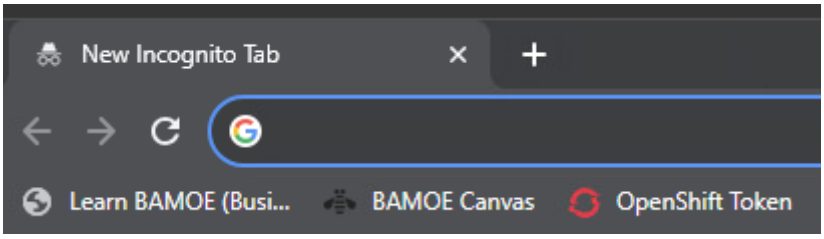
8. When your token is pasted, the IBM Business Automation Manager Canvas will return a similar screen to below towards your GitHub account signifying you've connected, your GitHub user ID and some extra details.

10.3.2 CREATE A DMN MODEL AND CREATE A PROJECT IN IBM BUSINESS AUTOMATION MANAGER CANVAS

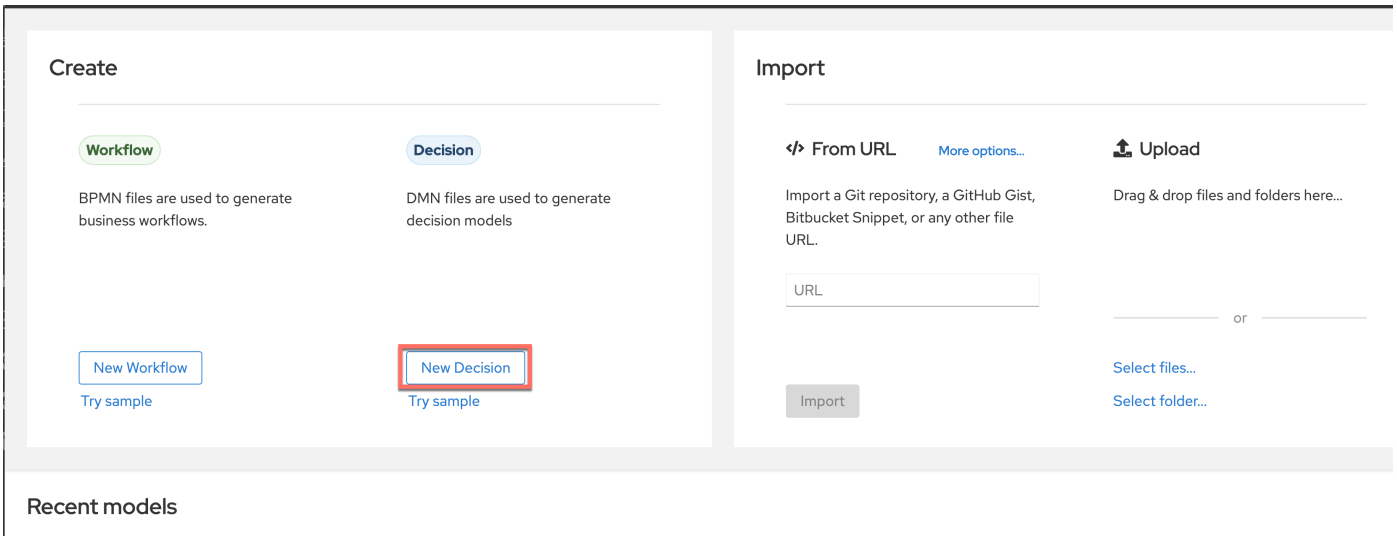
Now that our account is linked, let's go ahead and create a new DMN model and then later produce a project for it that will reside in our GitHub repositories. IBM Business Automation Manager Canvas provides an excellent way to both *push* and *pull* from your GitHub repositories. This methodology provides a true canvas over your process and decision models that sits on top of your artifact repositories as a means of seeing/creating/editing some of your most important assets for process and decision services. From IBM Business Automation Manager Canvas, you can create and edit various types of open-standards models in BPMN, DMN and PMML using the editors here. The editors are based on the standards, so if your model follows the standards, it will make a best effort representation of them to be able to edit. In theory a different DMN model written for another DMN

platform would be editable if it follows the specification. In this lab you will see how we can use these editors to produce a model and a project that's ready to be deployable in OpenShift.

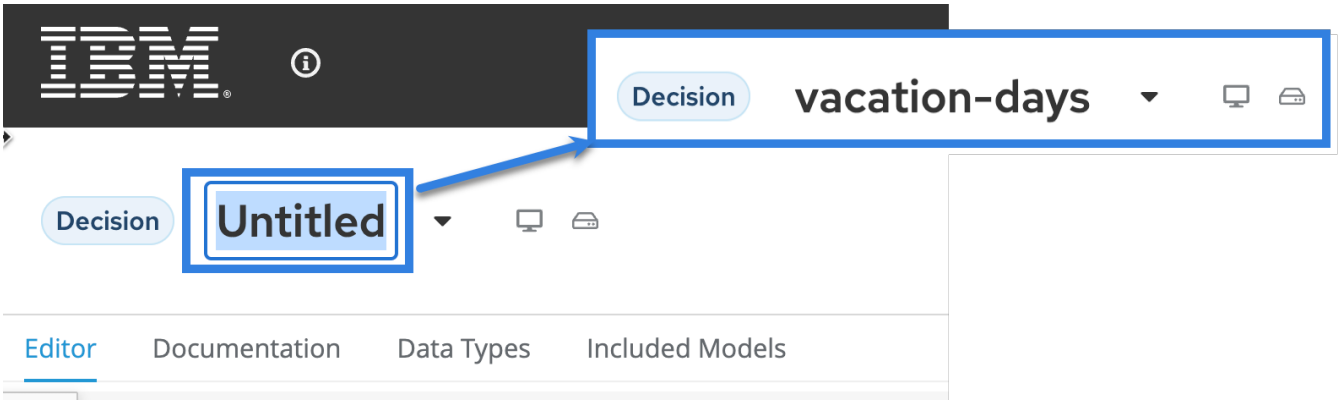
1. Navigate to http://localhost:9090/# and we will start creating a DMN model for a Vacation Days Decision. This will provide some of the basics of a DMN decision and start getting you acquainted to IBM Business Automation Manager Canvas and DMN in general. This can either be done from the bookmark from Chrome on the desktop or by navigating to https://localhost:9090/ on the provided image.



2. From the IBM Business Automation Manager Canvas landing page, you can create and edit various types of open-standards models in BPMN, DMN and PMML using the editors here. We will be creating a DMN model for this lab, so to do this, you can click **New Decision** to create a new DMN model.



3. You will now have an empty canvas and can start working on your DMN model for designing the number of vacation days decision. Change the name at the top of the model from `Untitled` to `vacation-days` or whatever you want to call it.



4. In the next section we will start to create the decision.

Last update: 2023-12-06

3.4.4 11. Vacation Days - Authoring Decisions

Let's get working on the decision model! When writing decisions with IBM Business Automation Manager Canvas, with DMN, we are able to define, model and create our decision all in one editor.

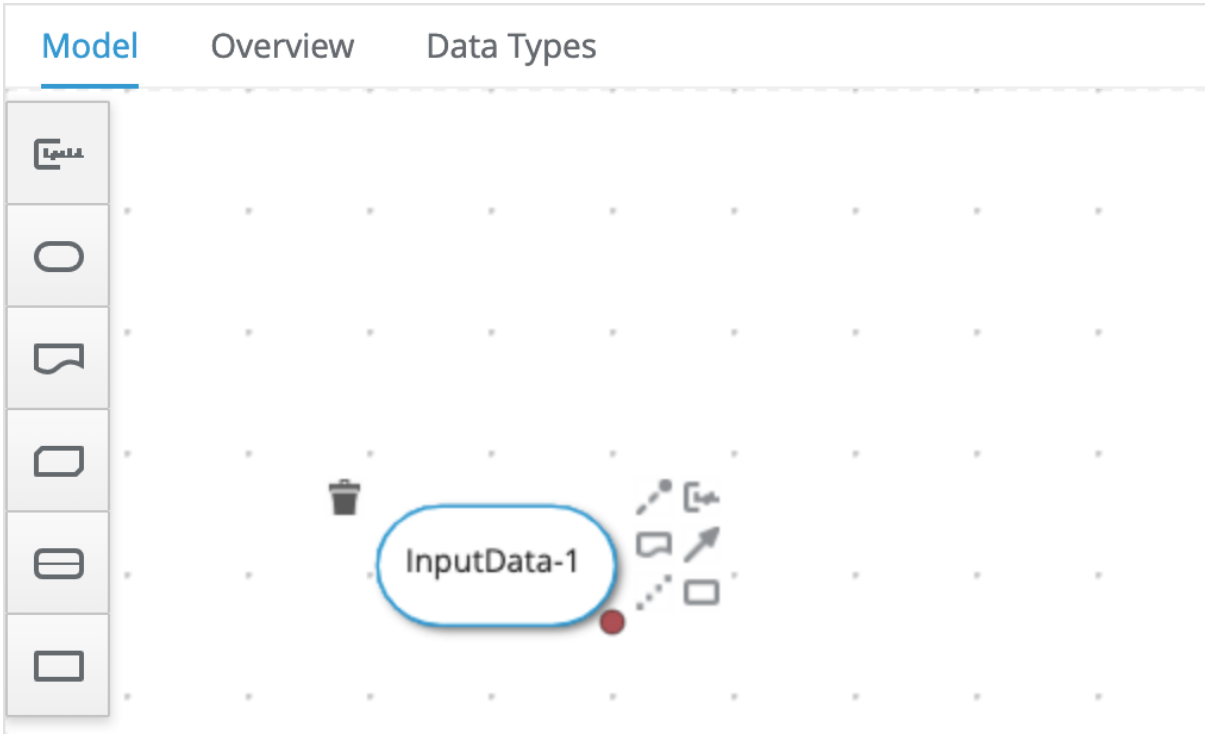
11.1 Input Nodes

The problem statement describes a number of different inputs to our decision:

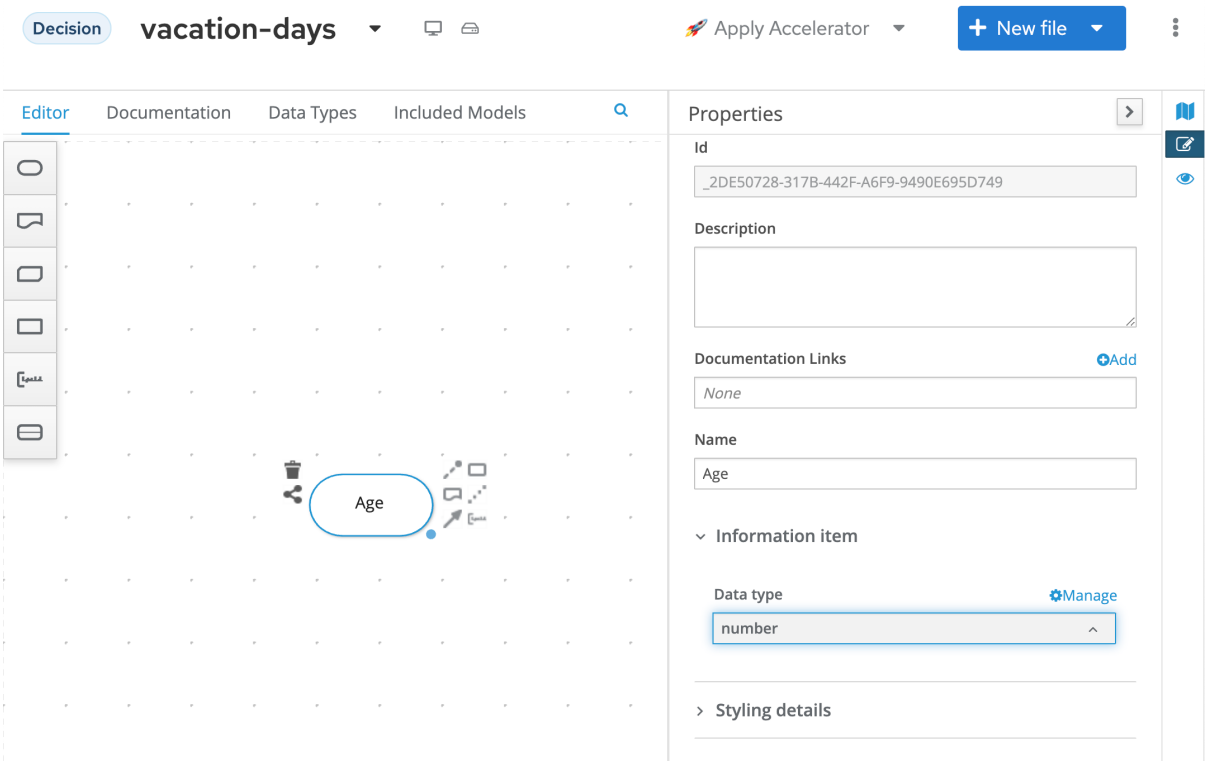
- **Age** of the employee
- **Years of Service** of the employee

Therefore, we should create two input nodes, one for each input:

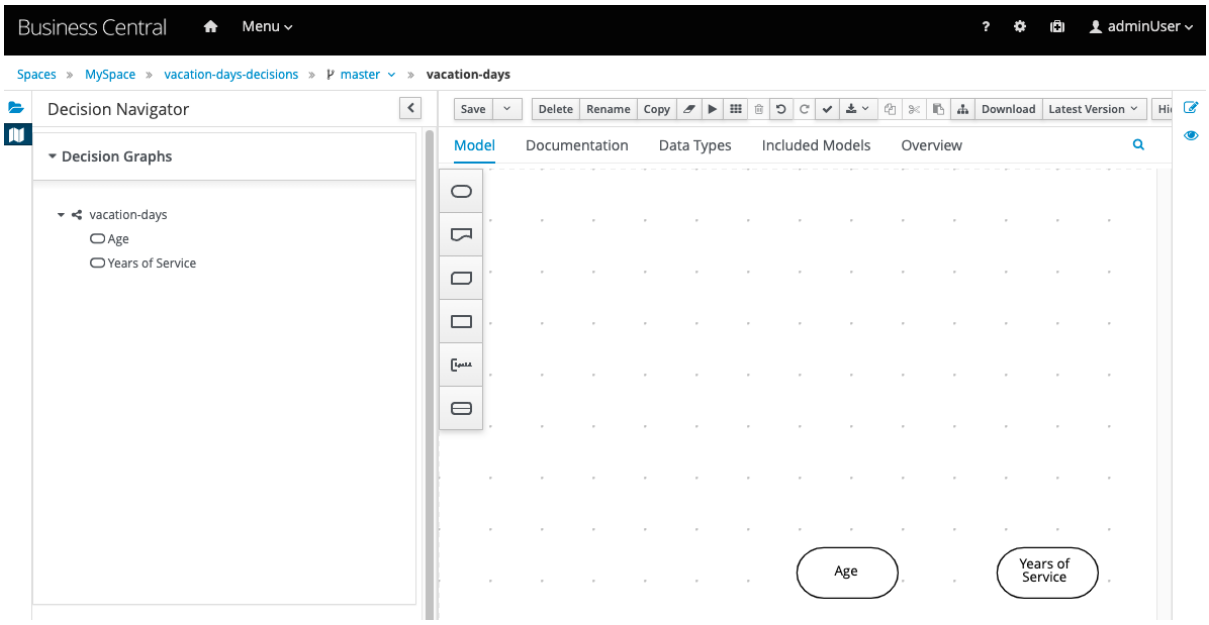
1. Add an **Input** node to the diagram by clicking on the **Input** node icon and placing it in the DRD.



2. Double-click on the node to set the name. We will name this node `Age`.
3. With the `Age` node selected, open the property panel. Set the **data type** to `number`.



4. In the same way, create an **Input** node for `Years of Service`. This node should also have its **data type** set to `number`.

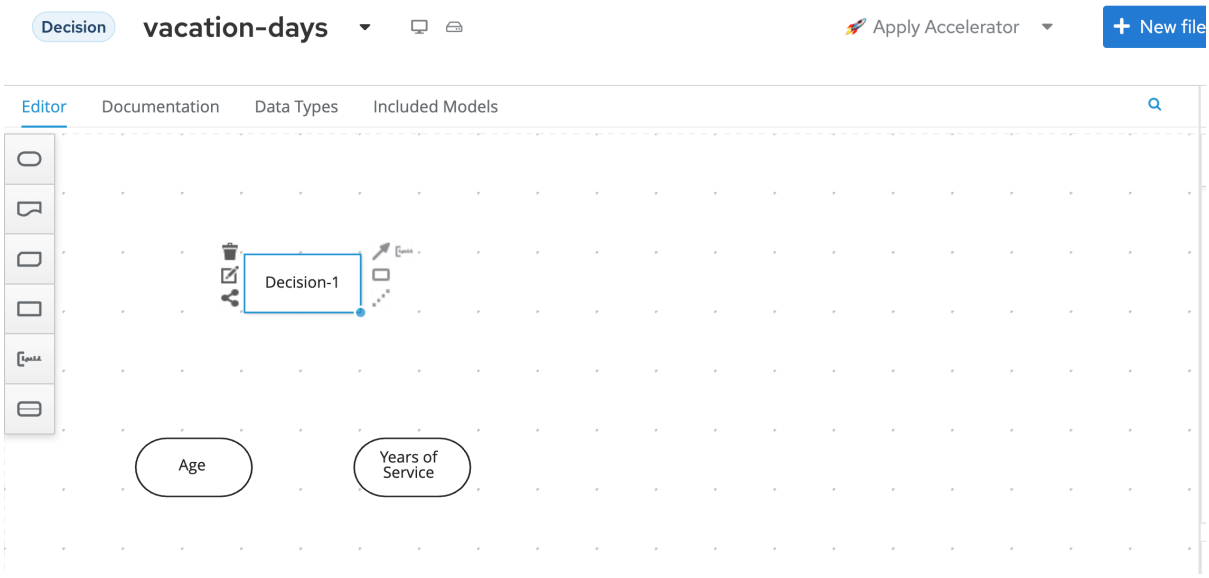


5. The model is constantly saved in browser storage, so you don't have to save it constantly.

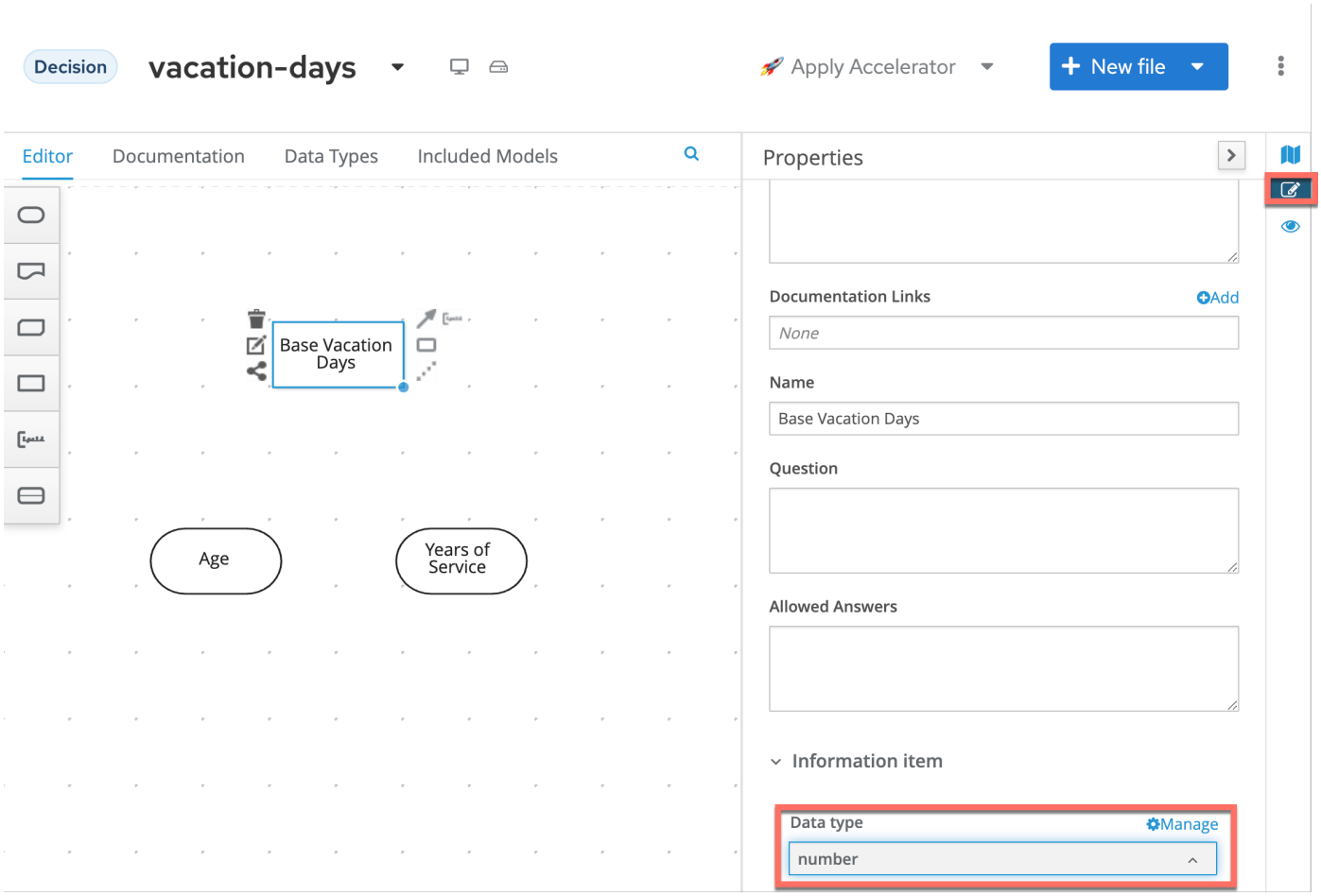
11.2 Constants

The problem statement describes that every employee receives at least 22 days. So, if no other decisions apply, an employee receives 22 days. This is can be seen as a constant input value into our decision model. In DMN we can model such constant inputs with a **Decision** node with a **Literal** boxed expression that defines the constant value:

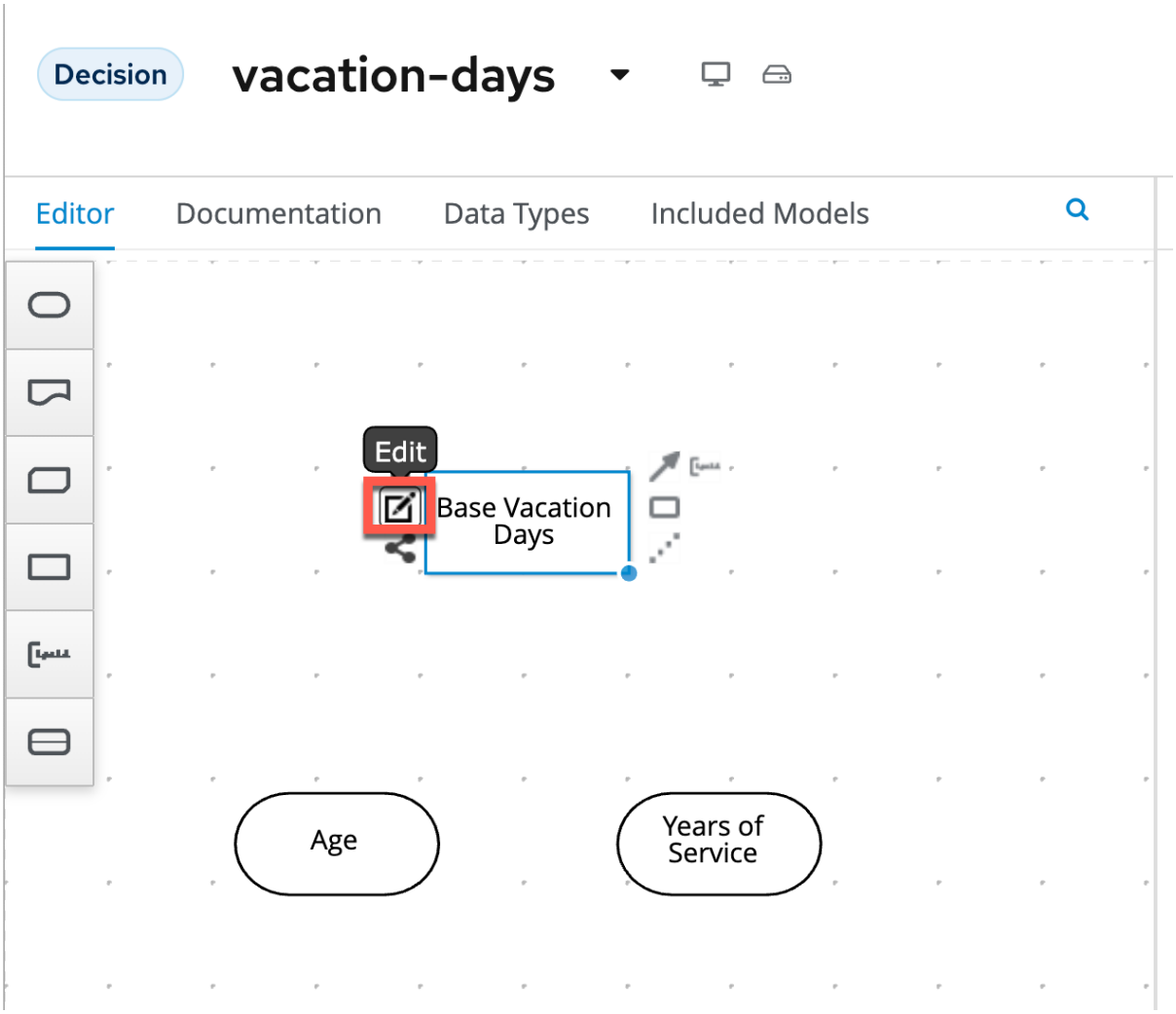
1. Add a **Decision** node to the DRD



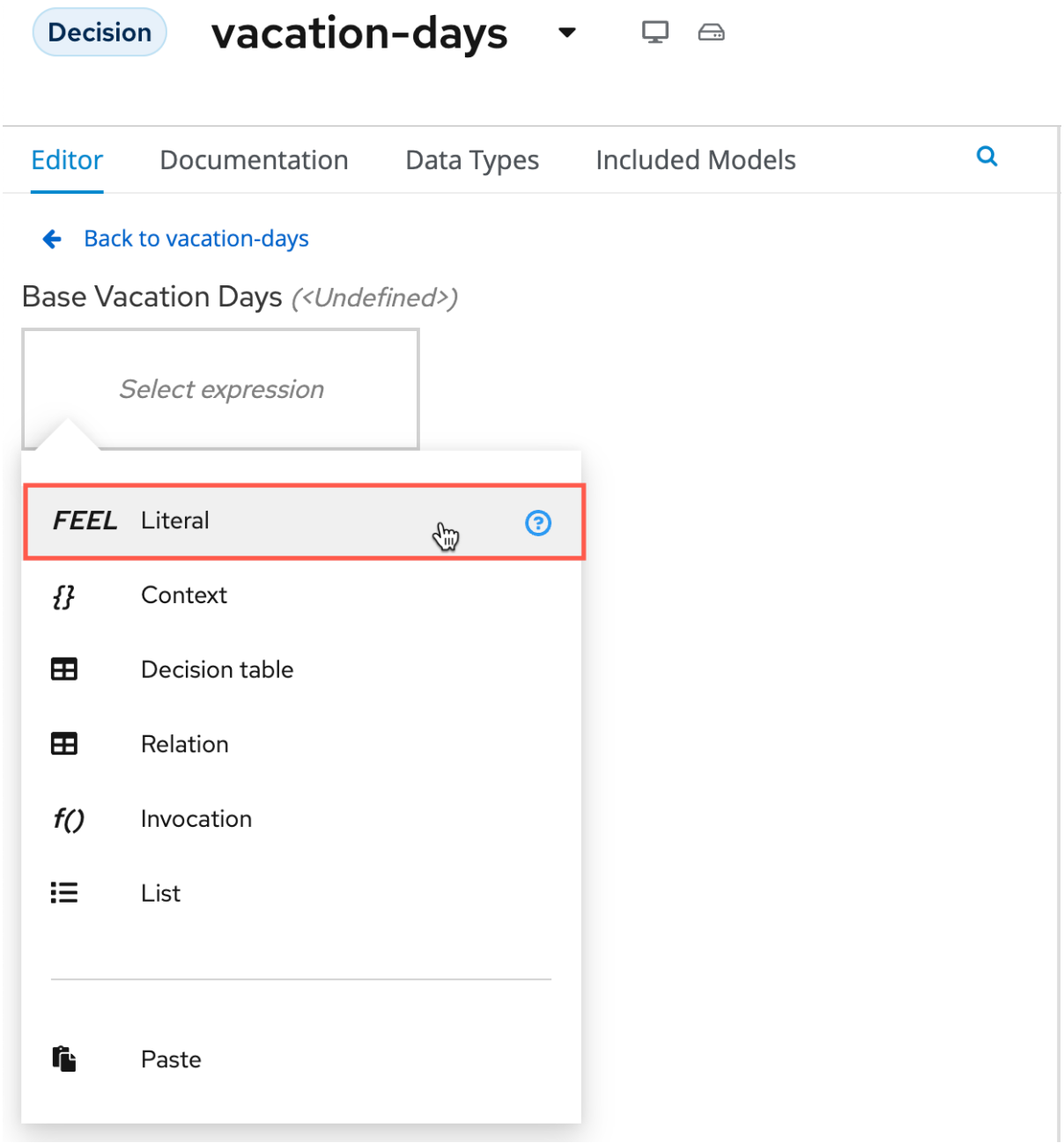
2. Give the node the name `Base Vacation Days`.
3. Click on the node to select it and open the property panel. Set the node's **data type** to `number`.



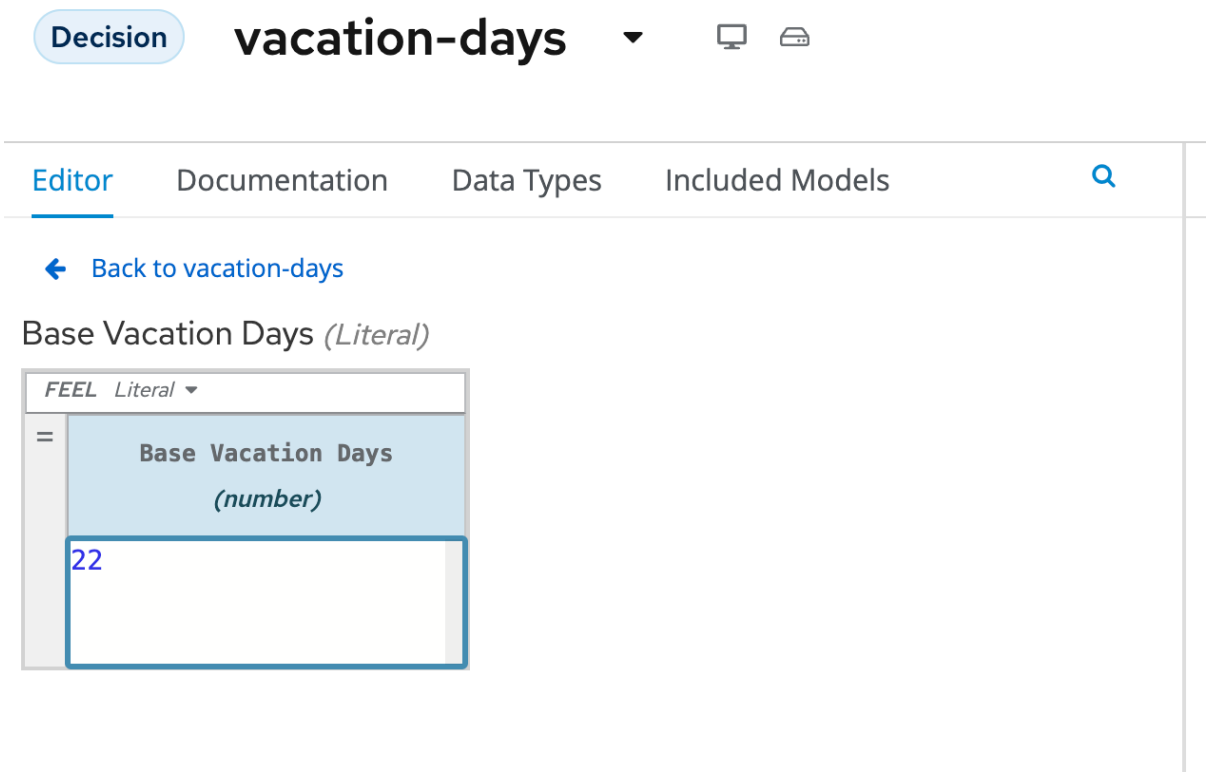
4. Click on the node and click on the **Edit** icon to open the expression editor.



5. In the expression editor, click on the box that says **Select expression** and select **Literal expression**.



6. Simply set the **Literal Expression** to `22`, the number of base vacation days defined in the problem statement. When completed press the link to go **Back to vacation-days** to return to the main DMN diagram.



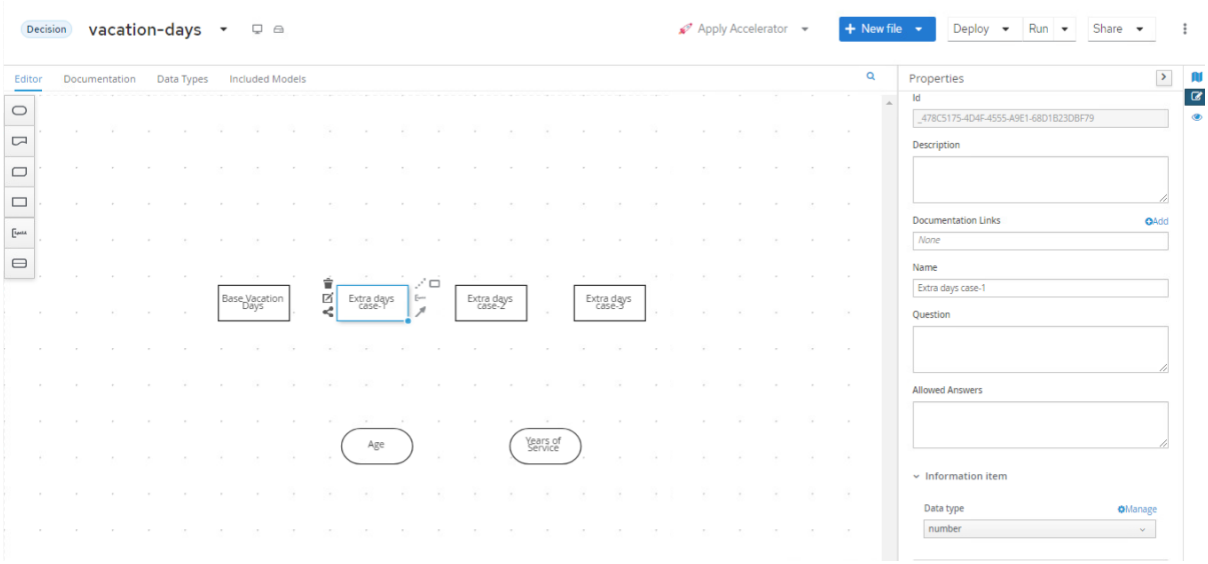
11.3 Decisions

The problem statement defines 3 decisions which can cause extra days to be given to employees based on various criteria. Let's simply call these decision:

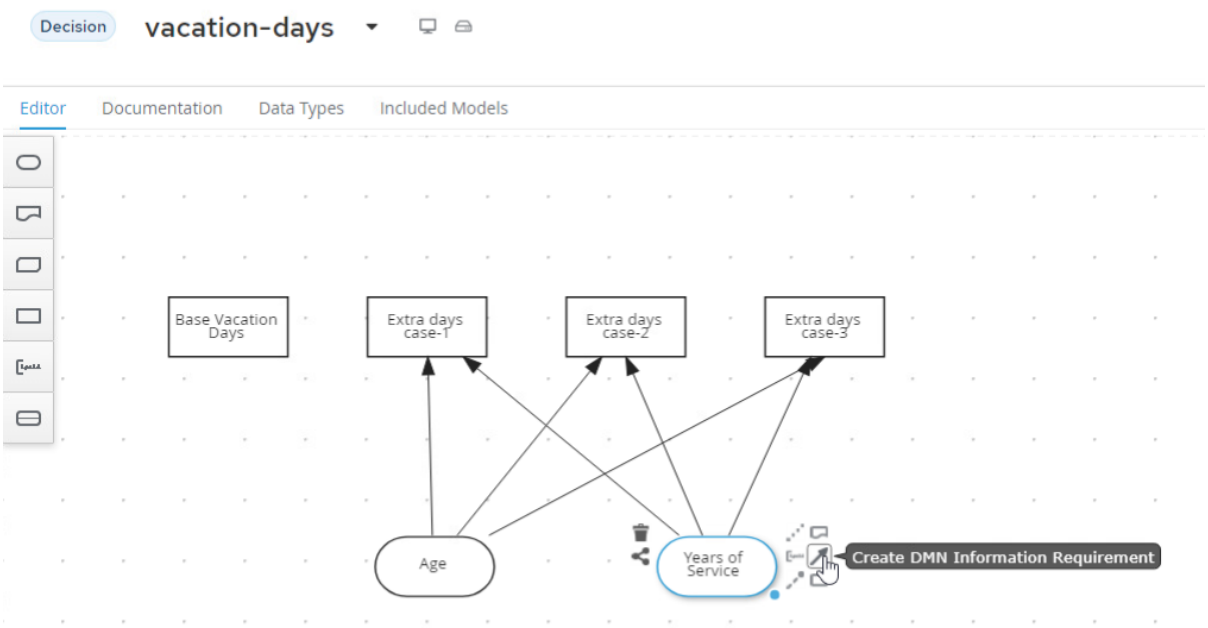
- Extra days case 1
- Extra days case 2
- Extra days case 3

Although these decisions could be implemented in a single decision node, we've decided, in order to improve maintainability of the solution and visibility of the solution, to define these decisions in 3 separate decision nodes.

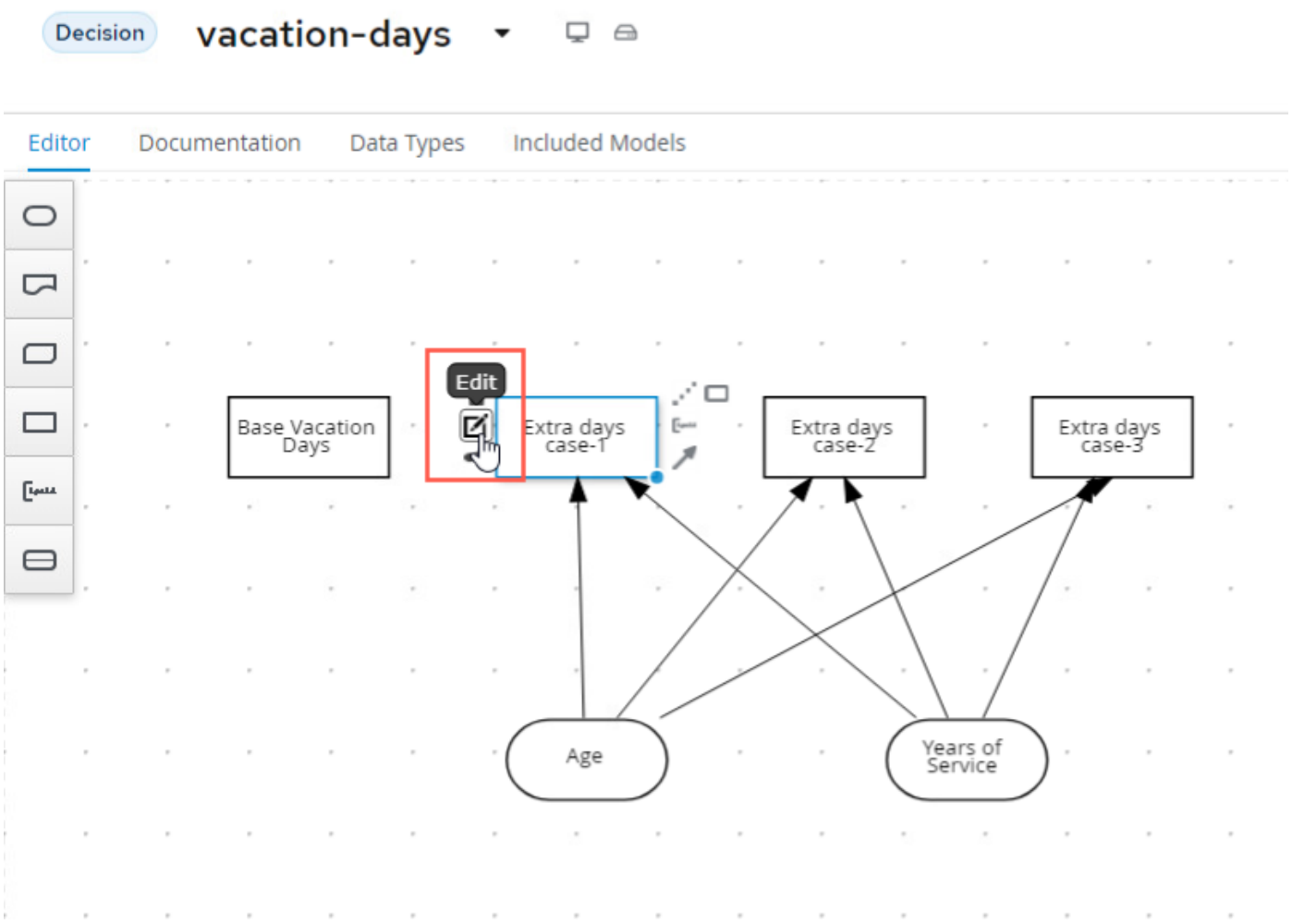
1. In your DRD, create 3 decision nodes with these given names. Set their **data types** to `number`. You can start setting one of the Decision nodes if you like as **Extra days case** with the `number` type and use the keyboard short cut with the node highlighted to copy using *Control + C* or *Command + C* then using *Control + V* or *Command + V* to copy and paste the same node two times. This will take the underlying data from the node and use it to craft your extra nodes. In my case this would produce **Extra days case**, **Extra days case-1** and **Extra days case-2** complete with the `number` data type already selected. You can do it however you feel most comfortable.



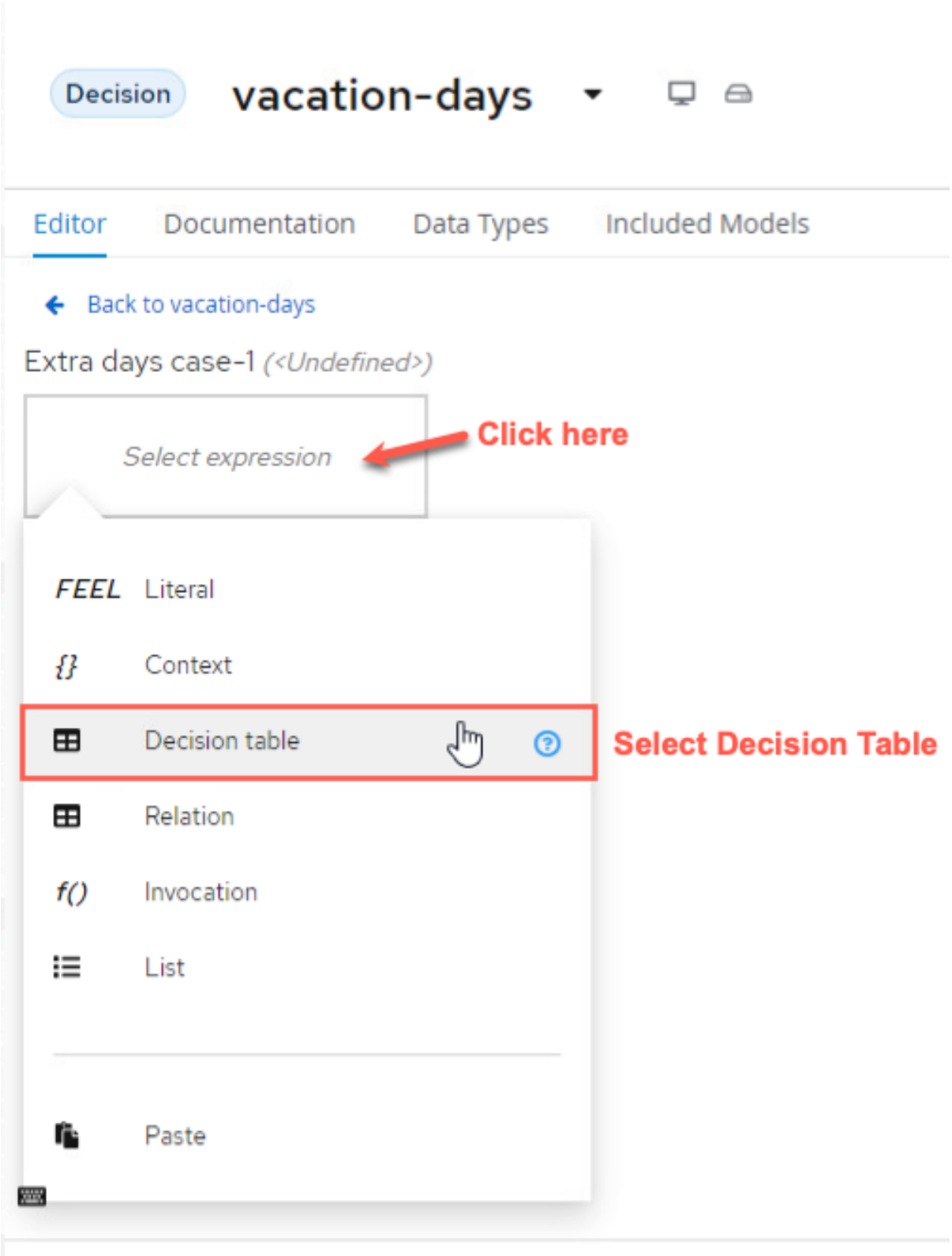
2. We need to attach both input nodes, **Age** and **Years of Service** to all 3 decision nodes. We can do this by clicking on an Input node, clicking on its arrow icon, and attaching the arrow to the Decision node. This tells the Decision node that is has a requirement of both **Age** and **Years of Service** for each respective node it connects. With DMN this explicit linkage is how decisions requirements diagrams (DRD) are crafted.



3. Select the **Extra days case 1** node and open its expression editor by clicking on the **Edit** button.



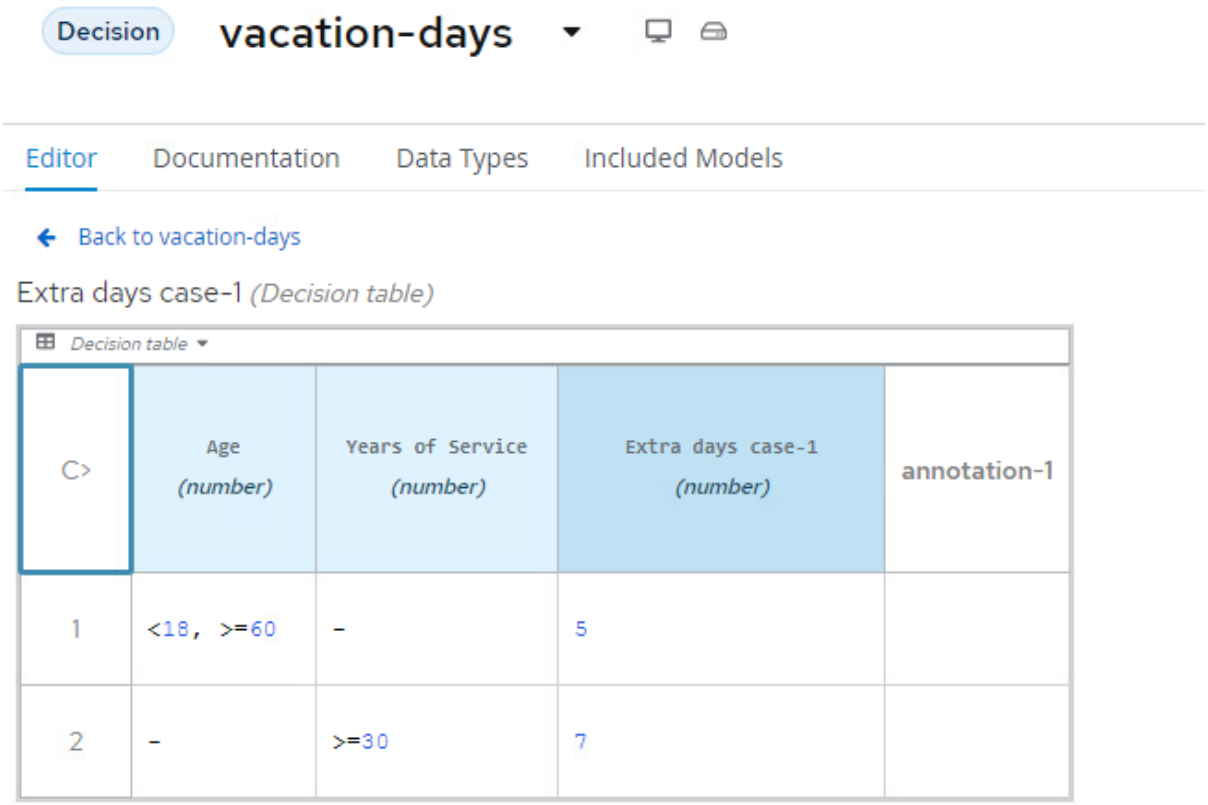
4. Select the expression **Decision Table** to create a boxed expression implemented as a decision table.



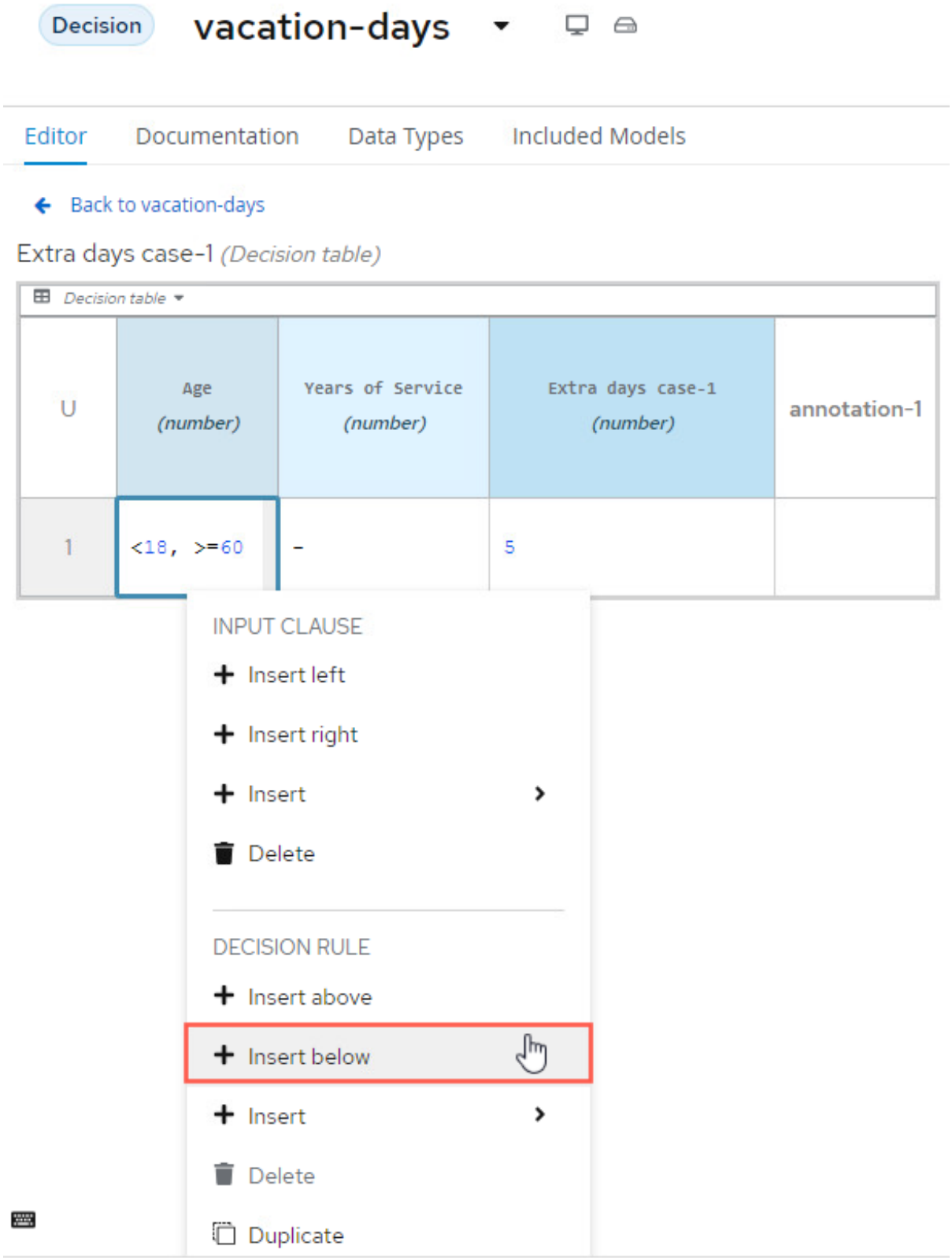
5. The first case defines 2 decisions which can be modelled with 2 rows in our decision table as such:

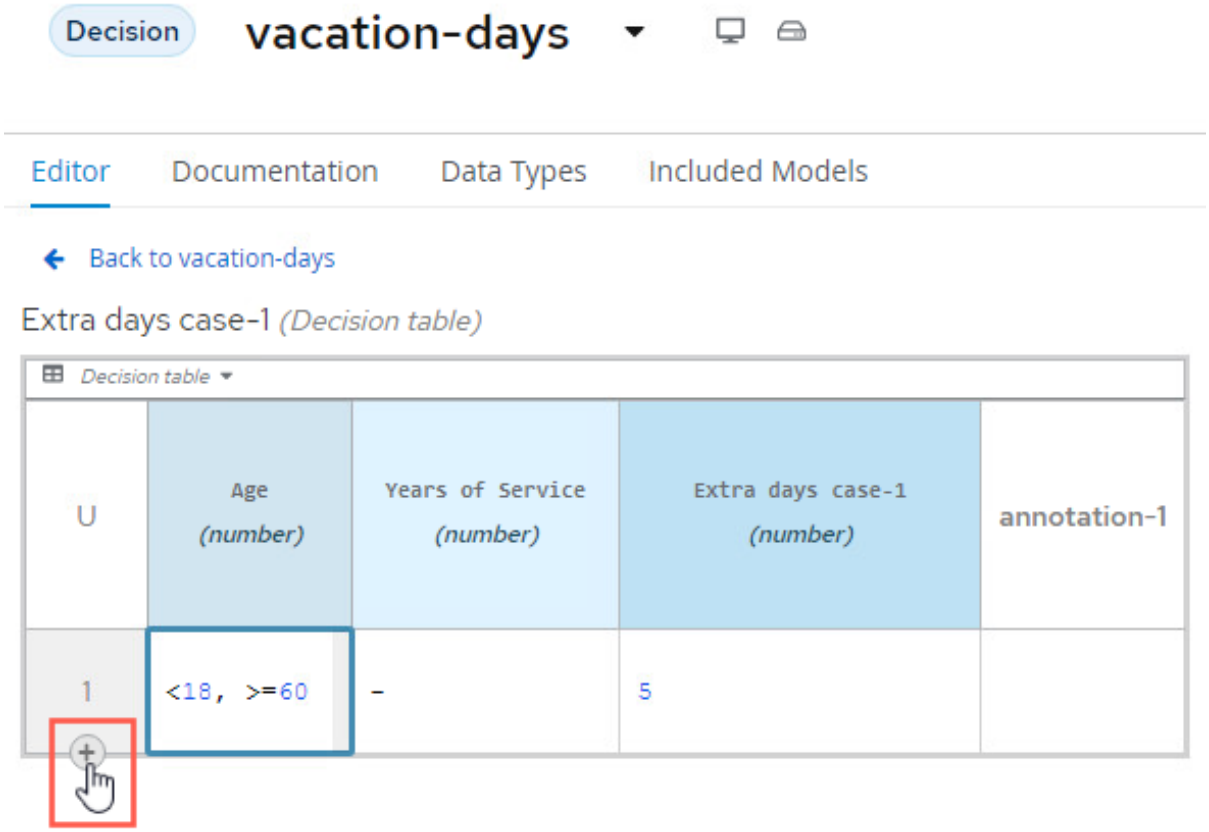
a. employees younger than 18 or at least 60 years will receive 5 extra days, or …

b. employees with at least 30 years of service will receive 7 extra days

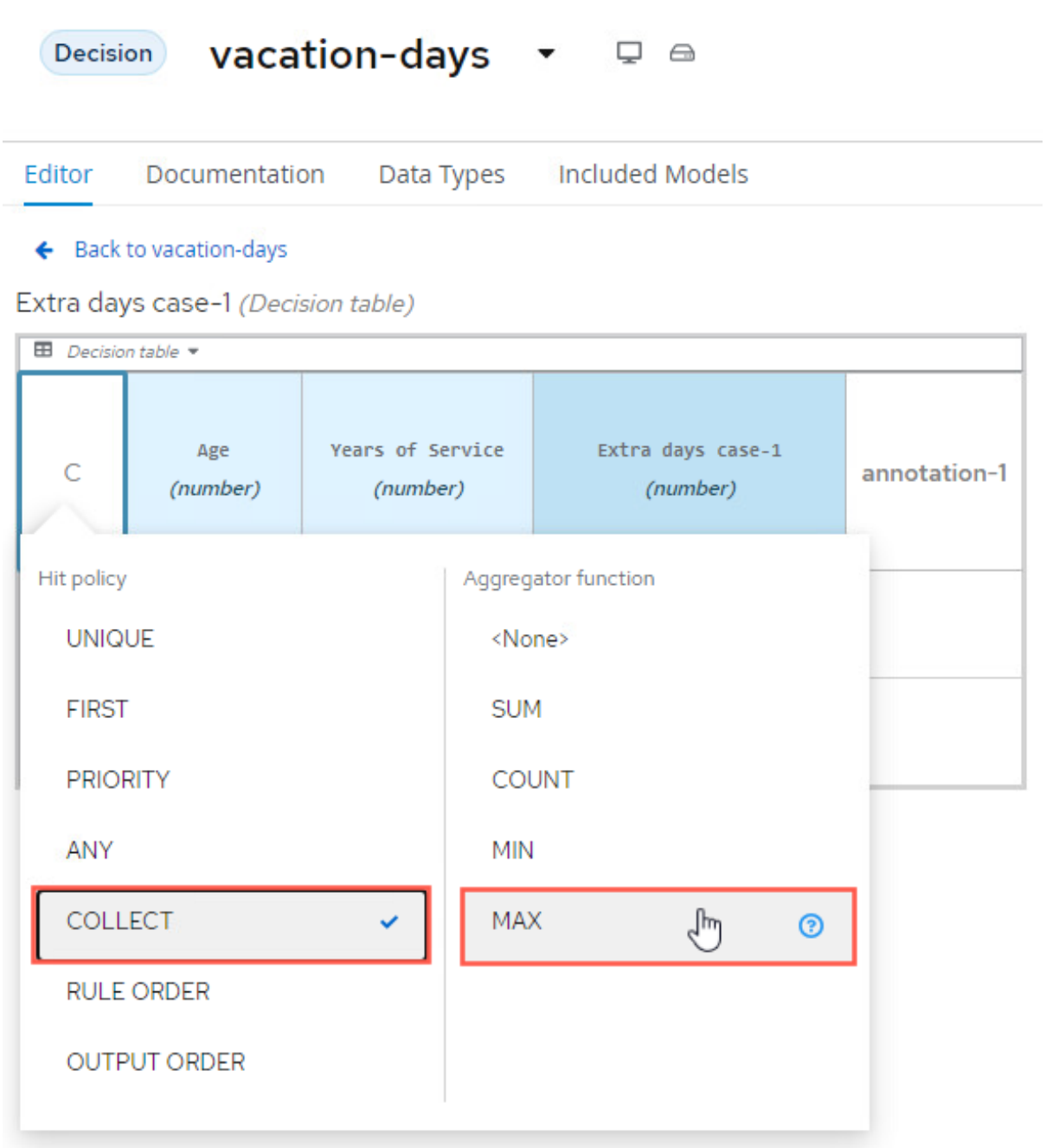


6. To add new lines to your table, right click the first column and select "Insert below" under *Decision Rule* or you can click the **Plus Sign** below the 1 under the *U*.


Decision
vacation-days
Editor
Documentation
Data Types
Included Models
Back to vacation-days
Extra days case-1 (Decision table)
Decision table
U
Age (number)
Years of Service (number)
Extra days case-1 (number)
annotation-1
1
<18, >=60
-
5
INPUT CLAUSE
Insert left
Insert right
Insert
Delete
DECISION RULE
Insert above
Insert below
Insert
Delete
Duplicate



7. Note that the **hit-policy** of the decision table is by default set to `U`, which means `Unique`. This implies that only one rule is expected to fire for a given input. In this case however, we would like to set it to `Collect Max`, as, for a given input, multiple decisions might match, but we would like to collect the output from the rule with the highest number of additional vacation days. To do this, click on the `U` in the upper-left corner of the decision table. Now, set the **Hit Policy** to `Collect` and when you click this, it will ask the **Aggregator function** to use, select `MAX` so you pull the largest value from the table.

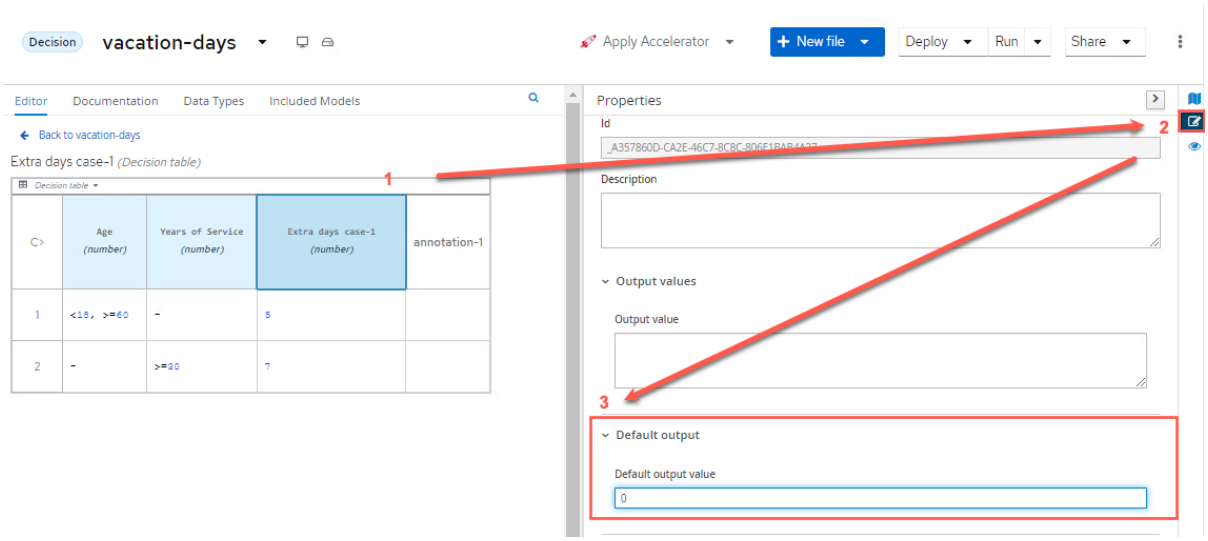


8. Finally, we need to set the default result of the decision. This is the result that will be returned when none of the rules match the given input. This is done as follows:

a. Select the output/result column of the decision table (*Extra days case-1*).

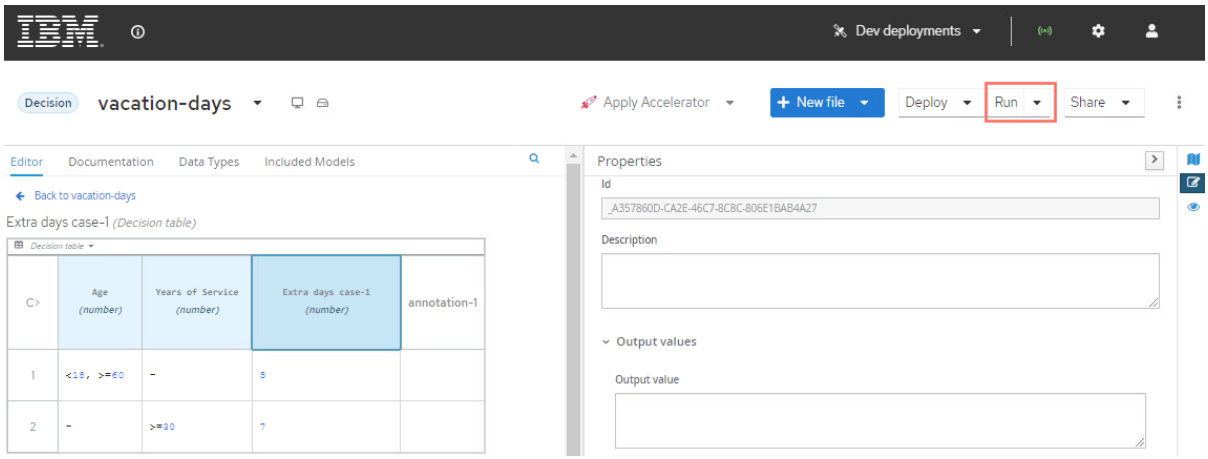
b. Open the properties panel on the right-side of the editor. Expand the **Default output** section.

c. Set the `Default output value` to `0`.



11.4 Decision Runner

Your model will be saved throughout this process, if you want to see how the decision is starting to execute. You can start to use the DMN Runner (which we could have started from the moment we added input values, but more fun with decisions in place!). To do this click **Run** just below the Black IBM banner.

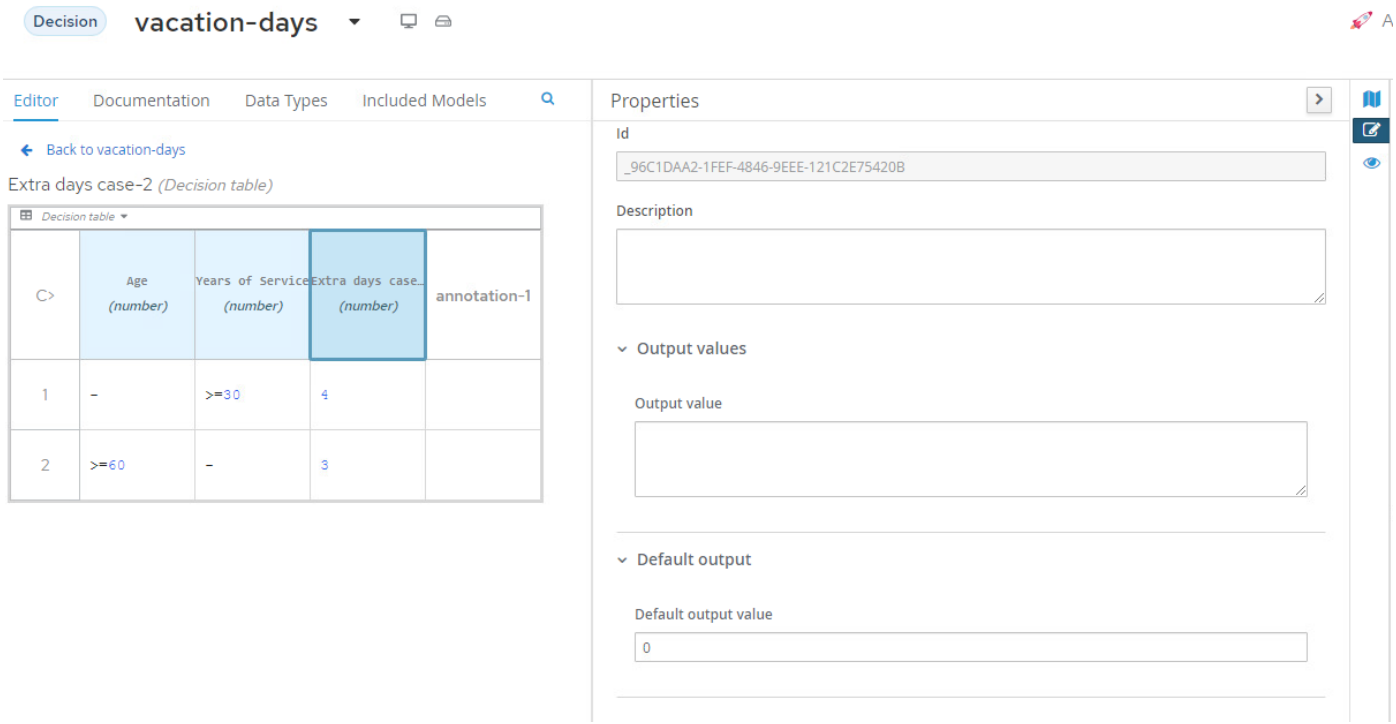


Now that the DMN Runner is open, you can see that the IBM Business Automation Manager Canvas created a form based on the inputs you have and is also displaying the results of the various decision nodes that we have. You will see that **Base Vacation Days** is currently displaying *22* and the rest of the decisions are *(null)* because we have no input data. If you start adding data, e.g. an Age of 60 with 5 years of service, you will see the result also update to have Extra days case-1 having `5` as the final result. Since DMN is also an execution specification with how it is written, all of the updates we make to our decisions, as we make them will be taken once the cell that was being actively changed is no longer selected. You can try this now or just leave it open while you're creating your other decisions so that you can see how your model is actively behaving based on your inputs.

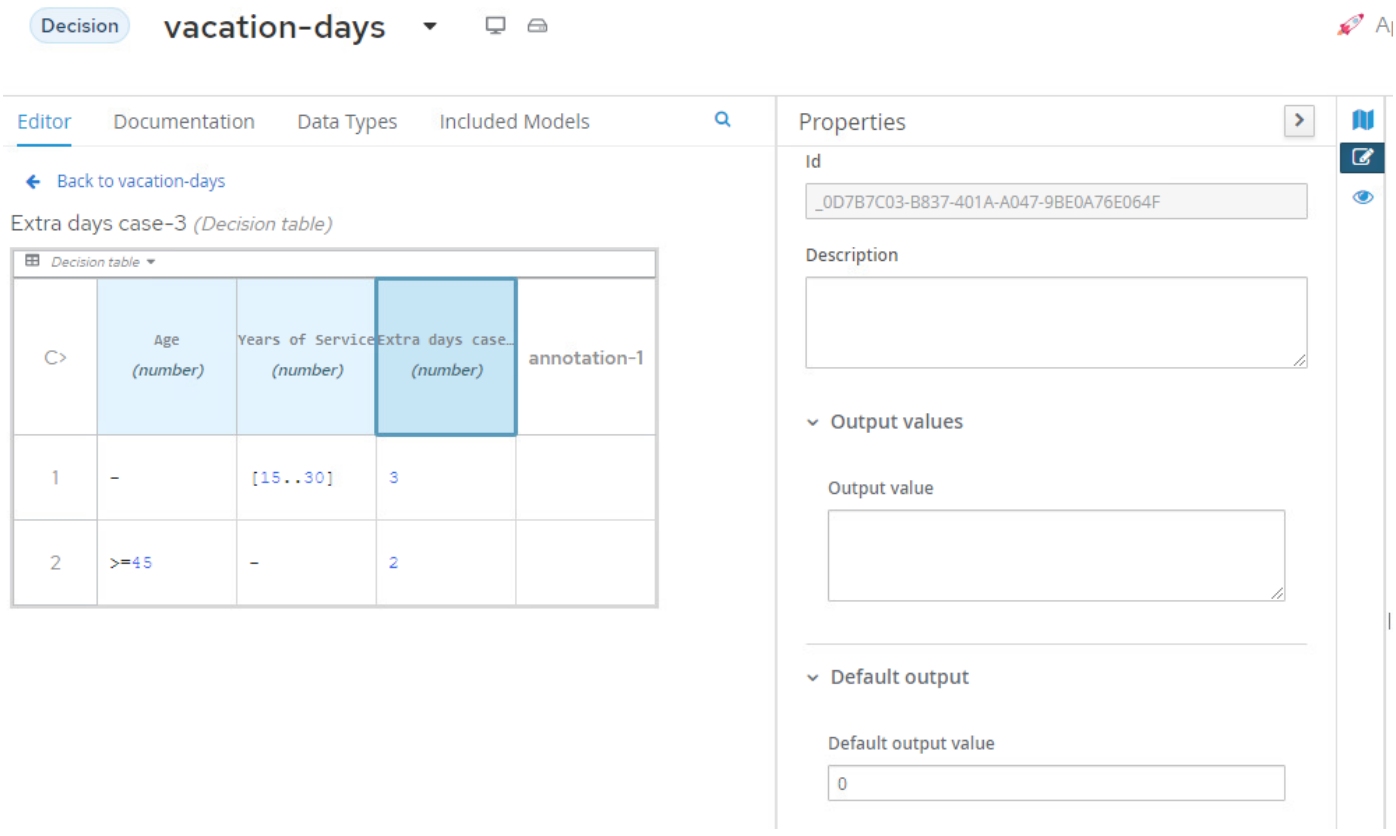
11.5 Continuining with Decisions for Use Case 2 and Use Case 3

1. The other two decisions can be implemented in the same way. Now, implement the following two decision tables:

- Case 2:

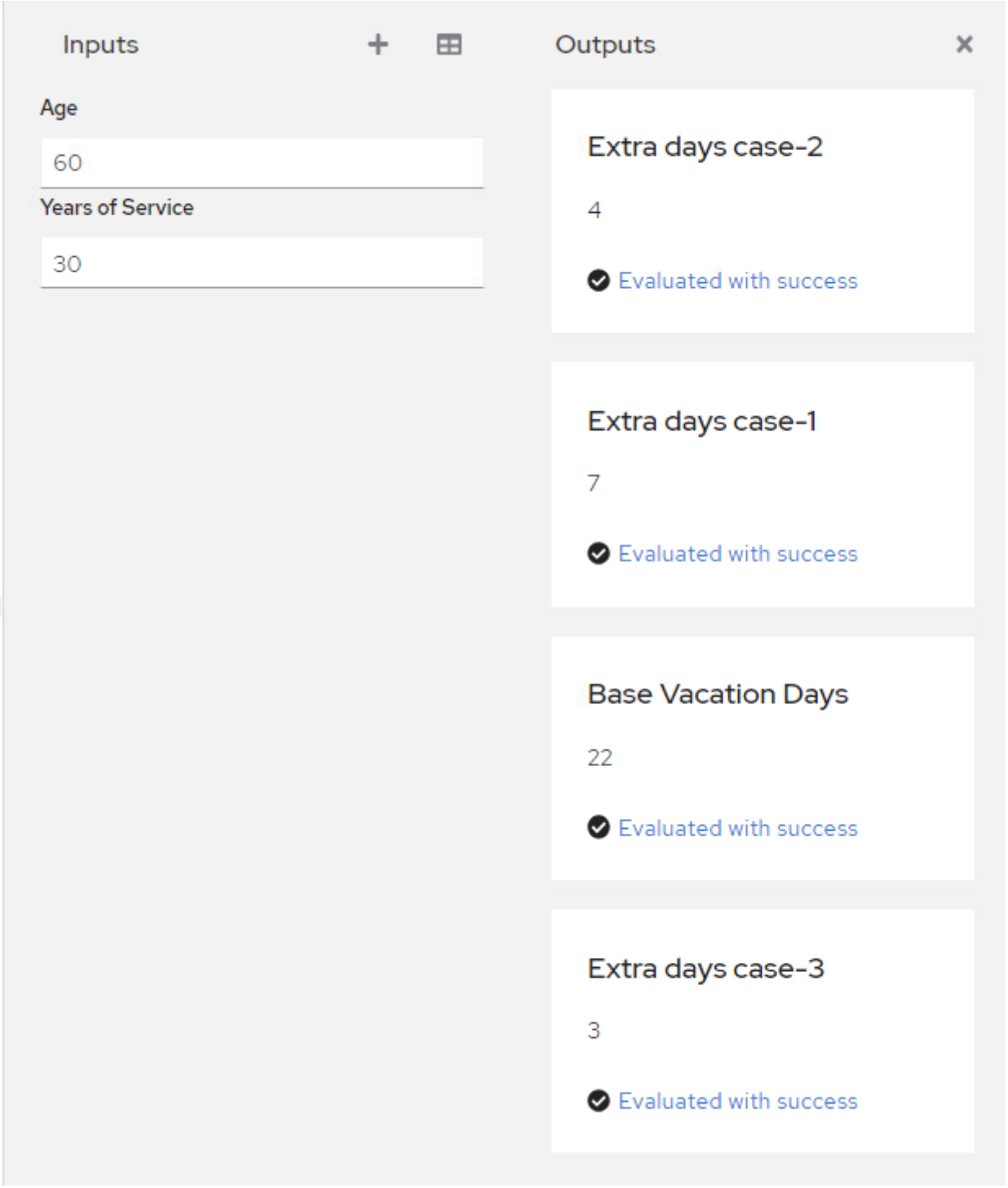


- Case 3:



NOTE: If you want to resize the columns, you can double click the lines between them to auto-resize. More auto-resizing to column headers features are coming soon!

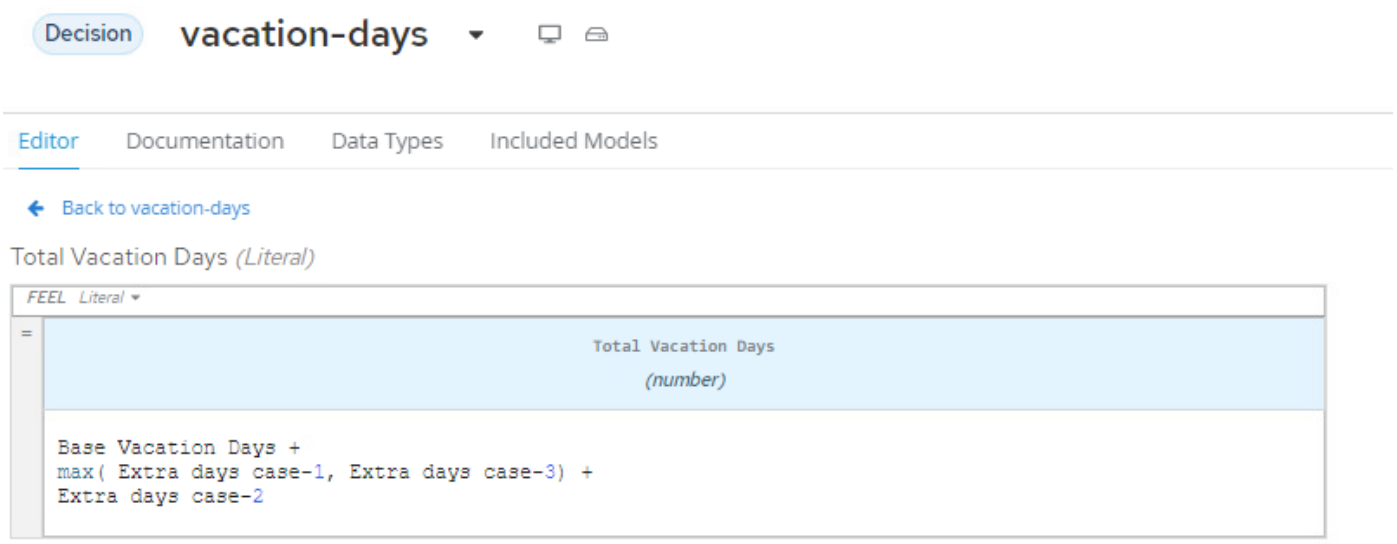
1. If you check the DMN Runner if you are using the same `Age: 60` and `Years of Service: 30` will now render a decision for each one in the table and you can adjust to execute other decisions.



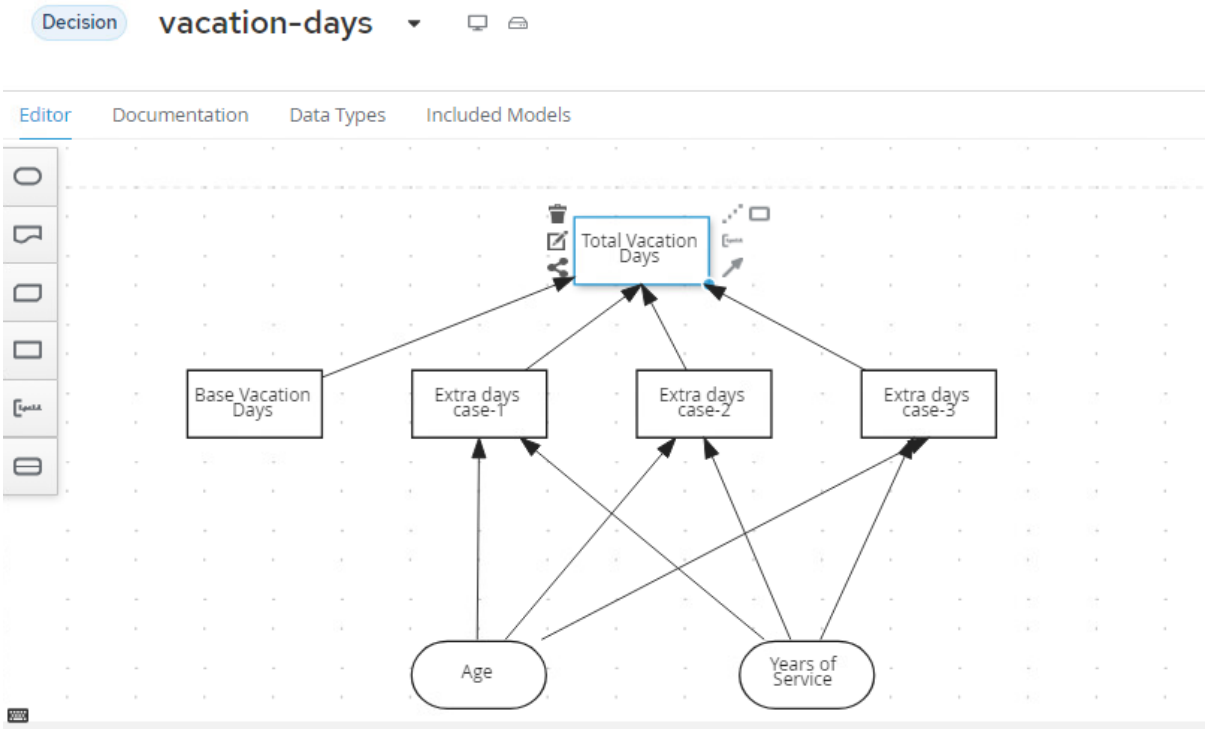
11.6 Total Vacation Days

The total vacation days needs to be determined from the base vacation days and the decisions taken by our 3 decision nodes. As such, we need to create a new Decision node, which takes the output of our 4 Decision nodes (3 decision tables and a literal expression) as input and determines the final output. To do this, we need to:

1. Create a new Decision node in the model. Give the node the name `Total Vacation Days` and set its **data type** to `number`.



2. Connect the 4 existing Decision nodes to the node. This defines that the output of these nodes will be the input of the next node. Without putting a line connecting `Age` or `Years of Service` connected to Total Vacation Days, this data will not be available to this decision, not that they are needed here, but just an overall note of how DMN works!



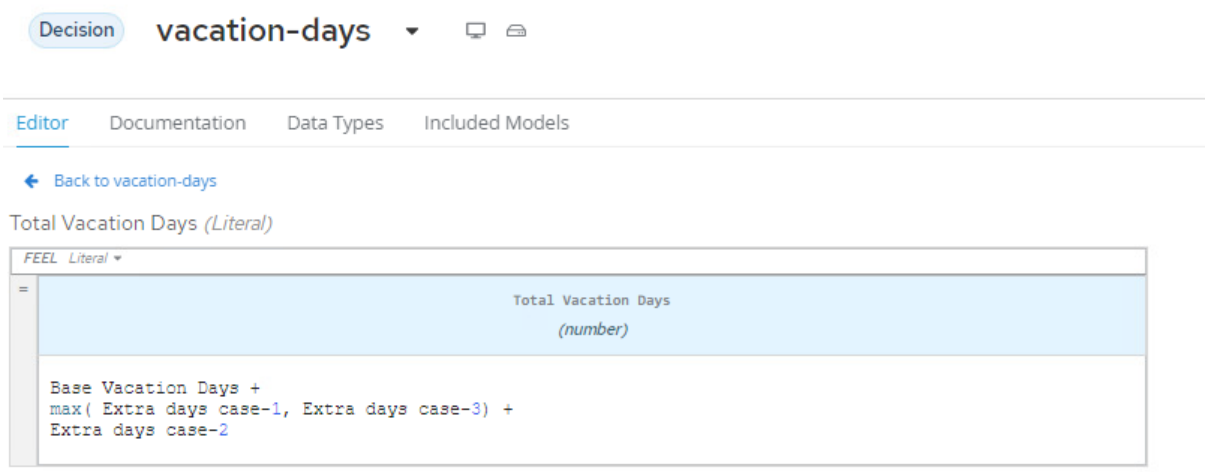
3. Click on the `Total Vacation Days` node and click on **Edit** to open the expression editor. Configure the expression as a literal expression.
4. We need to configure the following logic:

a. Everyone gets the Base Vacation Days.

b. If both case 1 and case 3 add extra days, only the extra days of one of this decision is added. So, in that case we take the maximum.

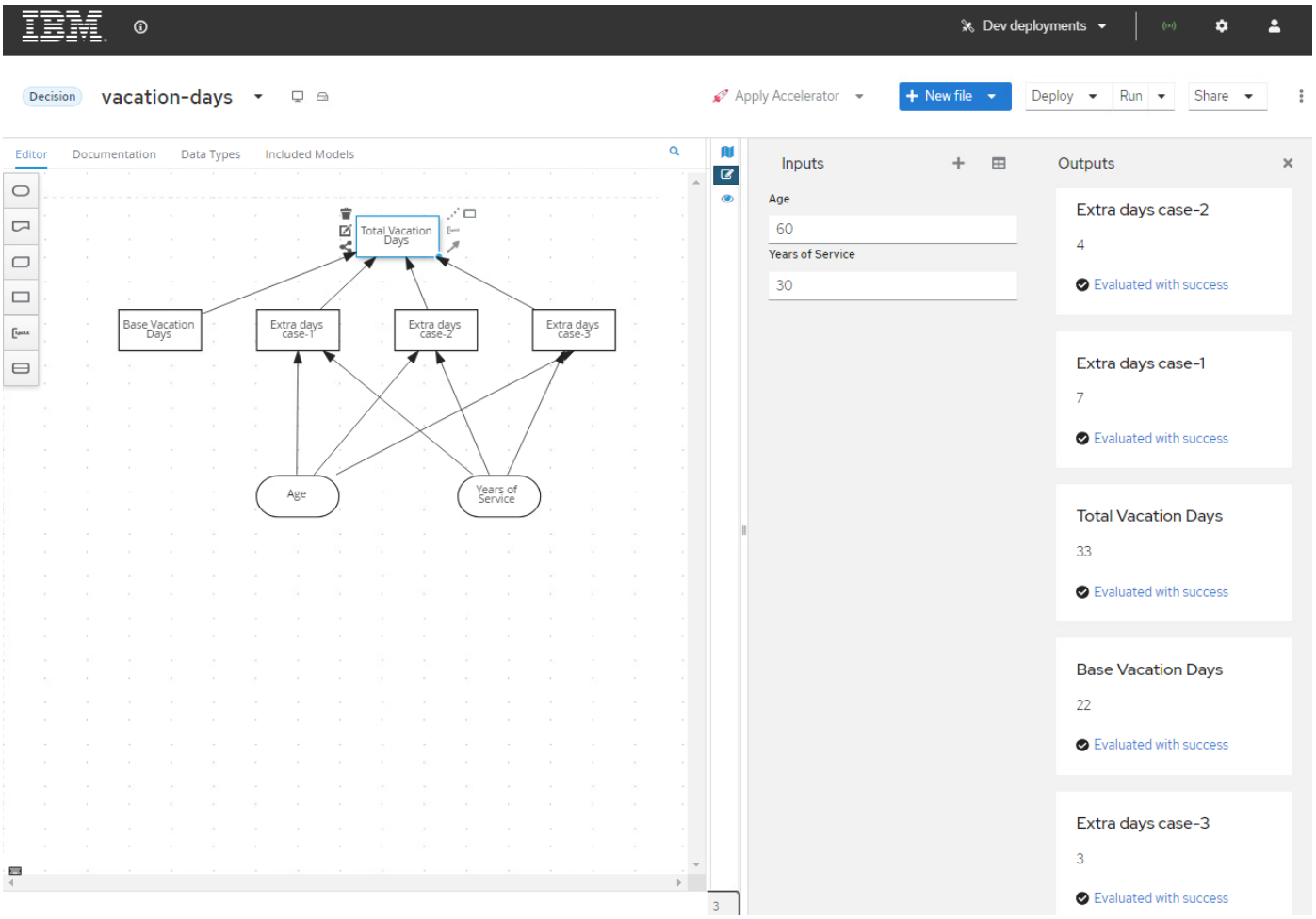
c. If case 2 adds extra days, add them to the total.

5. The above logic can be implemented with the following FEEL expression - note that these are using the values that are produced by the Decision Nodes names and match the case *exactly*:




```
Base Vacation Days +
max( Extra days case-1, Extra days-case3) +
Extra days case-2
```

6. Using your DMN Runner you can test your decision exactly as it sits today and return a Total Days based on the sample employee from before or any other changes.



7. Your model is now ready for consumption. There are a few ways to explore how to use it which we will cover in the next section!

Last update: 2023-12-06

3.4.5 12. Vacation Days - Consuming Decisions

There are several ways to consume decisions, but the first way we will explore is through the utilization of the Canvas provided methods, but there will also be methods showing how to do it with IBM Business Automation Open Edition 8.0 provided as informational and not required for these exercises.

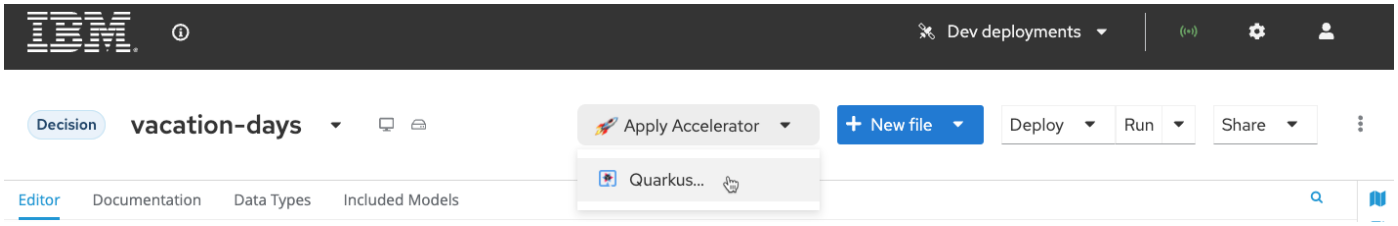
12.1 Deploying and testing the Decision Service

With our decision model completed, we can now package our DMN model in a Kogito service. This can be done using the Accelerators included with IBM Business Automation Manager Canvas. These accelerators will quickly take the DMN file and start building the basis of the project as a IBM Business Automation Open Edition 9.0 compatible decision service.

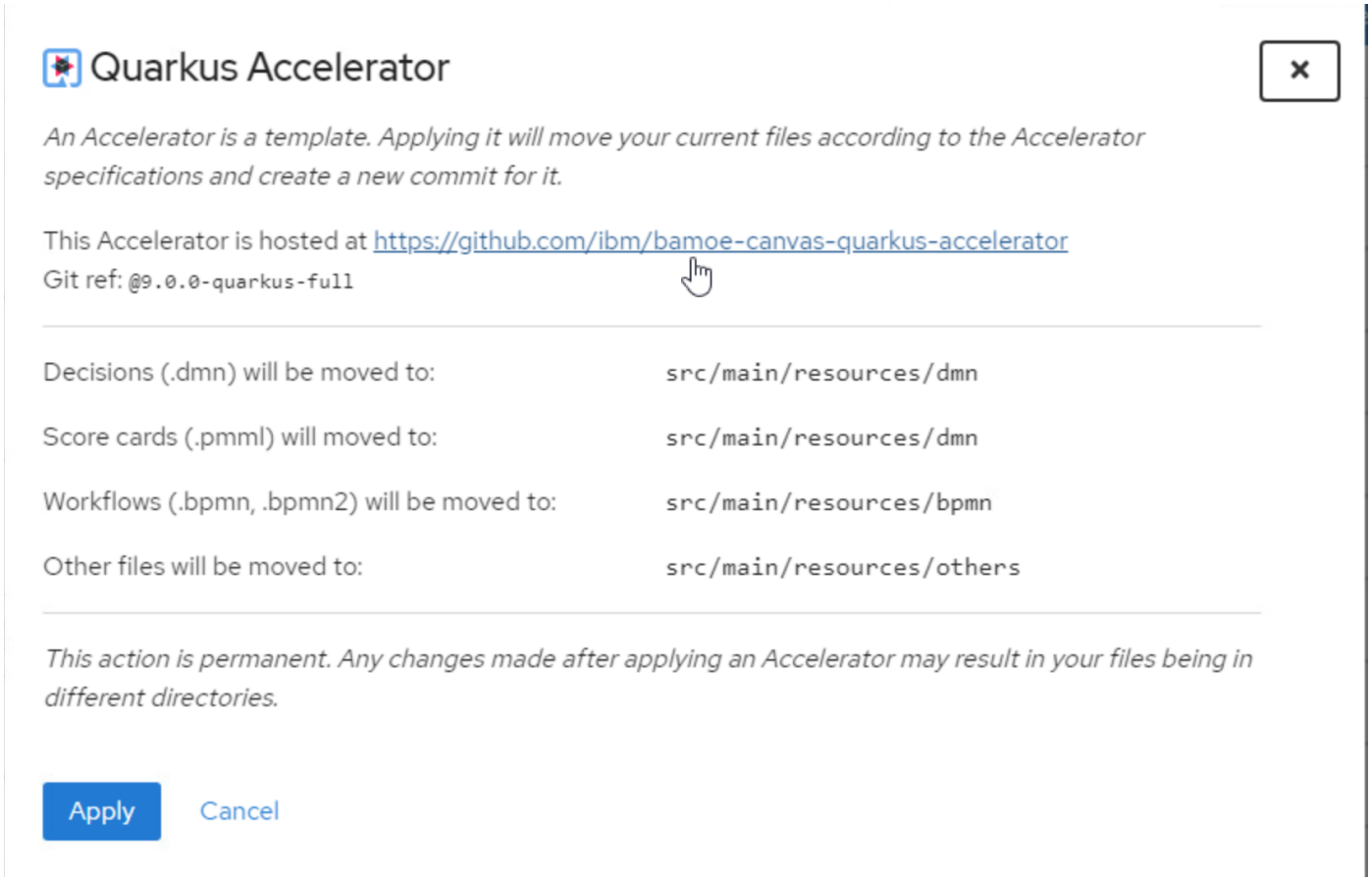
12.2 Applying the Accelerator

To take this decision service from a standalone DMN model to a full Kogito architected decision, you will use the accelerator by clickig the button at the top of the screen. To do so follow the instructions and then we will synchronize the project to your GitHub account and also be capable being deployed as an OpenShift service.

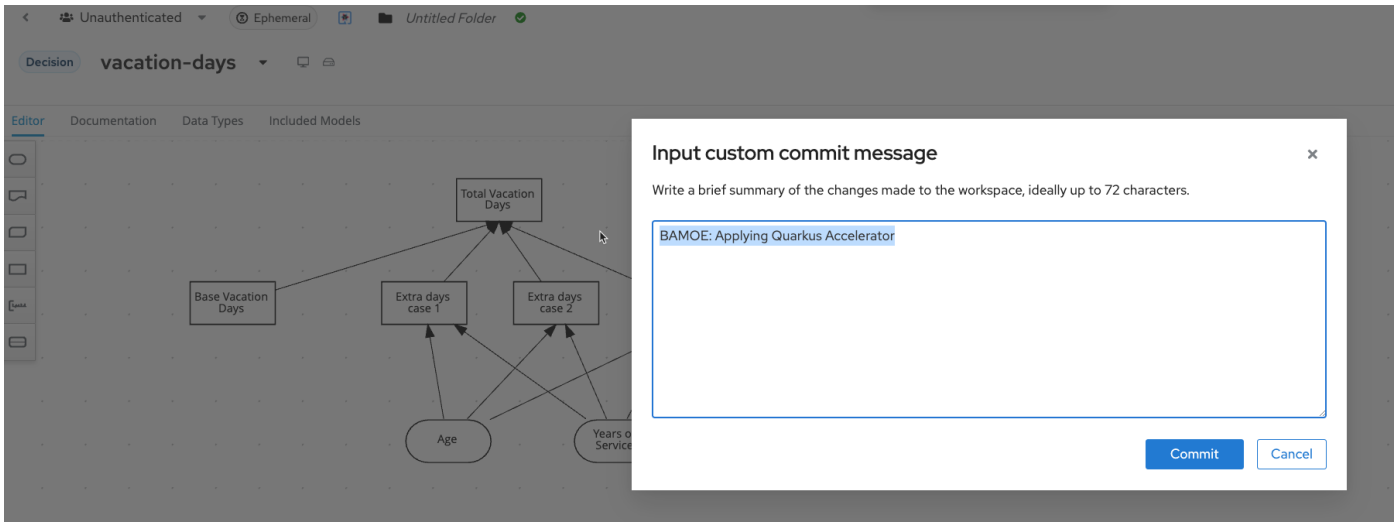
1. At the top of the DMN model page for `vacation-days`, click the button `Apply Accelerator` and select **Quarkus...**.



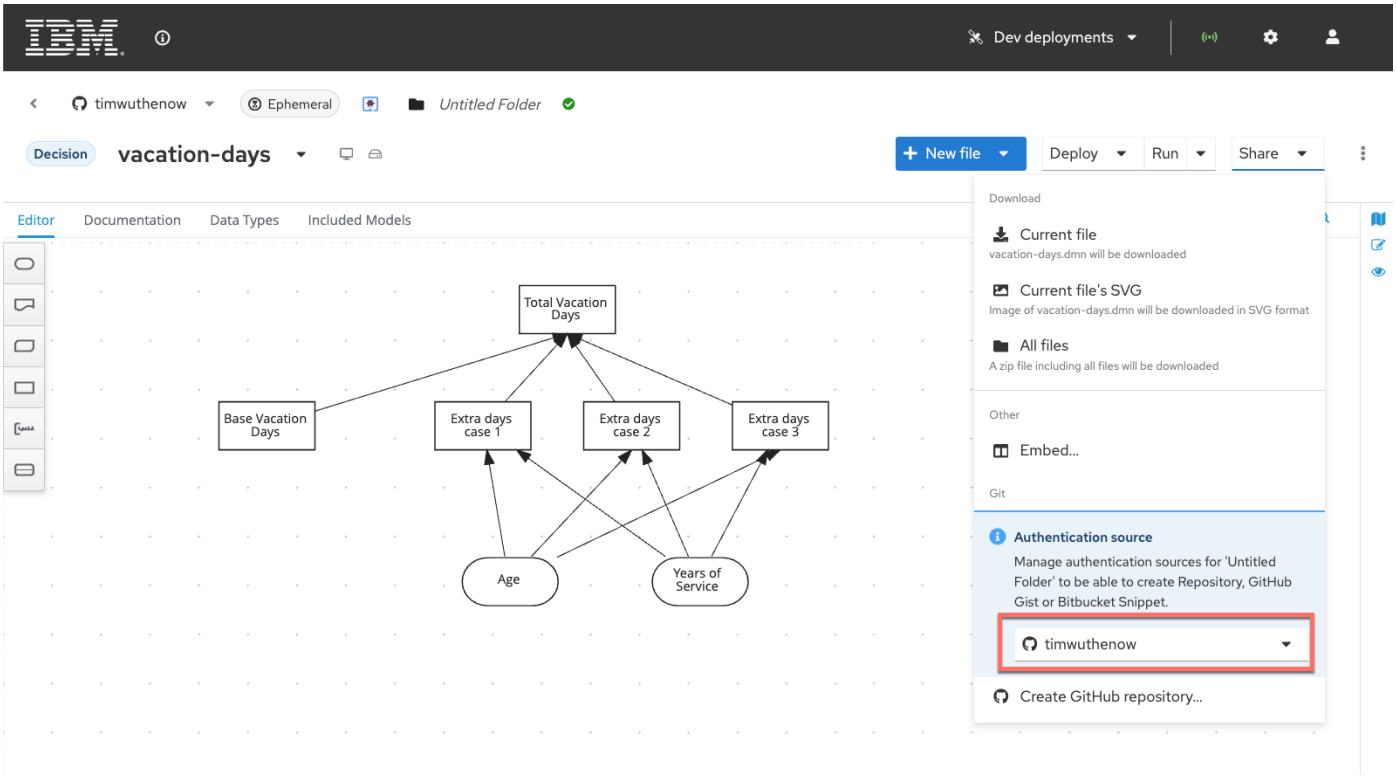
2. If you want to learn more about the accelerator, you can click the GitHub link and change the branch to the `9.0.0-quarkus-full` to learn more about it. Afterwards just click **Apply** to restructure your project into a Kogito service.



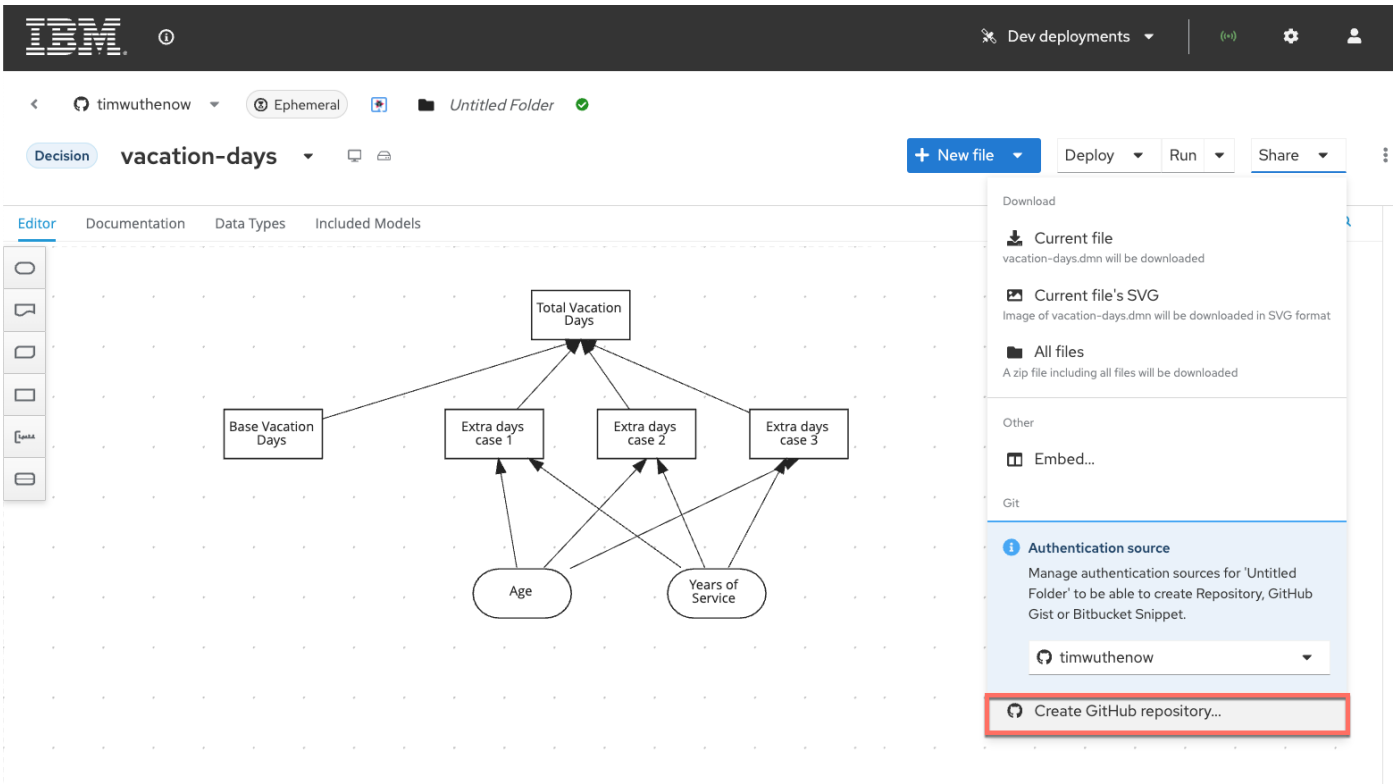
3. The wizard will come with a pop-up asking for a commit message for the change since this will create a Git project. You can use the default message or put whatever you would like, to do so press **Commit**.



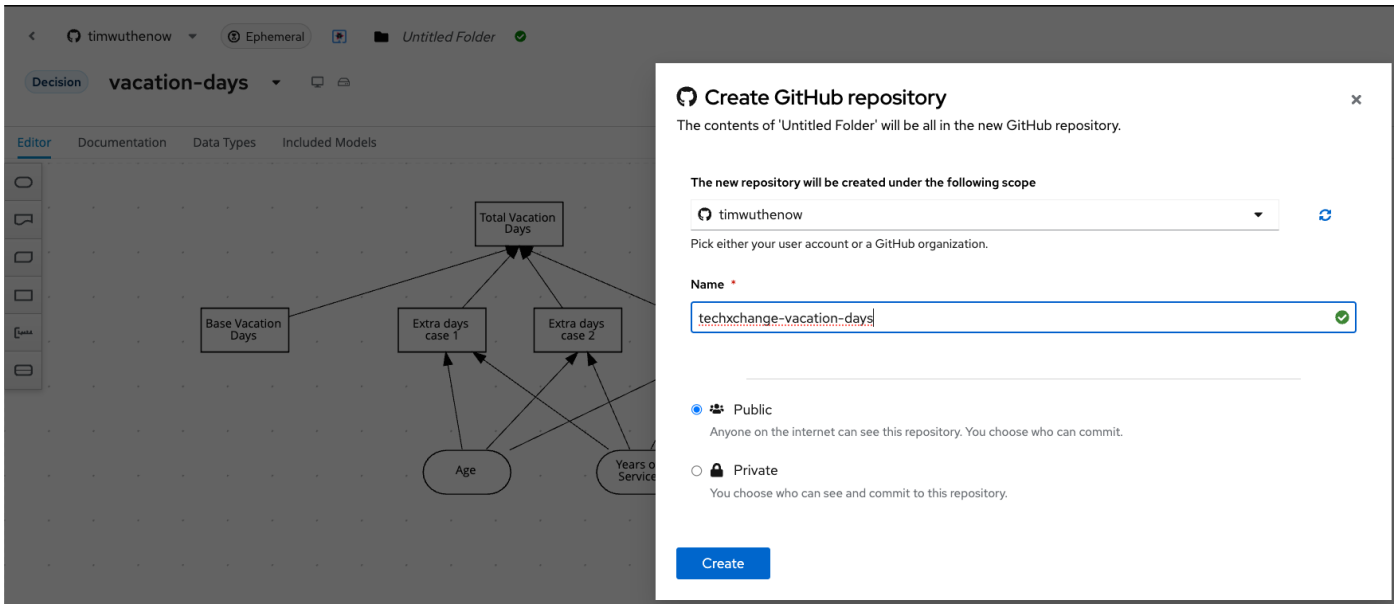
4. To create the project in Git, click **Share**, use your GitHub tokened ID.



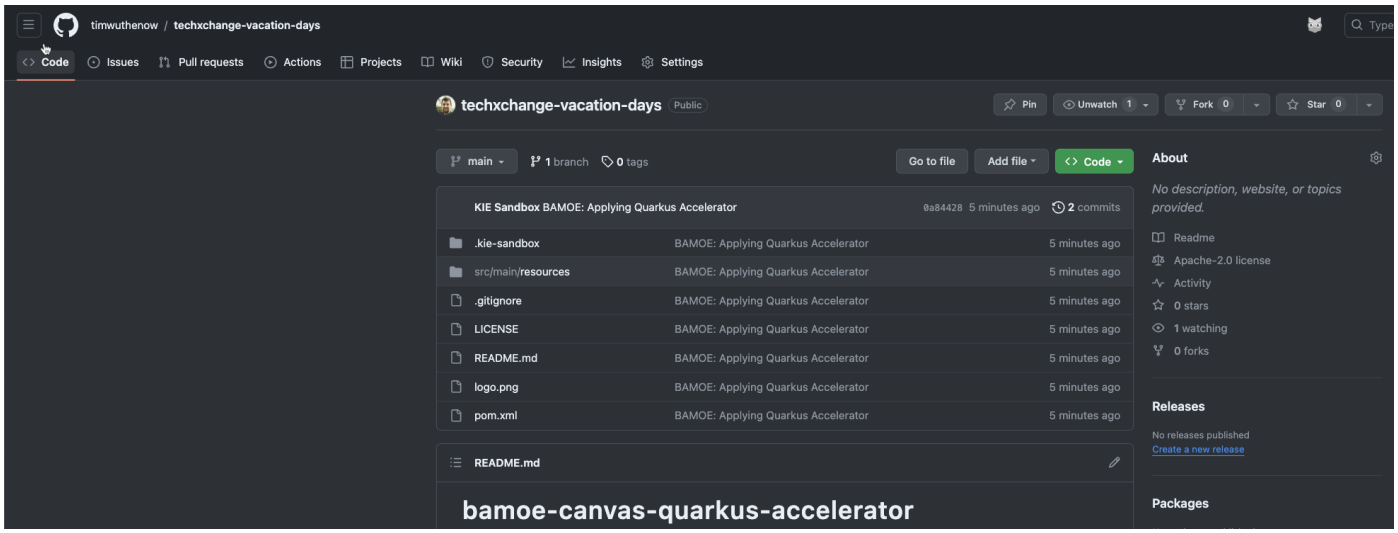
5. Once you select your ID, a new option **Create GitHub repository...** is now available, select this.



6. The repository you create, can be anything you want, for the purposes of this lab, it will be called **techxchange-vacation-days**.



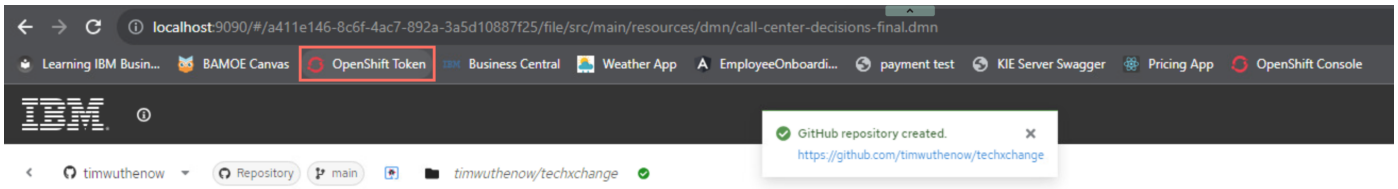
7. When you create the repository, a message will open at the top with a link to the Git repository that was created. In the case of the example it is at this example repository.



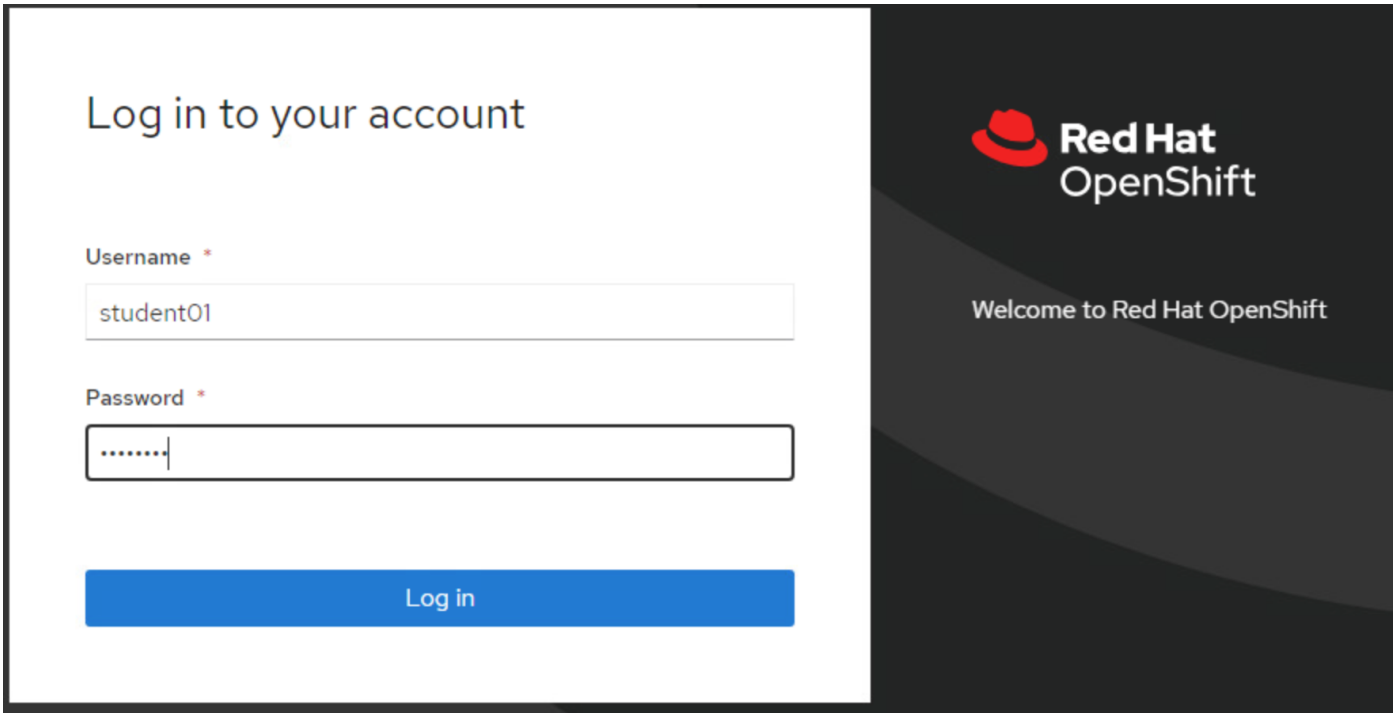
12.3 Deploying to OpenShift

Now that this repository is created, you can work on it locally or deploy it to OpenShift. For this lab, we will choose OpenShift since we have a cluster ready to use for TechXchange or you can use the Red Hat OpenShift Sandbox to provision a small environment to try it out on your own.

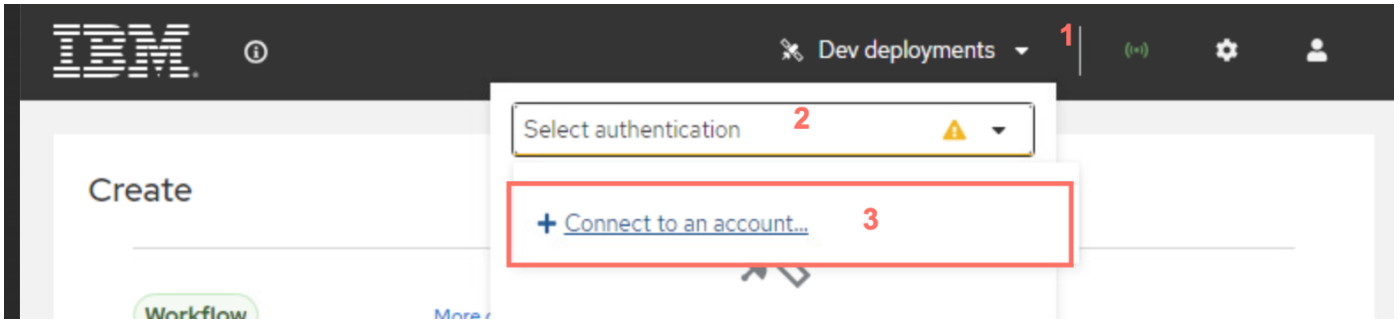
1. Login to get an OpenShift Token using the bookmark on Chrome. This will be used to connect IBM Business Automation Manager Canvas to OpenShift and deploy a sample development environment of the decision service.



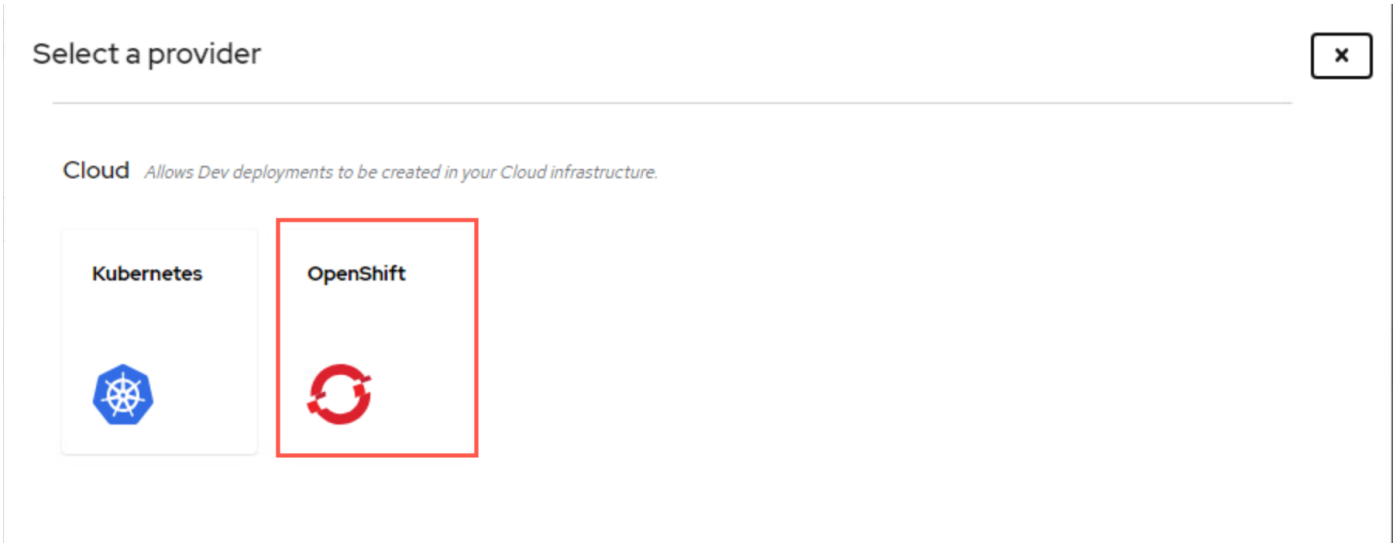
2. In the login screen use your username and password - this will be some combination of `student01` to `student20` with password `Passw0rd`. The username is all lowercase. This will



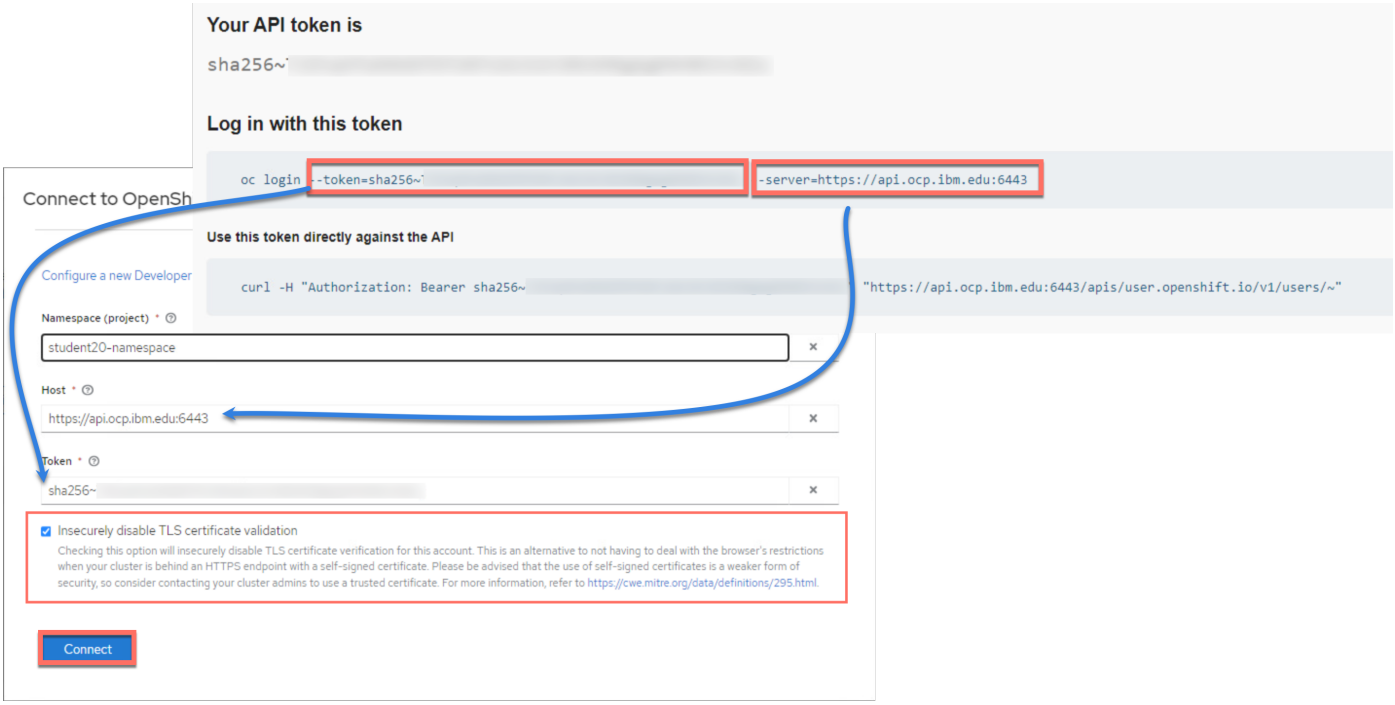
3. Click the **Display Token** link and switch back to the tab with IBM Business Automation Manager Canvas open on it. You will use the token contents from the OpenShift token page shortly by clicking on **Dev deployments** and then selecting the pull down **Select authentication** and then **Connect to an account**.



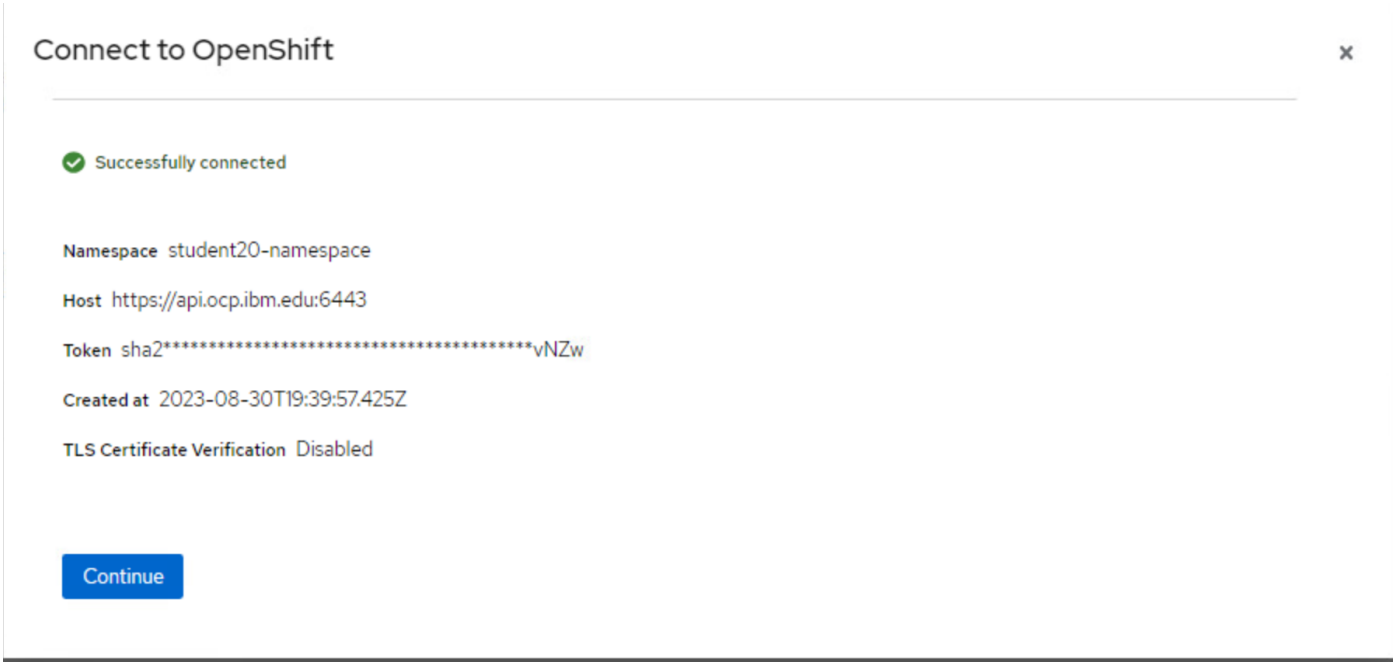
4. On the next wizard, select the **OpenShift Tile** to connect to an OpenShift instance.



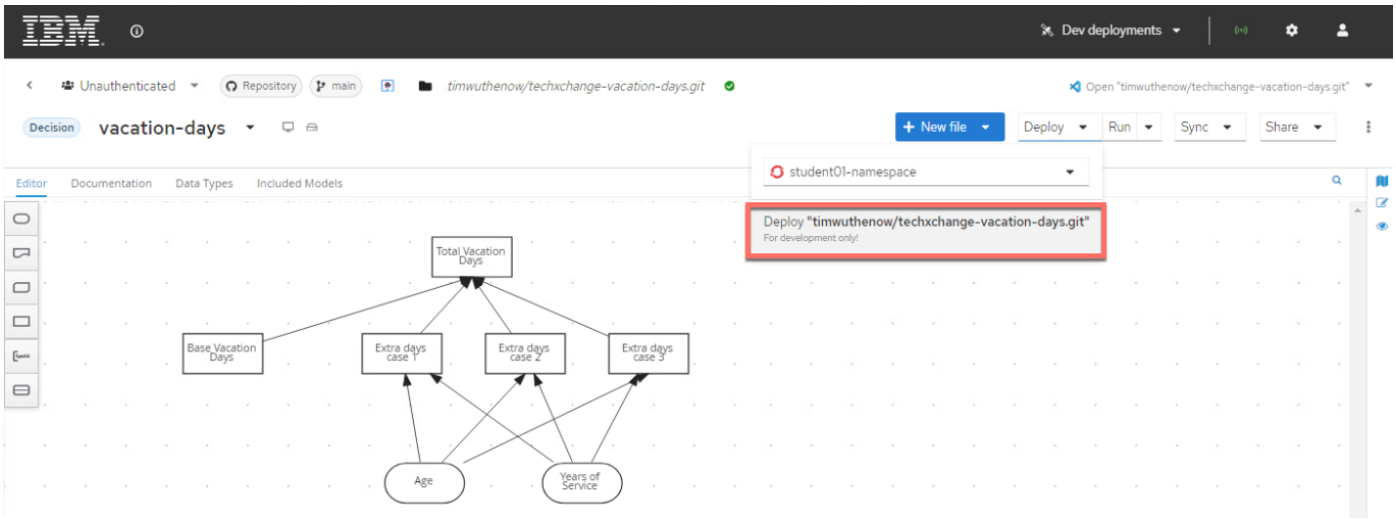
5. From here you will use the information from the OpenShift token page. Your namespace will be your `student##-namespace`, so if your username is student07, then you would connect to *student07-namespace*. The token and the console locations are both a part of the token as well. You will see a checkbox to Insecurely disable TLS validation, check it as this is a self contained environment with certificates not present. Press **Connect** when the form is completed.



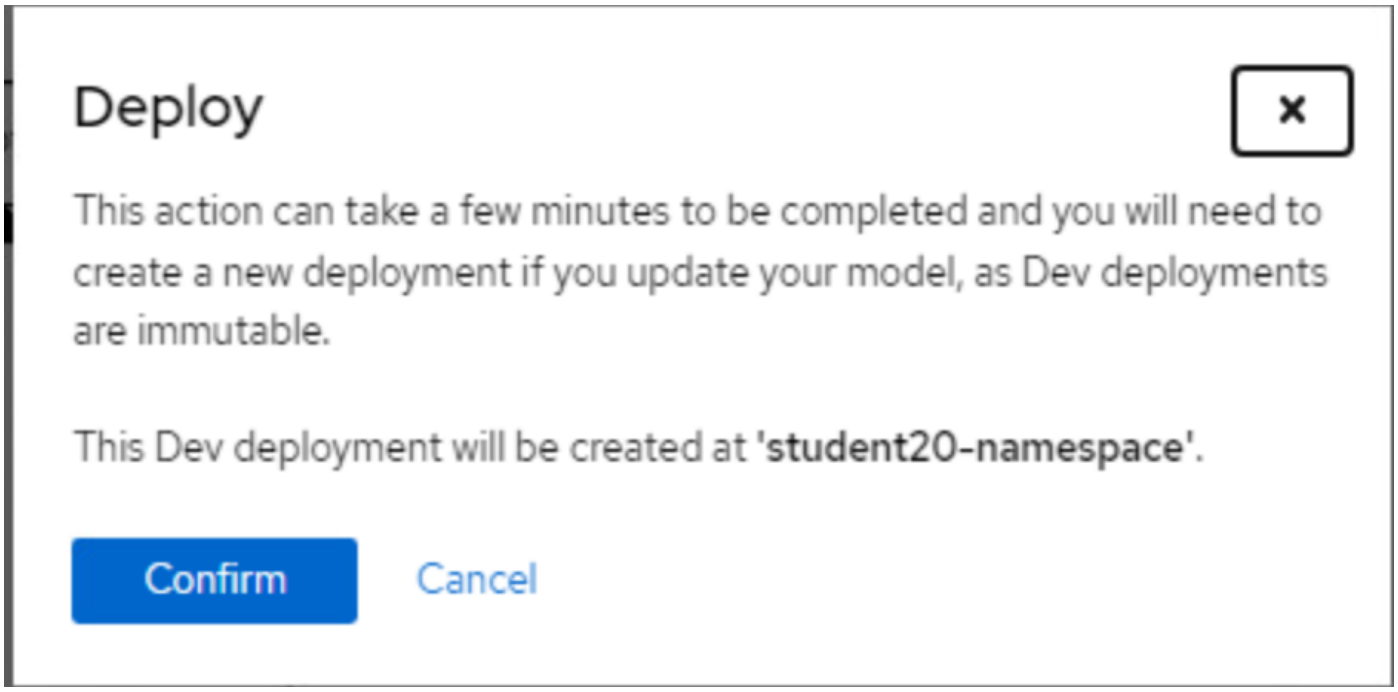
6. As long as it was successful to connect, you will be greeted with a Connect to OpenShift successful modal, click **Continue**.



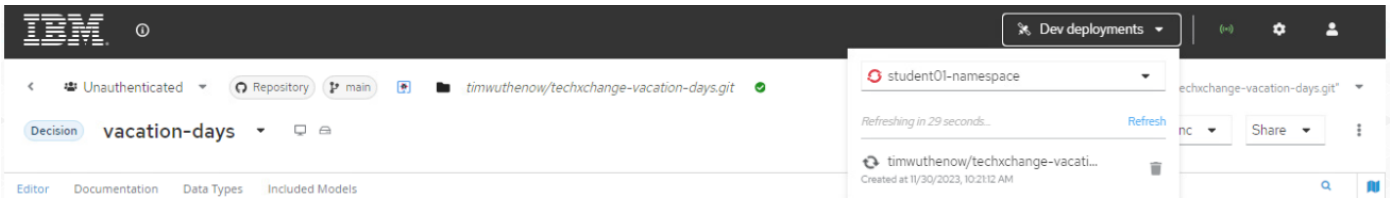
7. Now you can press the **Deploy** button and have the capability to select the namespace that you connected to and deploy a sample of your service to it.



8. From here a modal will pop up explaining that the deployment can take a few minutes and it is only intended for development, etc. Click **Confirm** on this modal and your service will be deployed.

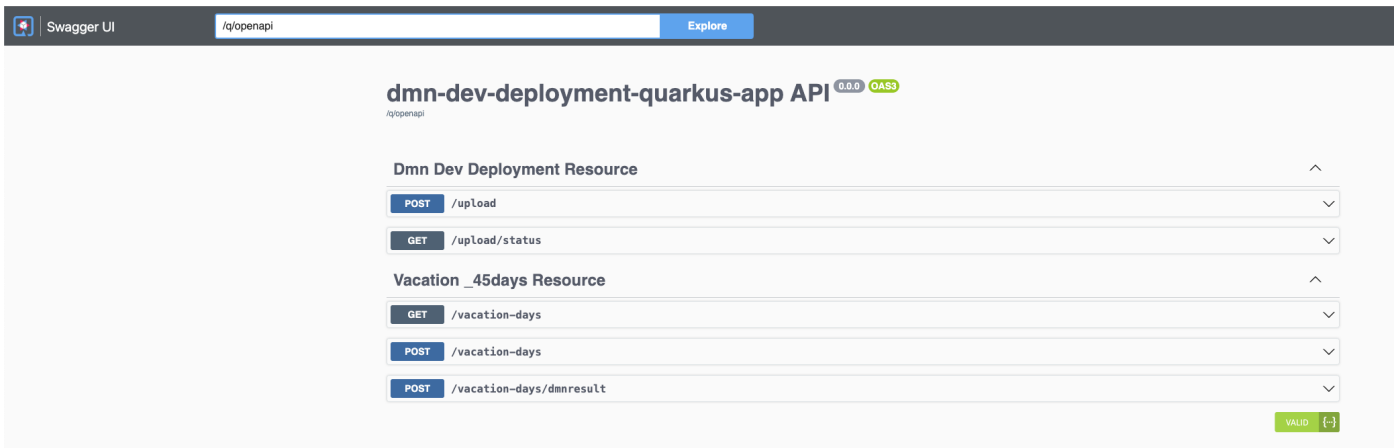


9. This process will take several minutes to complete.



10. The pulldown with deploy will refresh every 30 seconds, when the service is available, it will reflect as such. The way that the deployments from these services work are is that they are completely immutable and unaware of one another, so you could have all versions deployed as you make changes to validate how you want to eventually promote your DMN model to later environments. So if you were to deploy it again, there would be multiple different versions of it deployed. Canvas can manage these deployment samples, which can later be removed when you're done with them if you choose. If you click the green check marked box, it will take you to the service.

11. When you access the service with a form similar to the one you had in IBM Business Automation Manager Canvas and from that page you can explore it more using the kebab icon in the top right to access the Swagger-UI page to get access to the auto-generated DMN service's API page. The first post can be used to execute the decision itself.



12. This completes this lab as you can see how the deployment to OpenShit works with IBM Business Automation Manager Canvas!

12.4 Deploying the Decision Service in KIE Server (Not for TechXchange)

This section is not needed for TechXchange, but is just to provide some extra ways to showcase now you can deploy your decision. With our decision model completed, we can now package our DMN model in a Deployment Unit (KJAR) and deploy it on the Execution Server. To do this:

1. In the bread-crumb navigation in the upper-left corner, click on `vacation-days-decisions` to go back to the project's Library View.
2. Click on the **Deploy** button in the upper-right corner of the screen. This will package our DMN mode in a Deployment Unit (KJAR) and deploy it onto the Execution Server (KIE-Server).
3. Go to the **Execution Servers** perspective by clicking on "Menu → Deploy → Execution Servers". You will see the **Deployment Unit** deployed on the Execution Server.

12.5 Testing DMN Solution

In this section, you will test the DMN solution with Execution Server's Swagger interface and via Java KIE Client API.

12.6 Testing the solution via REST API

In this section, you will test the DMN solution with KIE Server's Swagger interface.

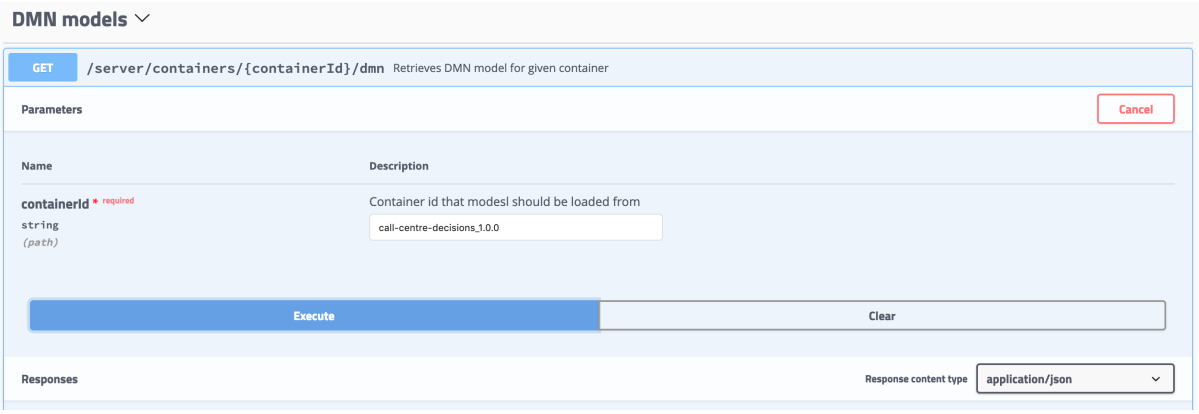
The Swagger interface provides the description and documentation of the Execution Server's RESTful API. At the same time, it allows the APIs to be called from the UI. This enables developers and users to quickly test, in this case, a deployed DMN Service.

1. Navigate to KIE Server
2. Locate the **DMN Models** section. The DMN API provides the DMN model as a RESTful resources, which accepts 2 operations:

a. `GET` : Retrieves the DMN model.

b. `POST` : Evaluates the decisions for a given input.

3. Expand the `GET` operation by clicking on it.
4. Click on the **Try it out** button.
5. Set the **containerId** field to `vacation-days-decisions` and set the **Response content type** to `application/json` and click on **Execute**



6. If requested, provide the username and password of your **Business Central** and **KIE-Server** user.
7. The response will be the model-description of your DMN model.

Next, we will evaluate our model with some input data. We need to provide our model with the **age** of an employee and the number of **years of service**. Let's try a number of different values to test our deicions.

1. Expand the `POST` operation and click on the **Try it out** button
2. Set the **containerId** field to `vacation-days-decisions`. Set the **Parameter content type** and **Response content type** fields to `application/json`.
3. Pass the following request to lookup the number of vacation days for an employee of 16 years old with 1 year of service (note that the namespace of your model is probably different as it is generated. You can lookup the namespace of your model in the response/result of the `GET` operation you executed ealier, which returned the model description).

```
{ "dmn-context":{ "Age":16, "Years of Service":1 } }
```

1. Click on **Execute**. The result value of the `Total Vacation Days` should be 27.
2. Test the service with a number of other values. See the following table for some sample values and expected output.

Age	Years of Service	Total Vacation Days
16	1	27
25	5	22
44	20	24
44	30	30
50	20	24
50	30	30
60	20	30

12.7 Using the KIE Java Client (if you were using IBM Business Automation Open Edition 8.0)

IBM IBM Business Automation Open Edition 8.0 provides a KIE Java Client API that allows the user to interact with the KIE-Server from a Java client using a higher level API. It abstracts the data marshalling and unmarshalling and the creation and execution of the RESTful commands from the developer, allowing him/her to focus on developing business logic.

In this section we will create a simple Java client for our DMN model.

IMPORTANT: If your KIE Server is exposed via https you need to configure the `javax.net.ssl.trustStore` and javax.net.ssl.trustStorePassword `in the Java client code using the Remote Java API. If not, you may get a` rest.NoEndpointFoundException`. For more information check this solution Red Hat's knowledge base.

1. Create a new Maven Java JAR project in your favourite IDE (e.g. IntelliJ, Eclipse, Visual Studio Code).
2. Add the following dependency to your project:

```
<dependency>
  <groupId>org.kie.server</groupId>
  <artifactId>kie-server-client</artifactId>
  <version>7.67.2.Final-redhat-00006</version>
```

```
    <scope>compile</scope>
  </dependency>
```

1. Create a Java package in your `src/main/java` folder with the name `org.kie.dmn.lab`.
2. In the package you've just created, create a Java class called `Main.java`.
3. Add a `public static void main(String[] args)` method to your main class.
4. Before we implement our method, we first define a number of constants that we will need when implementing our method (note that the values of your constants can be different depending on your environment, model namespace, etc.):

```
 private static final String KIE_SERVER_URL = "http://localhost:8080/kie-server/services/rest/server";
 private static final String CONTAINER_ID = "vacation-days-decisions";
 private static final String USERNAME = "bamAdmin";
 private static final String PASSWORD = "ibmpam1!";
```

   !!! 📘 INFO: If you're using the Linux environment on Skytap use the following.

```
~~~java
private static final String KIE_SERVER_URL = "http://localhost:8080/kie-server/services/rest/server";
private static final String CONTAINER_ID = "vacation-days-decisions";
private static final String USERNAME = "pamadmin";
private static final String PASSWORD = "pamadm1n";
~~~
```

5. KIE-Server client API classes can mostly be retrieved from the `KieServicesFactory` class. We first need to create a `KieServicesConfiguration` instance that will hold our credentials and defines how we want our client to communicate with the server:

```
KieServicesConfiguration kieServicesConfig = KieServicesFactory.newRestConfiguration(KIE_SERVER_URL, new EnteredCredentialsProvider(USERNAME, PASSWORD));
```

6. Next, we create the `KieServicesClient`:

```
KieServicesClient kieServicesClient = KieServicesFactory.newKieServicesClient(kieServicesConfig);
```

7. From this client we retrieve our DMNServicesClient:

```
DMNServicesClient dmnServicesClient = kieServicesClient.getServicesClient(DMNServicesClient.class);
```

8. To pass the input values to our model to the Execution Server, we need to create a `DMNContext`:

```
DMNContext dmnContext = dmnServicesClient.newContext();
dmnContext.set("Age", 16); dmnContext.set("Years of Service", 1);
```

9. We now have defined all the required instances needed to send a DMN evaluation request to the server:

```
ServiceResponse<DMNResult> dmnResultResponse = dmnServicesClient.evaluateAll(CONTAINER_ID, dmnContext);
```

10. Finally we can retrieve the DMN evaluation result and print it in the console:

```
DMNDecisionResult decisionResult = dmnResultResponse.getResult().getDecisionResultByName("Total Vacation Days"); System.out.println("Total vacation days: " +
decisionResult.getResult());
```

11. Compile your project and run it. Observe the output in the console, which should say: **Total vacation days: 27**

    The complete project can be found here

```
package org.kie.dmn.lab;

import org.kie.api.builder.KieScannerFactoryService;
import org.kie.api.internal.weaver.KieWeaverService;
import org.kie.dmn.api.core.DMNContext;
import org.kie.dmn.api.core.DMNDecisionResult;
import org.kie.dmn.api.core.DMNResult;
import org.kie.server.api.model.ServiceResponse;
import org.kie.server.client.CredentialsProvider;
import org.kie.server.client.DMNServicesClient;
import org.kie.server.client.KieServicesClient;
import org.kie.server.client.KieServicesConfiguration;
import org.kie.server.client.KieServicesFactory;
import org.kie.server.client.credentials.EnteredCredentialsProvider;

/**
 * Vacation Days DMN Client
 */
public class Main {

    private static final String KIE_SERVER_URL = "http://localhost:8080/kie-server/services/rest/server";

    private static final String CONTAINER_ID = "vacation-days-decisions";
```

```
    private static final String USERNAME = "bamAdmin";

    private static final String PASSWORD = "ibmpam1!";
    // Comment out the above 2 lines if using the Skytap image and uncomment the two below to use those logins
    // private static final String USERNAME = "pamadmin";
    // private static final String PASSWORD = "pamadm1n";

    public static void main(String[] args) {
        CredentialsProvider credentialsProvider = new EnteredCredentialsProvider(USERNAME, PASSWORD);
        KieServicesConfiguration kieServicesConfig = KieServicesFactory.newRestConfiguration(KIE_SERVER_URL, credentialsProvider);
        KieServicesClient kieServicesClient = KieServicesFactory.newKieServicesClient(kieServicesConfig);

        DMNServicesClient dmnServicesClient = kieServicesClient.getServicesClient(DMNServicesClient.class);

        DMNContext dmnContext = dmnServicesClient.newContext();
        dmnContext.set("Age", 16);
        dmnContext.set("Years of Service", 1);

        ServiceResponse<DMNResult> dmnResultResponse = dmnServicesClient.evaluateAll(CONTAINER_ID, dmnContext);

        DMNDecisionResult decisionResult = dmnResultResponse.getResult().getDecisionResultByName("Total Vacation Days");
        System.out.println("Total vacation days: " + decisionResult.getResult());
    }
}
```

Last update: 2023-12-06

3.4.6 13. Call Centre - Intro and Use Case

This is an advanced Decision Model & Notation lab that introduces DMN Decision Services, Relations, nested boxed expressions, etc. It also explores a number of different FEEL constructs and expressions like, for example, `list contains`.

13.1 Goals

- Implement a DMN model using the IBM Business Automation Manager Canvas DMN editor
- Deploy the existing DMN project to OpenShift

13.2 Problem Statement

In this lab we will create a decision that determines if a call-center can take an incoming call. Whether a call will be accepted by a certain office depends on:

- The office accepts the call.
- There are employees currently available at the office.

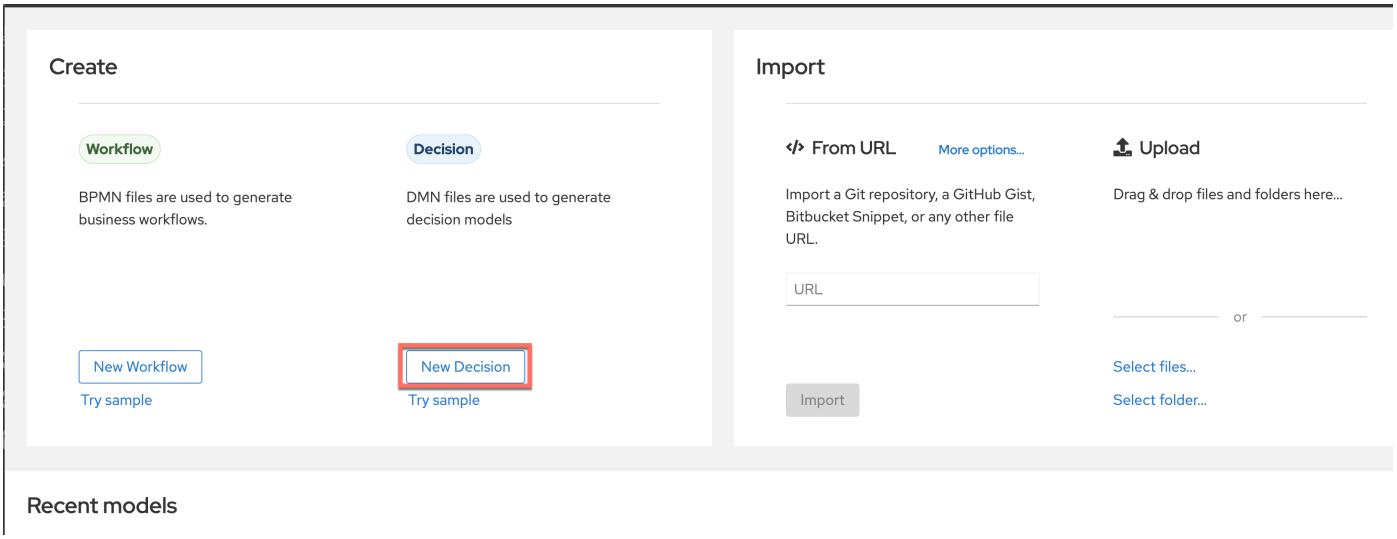
Whether the office can accepts a call depends on:

- whether the phone number has been banned
- the purpose of the phone call ("help" or "objection").

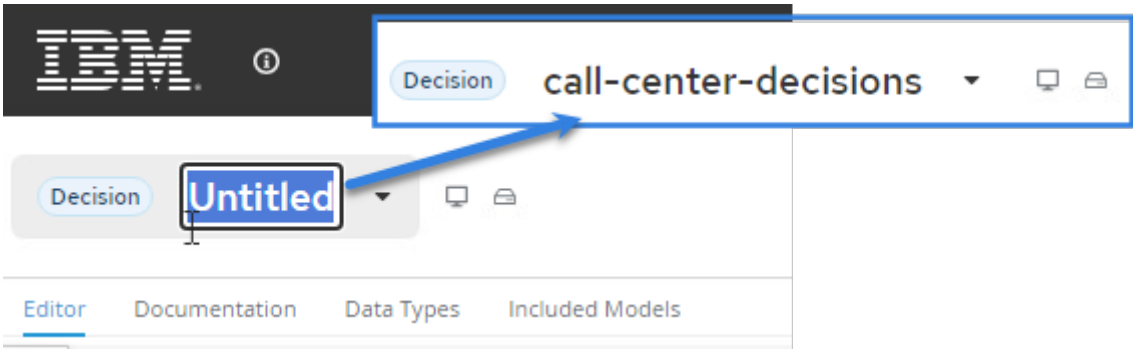
13.3 Create a new DMN Decision

Similar to the first lab, we're going to use IBM Business Automation Manager Canvas to define and deploy a DMN decision model, we first need to create a new model:

1. Navigate to IBM Business Automation Manager Canvas
2. From the IBM Business Automation Manager Canvas landing page, you can create and edit various types of open-standards models in BPMN, DMN and PMML using the editors here. We will be creating a DMN model for this lab, so to do this, you can click **New Decision** to create a new DMN model.



3. You will now have an empty canvas and can start working on your DMN model for designing the number of vacation days decision. Change the name at the top of the model from `Untitled` to `call-center-decisions` or whatever you want to call it.



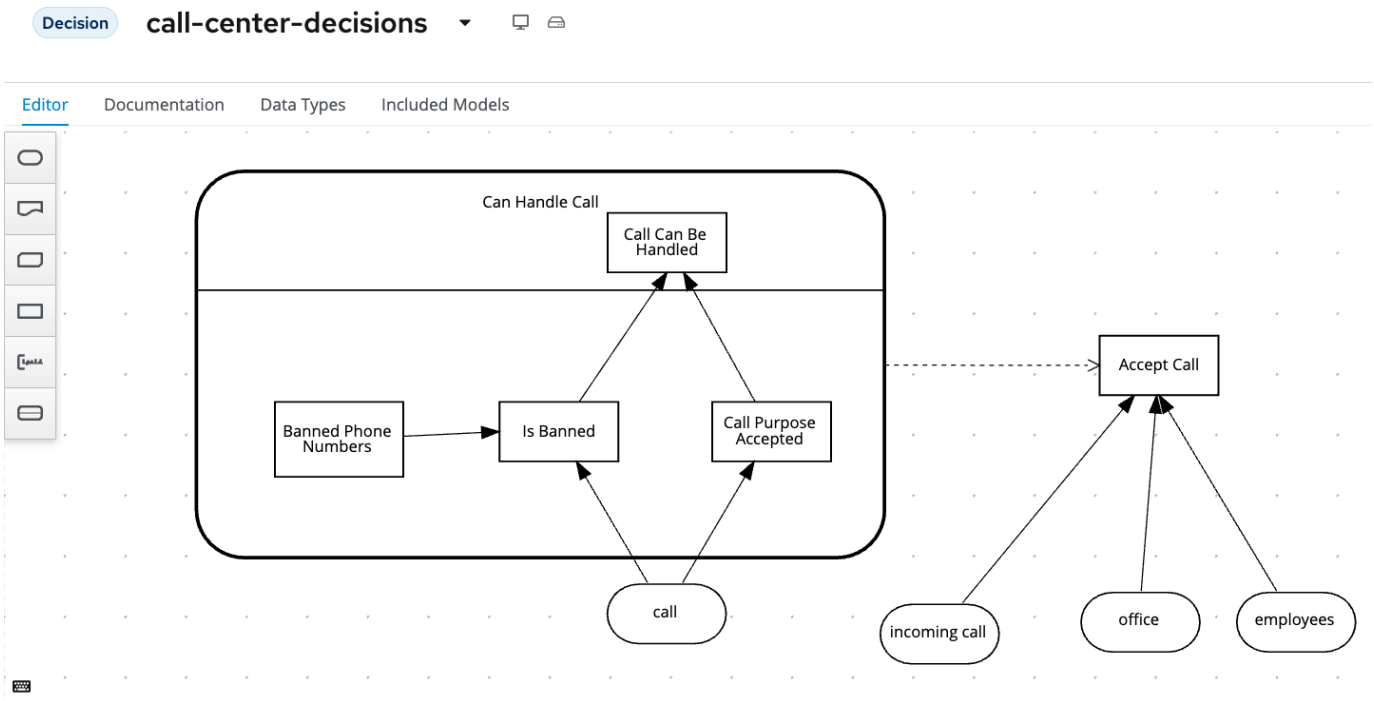
4. In the next section we will start to create the decision.

13.4 Next Steps

You can do this lab in 2 ways:

1. If you already have (some) DMN knowledge, we would like to challenge you to build the solution by yourself. After you've built solution, you can verify your answer by going to the next module in which we will explain the solution and will deploy it onto the runtime.
2. Follow this step-by-step guide which will guide you through the implementation.

To do this on your own without the walk-through your model will ultimately end up looking like the below model with 5 Decision Nodes (*Banned Phone Numbers, Is Banned, Call Purpose Accepted, Call Can Be Handled, Accept Call*). Four of these are built in a Decision Service to control what parts of the decision are exposed when calling the service and ultimately a final decision to *Accept Call*.



Last update: 2023-12-06

3.4.7 14. Authoring the decisioning for the Call Center

With this lab, it is highly recommended to use DMN Runner and while you're building your model and the various custom data types to have the example right next to you. Taking advantage of the tools at hand will make your decision design much smoother and faster!

The problem statement describes a number of different inputs to our decision:

- **Call**: the incoming call into the call-center
- **Employees**: the employees of certain office.
- **Office**: an office to which the call could potentially be routed.

Furthermore, the problem statement describes that phone numbers could be banned. So, also **banned numbers** can be regarded as an input to our model (although we will not implement it as an input in this lab).

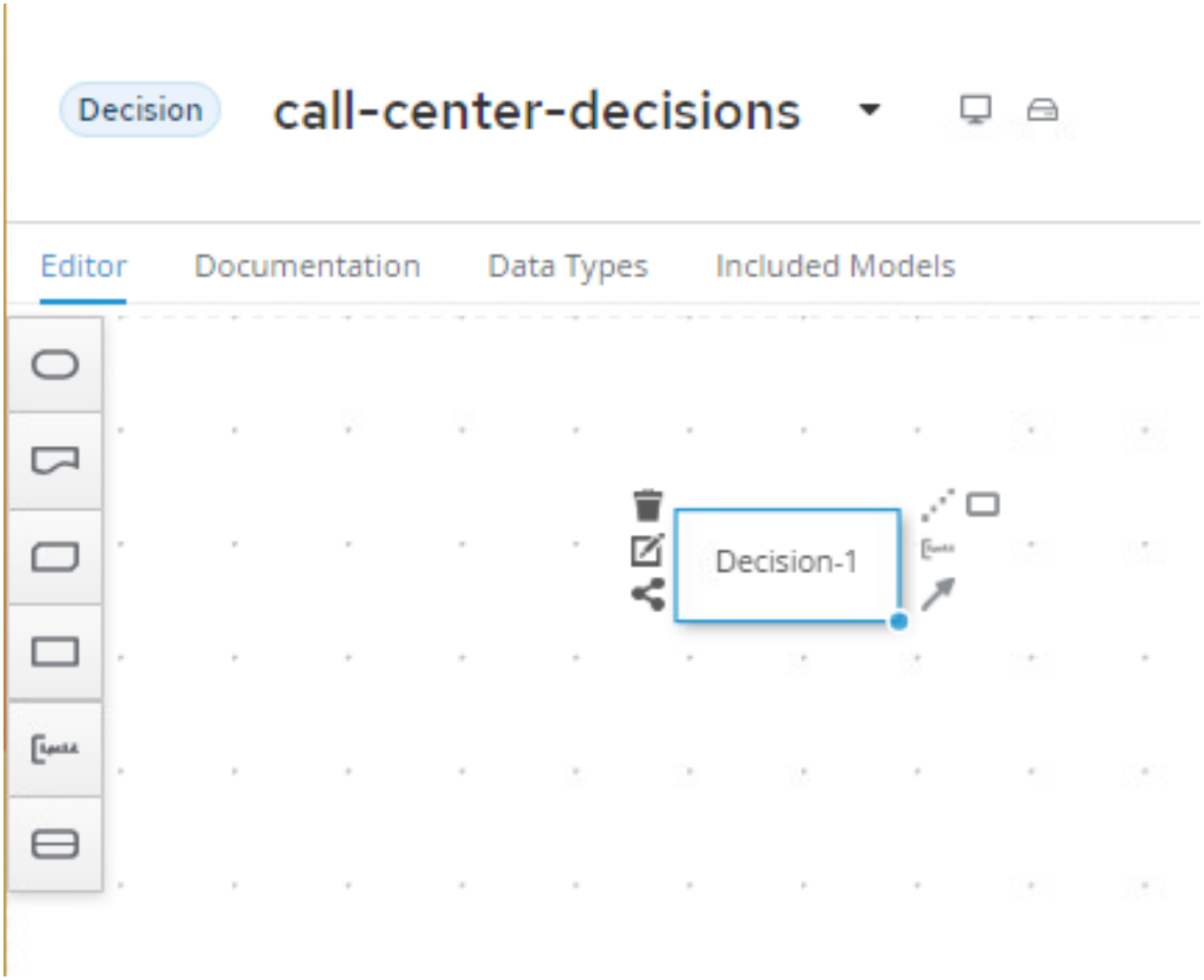
With the given input, we need to make the following decisions:

- **Accept Call**: the final decision we need to make is whether the given office will accept the call.
- **Can Handle Call**: whether the office can actually accept the call. As defined in the problem statement, this depends on:
- whether the phone number has been banned;
- the purpose of the phone call (“help” or “objection”).

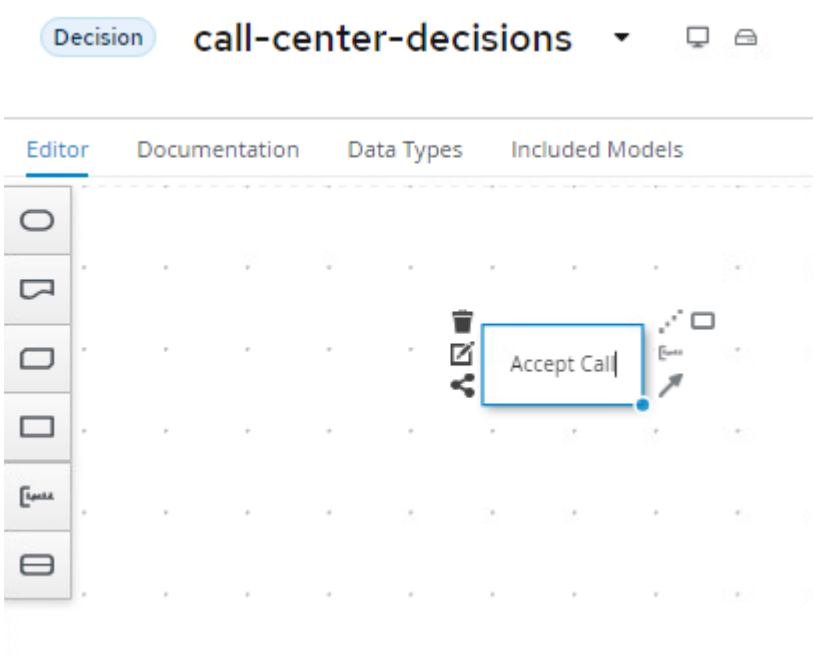
14.1 . Accept Call Decision Structure

• **Accept Call**: the final decision we need to make is whether the given office will accept the call.

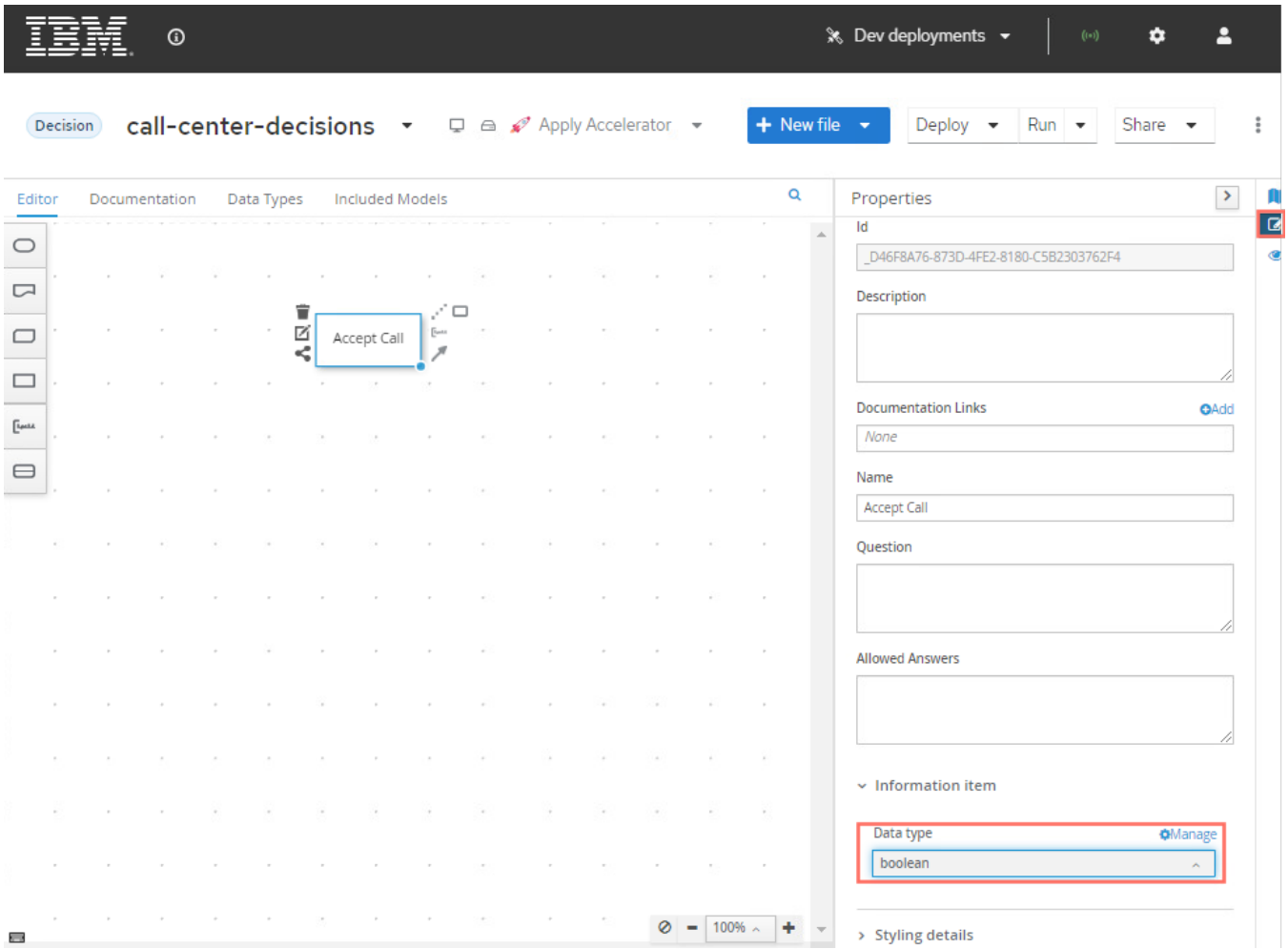
a. Add a **Decision** node to the diagram by clicking on the **Decision** node icon and placing it in the DRD.



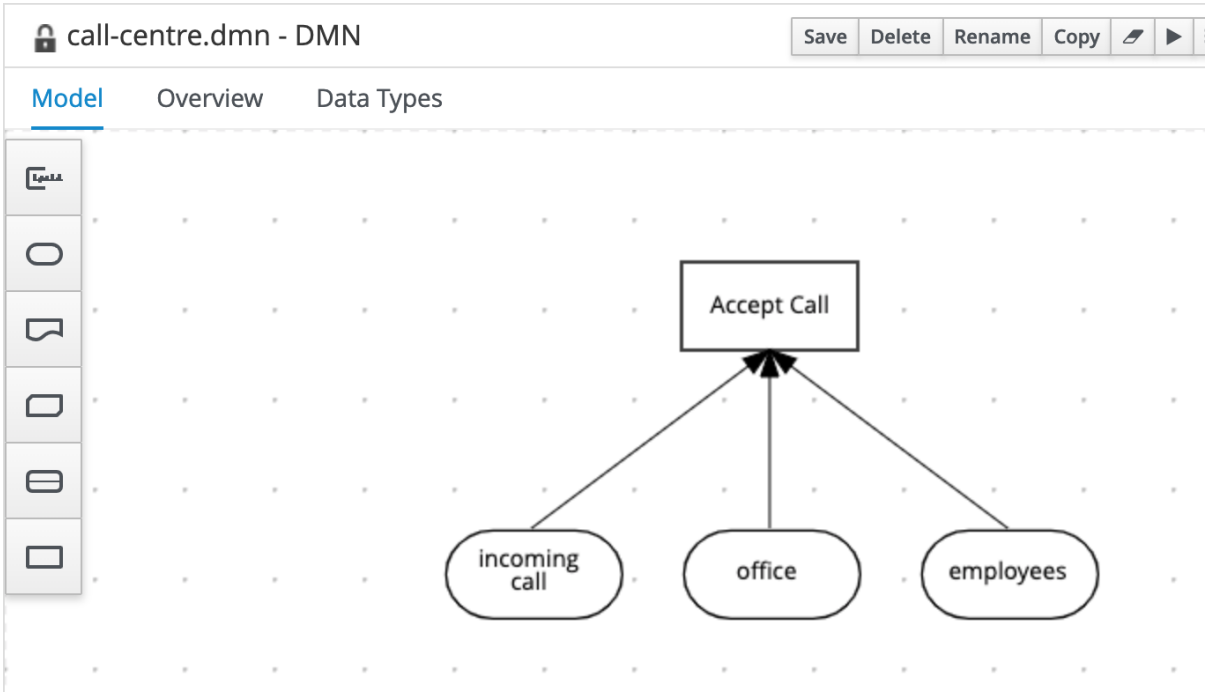
b. Double-click on the node to set the name. We will name this node `Accept Call`.



c. With the `Accept Call` node selected, open the property panel. Set the **Output data type** to `boolean`.

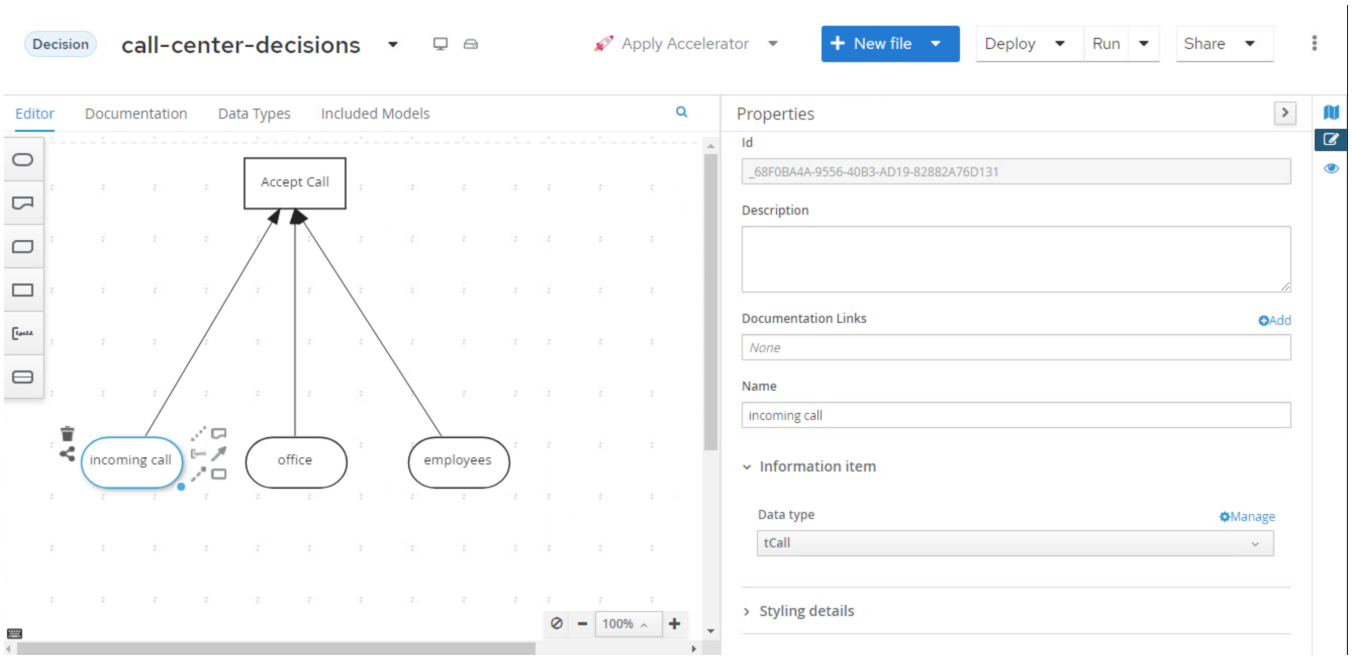


d. The input of this decision is the **incoming call**, **office** and **employee**. Create these 3 input nodes and connect them to the **Accept Call** decision.

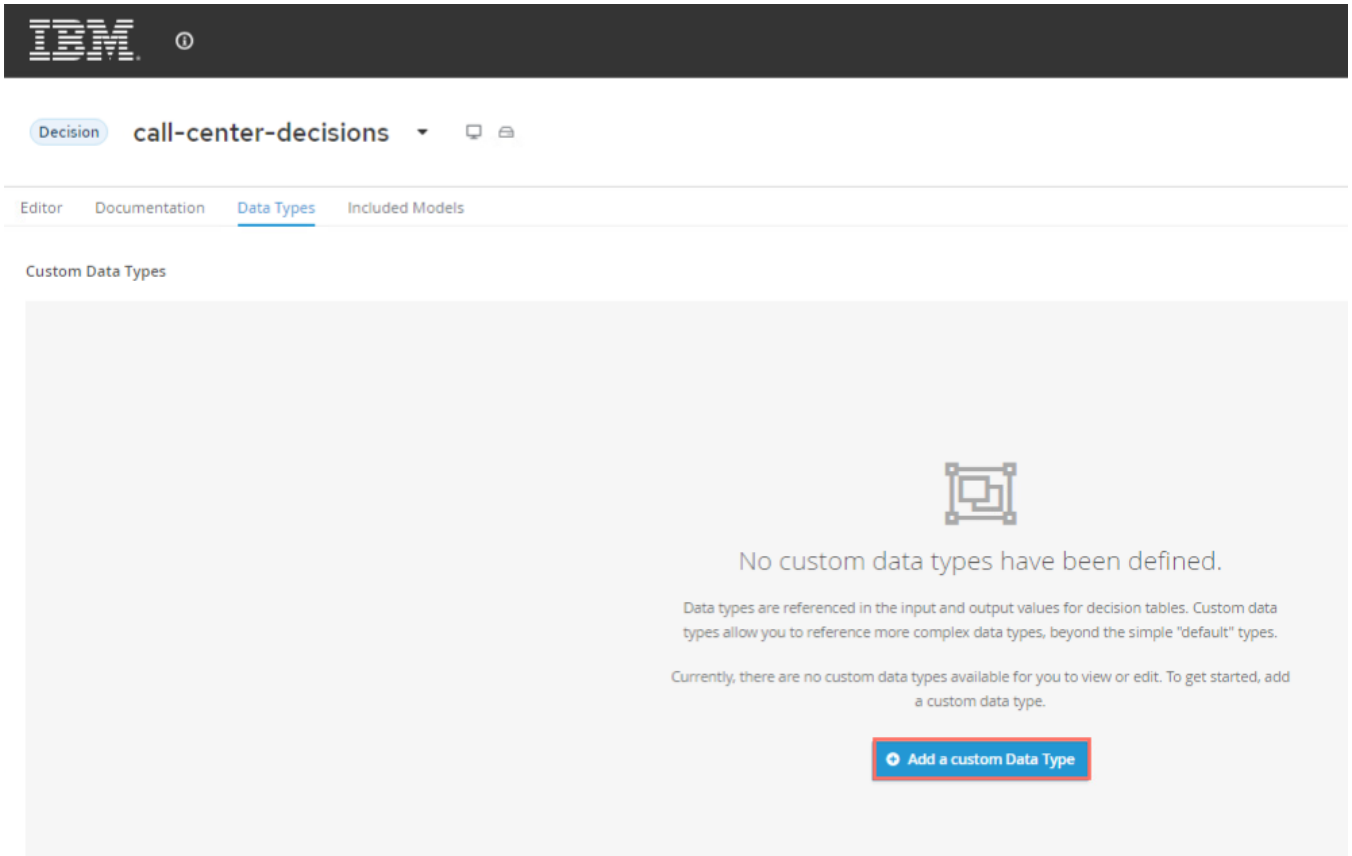

call-centre.dmn - DMN
Save
Delete
Rename
Copy
Model
Overview
Data Types
Accept Call
incoming call
office
employees

e. We can now set data types of our input nodes.

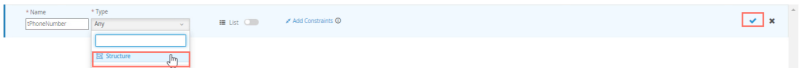
i. Click on the `incoming call` node, open the property panel and in the **Output data type** section and click on the **Manage** button. This will open the **Custom Data Types** window.



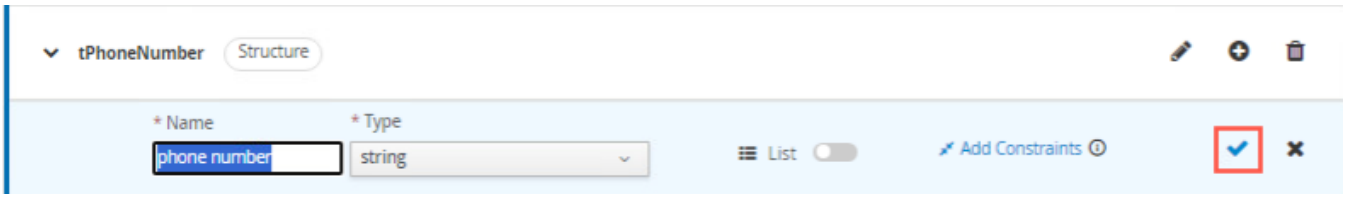
ii. In the **Custom Data Types** window, click on the **+ Add** button.



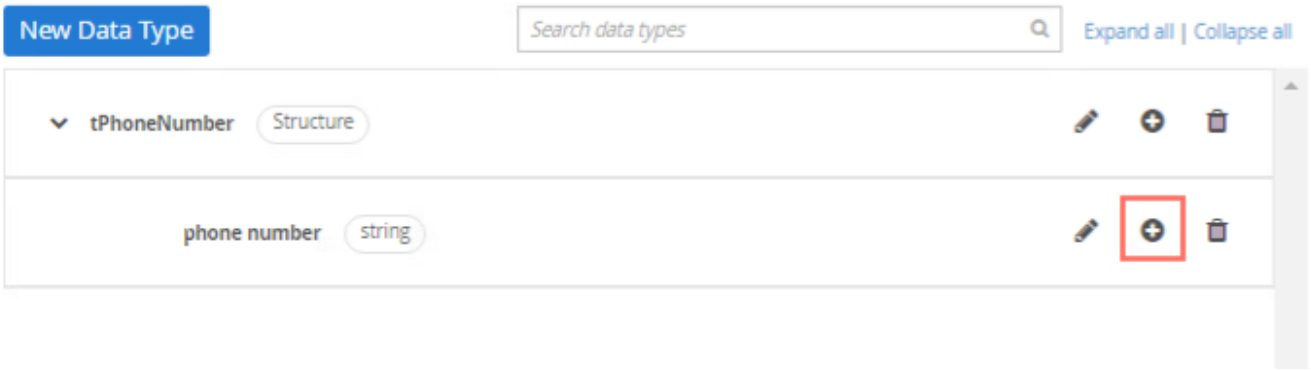
iii. Define the data type `Phone Number` as a structure and be sure to press the blue checkmark.



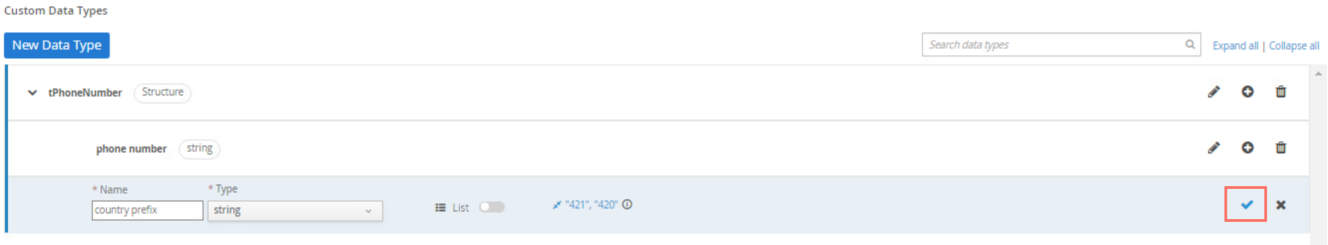
iv. When you click the blue checkmark, a new row will open for the next type, for the first element, call it `phone number` with type `string` and then press the blue checkmark.



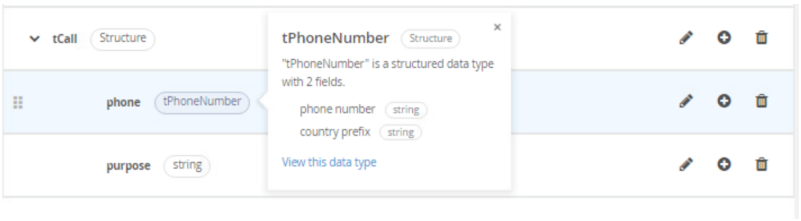
v. Now to create one more item, press the plus sign in the circle that appears where the checkmark was.



vi. For this data type call it `country prefix` with a type `string`. You can add a constraint to the limited values if you want, but not required, the example will use "+421" and "+420". These are more used for the forms rendering than anything else at this time. Make sure you check the blue checkmark when you're finished.

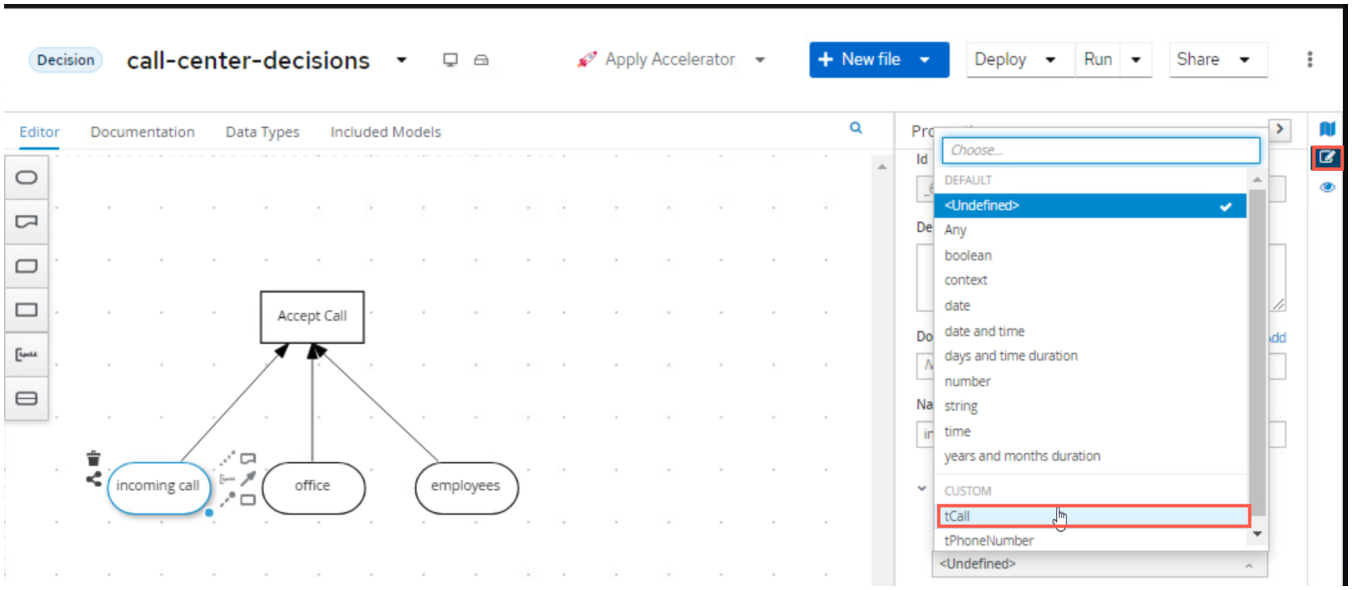


vii. Define another data type `tCall` as a **Structure** which will contain both the `tPhoneNumber` structure and an additional field `purpose` of type `string`:

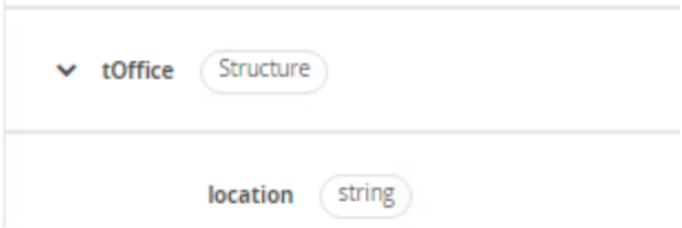


viii. When you've created the `tCall` type, go back to the DRD by clicking on the **Editor** tab.

ix. Select the `incoming call` node, and in the property panel, under **Information item**, set the node's **Output data type** to `tCall`



f. Next, define the following data type similar to `tCall` called `tOffice` with a field `location` and set it as the **Output data type** of the `office` input as such:



g. Define the data type for `employees` as follows. Note that we've first defined the type `tEmployee`, and afterwards we've defined `tEmployees` as a `List` of `tEmployee`.

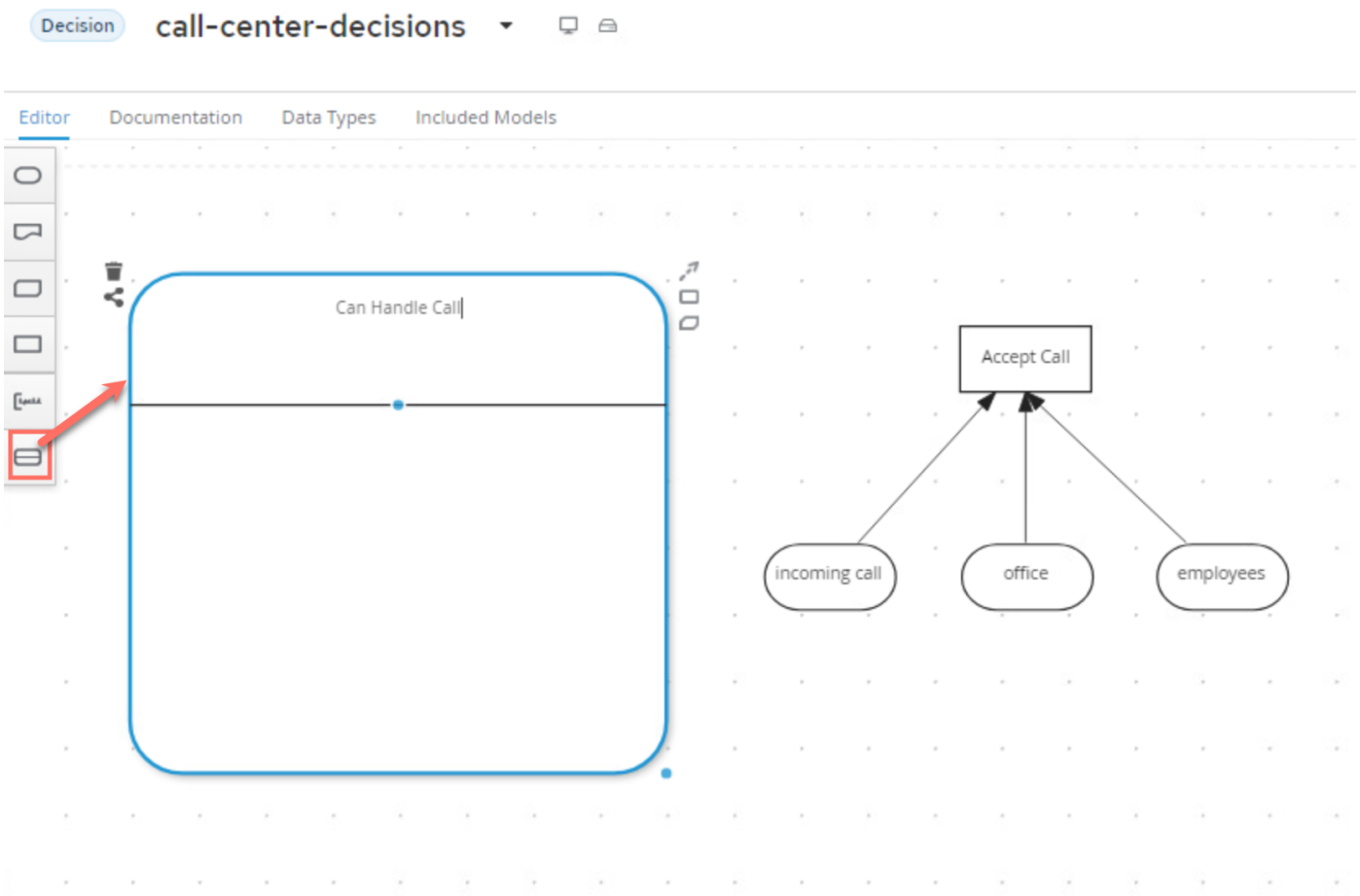
14.2 Decision Service

With the main structure defined, we can now look at the requirements of the decision whether the office can actually accept the call. As defined in the problem statement, this depends on:

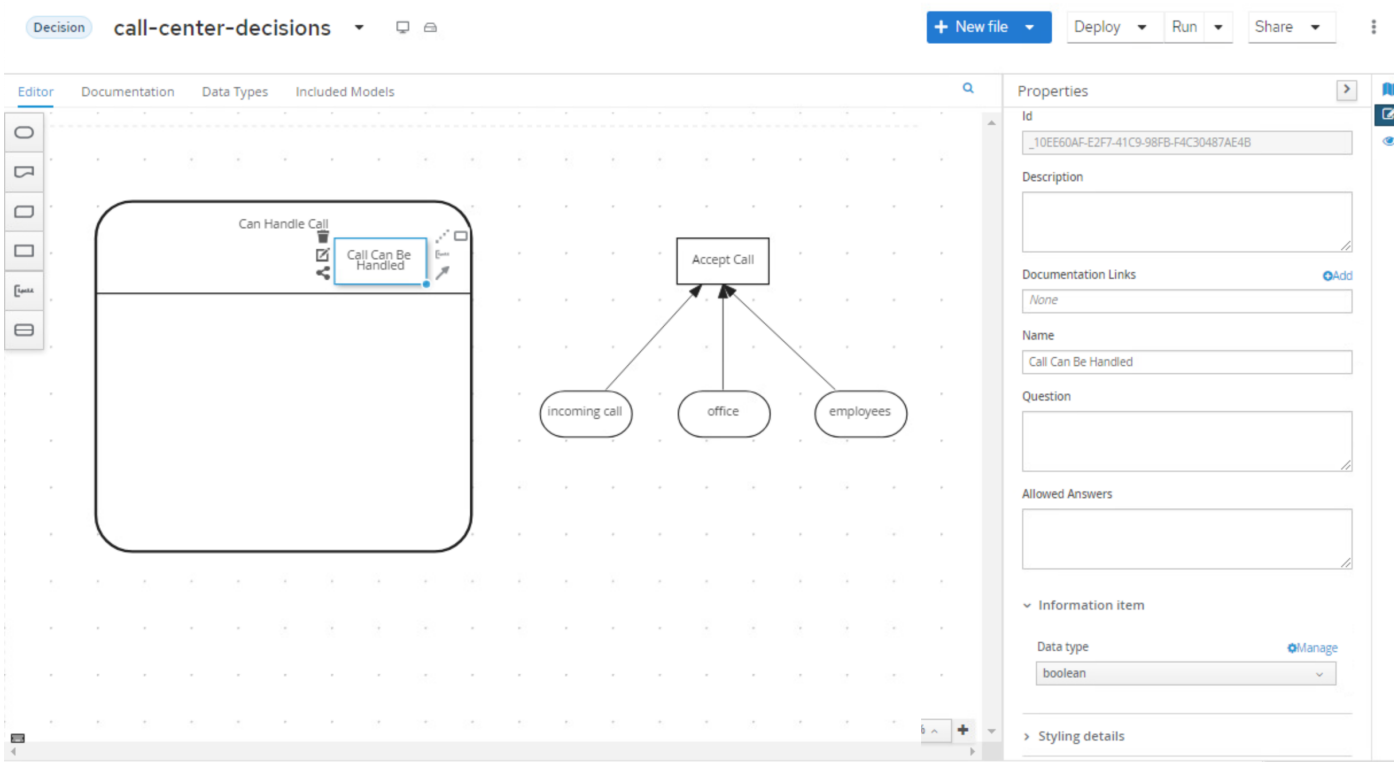
- whether the phone number has been banned.
- the purpose of the phone call ("help" or "objection").

We will model this decision as a DMN **Decision Service** that can be called by our main decision `Accept Call`.

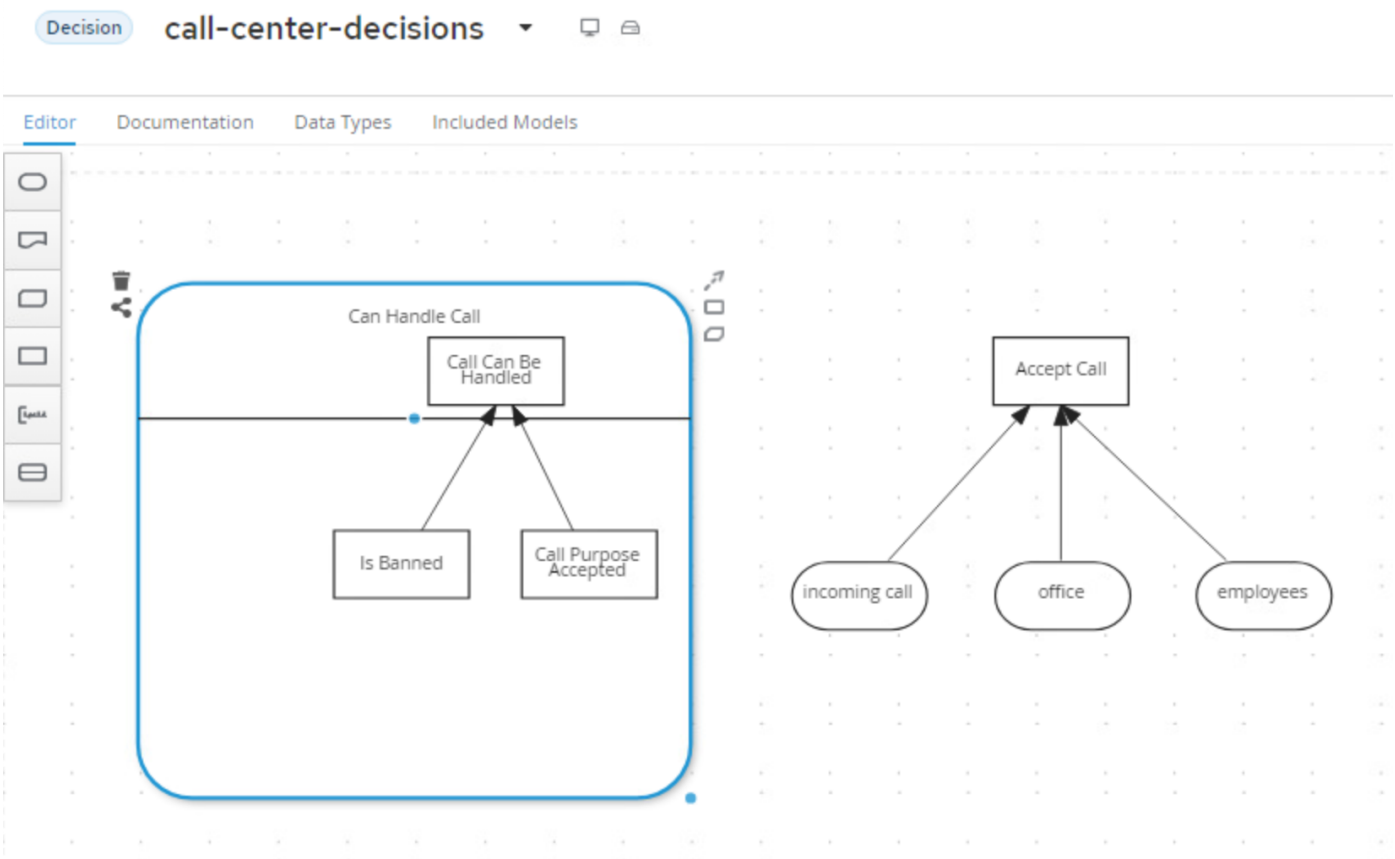
1. First, model the **Decision Service** in the DRD and give it the name `Can Handle Call`. Set it's **Output data type** to `boolean`.



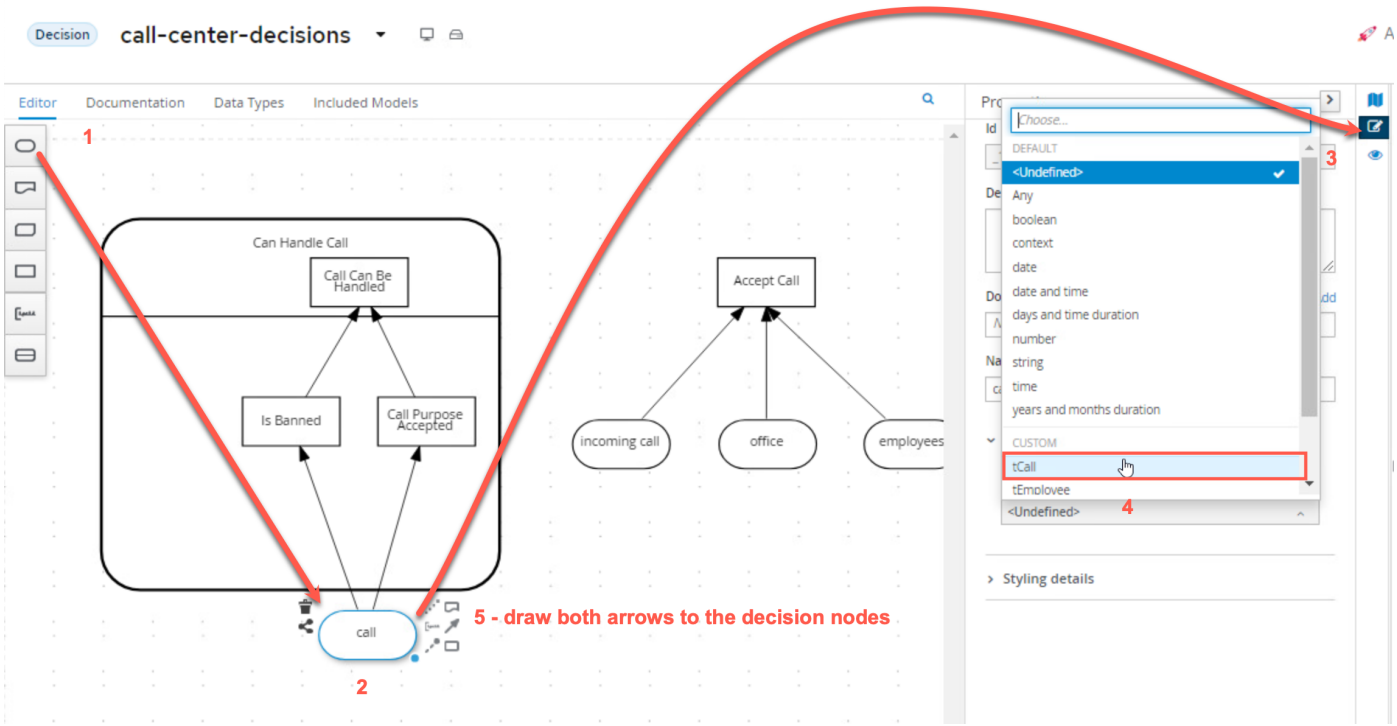
2. Add a **Decision Node** to the **Decision Service**. Name it `Call Can Be Handled` and set it's **Output data type** to `boolean`.



3. Add 2 additional **Decision Nodes** and name them `Is Banned` and `Call Purpose Accepted`. Both should have an **Output data type** of type `boolean`. These will be put "below the bar" on the Decision Service node, so the decisions will be evaluated, but the results will not be passed back from final service by default.
4. Connect the 2 **Decision Nodes** to the `Call Can Be Handled` node.



5. The input to both the `Is Banned` and `Call Purpose Accepted` decisions is going to be a separate item called `call`. You will create the input node called `call` with data type `tCall`. While it will look like you're creating a separate call item here (and that is definitely how it looks), this decision service could be called independently of the whole service, which is why this call object can be used. Later in the lab, you will see how this ultimately works!


Decision
call-center-decisions
Editor
Documentation
Data Types
Included Models
1
Can Handle Call
Call Can Be Handled
Is Banned
Call Purpose Accepted
call
2
Accept Call
incoming call
office
employees
5 - draw both arrows to the decision nodes
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DEFAULT
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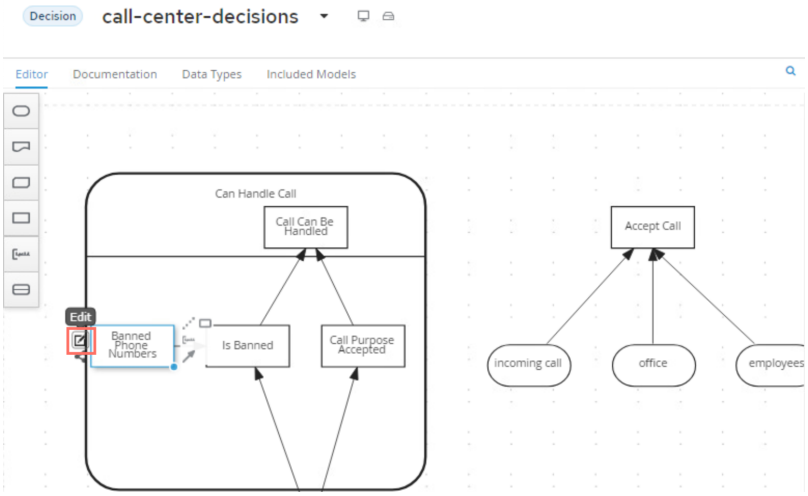
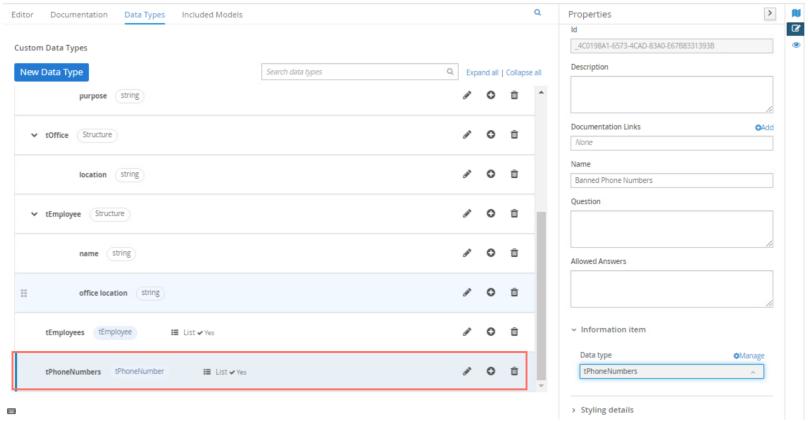
Any
boolean
context
date
date and time
days and time duration
number
string
time
years and months duration
CUSTOM
tCall
tEmolovee
<Undefined>
3
4
Styling details

6. The `Is Banned` decision also needs a collection of banned phone numbers. Instead of implementing this as an **Input** node, we will implement this as a DMN **Relation Decision**.

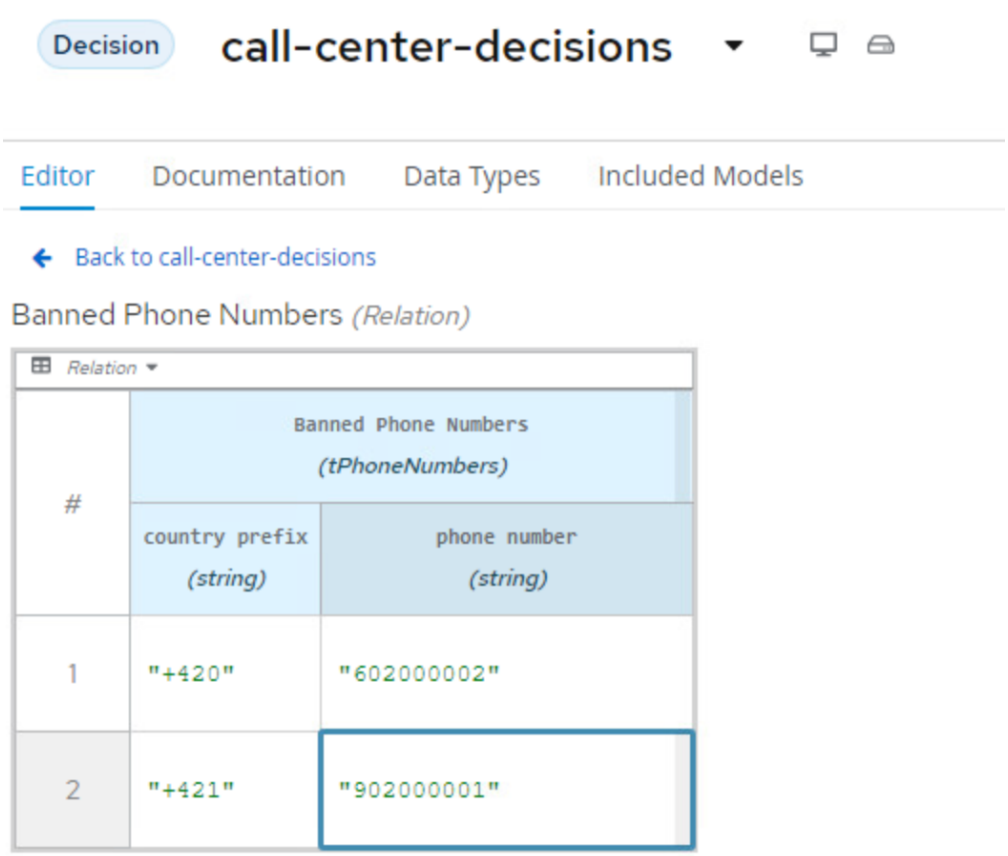
a. Create a new **Decision Node** and name it `Banned Phone Numbers`. Connect it to the `Is Banned` decision node.



b. The **Ouput data type** of this nodes is a new custom data type, which is a list of `tPhoneNumber`. We'll name this type `tPhoneNumbers`, similar to how `tEmployees` was setup before:

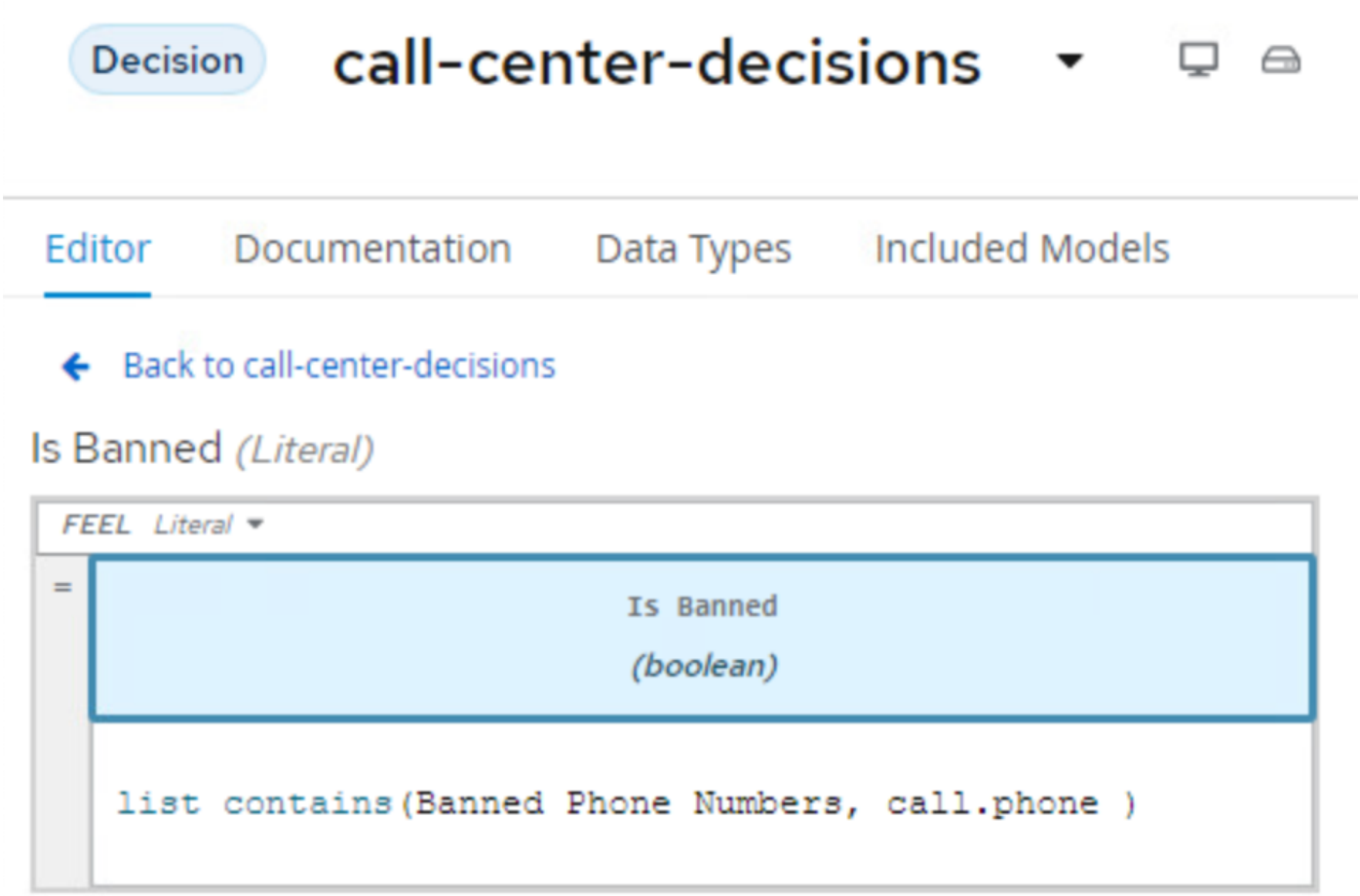


c. Click on the **Edit** button of the `Banned Phone Numbers` node. Set the **logic type** of the decision to `Relation`. Create the following table, you will need to add one extra column and use the headers as shown of `country prefix` with type `string` and `phone number` with type `string`:

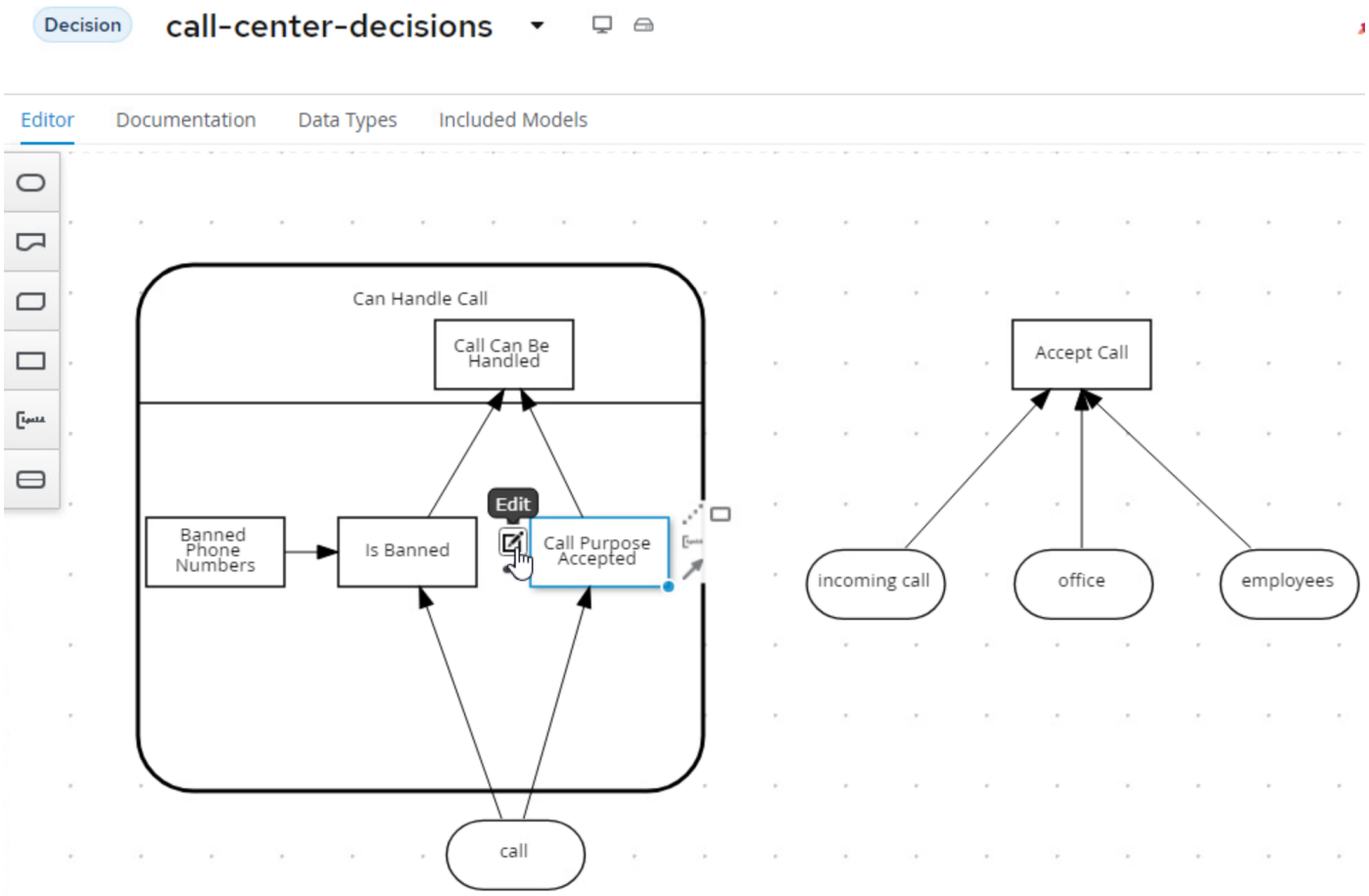


7. We can now implement the logic of the `Is Banned` decision. Click on the **Edit** button of the decision node. We will implement the logic as a **Literal Expression**. Define the following FEEL expression as below showing that we're going to take the Relational List from `Banned Phone Numbers` and comparing it to `call.phone` which is using the tCall's phone number input:

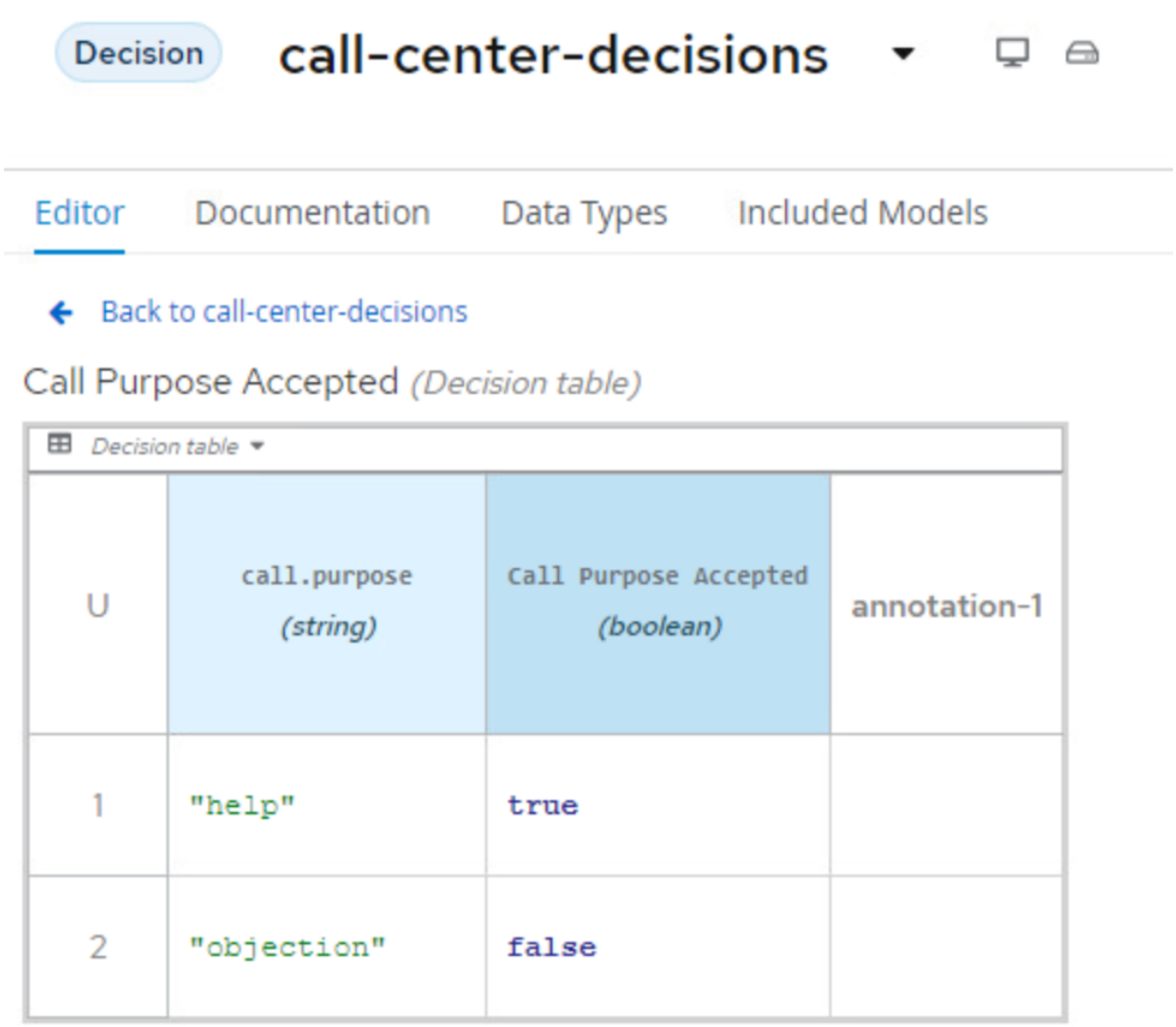
```
list contains(Banned Phone Numbers, call.phone)
```



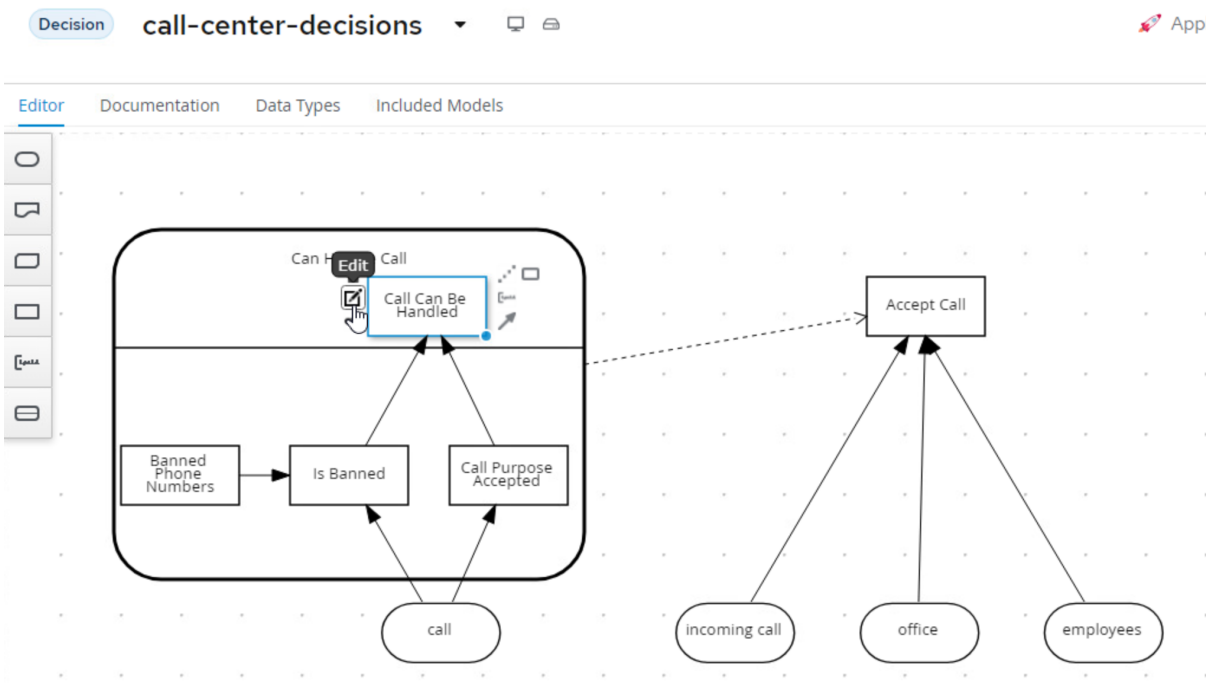
8. The next node for which we want to implement the decision logic is `Call Purpose Accepted`. Click on the node, and click on the **Edit** button.



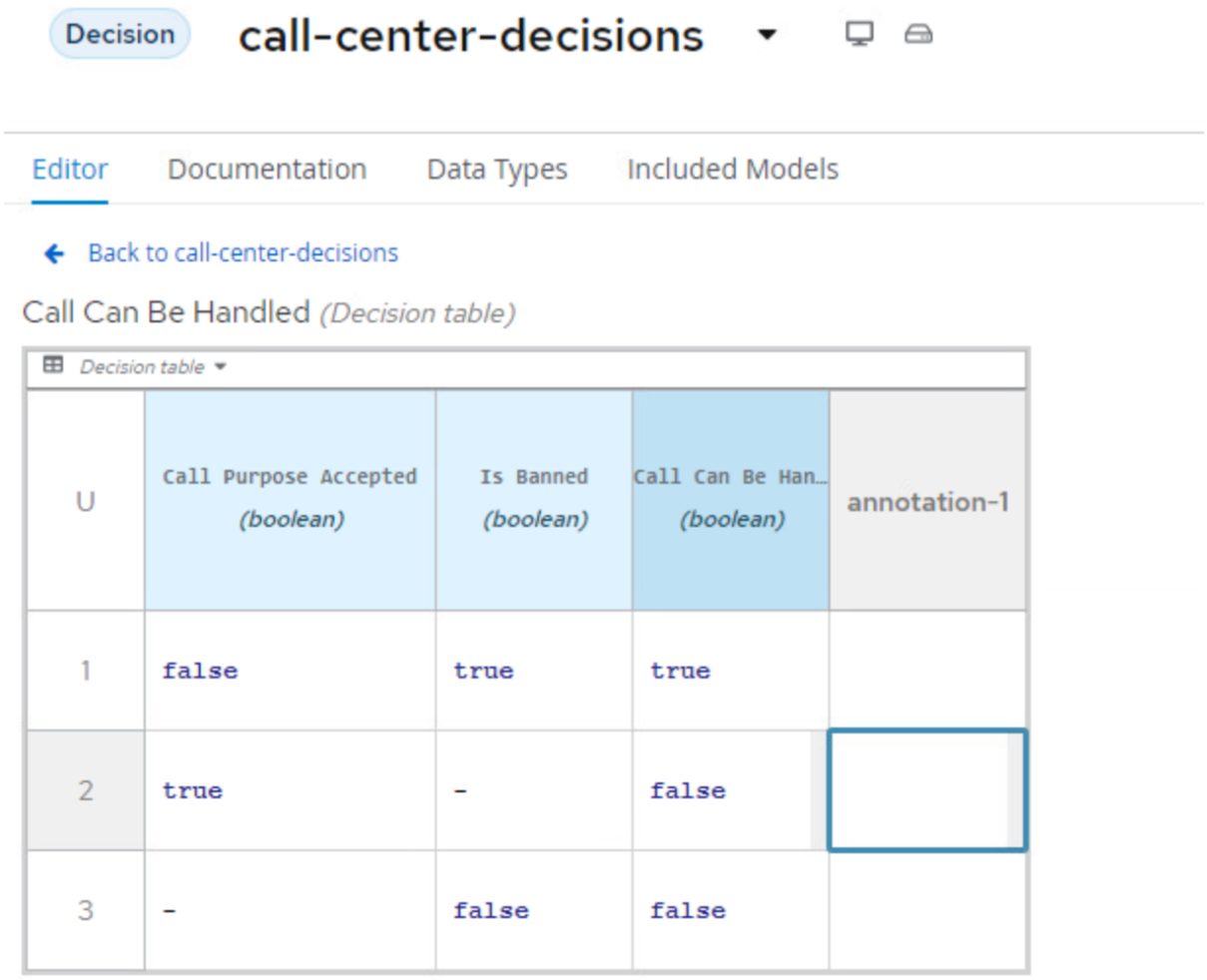
9. Implement the following logic as a **Decision Table**:



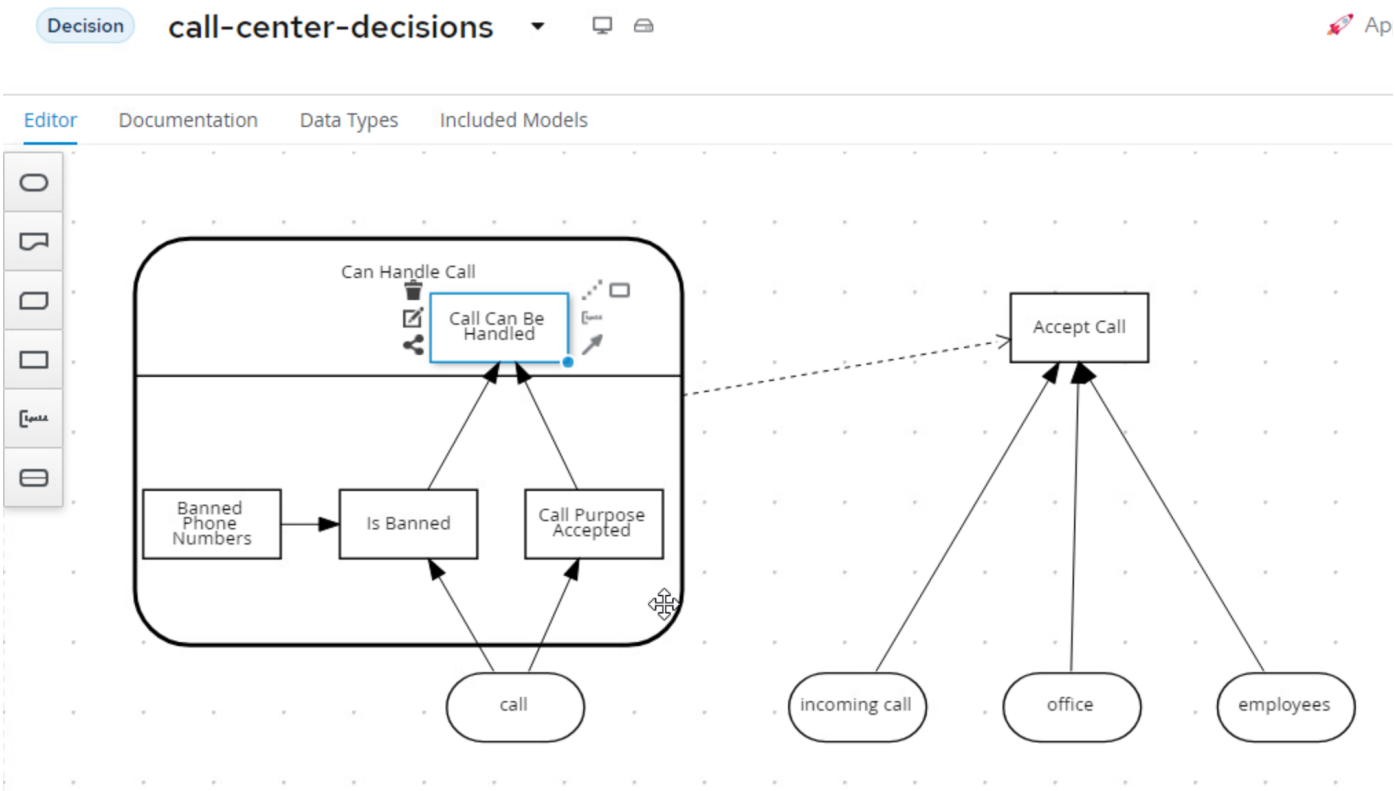
10. Click on the `Call Can Be Handled` node and click on the node's **Edit** button.



11. In the decision editor, click the **Select expression** to **Decision Table** and implement the following table:

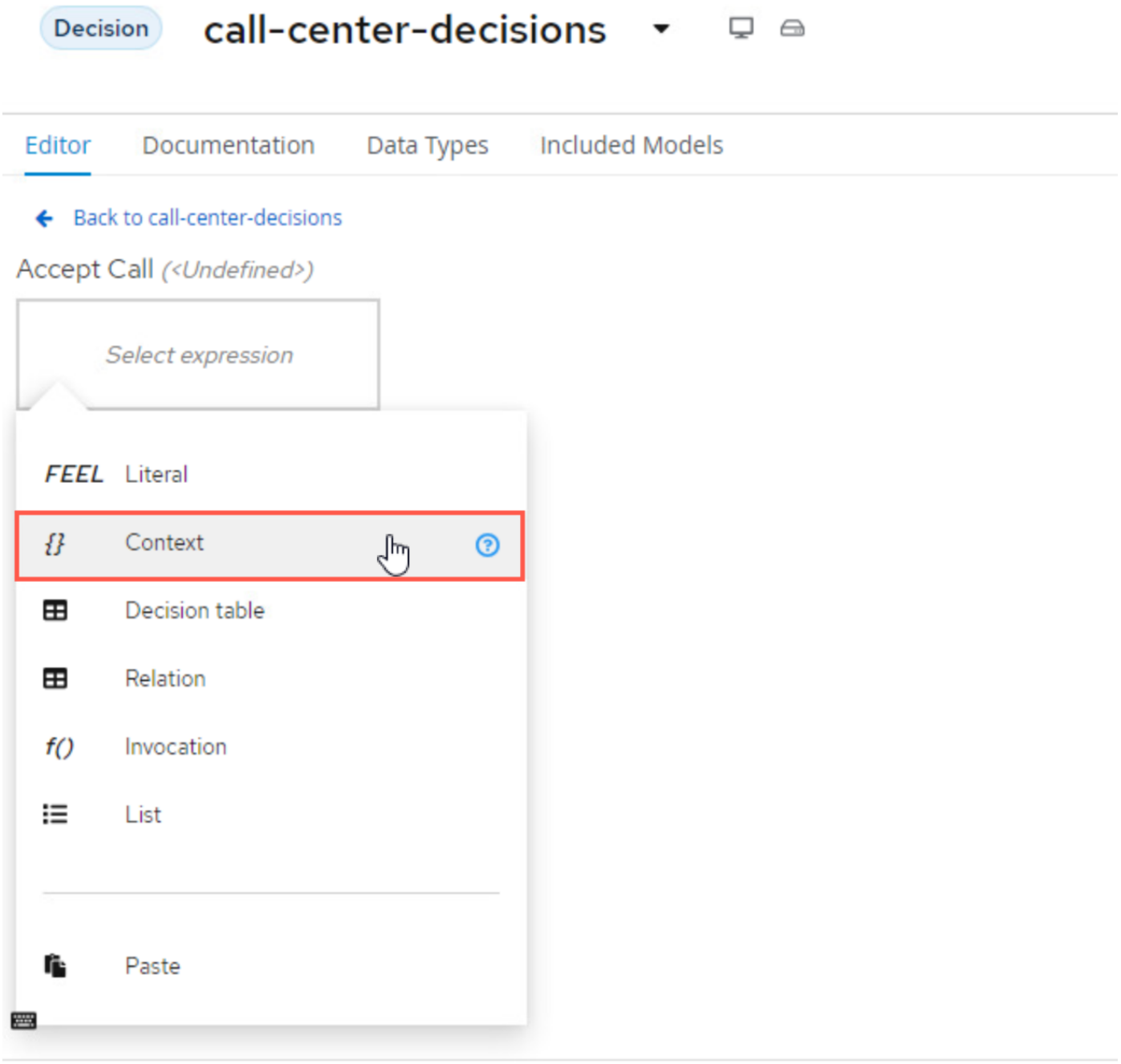


12. We can now implement the decision of `Accept Call Decision`. To do this we need to link the Decision Service to the `Accept Call`, to do this, you will click the outside of the Decision Service node and use the `Create DMN Knowledge Requirement` to connect the Decision Service to the `Accept Call`.

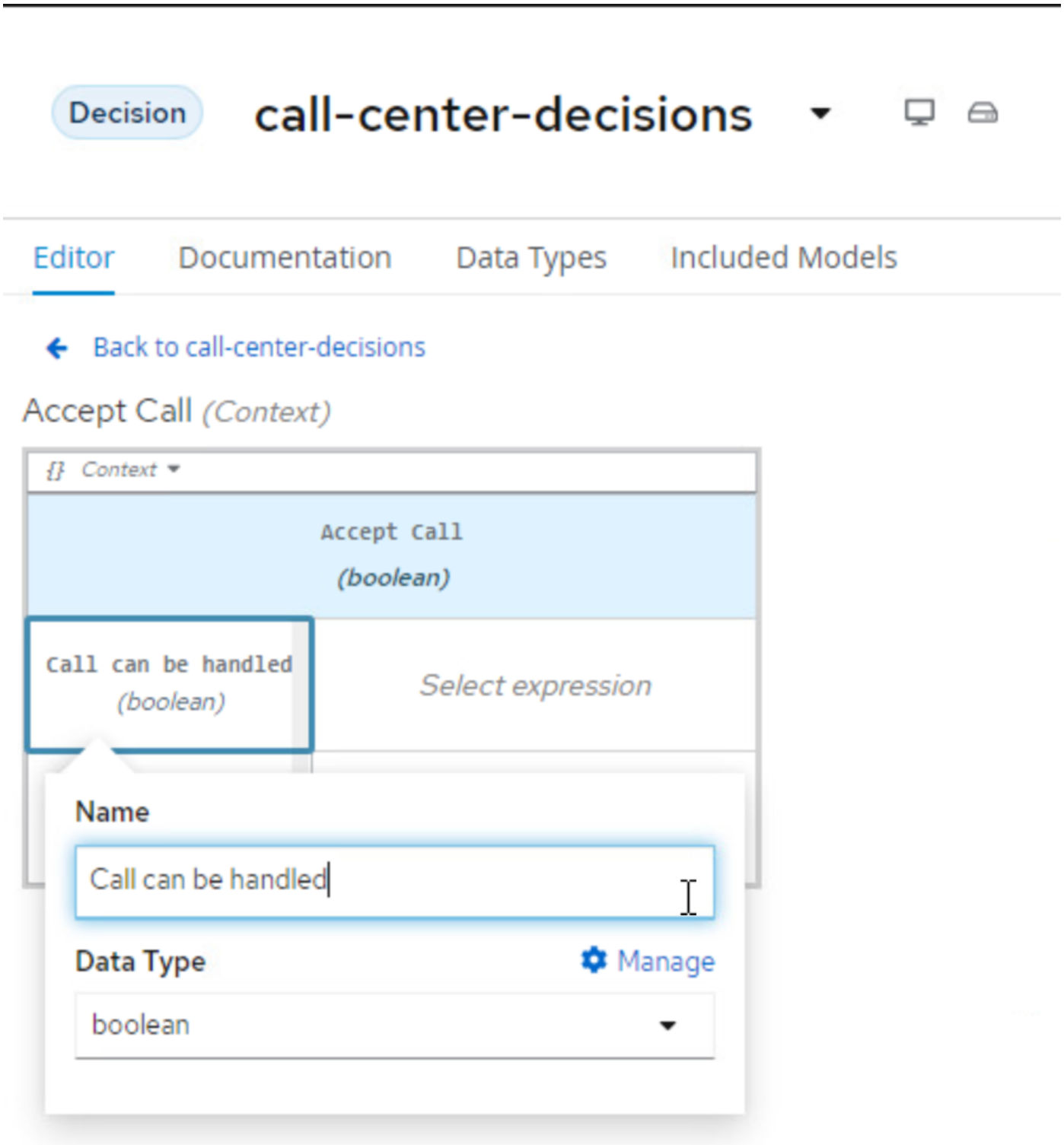


14.3 "Accept Call" Decision Logic

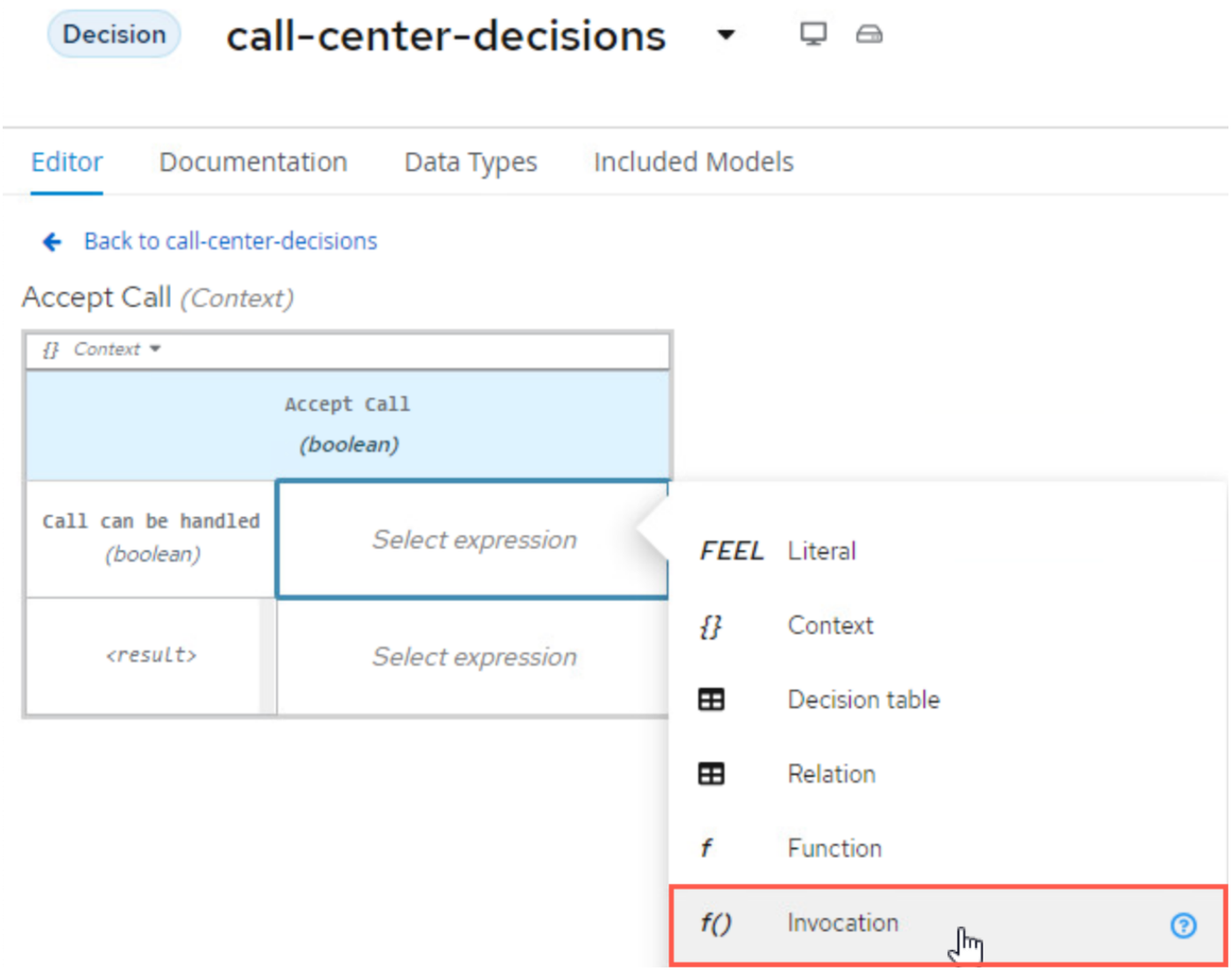
1. Finally we need to Implement the `Accept Call` decision. This is going to be built as a `Context` since this can be built as a boxed expression that will have multiple steps yielding the final decision to either Accept or Deny the call!



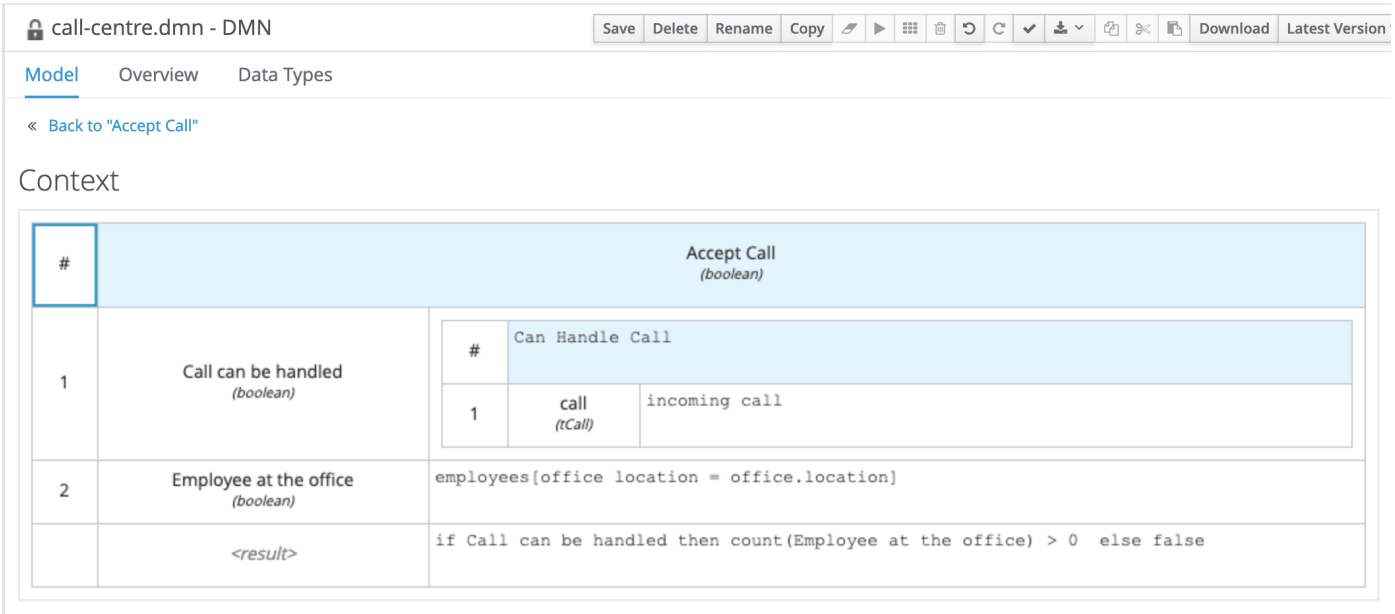
2. With the Context now the Decision Type. The first row is going to be `Call can be handled` with type `boolean`.



3. Now we need to set the expression for the first row, this is going to be of type `Invocation`.



4. For the invocation, we need to use it to call the Decision Service that was created.

5. 

Notice that the line 1 is the invocation of the decision service "Can Handle Call". This is an **Invocation** of the `Can Handle Call` service, passing the `incoming call` input as the variable `call`. The output of this invocation will be the `boolean` variable `Call can be handled`. This will be done using a Literal FEEL function to do this.

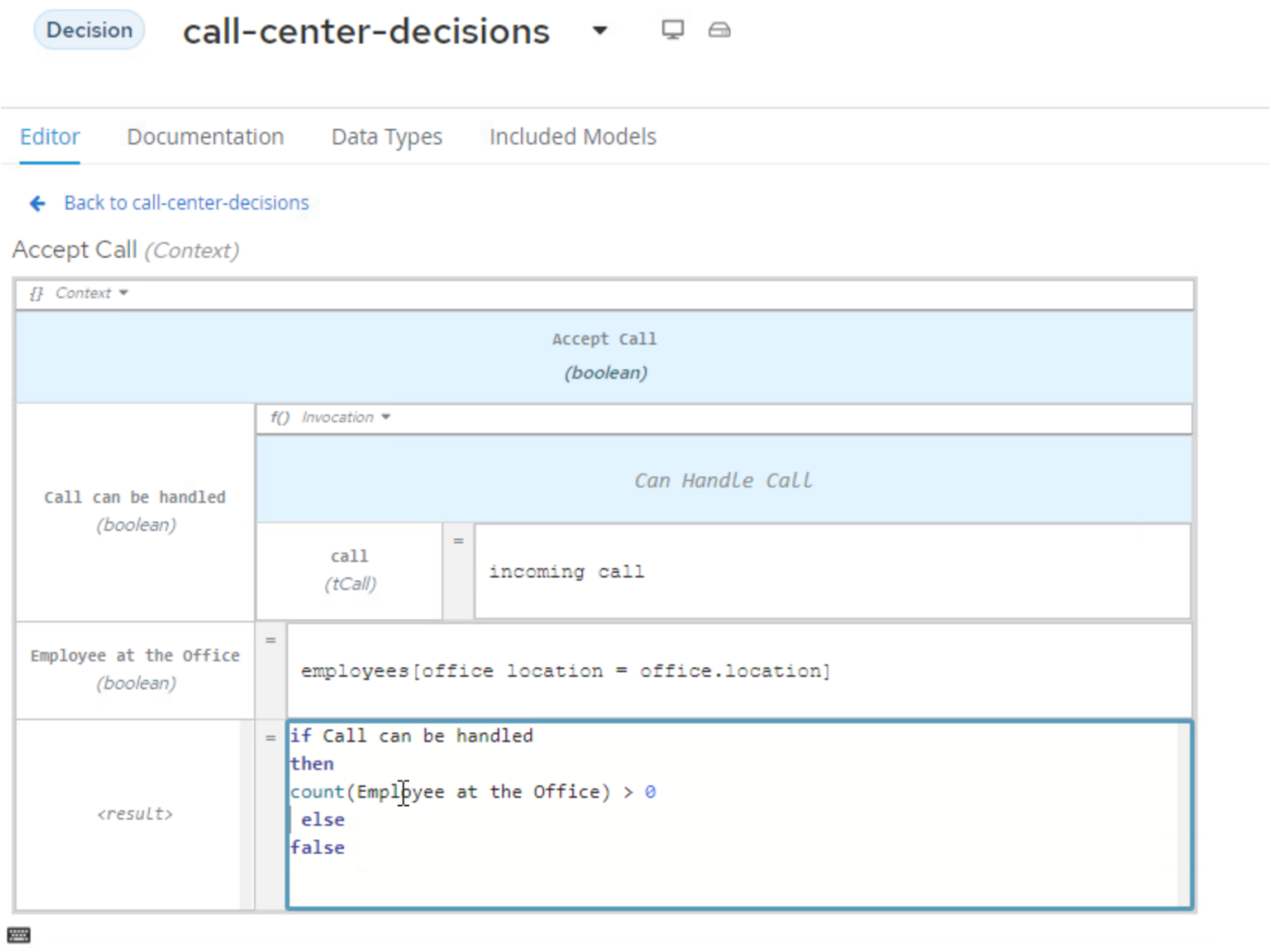
1. Next create a new line with a data type `Employee at the Office` with data type `boolean`. Set the expression as another Literal expression. In this function, you will be mapping the Office locations of the employees who are working to the location of the office location. Since this is a list, you're essentially getting a collection of the employees office location and the location of the office that the call is coming from and trying to map them.

```
employees[office location = office.location]
```

2. After this is set, the last row, `<result>` can be set with a `Literal` expression again with the following:

```
if Call can be handled then count(Employee at the Office) > 0 else false
```

The `Call can be handled` variable as then used to validate the decision result in the last line.



14.4 Next steps

Next, we should deploy the project in OpenShift as a sample service.

Last update: 2023-12-06

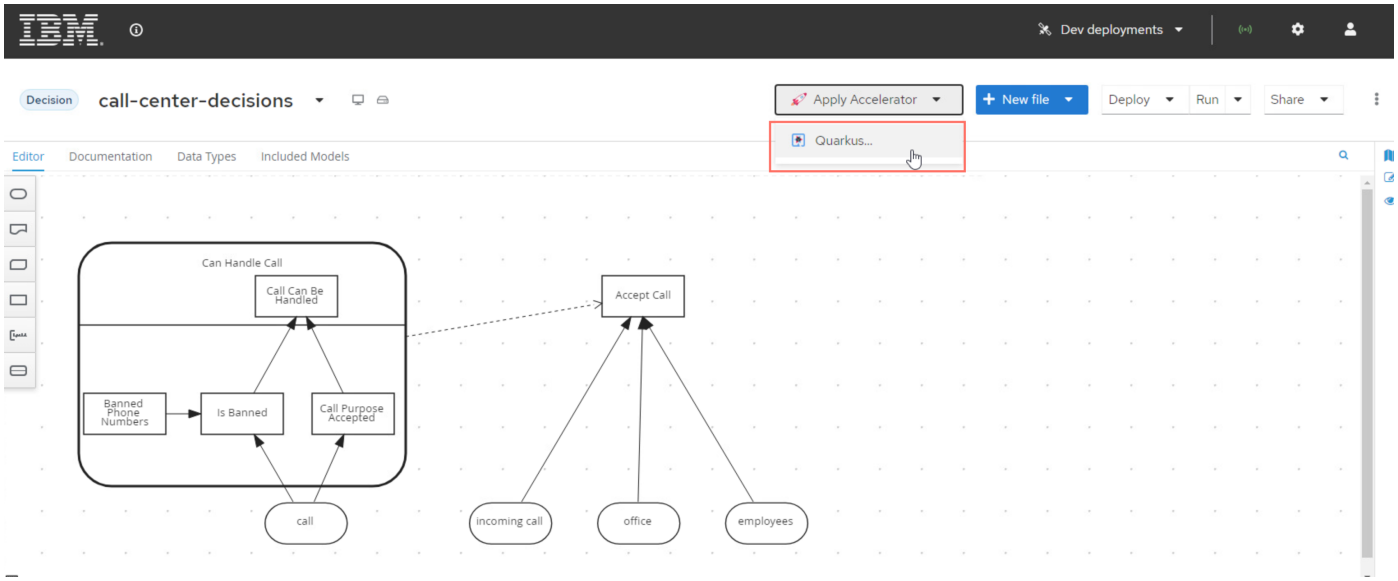
3.4.8 15. Deploying and testing the Decision Service

With our decision model completed, we can now package our DMN model in a Kogito service. This can be done using the Accelerators included with IBM Business Automation Manager Canvas. These accelerators will quickly take the DMN file and start building the basis of the project as a IBM Business Automation Open Edition 9.0 compatible decision service.

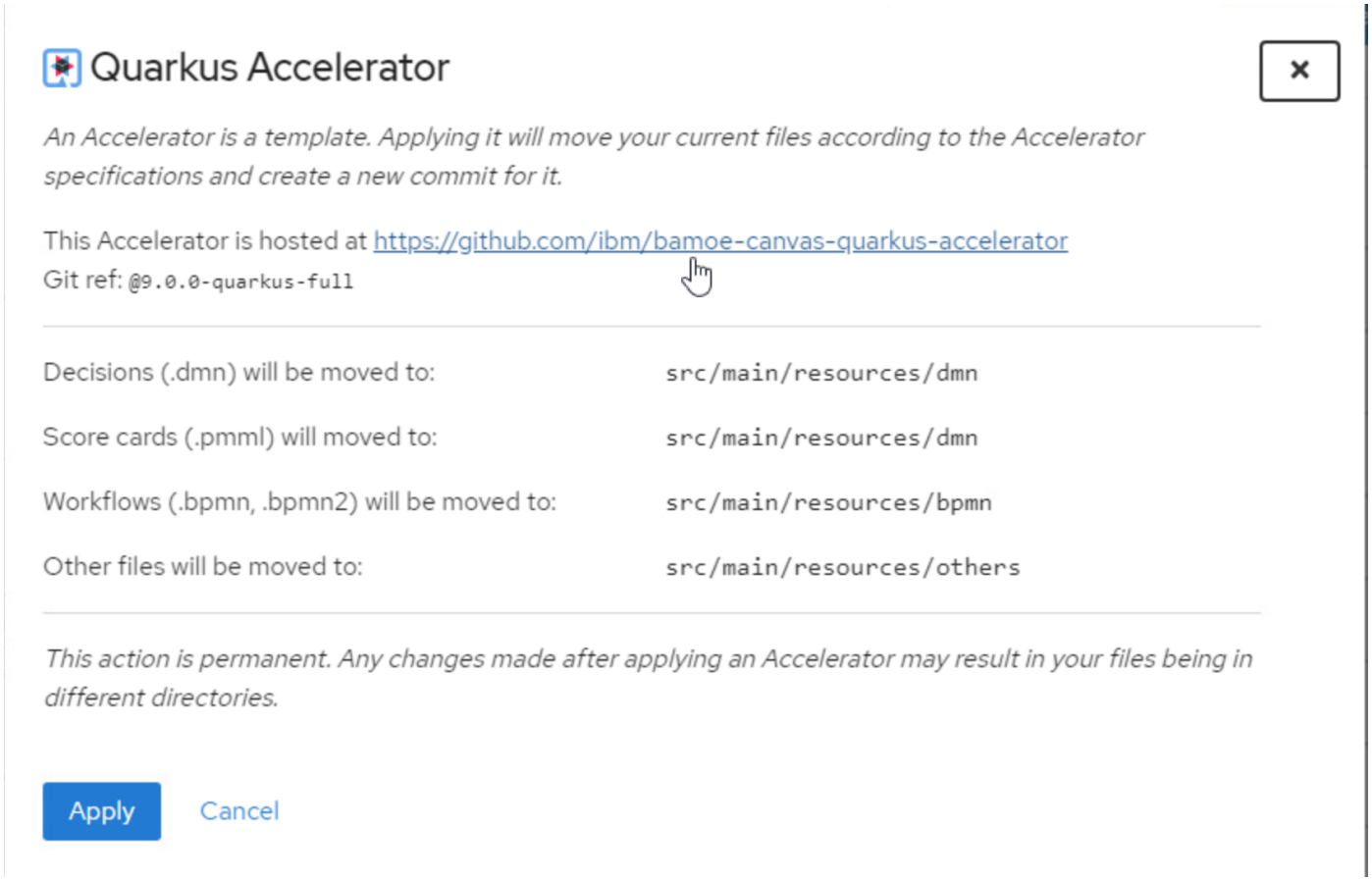
15.1 Applying the Accelerator

To take this decision service from a standalone DMN model to a full Kogito architected decision, you will use the accelerator by clickig the button at the top of the screen. To do so follow the instructions and then we will synchronize the project to your GitHub account and also be capable being deployed as an OpenShift service.

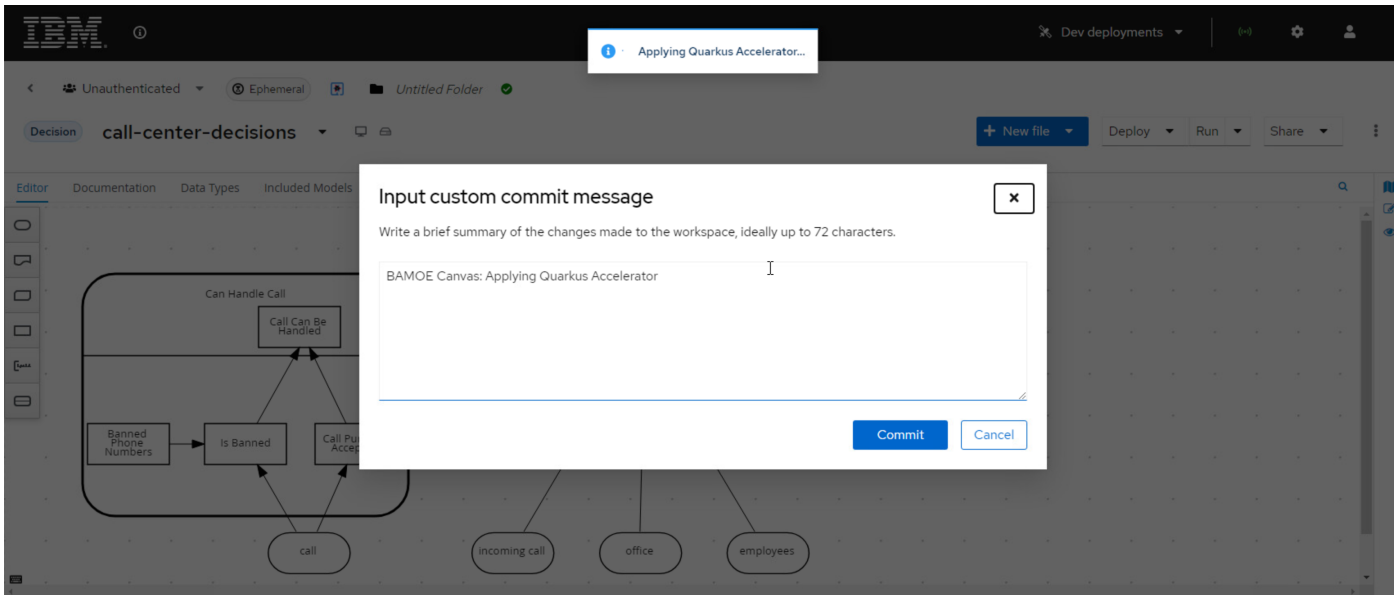
1. At the top of the DMN model page for `call-center-decisions`, click the button `Apply Accelerator` and select **Quarkus...**.



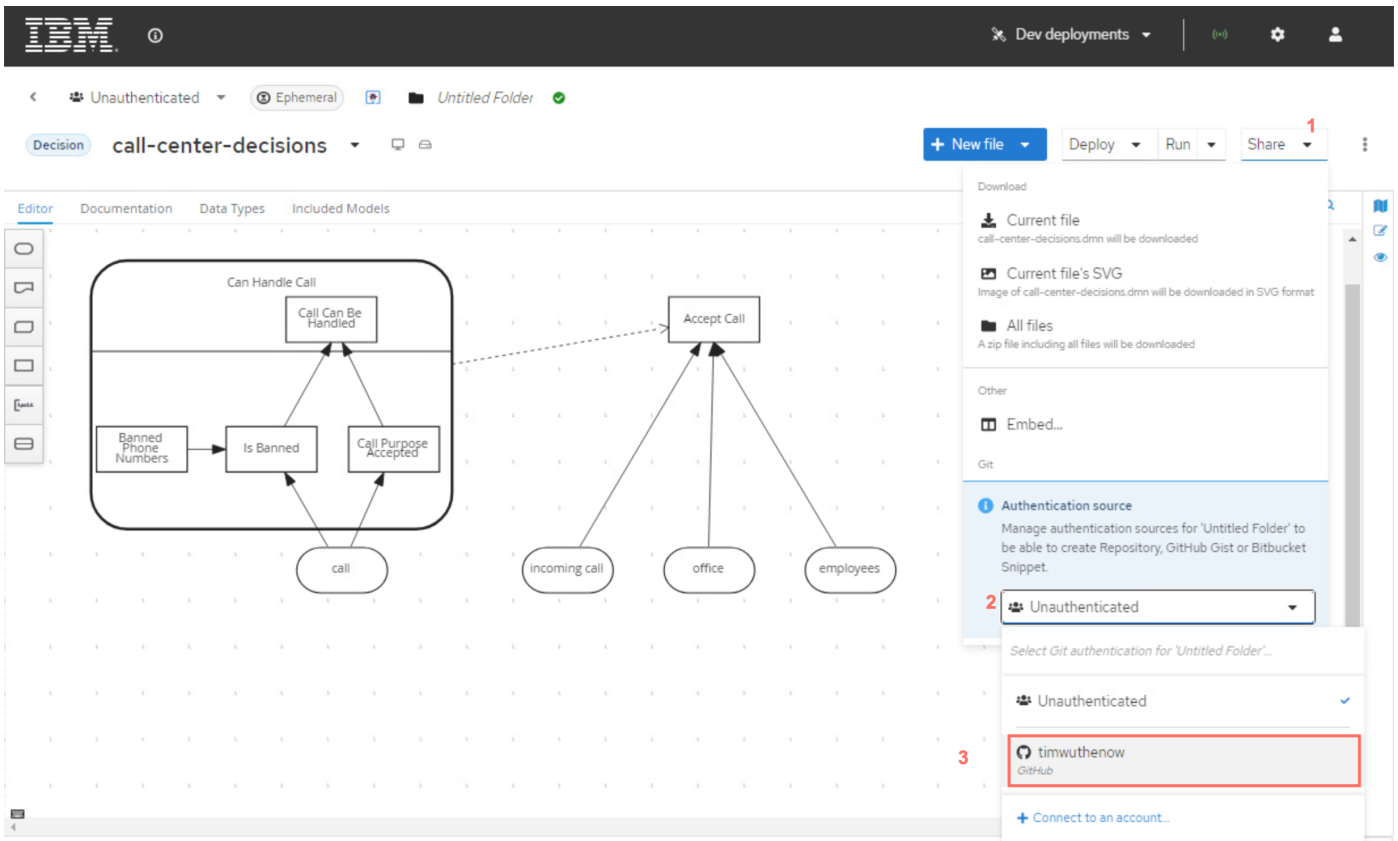
2. If you want to learn more about the accelerator, you can click the GitHub link and change the branch to the `9.0.0-quarkus-full` to learn more about it. Afterwards just click **Apply** to restructure your project into a Kogito service.



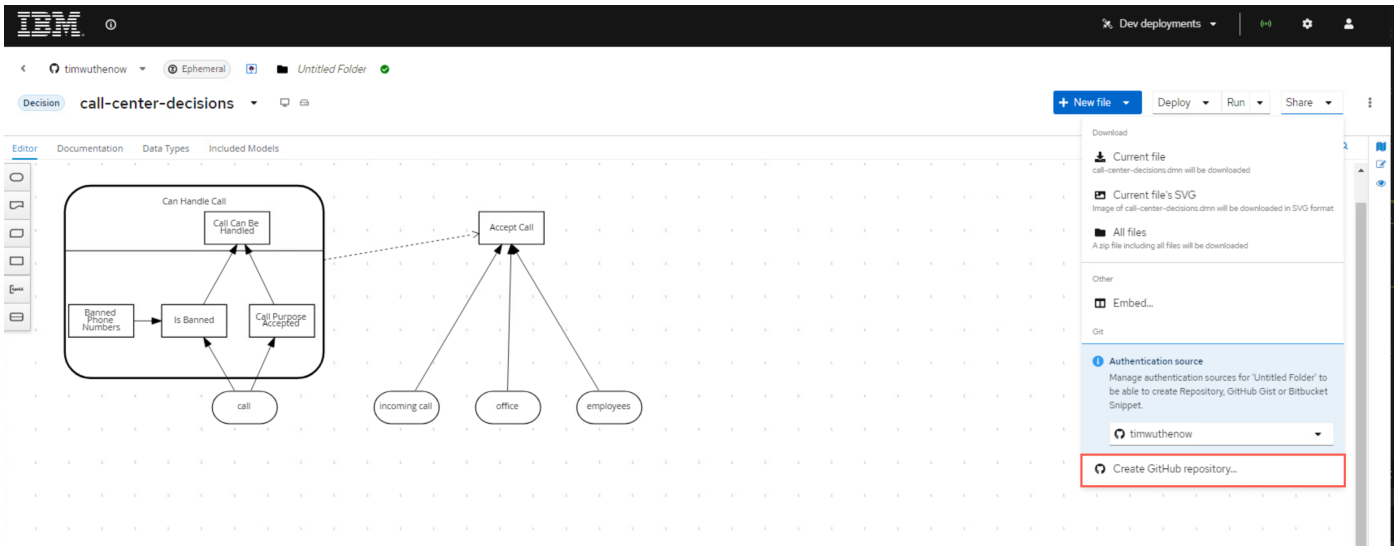
3. The wizard will come with a pop-up asking for a commit message for the change since this will create a Git project. You can use the default message or put whatever you would like, to do so press **Commit**.



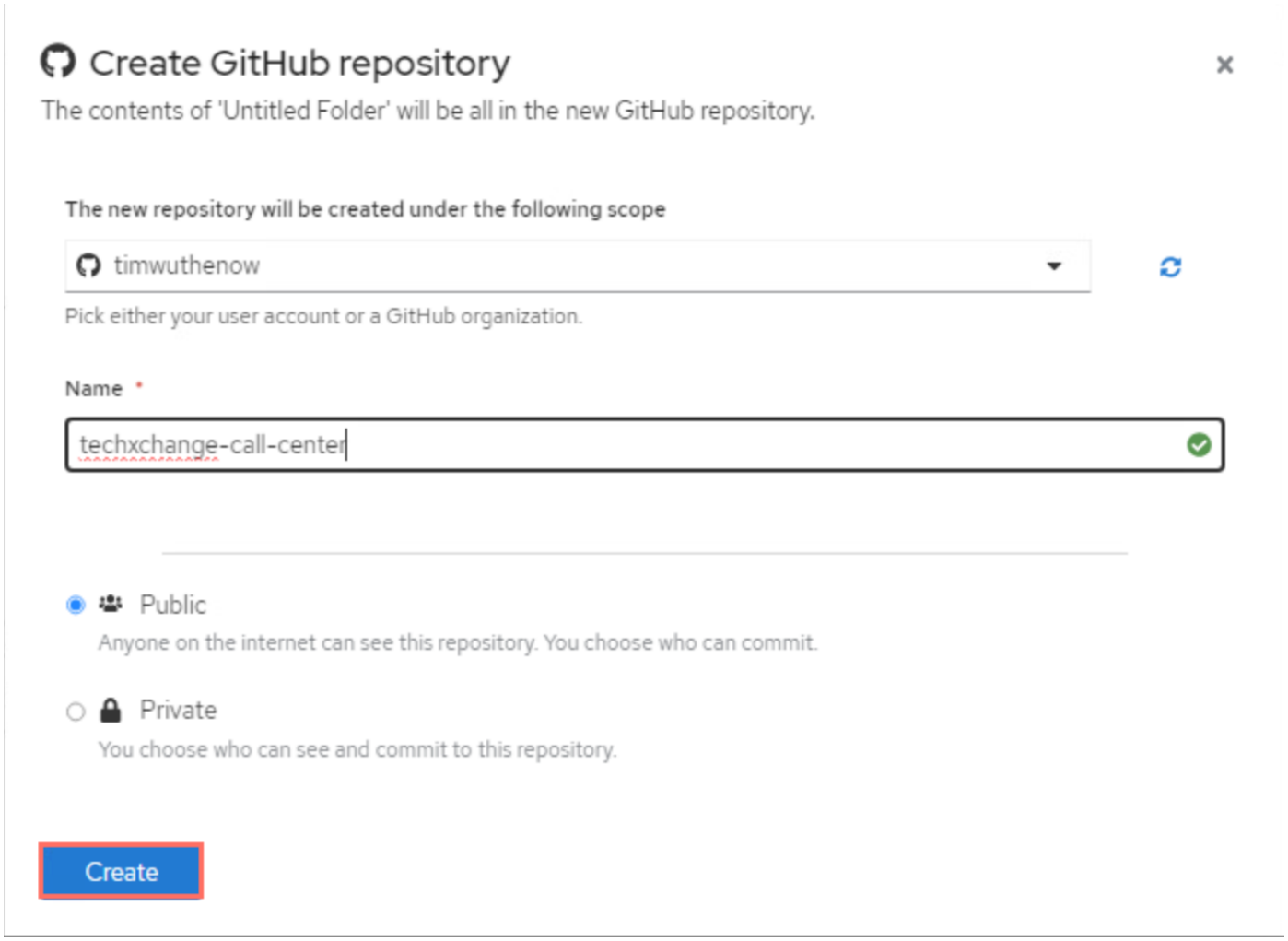
4. To create the project in Git, click **Share**, use your GitHub tokened ID.



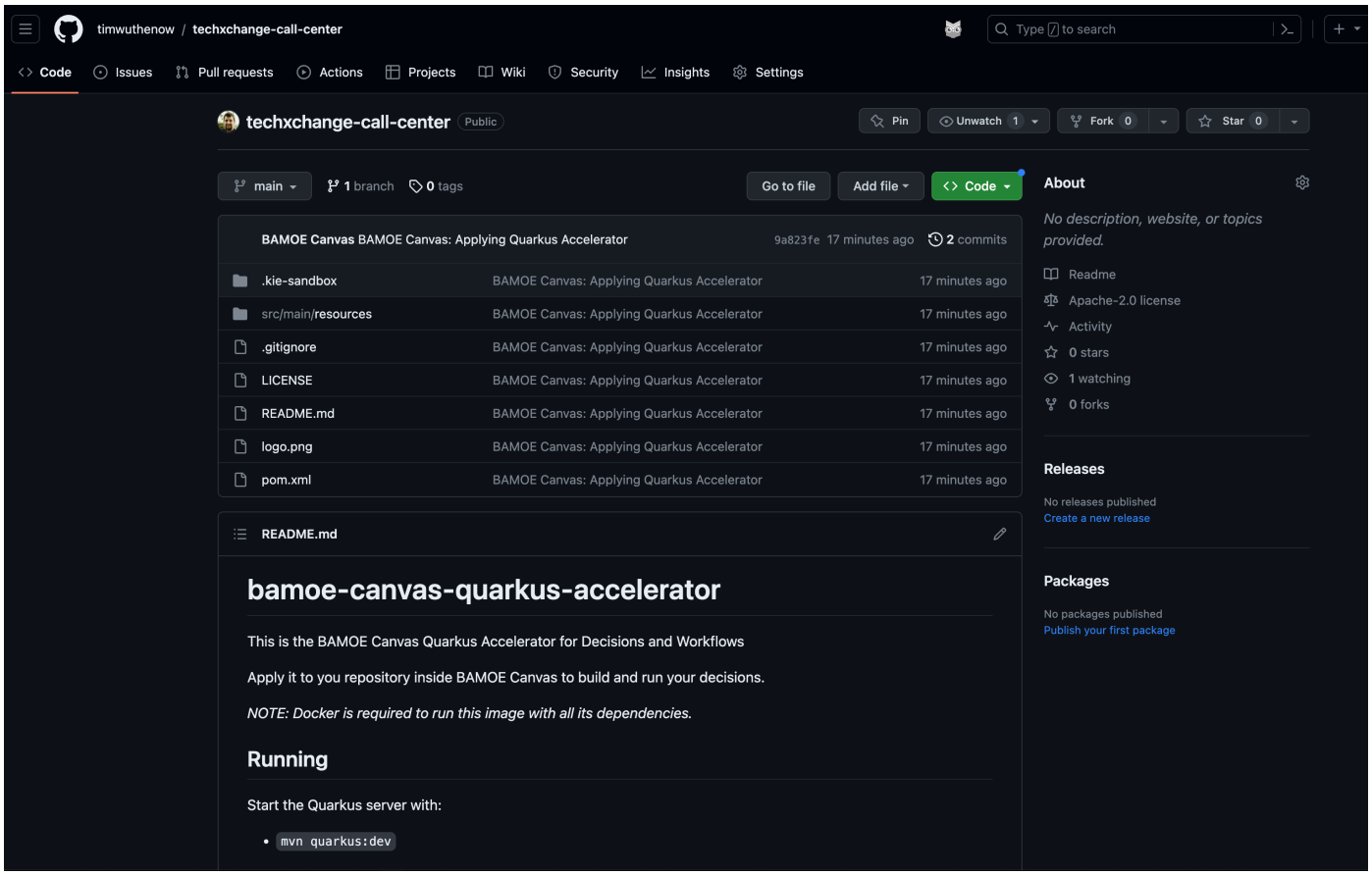
5. Once you select your ID, a new option **Create GitHub repository...** is now available, select this.



6. The repository you create, can be anything you want, for the purposes of this lab, it will be called **techxchange-call-center**.



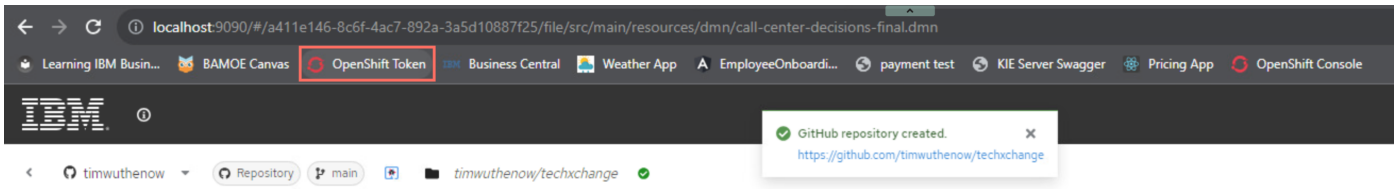
7. When you create the repository, a message will open at the top with a link to the Git repository that was created. In the case of the example it is at this example repository.


timwuthenow / techxchange-call-center
Type / to search
Code
Issues
Pull requests
Actions
Projects
Wiki
Security
Insights
Settings
techxchange-call-center
Public
Pin
Unwatch 1
Fork 0
Star 0
main
1 branch
0 tags
Go to file
Add file
Code
BAMOE Canvas BAMOE Canvas: Applying Quarkus Accelerator
9a823fe 17 minutes ago
2 commits
.kie-sandbox
src/main/resources
.gitignore
LICENSE
README.md
logo.png
pom.xml
BAMOE Canvas: Applying Quarkus Accelerator
17 minutes ago
About
No description, website, or topics provided.
Readme
Apache-2.0 license
Activity
0 stars
1 watching
0 forks
Releases
No releases published
Create a new release
Packages
No packages published
Publish your first package
README.md
bamoe-canvas-quarkus-accelerator
This is the BAMOE Canvas Quarkus Accelerator for Decisions and Workflows
Apply it to you repository inside BAMOE Canvas to build and run your decisions.
NOTE: Docker is required to run this image with all its dependencies.
Running
Start the Quarkus server with:
mvn quarkus:dev

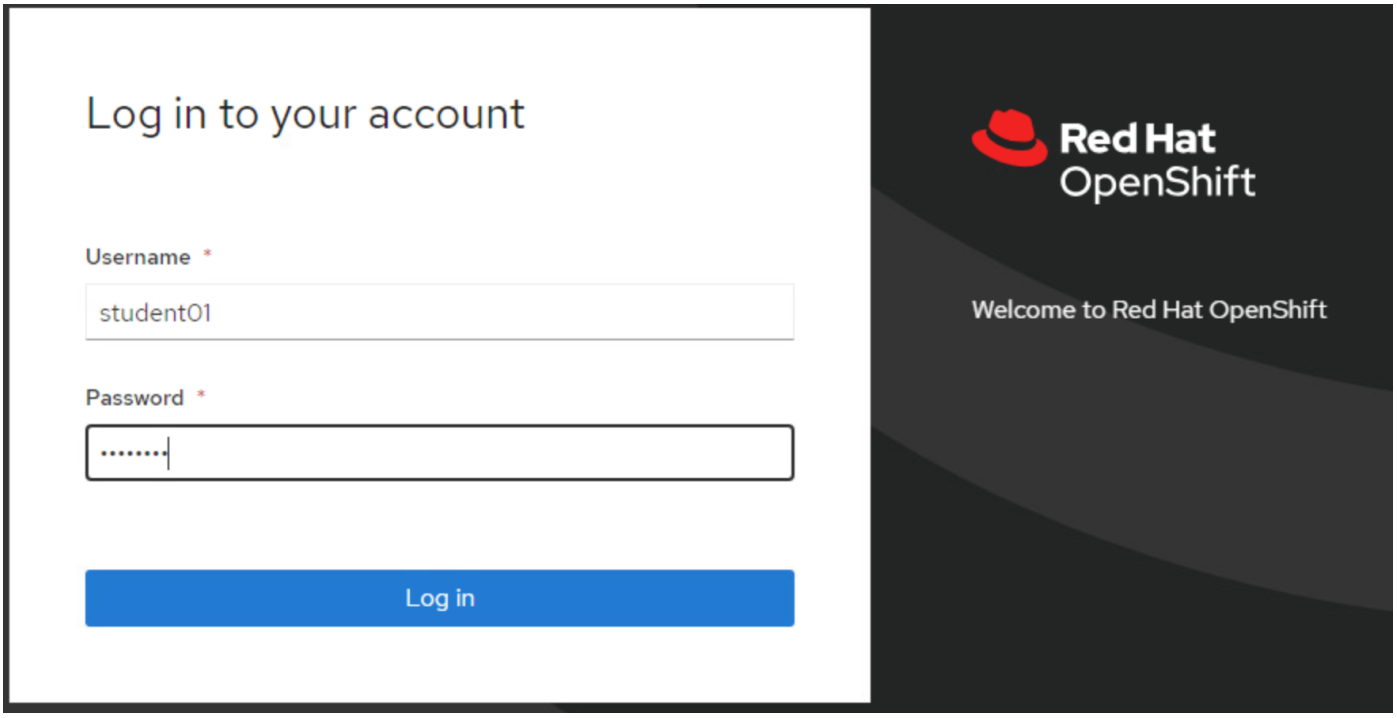
15.2 Deploying to OpenShift

Now that this repository is created, you can work on it locally or deploy it to OpenShift. For this lab, we will choose OpenShift since we have a cluster ready to use for TechXchange or you can use the Red Hat OpenShift Sandbox to provision a small environment to try it out on your own.

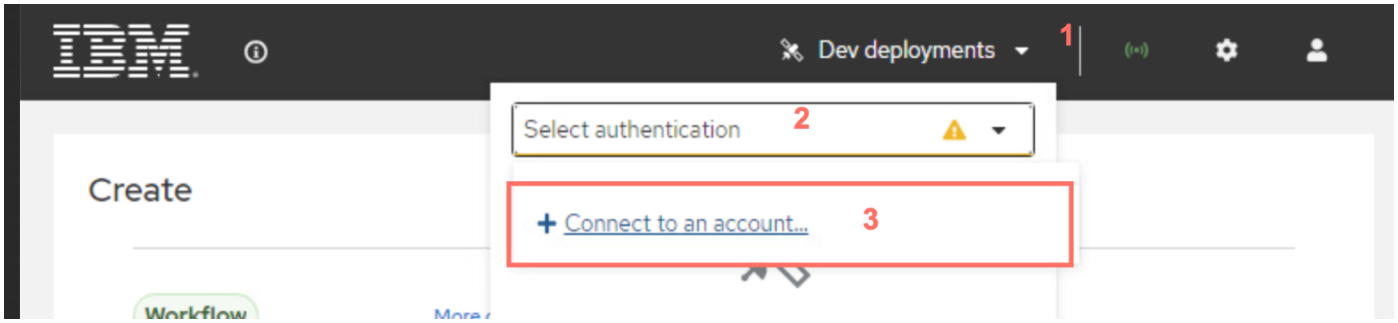
1. Login to get an OpenShift Token using the bookmark on Chrome. This will be used to connect IBM Business Automation Manager Canvas to OpenShift and deploy a sample development environment of the decision service.



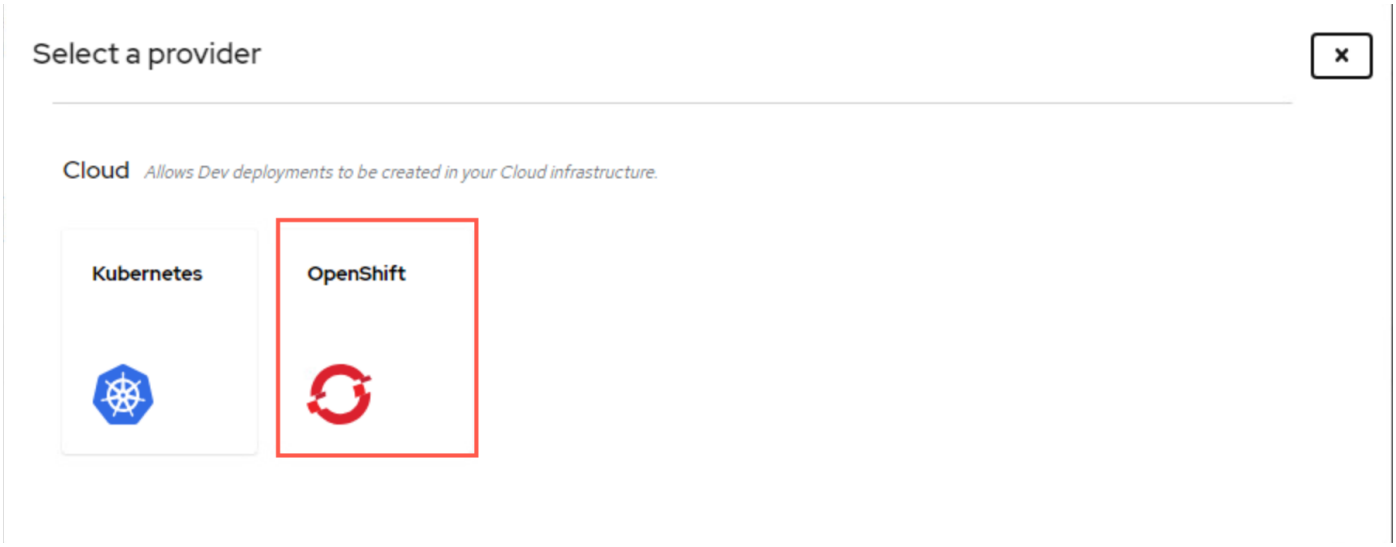
2. In the login screen use your username and password - this will be some combination of `student01` to `student20` with password `Passw0rd`. The username is all lowercase. This will



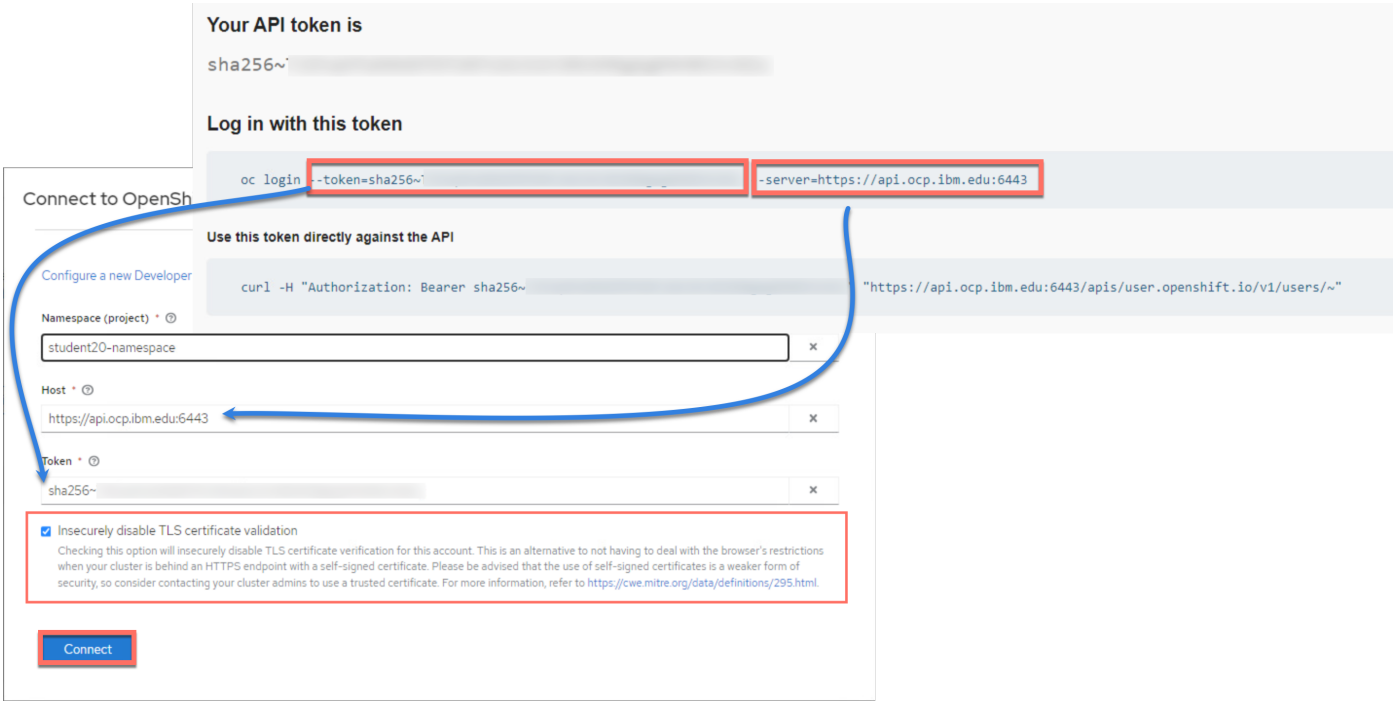
3. Click the **Display Token** link and switch back to the tab with IBM Business Automation Manager Canvas open on it. You will use the token contents from the OpenShift token page shortly by clicking on **Dev deployments** and then selecting the pull down **Select authentication** and then **Connect to an account**.



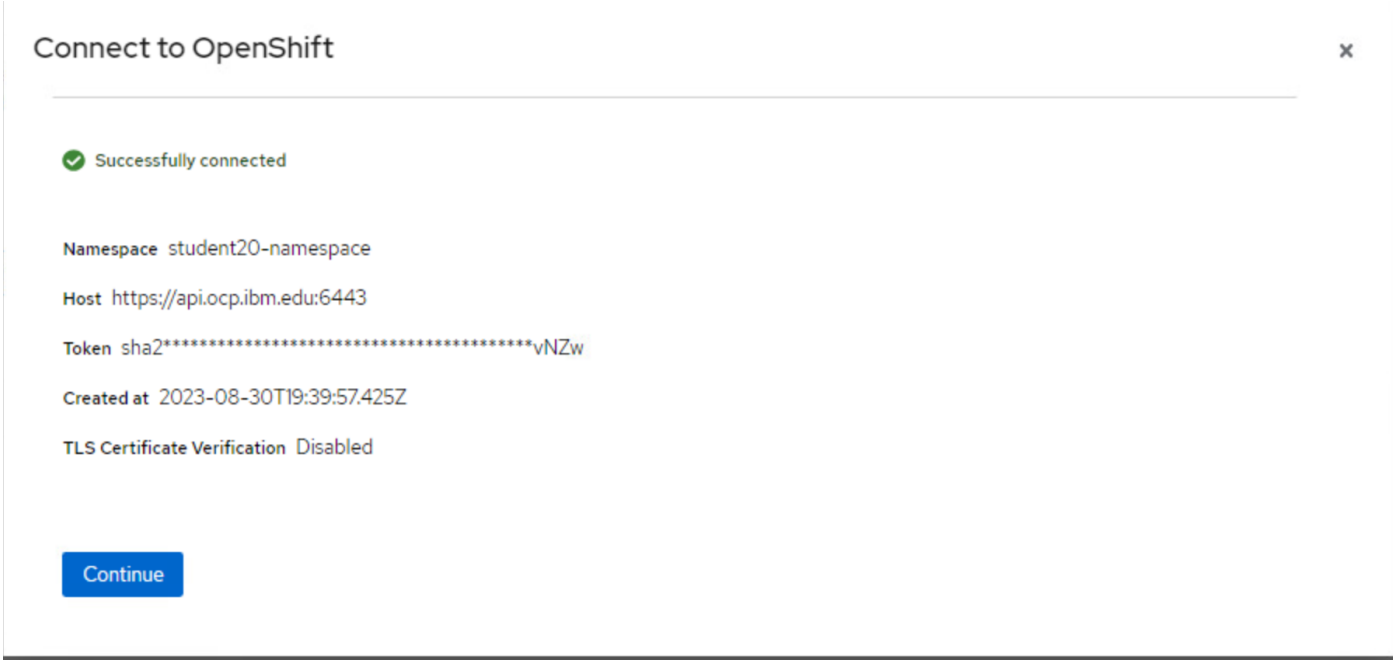
4. On the next wizard, select the **OpenShift Tile** to connect to an OpenShift instance.



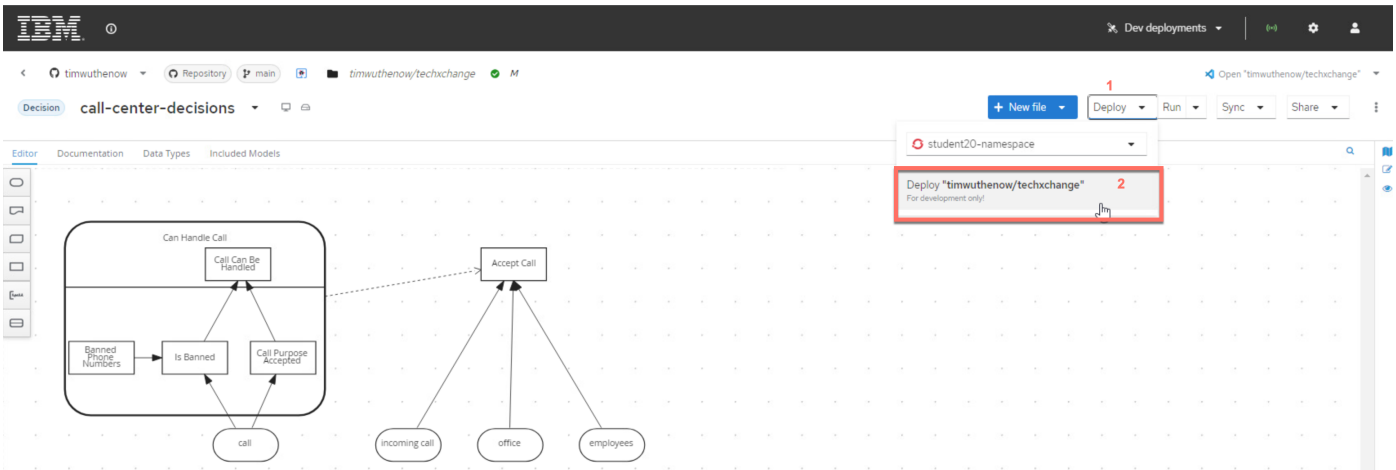
5. From here you will use the information from the OpenShift token page. Your namespace will be your `student##-namespace`, so if your username is student07, then you would connect to *student07-namespace*. The token and the console locations are both a part of the token as well. You will see a checkbox to Insecurely disable TLS validation, check it as this is a self contained environment with certificates not present. Press **Connect** when the form is completed.



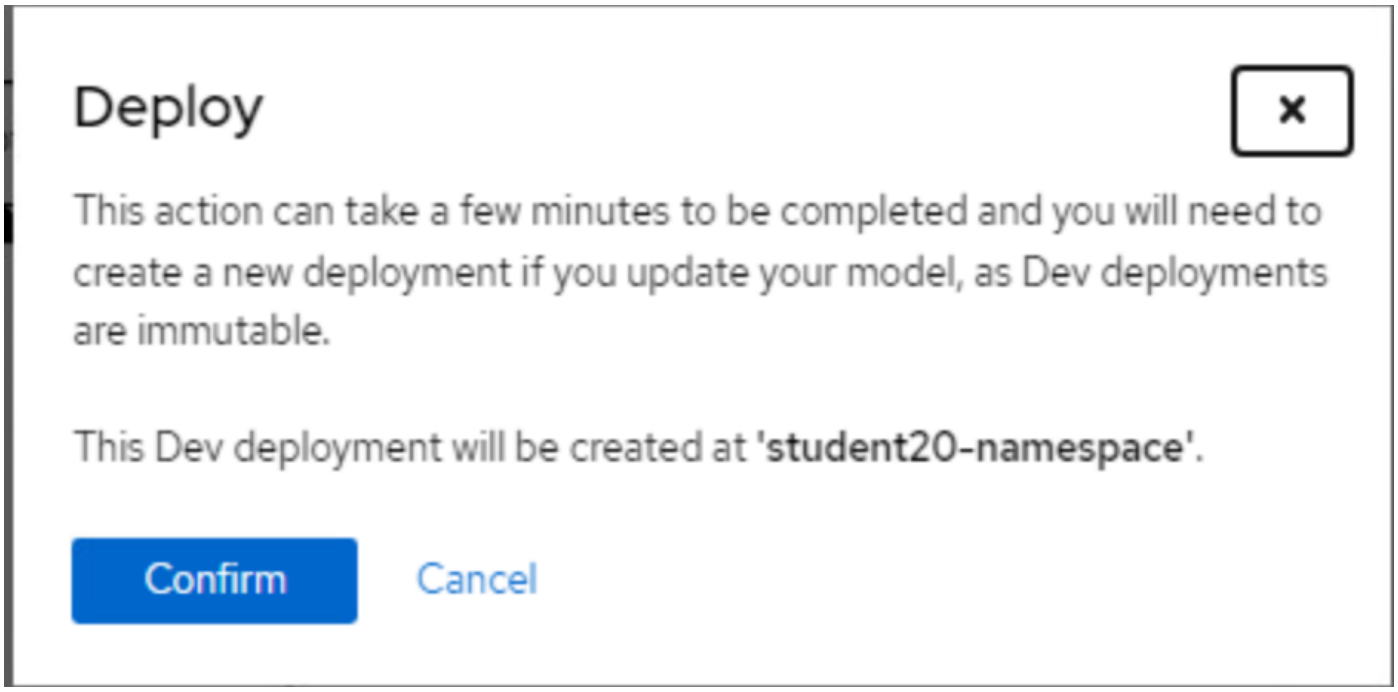
6. As long as it was successful to connect, you will be greeted with a Connect to OpenShift successful modal, click **Continue**.



7. Now you can press the **Deploy** button and have the capability to select the namespace that you connected to and deploy a sample of your service to it.



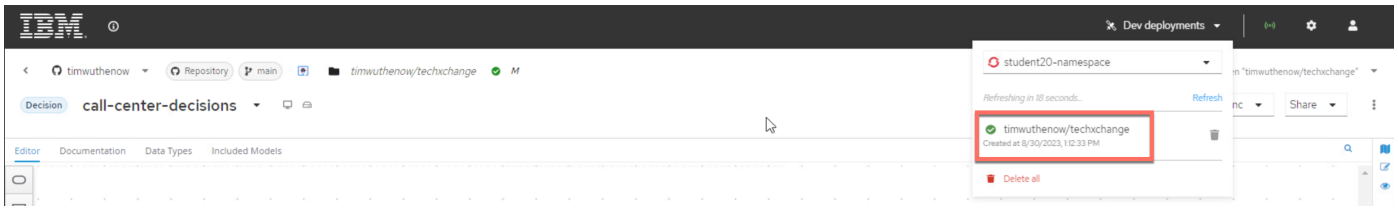
8. From here a modal will pop up explaining that the deployment can take a few minutes and it is only intended for development, etc. Click **Confirm** on this modal and your service will be deployed.



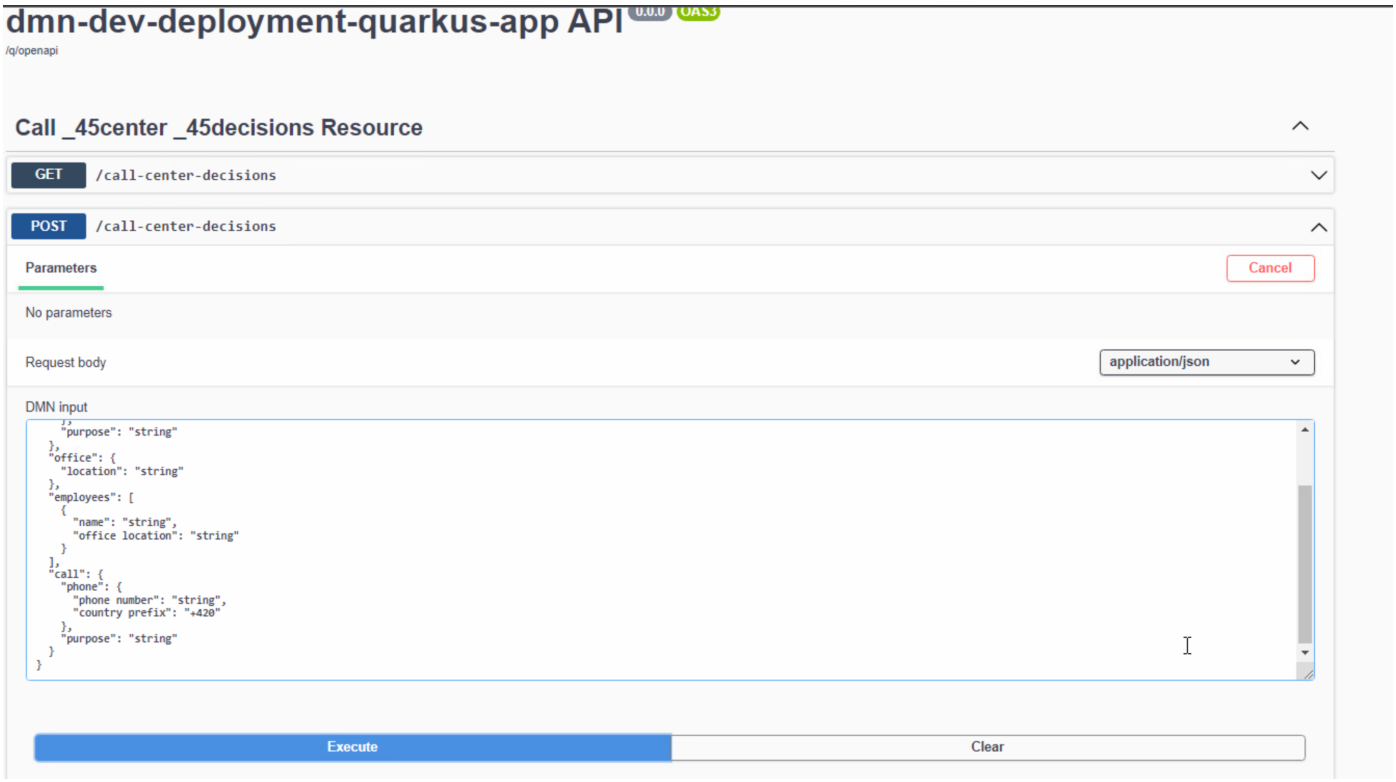
9. This process will take several minutes to complete.

   Canvas deploy in progress

10. The pulldown with deploy will refresh every 30 seconds, when the service is available, it will reflect as such. The way that the deployments from these services work are is that they are completely immutable and unaware of one another, so you could have all versions deployed as you make changes to validate how you want to eventually promote your DMN model to later environments. So if you were to deploy it again, there would be multiple different versions of it deployed. Canvas can manage these deployment samples, which can later be removed when you're done with them if you choose. If you click the green check marked box, it will take you to the service.



11. When you access the service with a form similar to the one you had in IBM Business Automation Manager Canvas and from that page you can explore it more using the kebab icon in the top right to access the Swagger-UI page to get access to the auto-generated DMN service's API page. The first post can be used to execute the decision itself.



12. This completes this lab as you can see how the deployment to OpenShit works with IBM Business Automation Manager Canvas!

Last update: 2023-12-06

3.5 16. IBM Business Automation Open Edition 9.0 CI/CD Overview

This lab was forked from the KIE Live session delived by Rafael Soares on YouTube found here. This lab has been updated to more current releases and also includes a provisioning of Nexus3 to deploy a Maven Repository in your environment. You do not need to do this if you have a Maven repository you can deploy your artifacts to. This lab will be using the OpenShift provided Pipelines built upon Tekton. With IBM Business Automation Open Edition 9.0, the projects are based on Maven artifact architectures, which provides an easy to build and deploy mechanism for all of your product needs. These can be done in Tekton as seen here, or with your favorite/enterprise provided CI/CD tools.

The project in this lab is a Spring Boot hosted Decision Service that is utilizing the embedded KIE Server that will have a build and deploy triggered through the changes in your code base that are pushed to the specified build branch. With Decision Service projects, it is highly recommended that on all push events you consider a build of the project. This ensures that all the resources that are required are constantly available, breaking changes are identified immediately and if you want to release immediately, it's very easy to do so.

3.5.1 16.1 Lab Overview

Within this lab you will see how you can use OpenShift Pipelines (a.k.a Tekton) to automate the delivery of decision services implemented with IBAMOE. In this lab you will see:

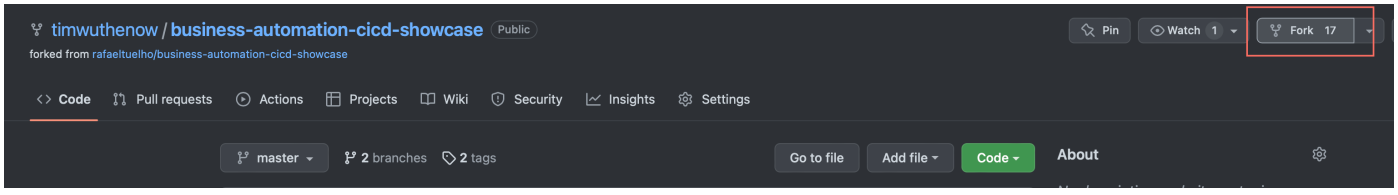
- The automation of repeatable decisions using the DMN specification;
- Decision tables implementation using XLS.
- Usage of the rules engine based on KIE Server and running on top of SpringBoot
- CI/CD Pipeline implemented using Tekton
- How to configure webhooks in your pipeline to deploy based on changes on a git repository
- Automated tests for decisions (with Test Scenarios) that are considered during the pipeline execution
- Deployment with zero downtime with OpenShift rolling deployment strategy

3.5.2 16.2 Pre-requisites

- Java 8
- OpenShift 4.10+
- OpenShift Command Line client (`oc`)
- VSCode
- VSCode Business Automation Extension

3.5.3 16.3 Installing on OpenShift

1. Fork this repository, to get started.



2. Clone your fork to your local machine.

```
git clone https://github.com/${yourgithubuser}/business-automation-showcase.git
cd business-automation-showcase
```

1. Run the provisioning script (Linux/MacOS):

```
sh provision.sh
```

2. When the script runs, you will be presented with a prompt to enter a namespace name, which is the namespace that will be created for your environment to be deployed in.

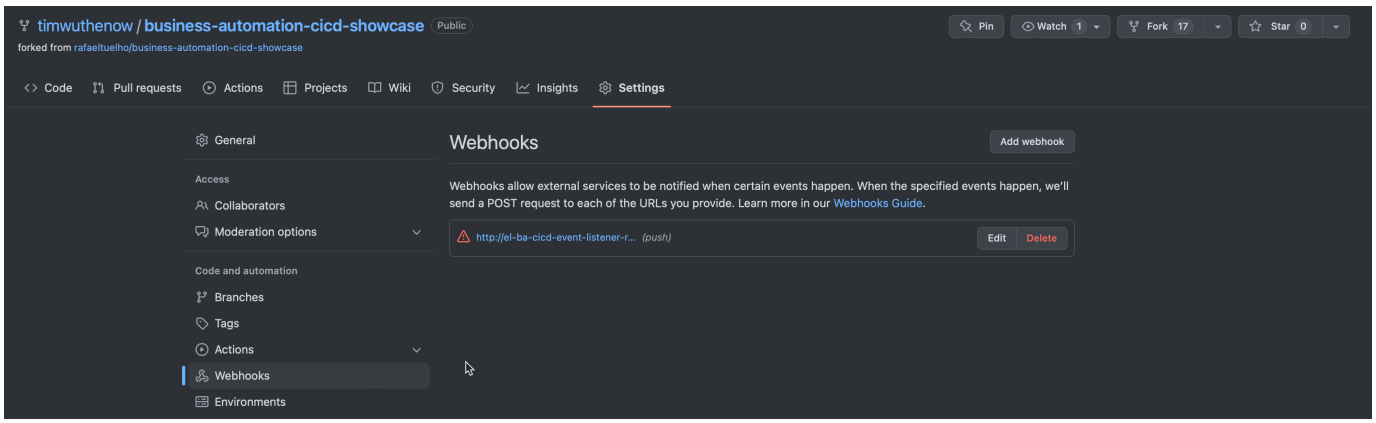
```
business-automation-cicd-showcase % ./provision.sh
Input a namespace root - first letter lowercase
namespace: tim-demo
```

3. When this completes you will get a console with a few links, as well as an admin password to the Nexus environment that was created.

```
*****************************************************************

Use this URL in your GitHub Webhook configuration for automatic deployment
http://el-ba-cicd-event-listener-tim-demo-rhdm-kieserver-cicd.openshift.io

Use this URL to access the front-end application:
http://decision-service-webclient-tim-demo-rhdm-kieserver-cicd.openshift.io

Use this URL to access the Nexus Repository:
http://nexus3-tim-demo-rhdm-kieserver-cicd.openshift.io

Use this password for admin access to Nexus 3:
long-strung-out-password-used-for-nexus-repo-admin

*****************************************************************
```

3.5.4 16.4 Configuring the automatic deployment on GitHub

1. To configure the webhook for automated deployment, open your fork in your GitHub. Next, add a new webhook by opening "**Settings** -> **Webhook** -> **Add webhook** button".



1. Fill the form with the information below:
2. **Payload URL**: provided after the provisioning. You can also get it using the command:

```
echo $(oc get route el-ba-cicd-event-listener --template='http://{{.spec.host}}')
```

3. **Content type**: `application/json`
4. **Secret**: empty
5. **Which events would you like to trigger this webhook?**: `Just the push event`.

At this point, you should already have a fully automated integration and deployment lifecycle for the business application. Any changes pushed to your repository will trigger the pipeline in your OpenShift cluster.

3.5.5 16.5 Maven Repository Setup

Typically an environment would already have a Maven repository included, but if you wanted to set one up and use your own, this is a quick run through of what's required to get the Maven Repository to connect to the current location of the IBM Business Automation Open Edition 9.0 Maven artifacts which reside in the Red Hat Maven General Access Repository.

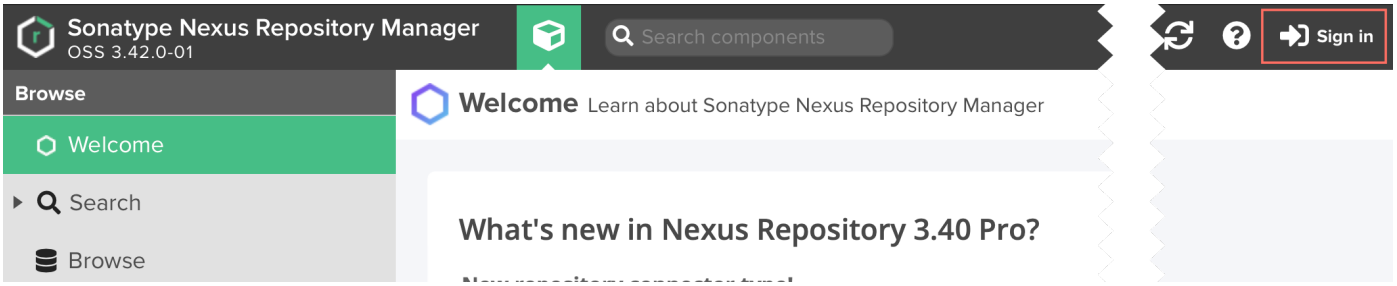
From the console log you got earlier, you would have received two messages with routes and password infromation for the Nexus repository location (the 3rd item) and the admin password (the commands to get these are found within the `provision.sh` file). If you hold Control (Linux/Windows) or Command (Mac) and click the link in VSCode, you will go to the location of your newly provisioned Nexus3 repository.

By default, the Nexus repository includes a Mirror of Maven Central which anyone can publish to following this documentation and is the typical environment for Community releases, but enterprise releases of Open Source Software can be found here as well. The practice within Red Hat, has been to publish artifacts to its own repository found here as these are the enterprise releases and outside of community. No access is required to pull from this repository. We will configure our newly minted Nexus repository to have a Mirror of the Red Hat Maven General Access Repository so that for any product releases that are used, it will pull them from Red Hat Maven General Access Repository and publish them in the Nexus repository as a proxy. This is common in most enterprise environments instead of a direct connection to the repositories to offset downtime, have security checks, etc.

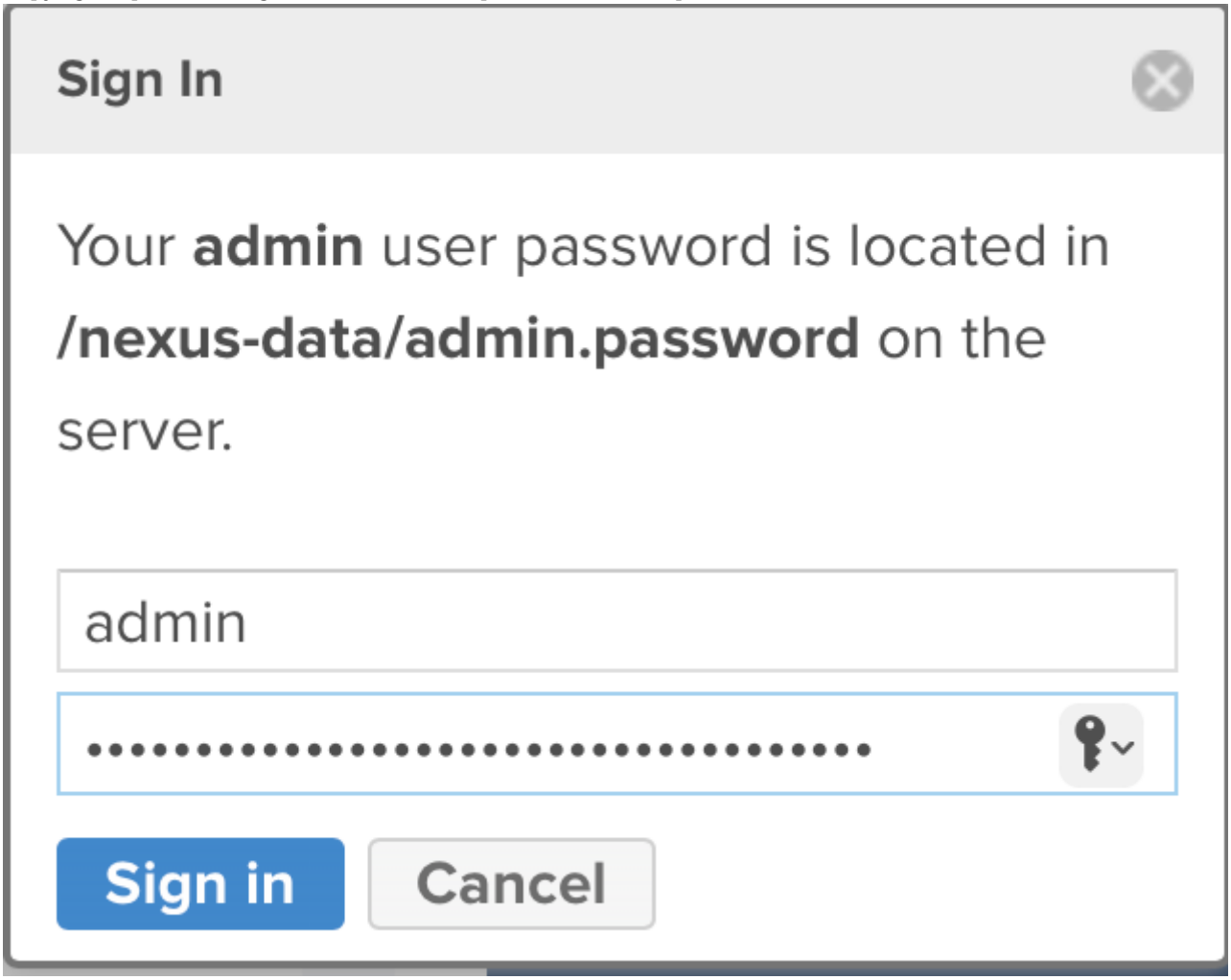
To setup the mirrow follow these steps:

1. From the route that was produced from the console output (or you can run `oc get route | grep nexus` where you will need to paste the output) and use that link to get to the Nexus admin screen.
2. From here, using the admin password that was a part of your console output. Click `Sign In`. Alternatively the command to run is below.

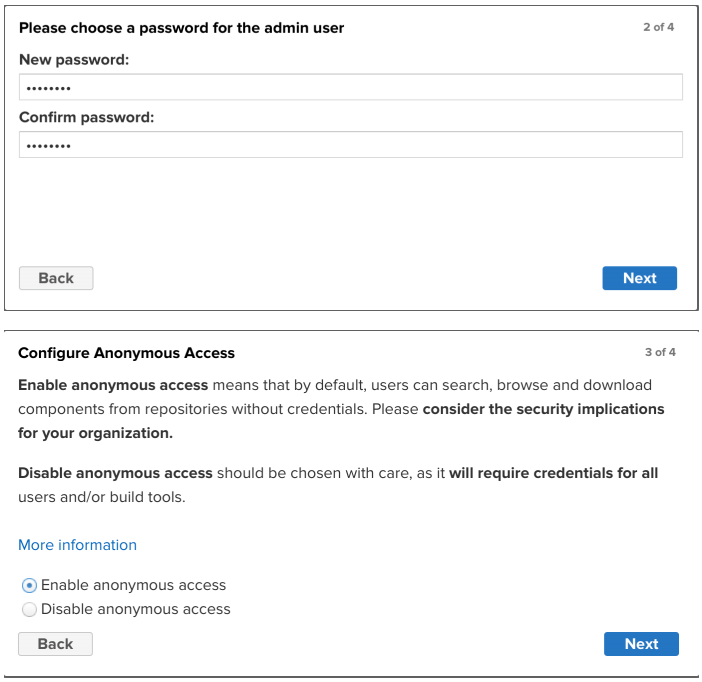
```
echo "$(oc exec $(oc get pod -o template --template '{{range .items}}{{.metadata.name}}{{"\n"}}{{end}}' | grep nexus) -- cat /nexus-data/admin.password)"
```



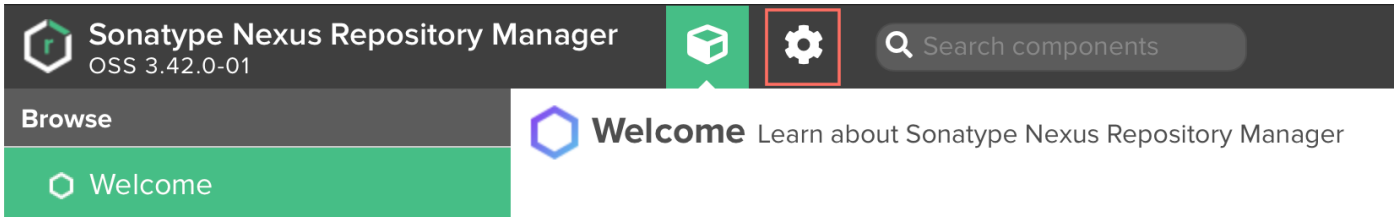
3. Copying the password, login as `Admin` with the password from the previous command.



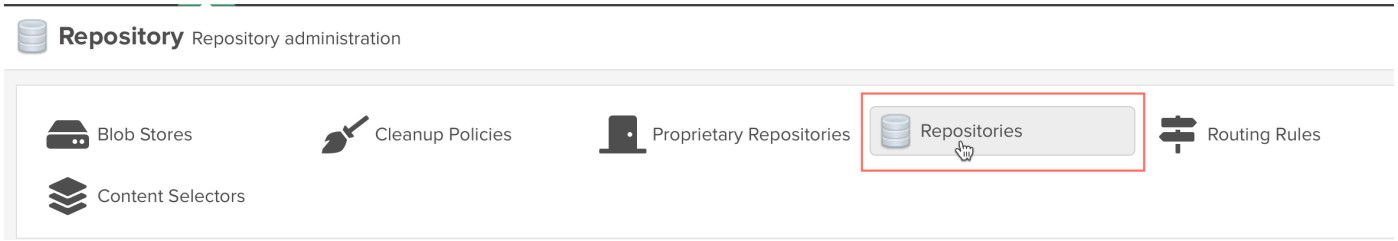
4. You will now have a Wizard popup to walk you through some setup, we're going to do very minimal changes: you can change the password (e.g. `password`). Typically in this development/throwaway environment, enabling anonymous access is the best way to do this, so select that option `Enable anonymous access`. Then click finish.



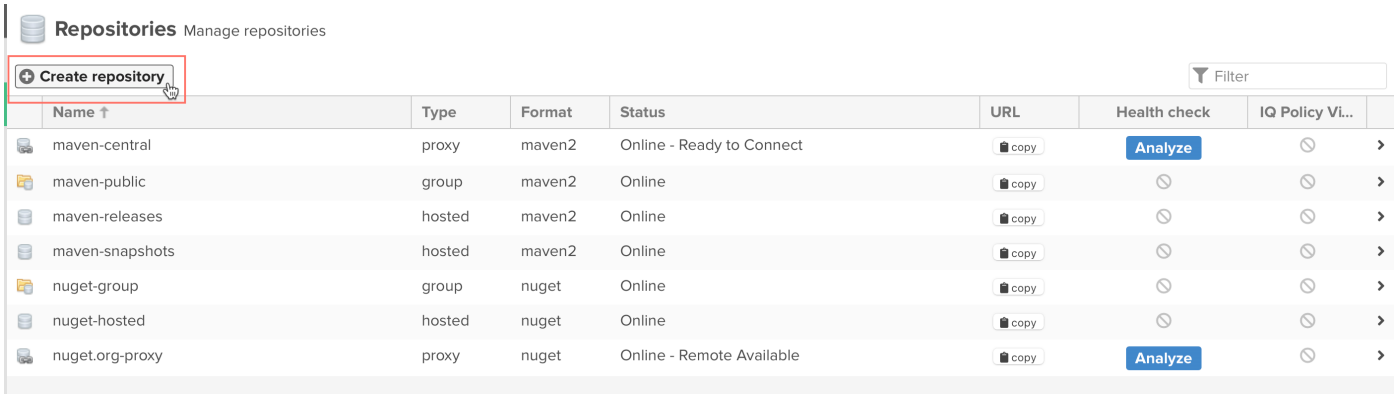
5. Now that the repository is ready to be configured, we are going to create a mirror of the Red Hat Maven General Access Repository so that we can pull resources through the proxy instead of direct. To do this, click the Gear icon (⚙) to open the settings screen.



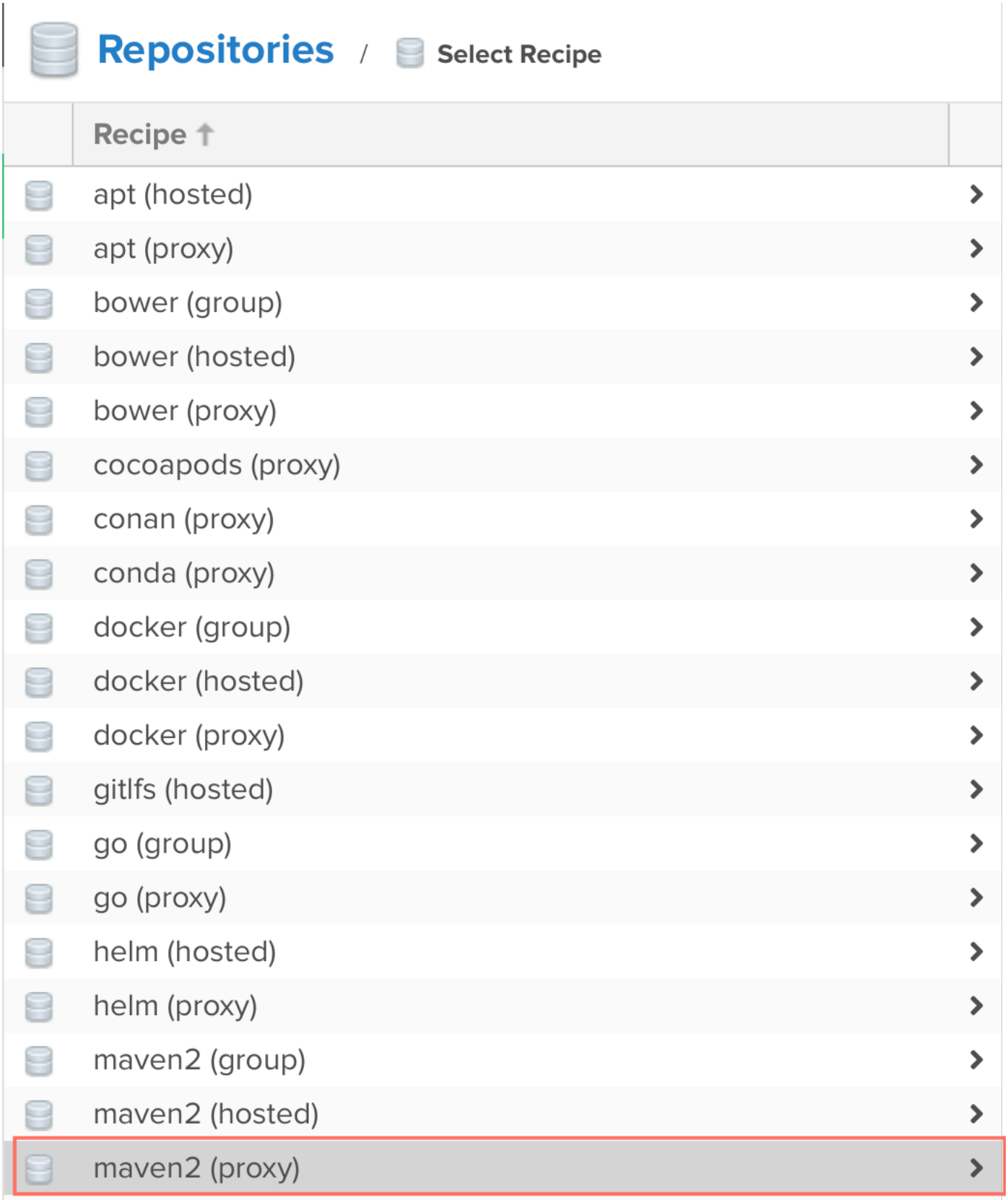
6. From here click `Repositories` to view the current repositories and also to be able to create another.



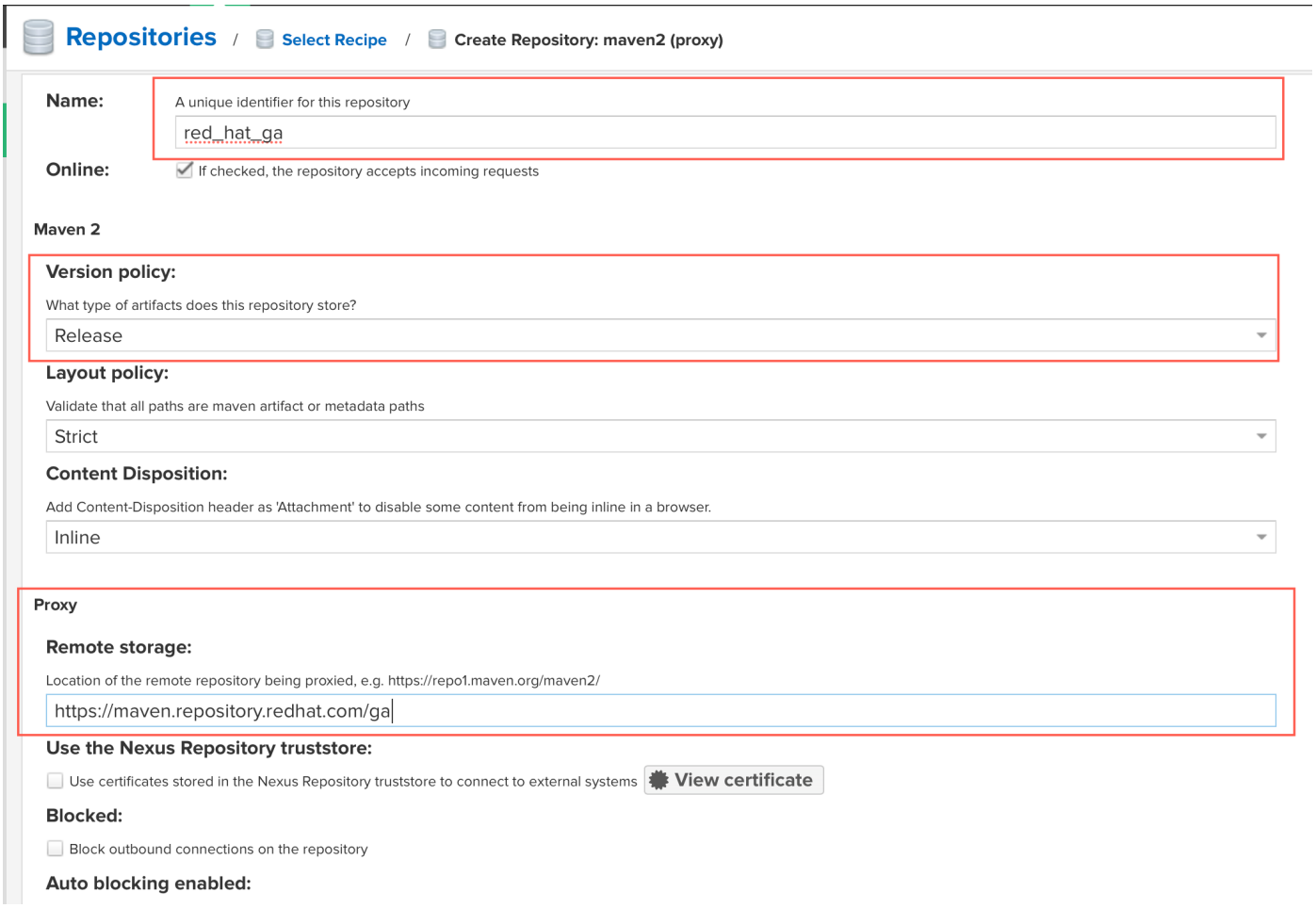
7. Here you will see a list of default repositorues. By default, Nexus will include the connection to *Maven_Central*, but we'd also like to add the Red Hat Maven General Access Repository connection to pull the resources from this repository. To do so, click `Create Repository` to build a new repository.



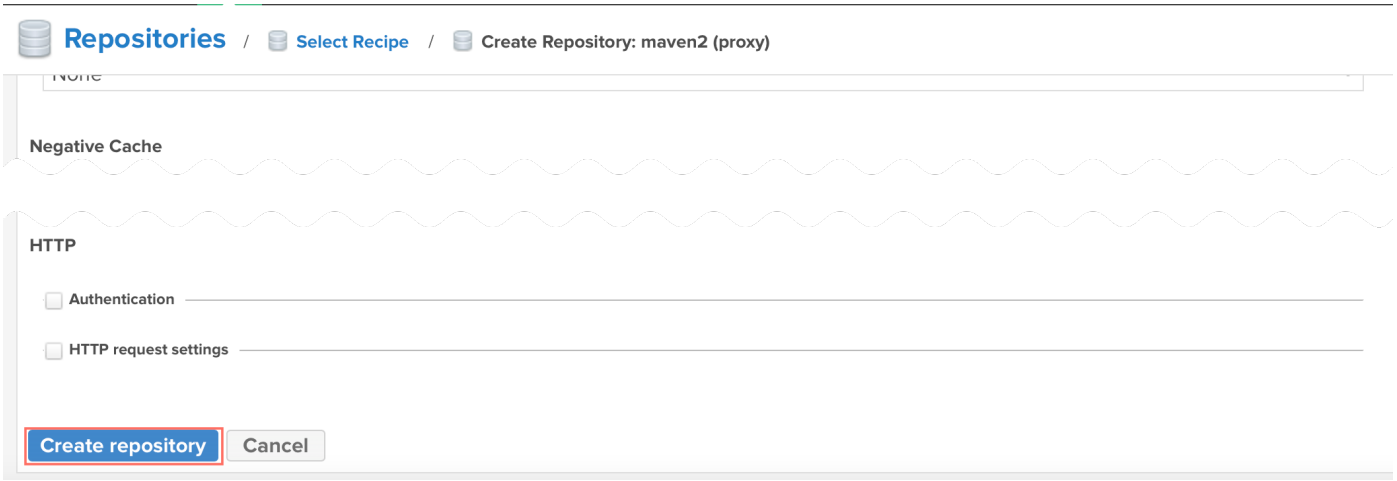
8. Scroll down and we're going to create a `maven2 (proxy)`. The reason we're doing a proxy is that we're going to allow our repository to reach out to the Red Hat Maven General Access Repository to retrieve artifacts it does not already have, but if it has previously pulled them, will be stored in the Nexus repository's cache. This way if there are new releases, you can pull as required, but are not taking the entire repository as required.



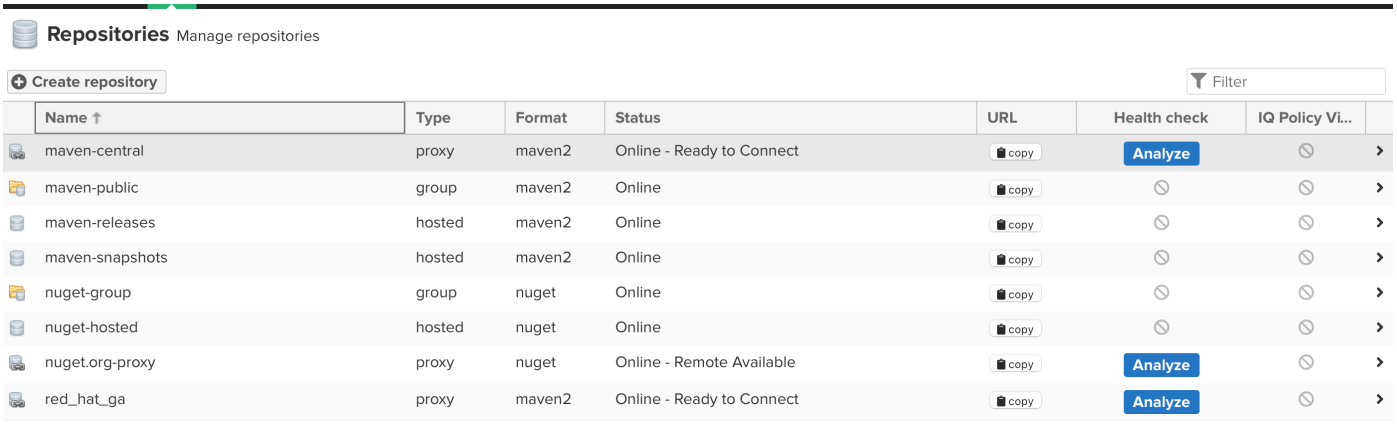
9. On the form that opens, you will add the following information (the name red_hat_ga needs to be exact to match the lab expectations):
10. *Name*: `red_hat_ga`
11. *What type of artifacts does this repository store*: `Release`
12. *Remote Storage*: `https://maven.repository.redhat.com/ga`



13. Click `Create repository` at the bottom to deploy the proxy instance of the Red Hat Maven General Access Repository



14. Your repositories should now be setup and look similar to the below.

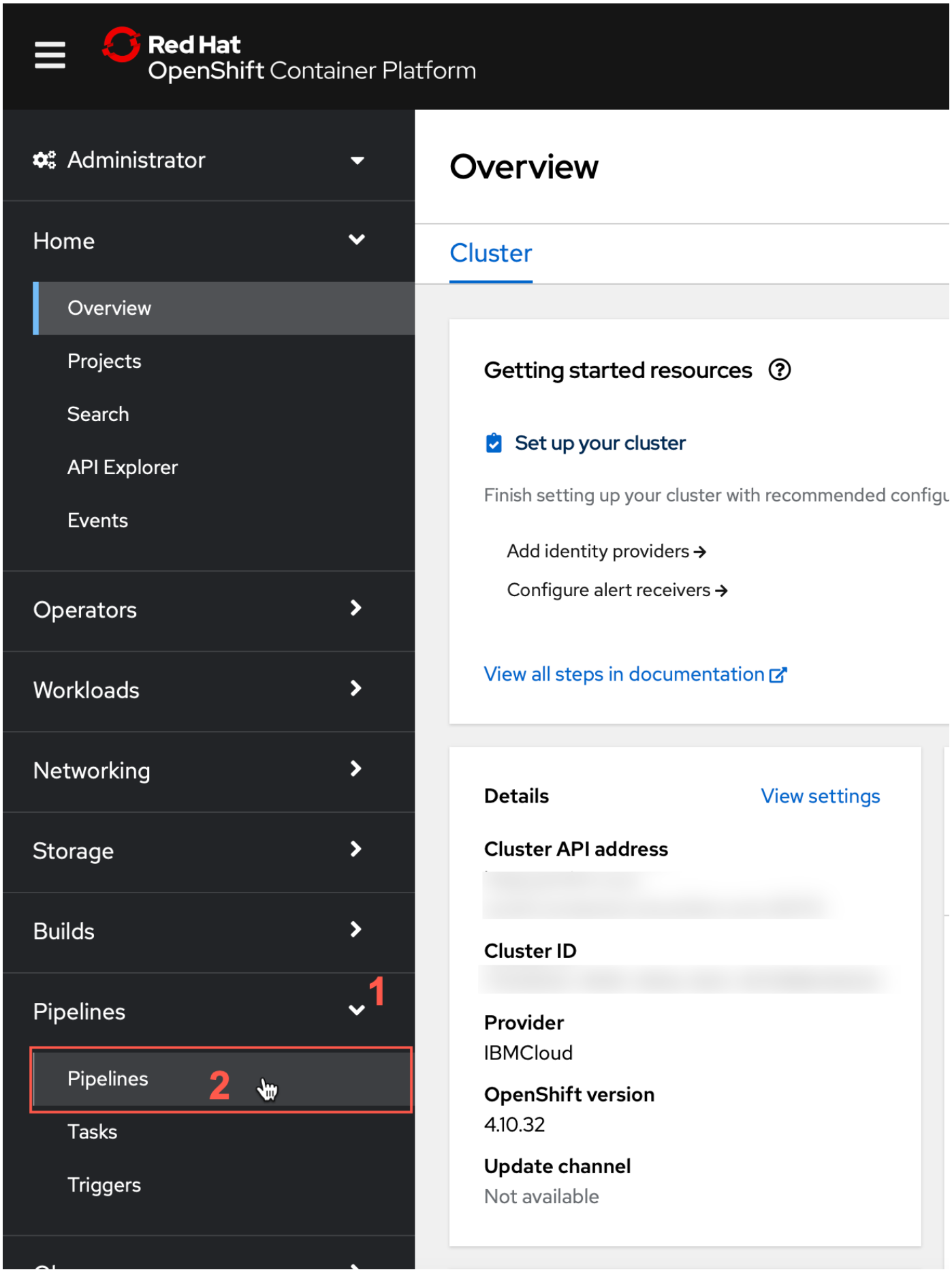


3.5.6 16.6 First run of the Pipeline to configure Persistent Volume Claims for the workspaces

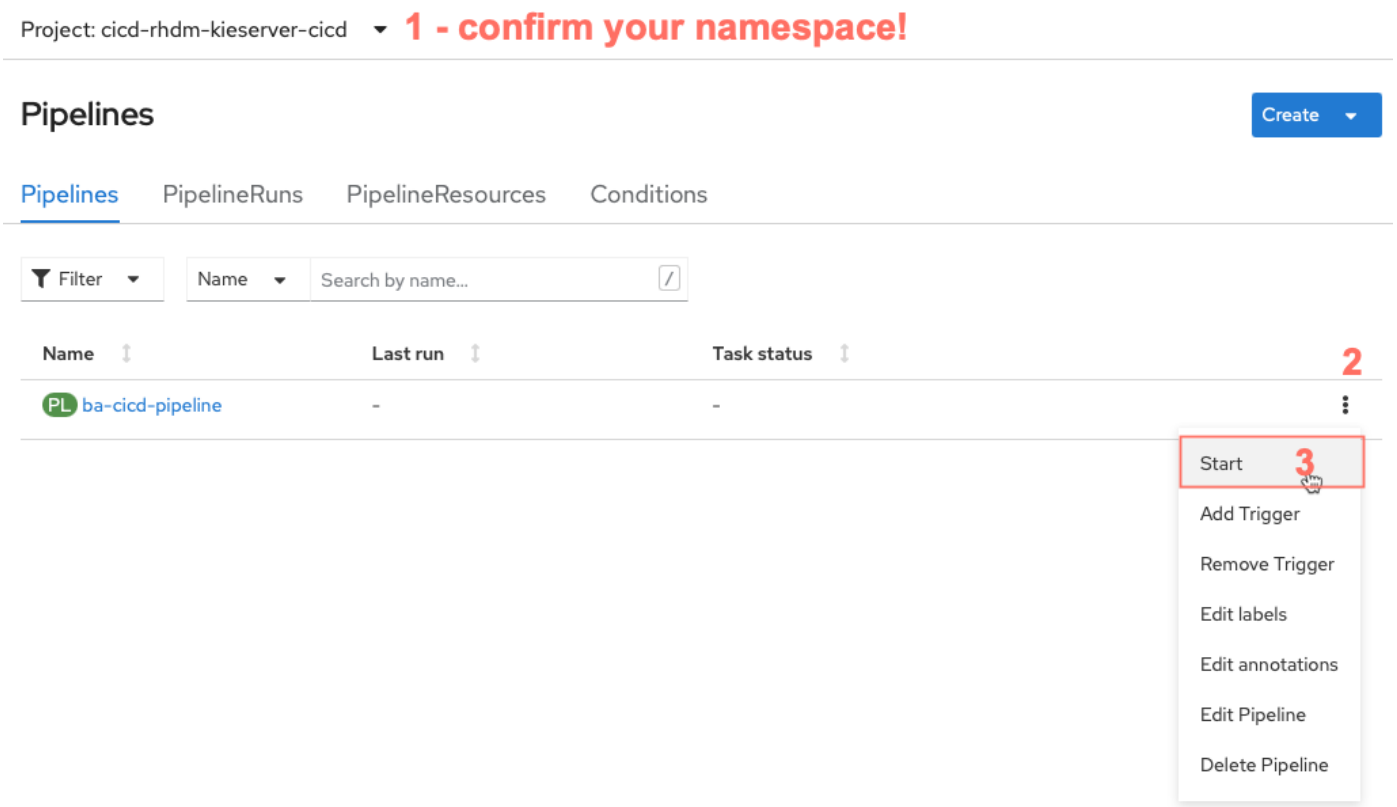
With the first run of the pipeline, you may have to run the pipeline manually. To do so, login to the OpenShift console for your project. You can see the console URL by running `oc whoami --show-console` and that will return the console link, Command/Control click it to open from VS Code.

Once logged in, make sure to go to our project that you created in the `provision.sh` script. Follow these steps to run the pipeline for the first time.

1. Make sure you change your project to the one you created in `provision.sh`. From the cluster home page, you can click `Pipelines` and then click `Pipelines`

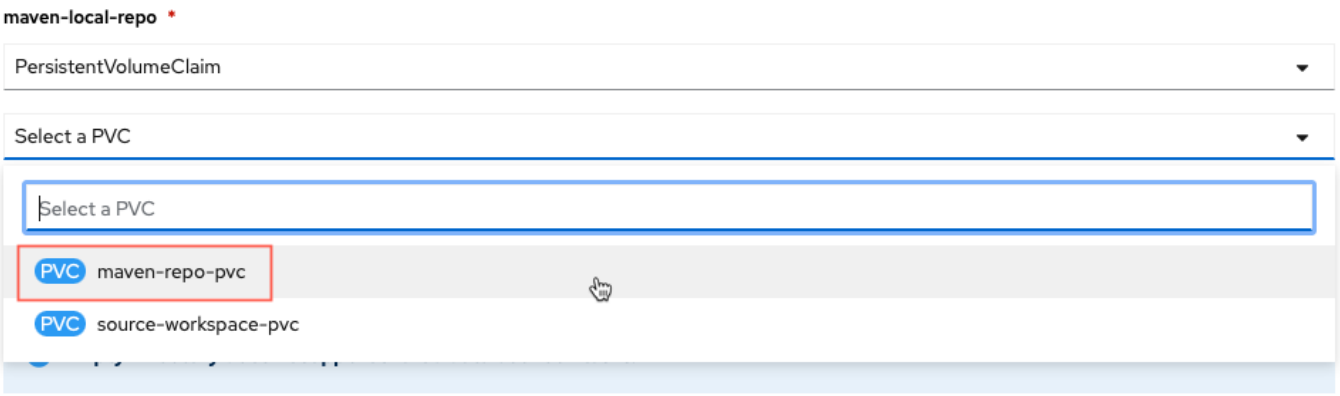

Red Hat
OpenShift Container Platform
Administrator
Home
Overview
Projects
Search
API Explorer
Events
Operators
Workloads
Networking
Storage
Builds
Pipelines
1
Pipelines
2
Tasks
Triggers
Overview
Cluster
Getting started resources
Set up your cluster
Finish setting up your cluster with recommended configu
Add identity providers
Configure alert receivers
View all steps in documentation
Details
View settings
Cluster API address
Cluster ID
Provider
IBMCloud
OpenShift version
4.10.32
Update channel
Not available

2. From the Pipelines screen, confirm your namespace matches what you created in the first part of the lab and after that, click the *kebab* icon to open the menu to `Start Pipeline`.

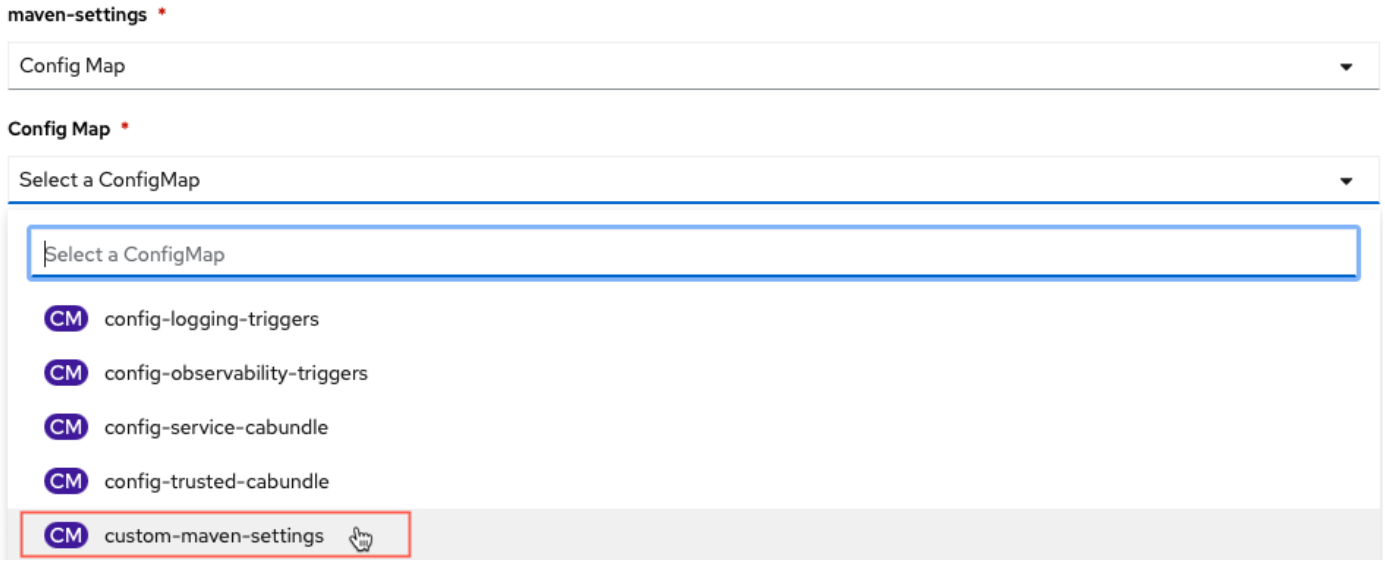


3. Once you click start pipeline, a form will come up to set some settings for the pipeline. These should only have to be the first time you run this pipeline. You will modify the ones below if you followed the previous section for the workspaces to align to the ConfigMap of `settings.xml` used by Maven to build and the Persistent Volumes used for workspace data (git clones and the Maven artifacts).

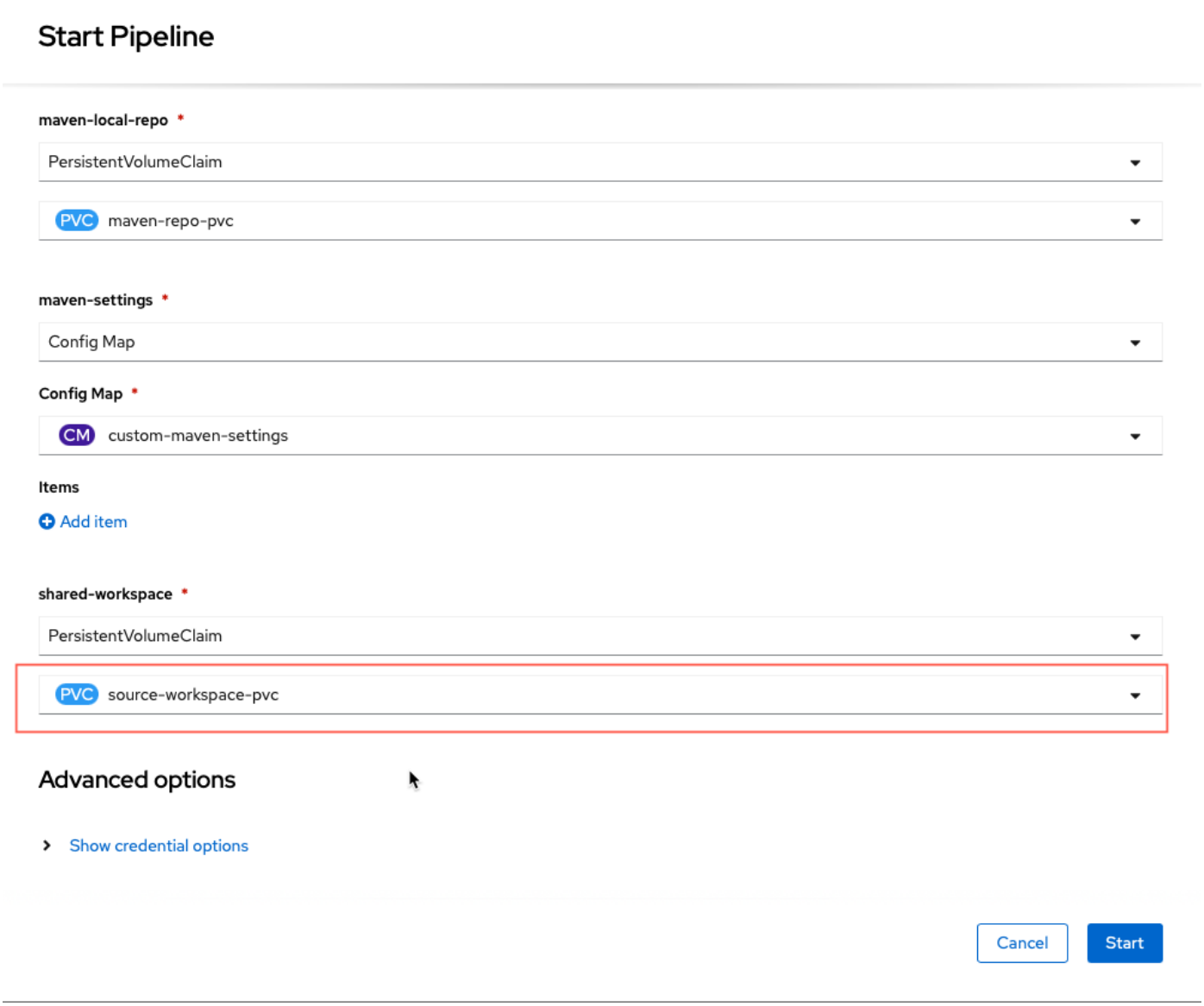
4. *maven-local-repo*: click the dropdown menu and select `PersistentVolumeClaim` and in the *Select a PVC* dropdown that appears, select `maven-repo-pvc`



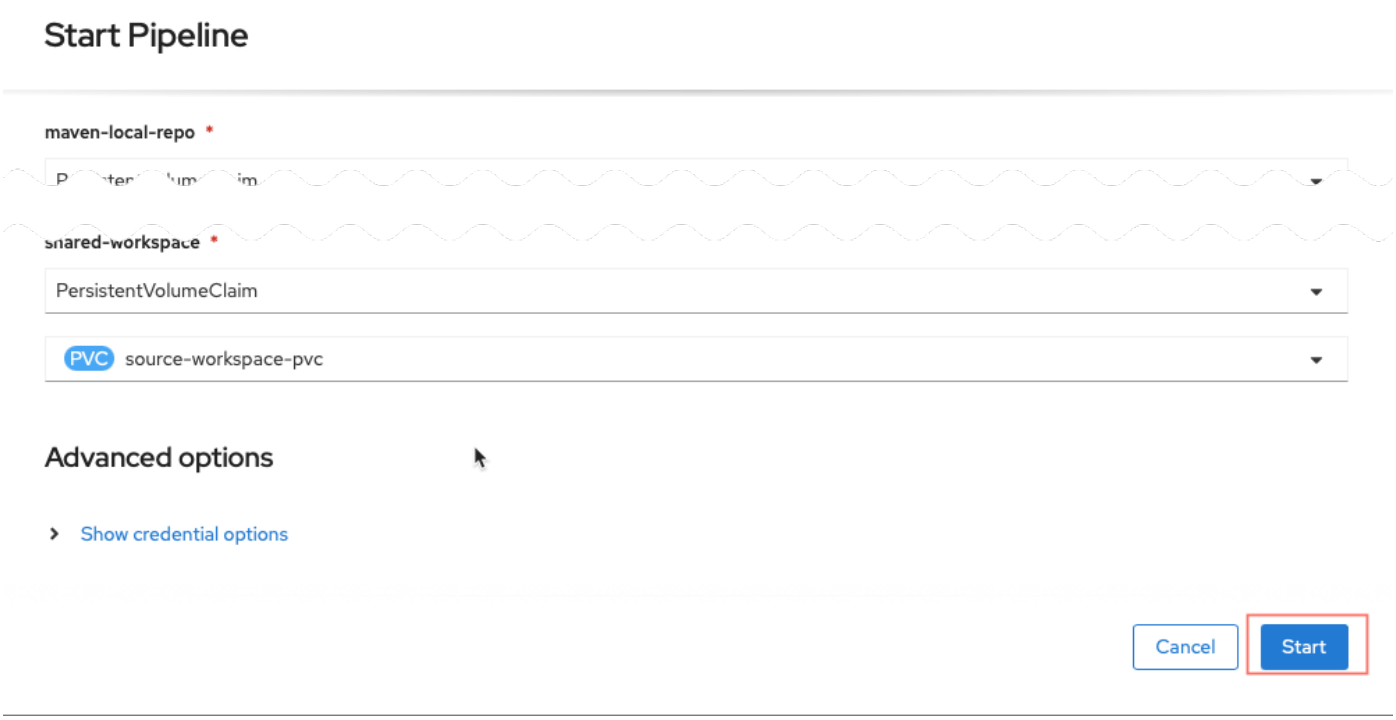
5. *maven-settings*: click the drop down and select `Config Map` and select from the new dropdown `custom-maven-settings`



6. *shared-workspace*: click the dropdown menu and select `PersistentVolumeClaim` and in the *Select a PVC* dropdown, select `source-workspace-pvc`



7. With this complete you can click the `Start` button to begin the pipeline



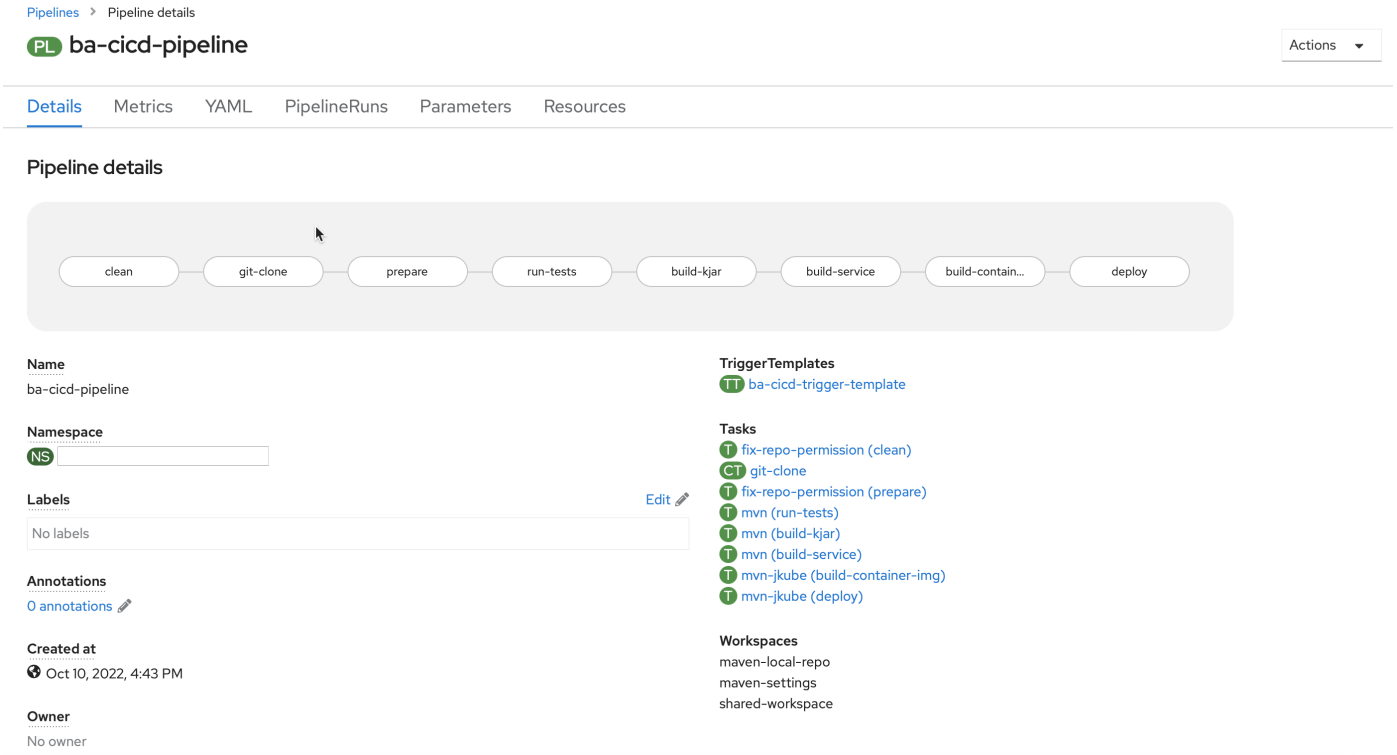
3.5.7 16.7 Testing GitHub and Pipeline integration

If you run this test, a new deployment should be triggered. The pipeline will deploy the decision service for the first time.

1. In your terminal, access your project folder.
2. Commit and push. You can use this empty commit sample if you need:

```
git commit -m "an empty commit to test the pipeline" --allow-empty
git push origin master
```

1. In OpenShift, access: "**Pipelines** -> **ba-cicd-pipeline** -> **Pipeline Runs** " and check the progress of your application deployment.



3.5.8 16.8 Using the web application

The web application allows you to interact with the deployed rules and decisions in a specific Decision Server (KieServer or Kogito runtime). To use the deployed web app to interact with the deployed decisions, first you need to set the KIE Server URL in the web app settings.

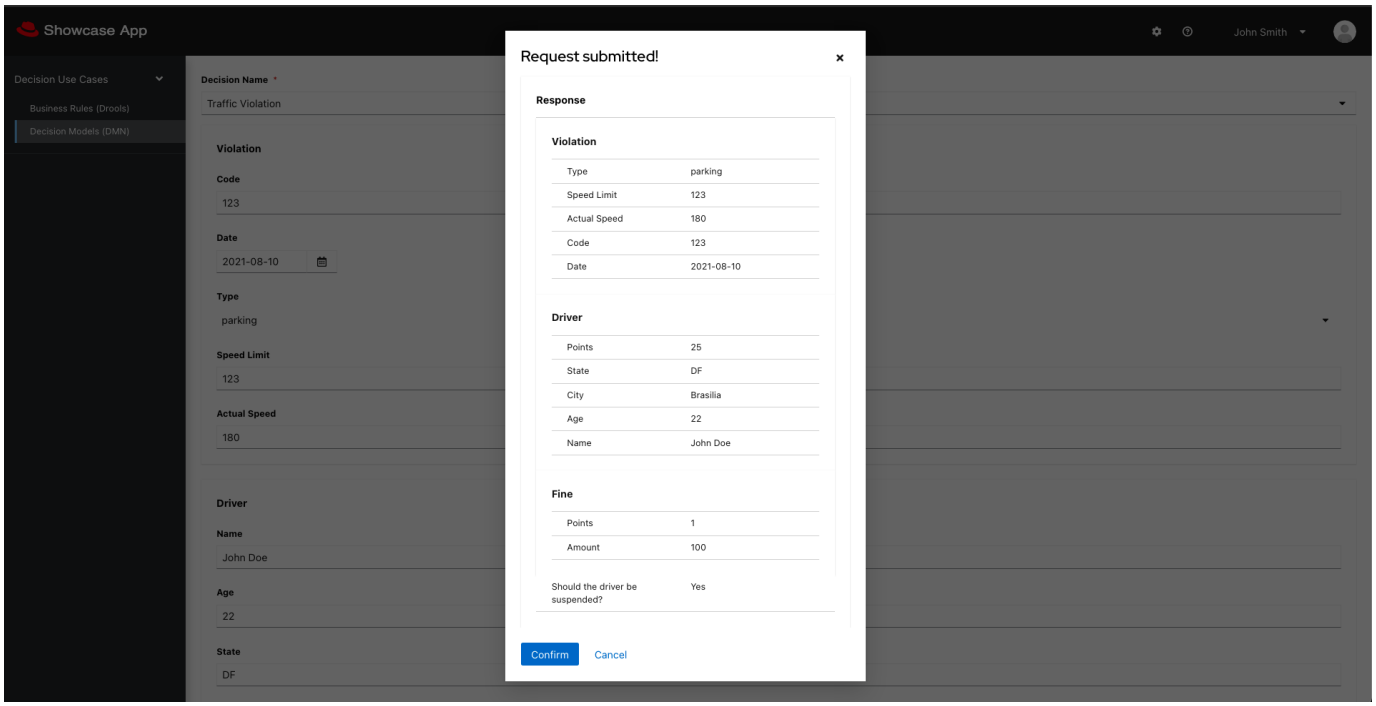
1. The deployed decision service is now deployed and accessible. Get your deployed KIE Server route. You can use the command:

```
echo "http://"$(oc get route business-application-service-route -n rhdm-kieserver-cicd | awk 'FNR > 1 {print $2}')"/rest/server"
```

2. Open your web application. The URL was provided in the installation step. If you lost it, use the command

```
oc get route decision-service-webclient --template='http://{{.spec.host}}' -n rhdm-kieserver-cicd
```

1. In the web application, click on the settings icon on the top right corner. In the field `Kie Server Base URL`, insert KIE Server URL.
2. You can use the "Test Connection" button to validate the communication between the two services, then Save.
3. You should be able to test the available decisions and rules.



With this, the whole demo is now set up and ready to use.

NOTE: If you get interested in see how this webapp was developed the src code is available here

3.5.9 16.9 Extra information

The provisioning script `provision.sh` will:

- Create a new namespace called rhdm-kieserver-cicd
- Install OpenShift Pipelines
- Create the pipeline resources
- Deploy a front-end application that you can use to interact with the decision service once you deploy it.

At the moment there are 4 projects in this repository:

- decisions-showcase: Decision use cases using Business Rules (Drools) and Decision Logic (DMN)
- business-application-service: Spring Boot runtime based Kie Server exposing the API for Decisions provided with this Showcase demo
- cicd: Tekton Pipeline resources to implement a fully automated CI/CD pipeline for your Business Application Services
- monitoring: working in progress...

To see a detailed instruction on each service and each deployment processes (with images), check:

- Provisioning and testing the CI/CD Pipeline
- Provisioning and testing the webclient application

16.9.1 Interested in Kogito?

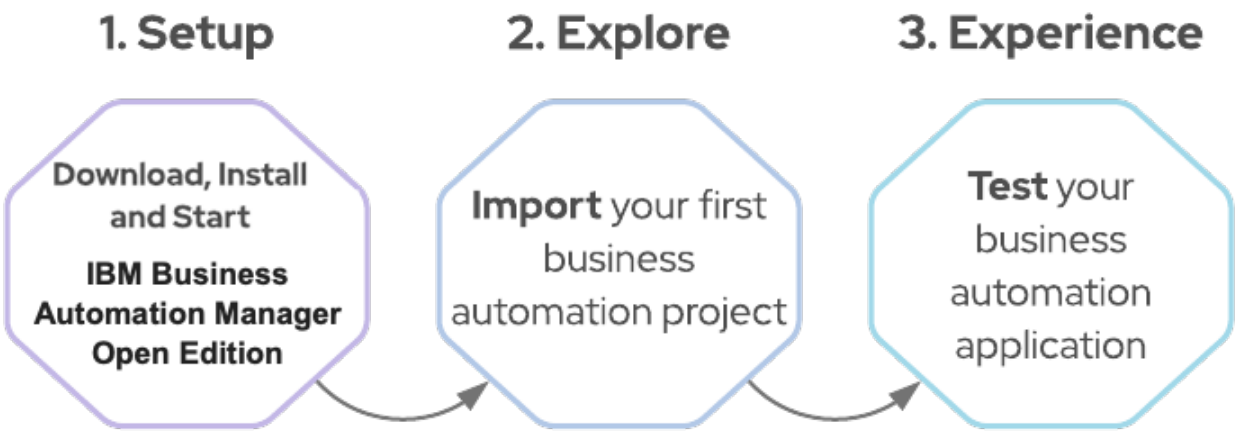
Check out the kogito-quarkus branch to see this same demo but using Kogito based Decision Services instead of KieServer.

Last update: 2023-12-06

3.6 Order Management

3.6.1 17. Getting started with IBAMOE

This guide shows you the experience of using IBM Business Automation Open Edition 8.0 to author, deploy, and execute your business automation applications. With three steps, this guide will get you from installation to deployment and testing of a business application:



We will install IBAMOE locally, and it will run on top of Red Hat JBoss EAP (a.k.a. WildFly). Once we have it up and running, we will import an existing application, so that we have an overview of some capabilities by exploring the tool and the project itself. Finally, we'll wrap up by deploying the project and testing it.

17.1 Pre-requisites

We expect you to have installed in your machine:

- Java JDK 11 (if you don't have it yet, you can download OpenJDK built by Red Hat https://developers.redhat.com/openjdk-install)
- GIT client (https://git-scm.com/)
- *IBM Business Automation Open Edition 8.0 Installation Demo*: **NOTE**: You should use this installer to quickly install EAP, PAM and pre-configure the environment and user access you'll need. `$ git clone https://github.com/timwuthenow/ibamoe-setup.git`

You should now have successfully installed IBM Business Automation Open Edition 8.0.

You have two key components deployed in your Red Hat EAP right now: **Business Central** and **KIE Server**.

Business Central is the component that allows you to develop business assets like processes and decisions, to manage projects, build and package them. Finally, you can deploy it in KIE Server.

KIE Server is a lightweight engine capable of executing business assets like processes, cases and decisions. It can be easily integrated with your services, for example via REST or JMS.

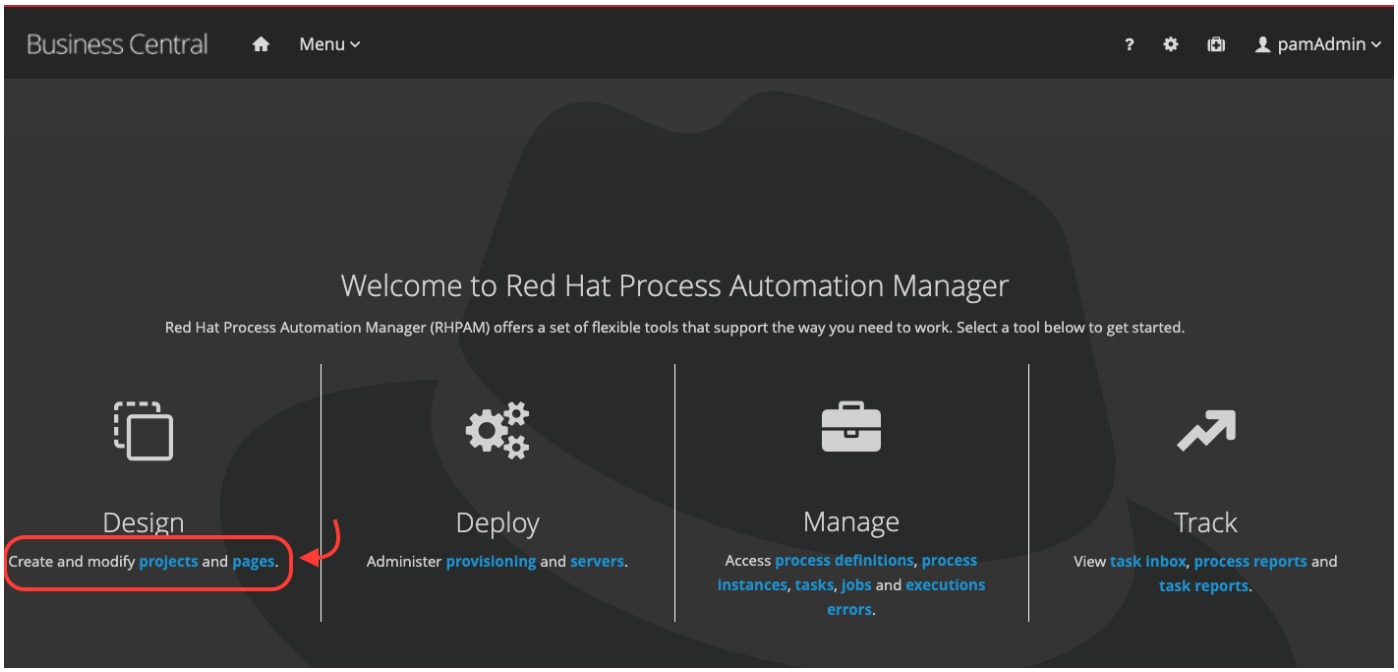
Luckily, IBM Business Automation Open Edition 8.0 comes with a number of out-of-the-box template and example applications that can be used to quickly build and deploy a process microservice.

17.2 Explore the Asset

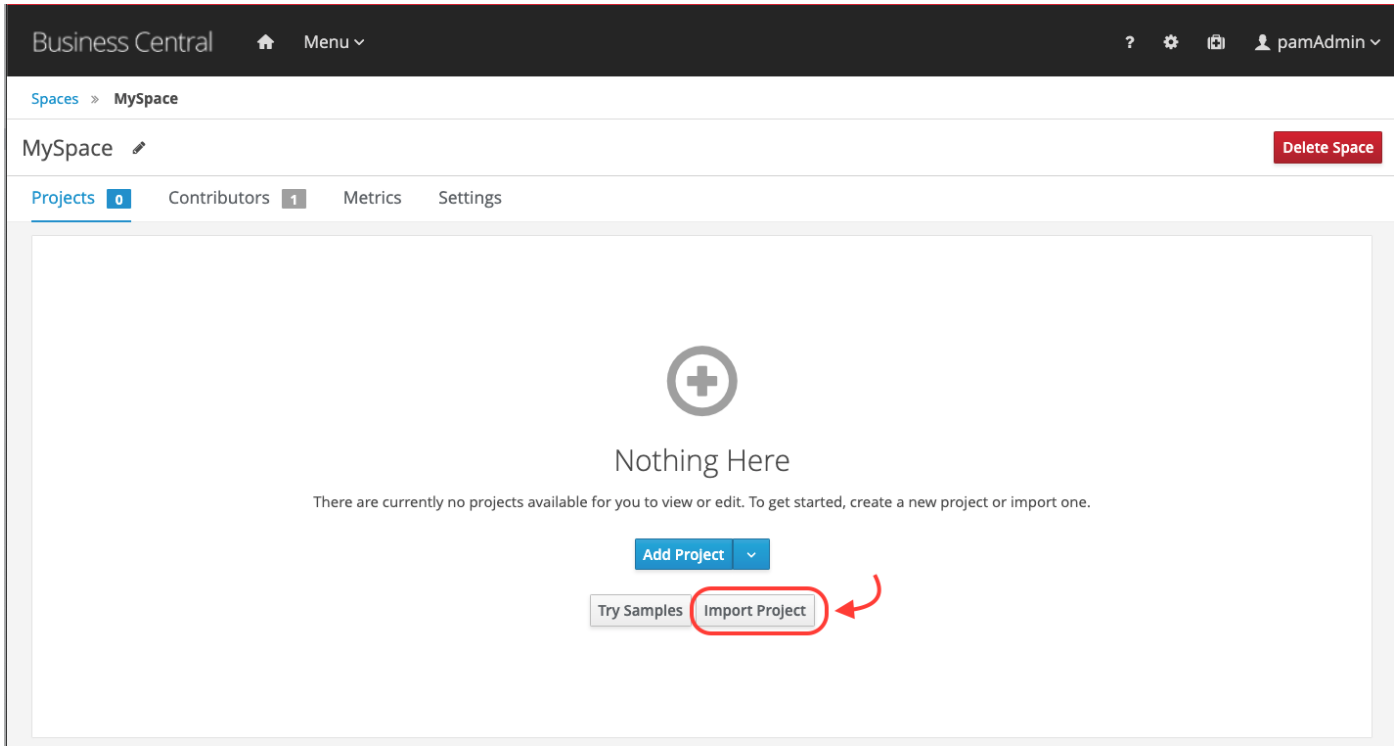
Let's start by accessing Business Central.

1. In your browser, access Business Central by navigating to http://localhost:8080/business-central
2. Log in with the credentials:
3. User: **bamAdmin**
4. Password: **ibmpam1!**

   INFO: If you're using the Linux environment on Skytap use *pamadmin:pamadm1n* as the username password
5. Click on "Design, create and modify projects and pages"

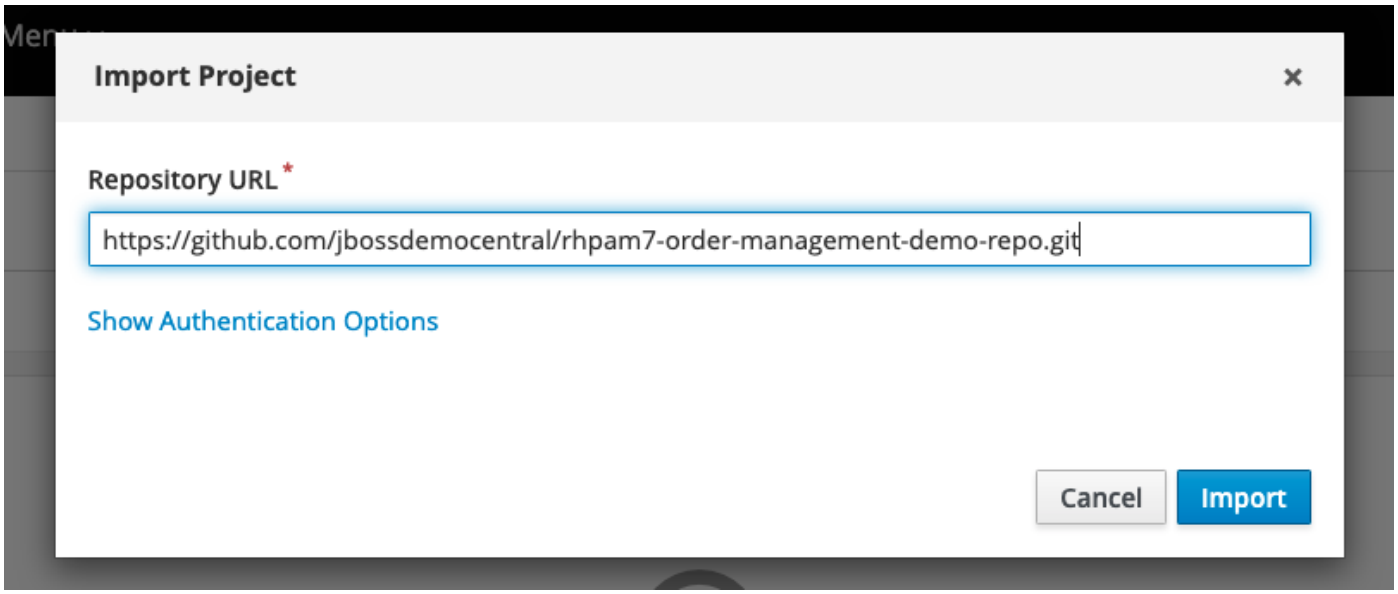


6. Select "MySpace", and next, click on "Import Project":

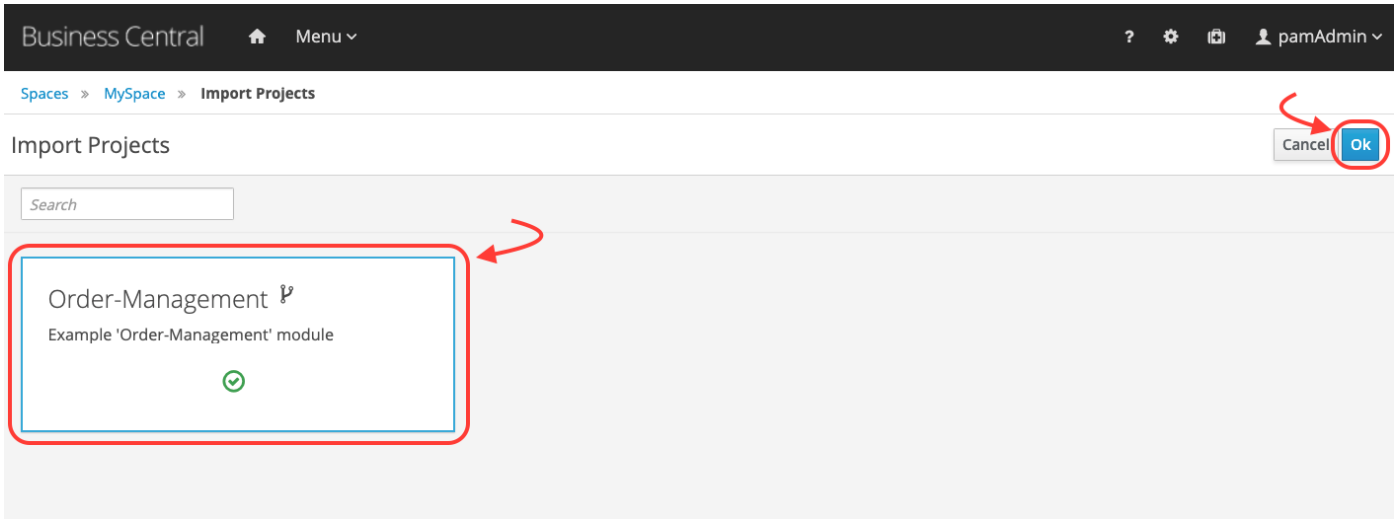


7. Insert the following repository URL, and click on Import.

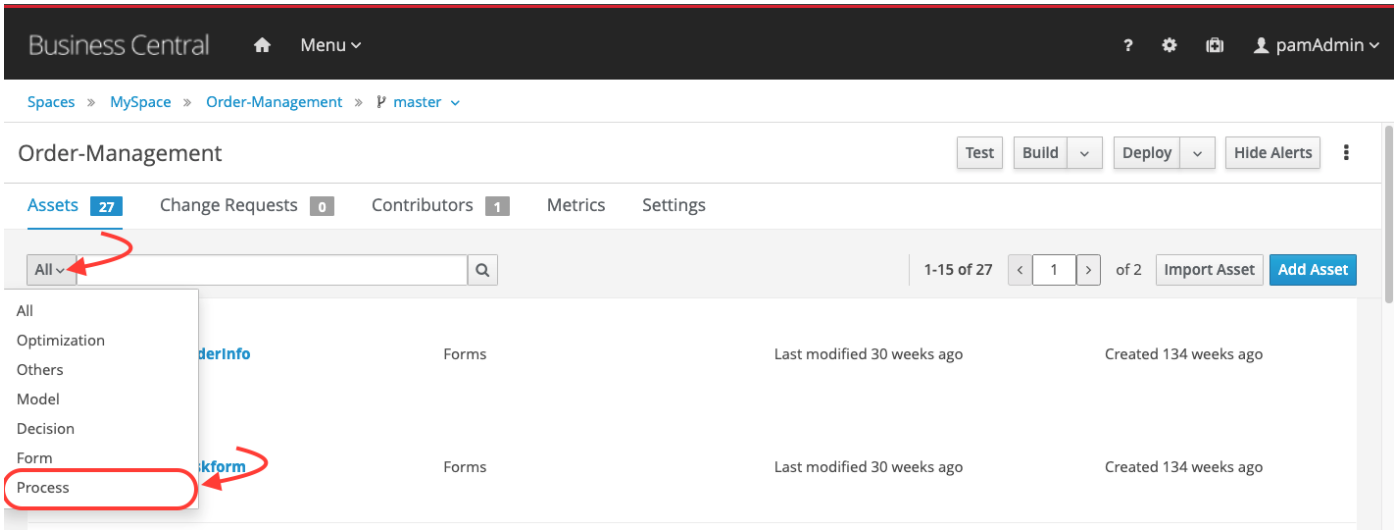
```
https://github.com/jbossdemocentral/rhpam7-order-management-demo-repo.git
```



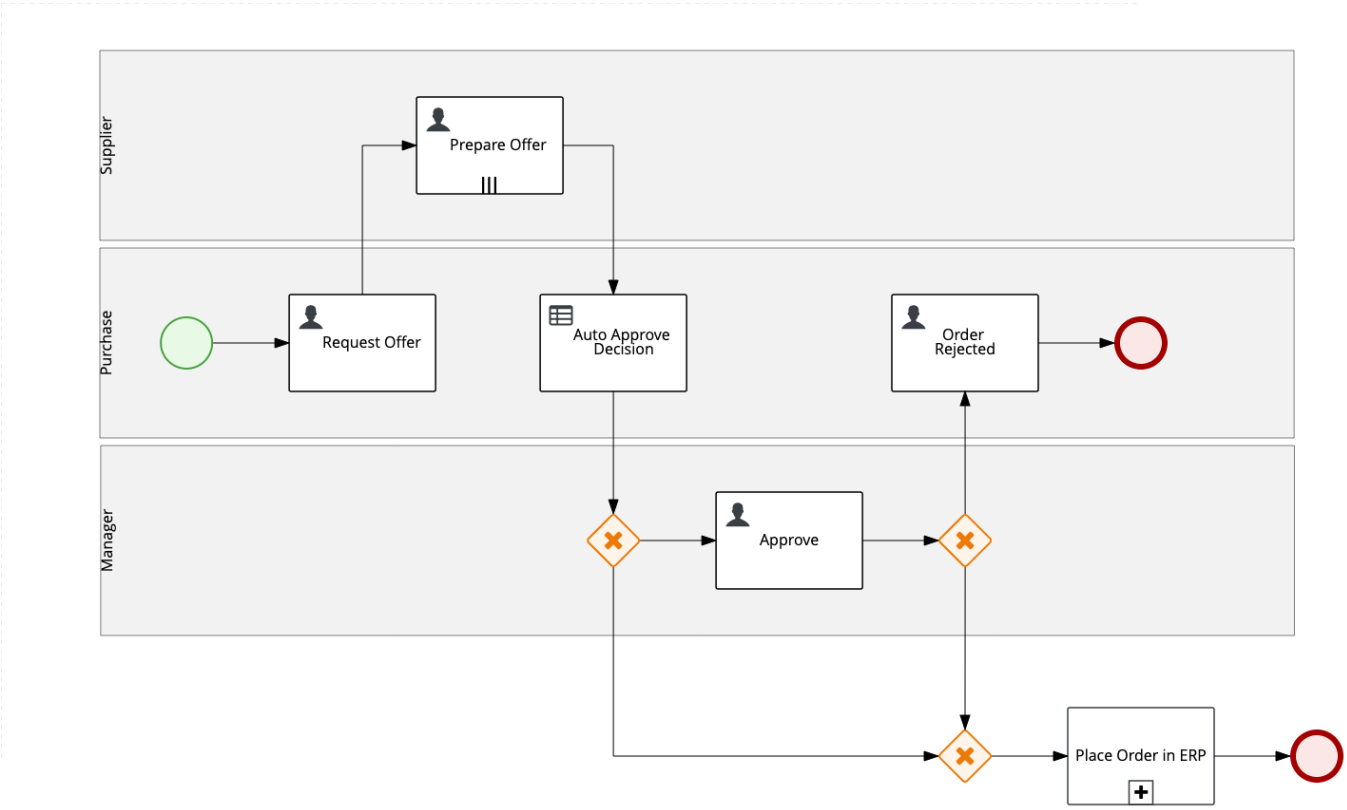
8. Select the Order-Management project and click on OK.



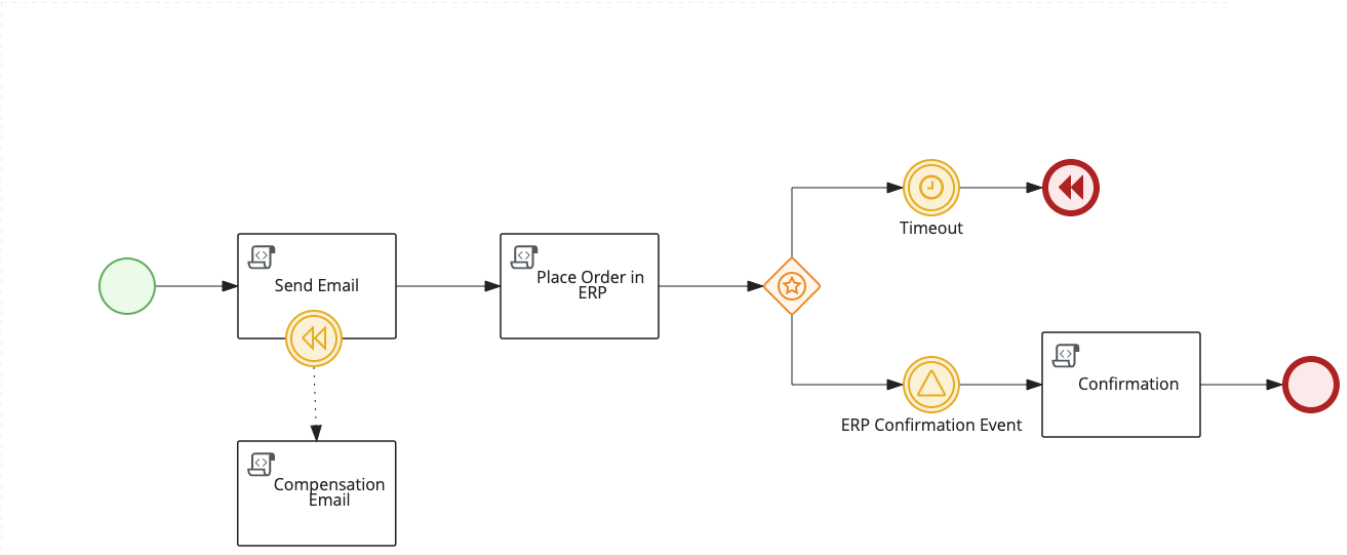
9. Once the project has been imported, notice it has 27 assets. Click on the filter button "All" and select Process.



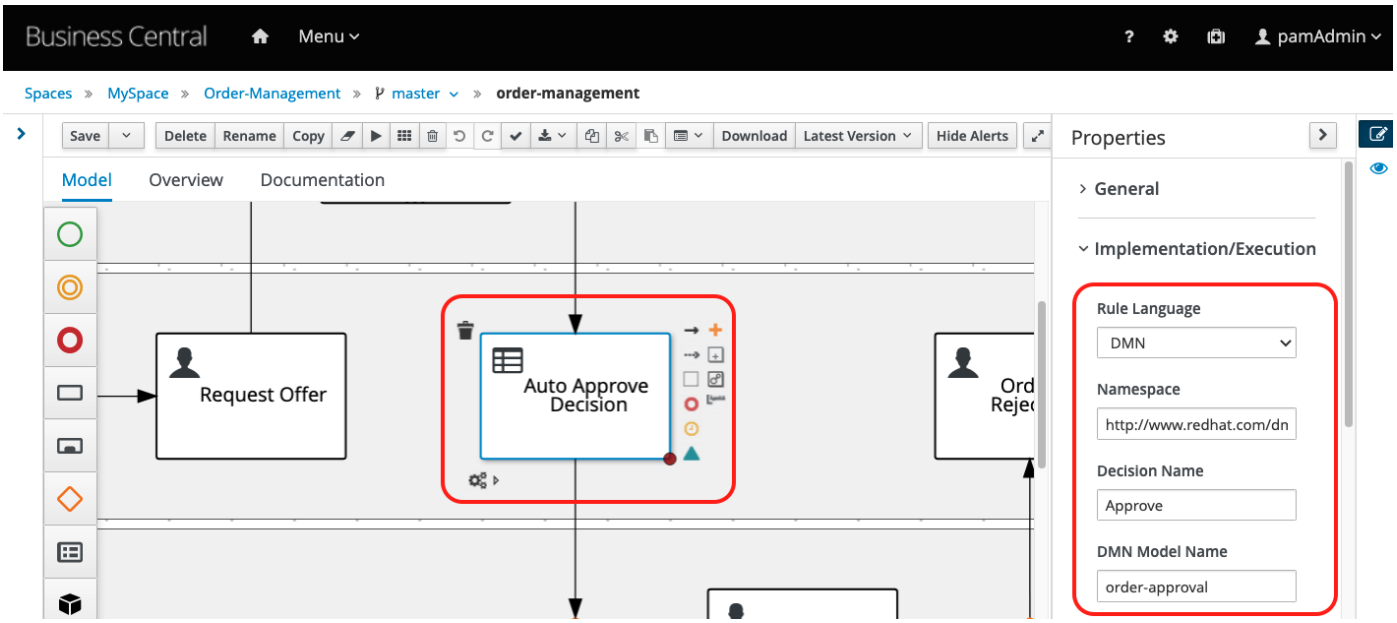
10. Open the order-management process. This is the automated process that determines the approval or denial of an order request. As you see below, it is implemented with the BPMN2 standard.



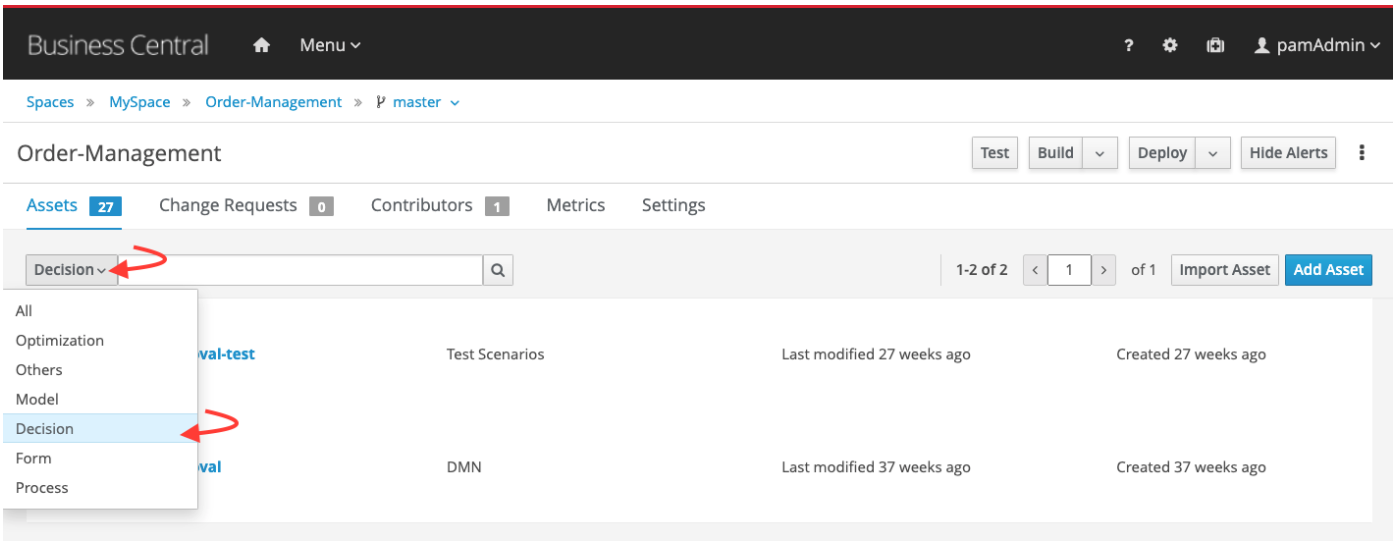
11. The final element of this process, is a sub-process "Place Order in ERP". This subprocess includes advanced bpmn2 modeling concepts like compensation and event based gateways. Have in mind that PAM supports the modeling of advanced flows using the bpmn2 specification, but don't worry if you don't fully get what is happening in this subprocess.



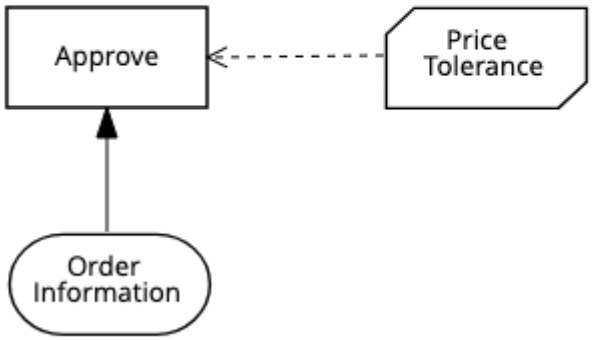
12. Notice this process tasks are aggregated in three lanes: Manager, Purchase and Supplier. The approval decision will be made based on multiple authors, but, in this process we even have the support of automated decision. The automated decision is made on the node "Auto Approve Decision", that references a DMN Model that is also part of this business project.



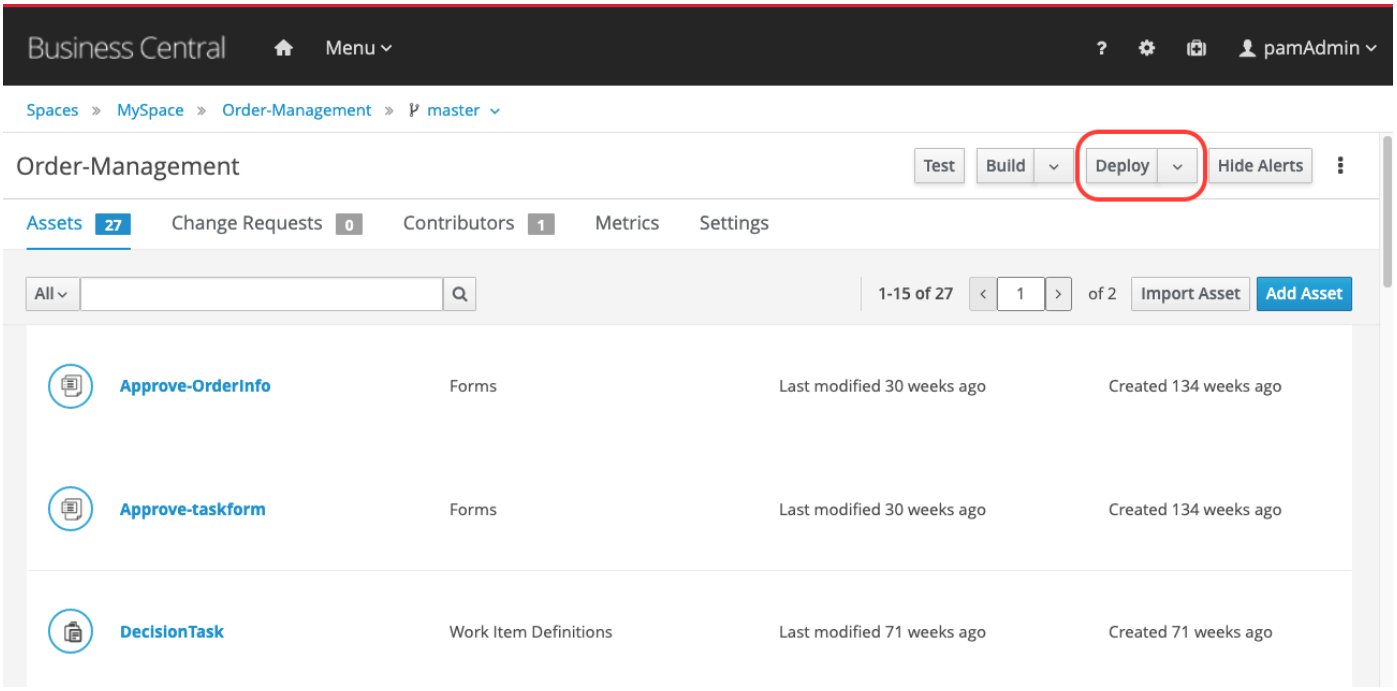
13. Close the process modeler. Now, filter the assets by Decision. You should see a Test Scenario and a DMN model.



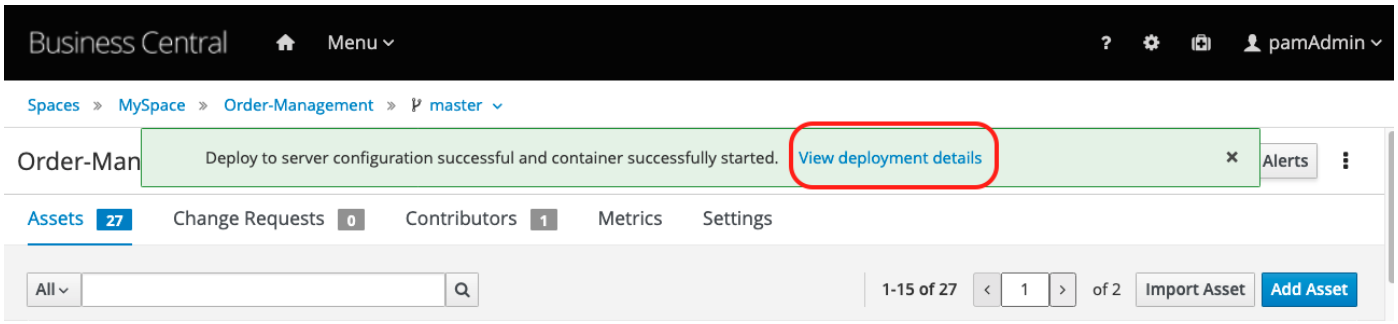
14. Open the order-approval. It is a simple decision model that can define the "Approve" decision based on the data input "Order Information" and on the "Price Tolerance" business rules.



15. Now, close the decision asset. In your project page, click on the Deploy button. Business Central will trigger the build of this maven project, that will be packaged in a KJAR (the deployment unit which contains the assets) and will be deployed on the KIE server.



16. Once the build and deployment has finished, you'll see a successful deployment message. Click on the "View deployment details" link.



17. The page will show a running “default-kieserver” with the “order-management_1.1-SNAPSHOT” container deployed.

Our business project is now available to be consumed by client applications! Let's have a look at how we can consume this business application.

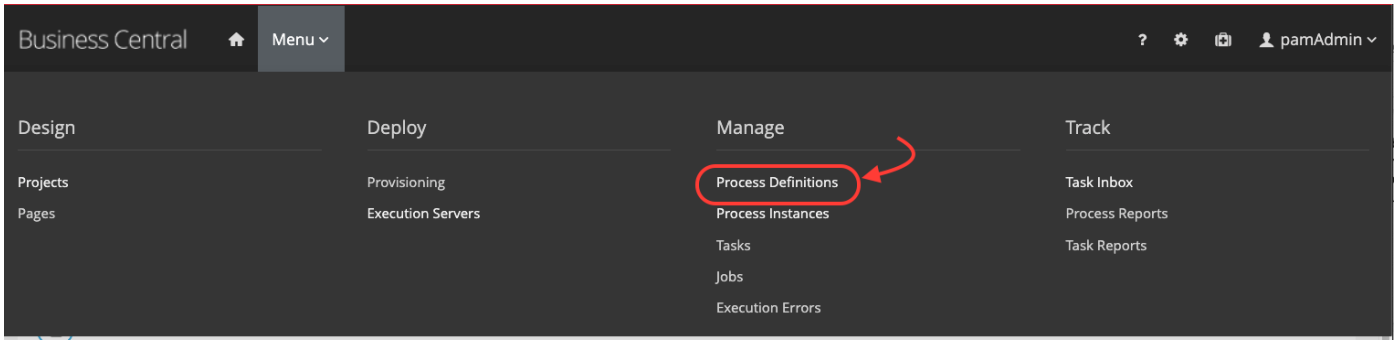
17.3 Experience

The engine, KIE Server, is the service which exposes the business project and also the one we use when integrating with client applications. It comes with a Swagger UI that allows us to test the RESTful endpoints of the engine and consume rules deployed on it.

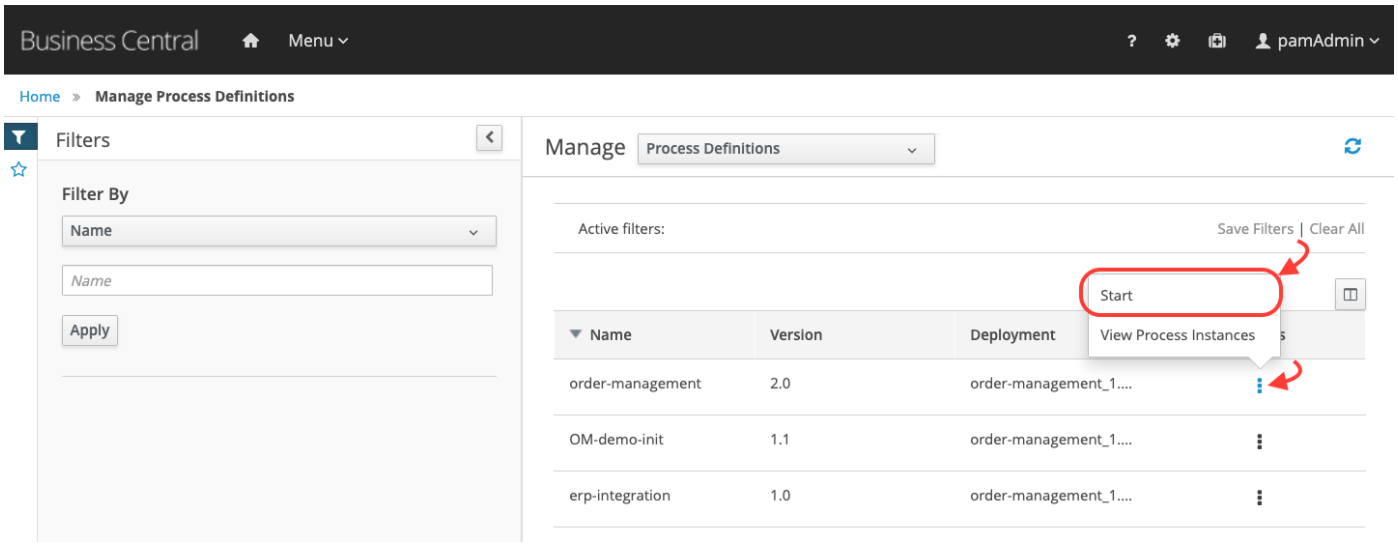
Another way to consume our business project is to use Business Central UI to interact with the engine and test our business assets.

For this hello world, let's use Business Central process and task management capabilities.

1. In Business Central, let's open the Menu in the top bar and navigate to "Process Definitions"



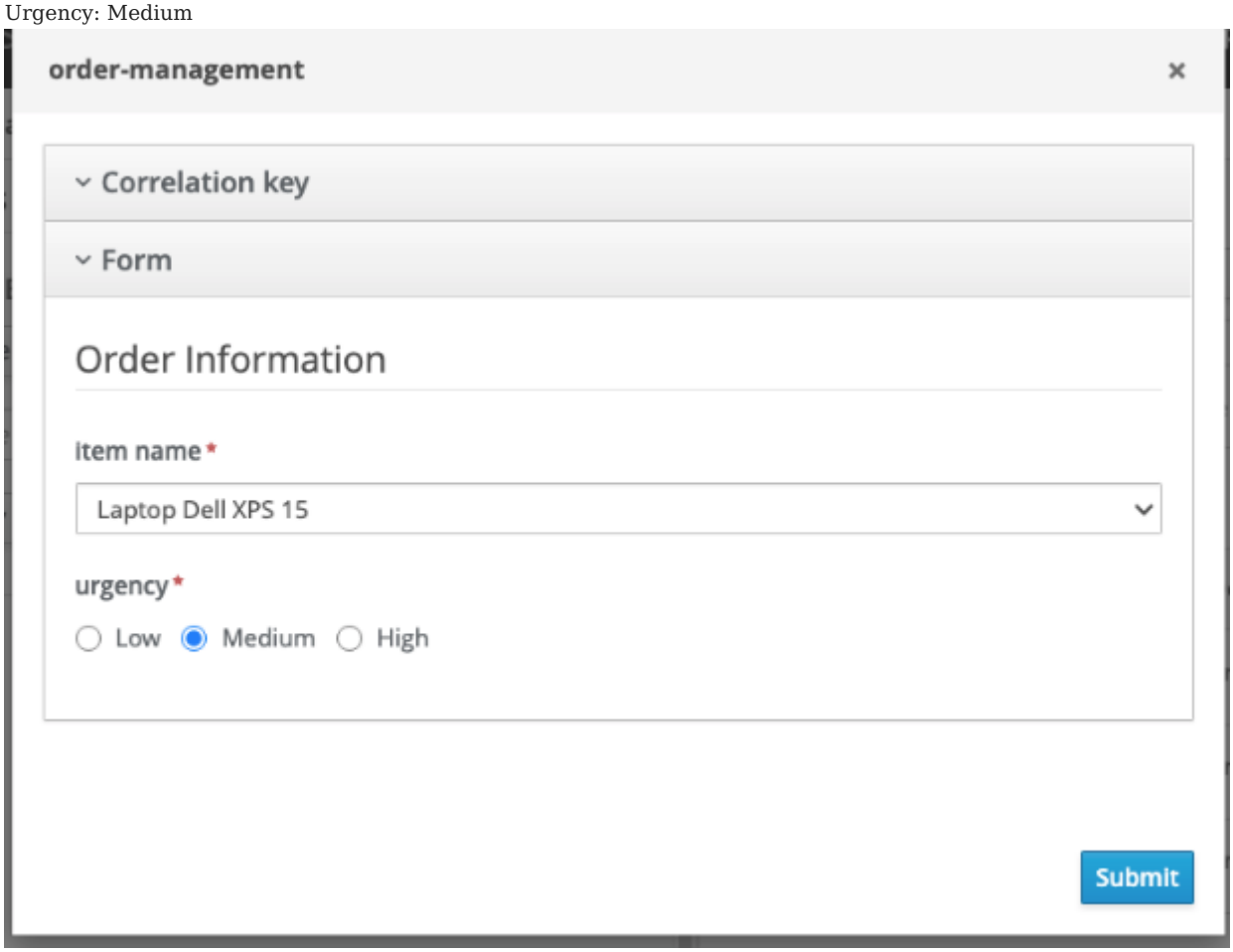
2. We can see three different process definitions. We'll start a new process instance based on the "order-management" process. Click on the actions kebab, and select "Start"



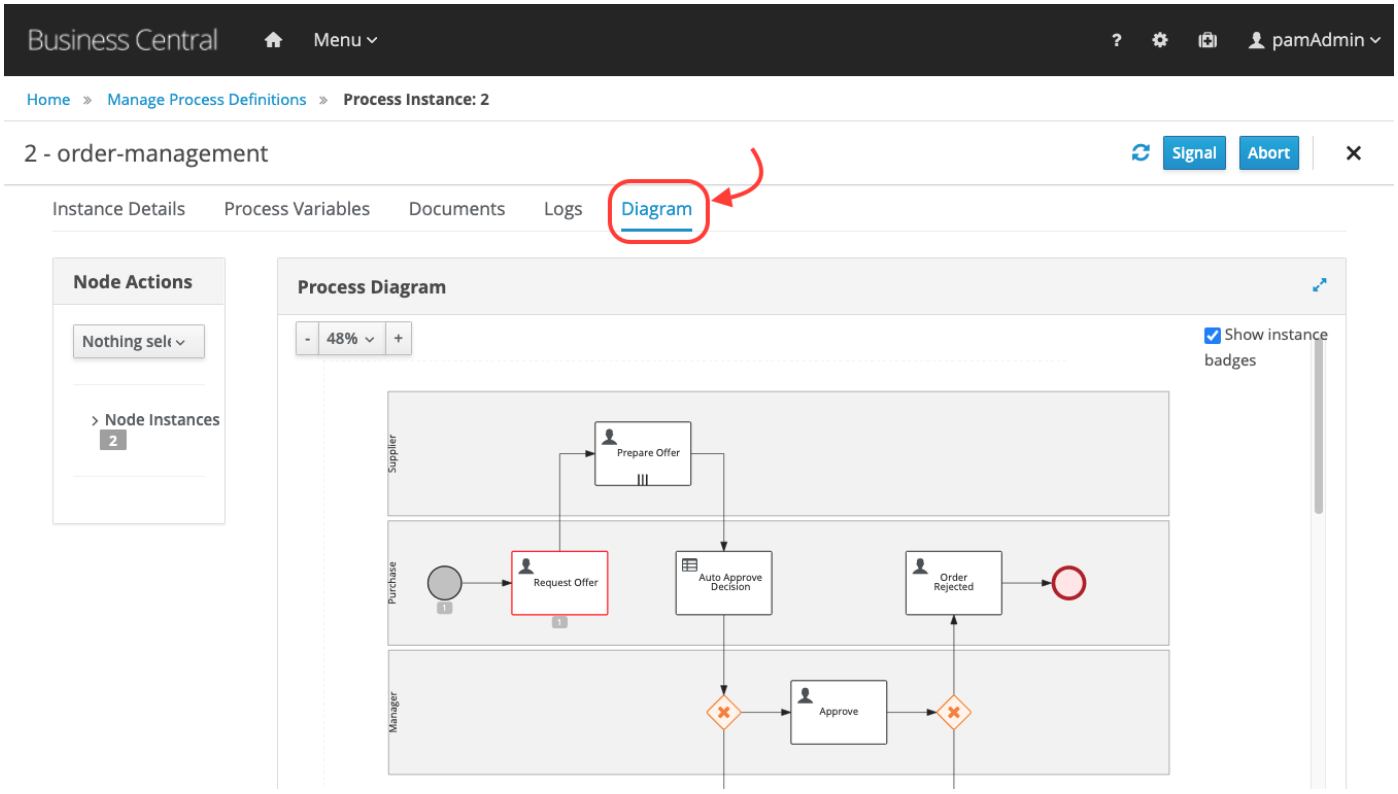
3. The form that opened is also part of our business process and we can customize it if needed. For now, let's just fill in the data required to start our process instance, and click the "Submit" button.

4. Item Name: Laptop Dell XPS 15

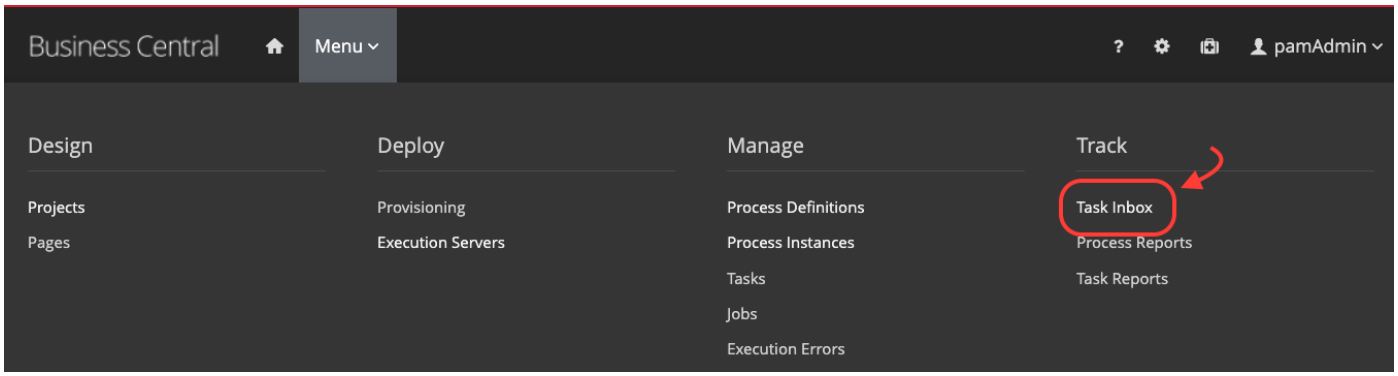
5. Urgency: Medium



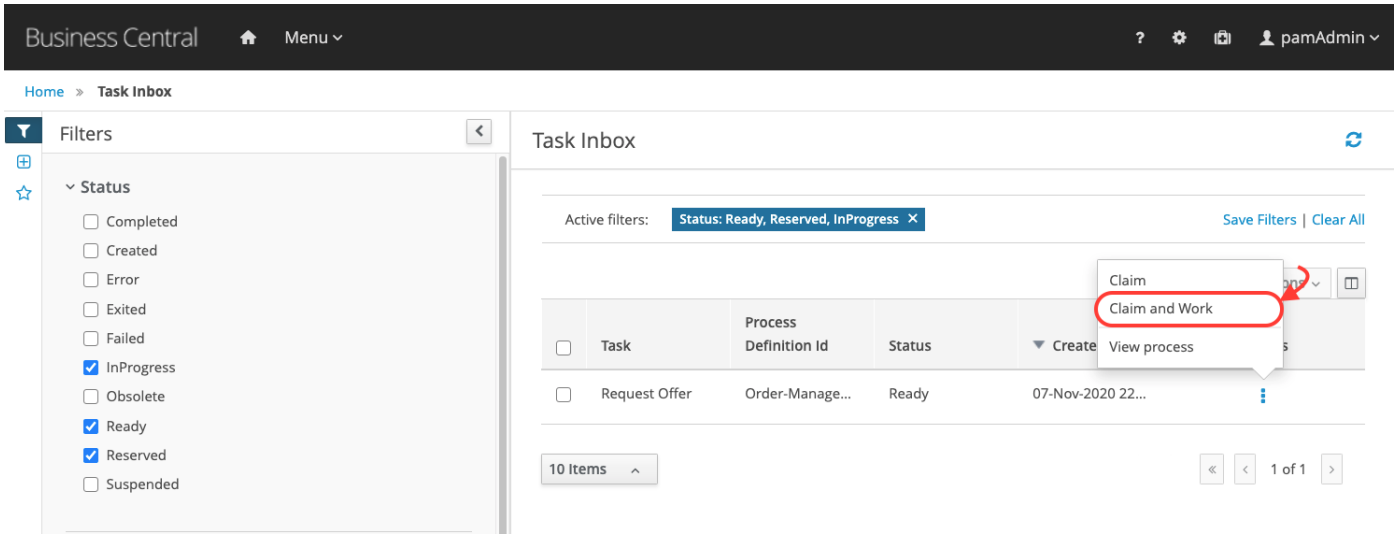
6. A new process instance will start in the engine. In order to visualize the current status, click on "Diagram".



7. Notice we currently have a Human Task named "Request Offer" waiting for human intervention. Now, let's work on this task. In the Menu, access the "Task Inbox":

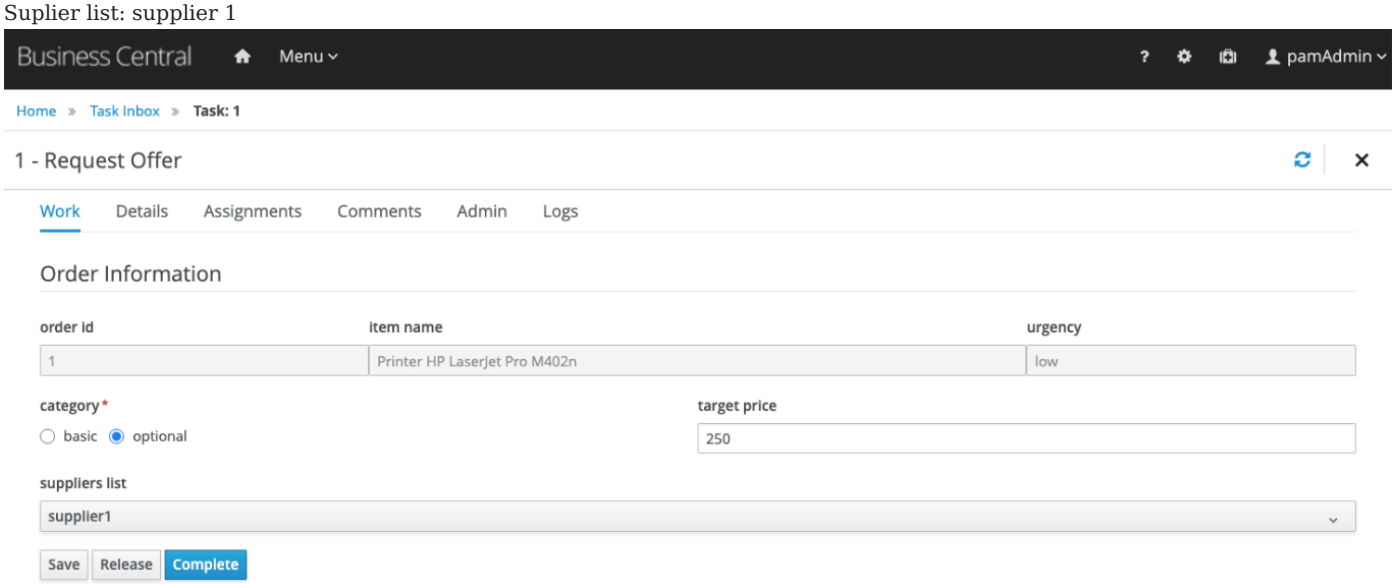


8. In the list you should see a list of tasks you have permission to see and work on. Let's claim the Request Offer task to our user, and start working on it. Click on the kebab and select the "Claim and Work" option:

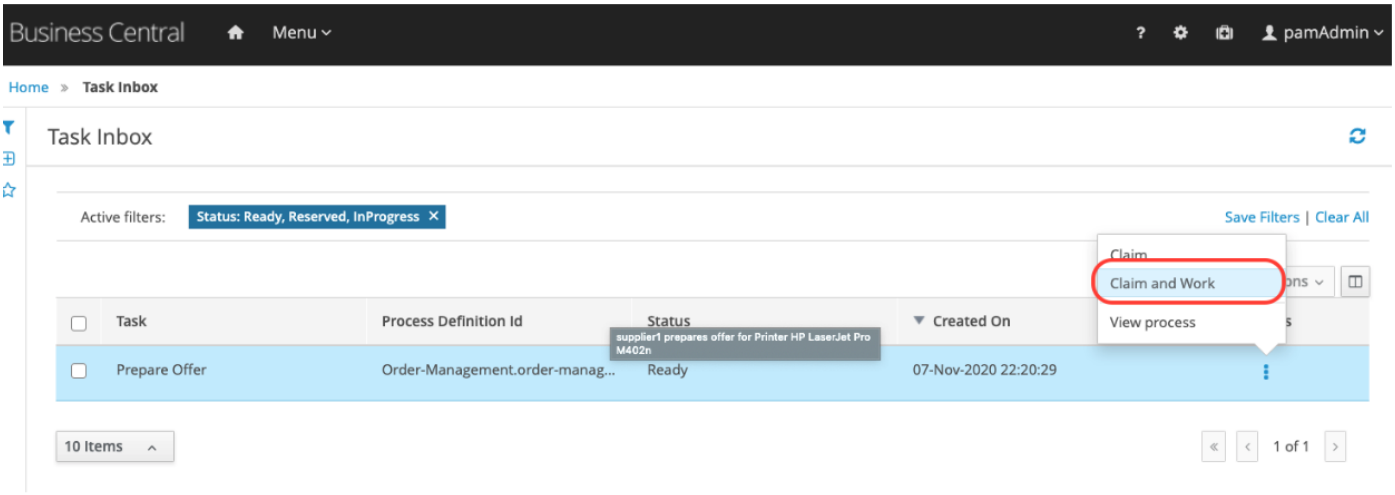


9. You'll see the task data available for your analysis, as a knowledge worker - someone responsible for executing the task.
10. Click on the blue "Start" button to start working on the task.Based on this offer, we'll define our reply. Inform the following data and click on the blue "Complete" button:
11. Category : optional
12. Target Price: 250

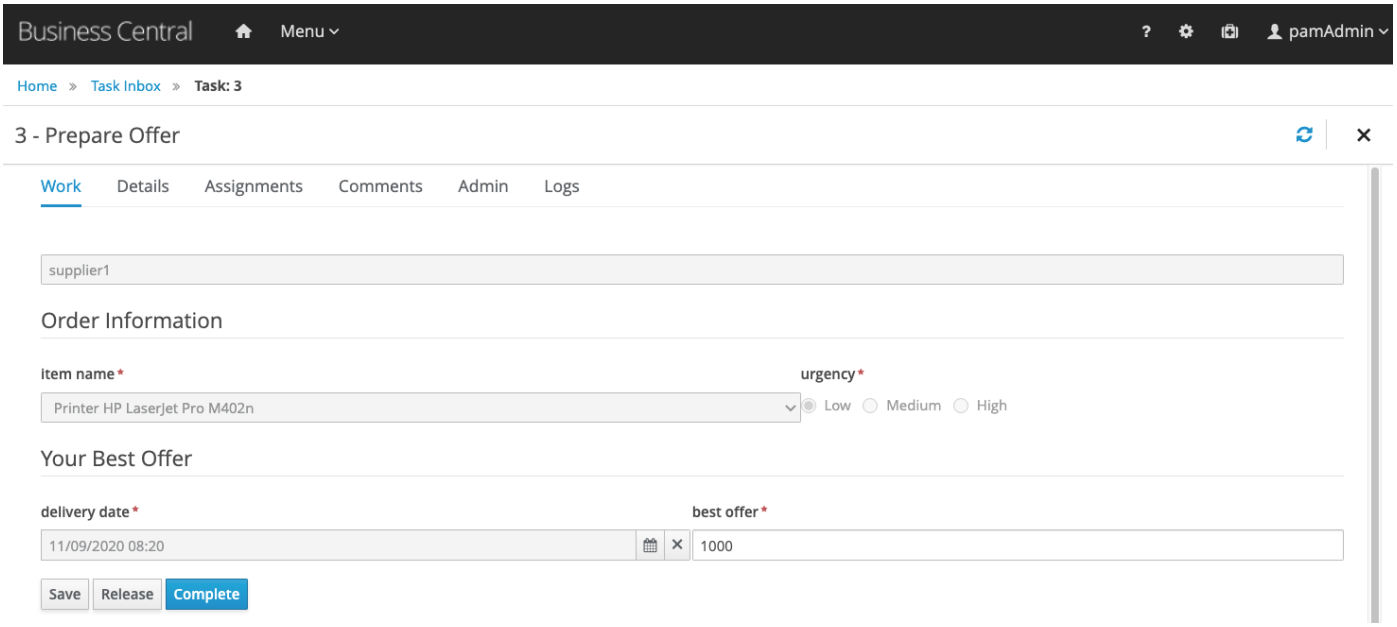
13. Suplier list: supplier 1



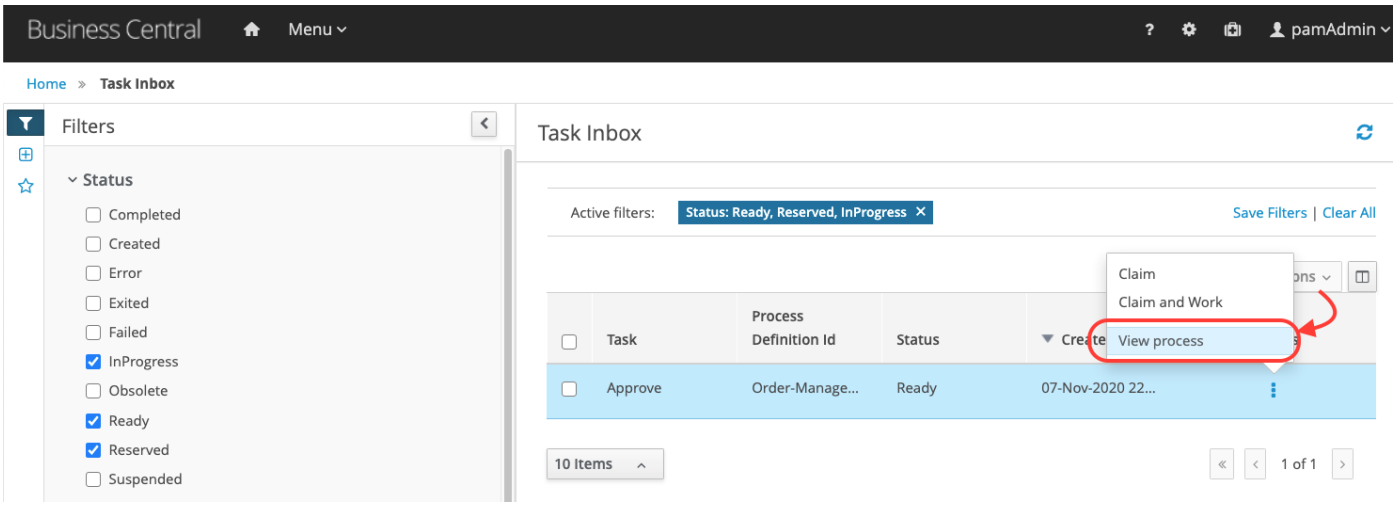
14. According to our process, a new task will be created for the suppliers. The supplier should provide an offer - so let's do it. Still on the task list, claim and work the task "Prepare Offer":



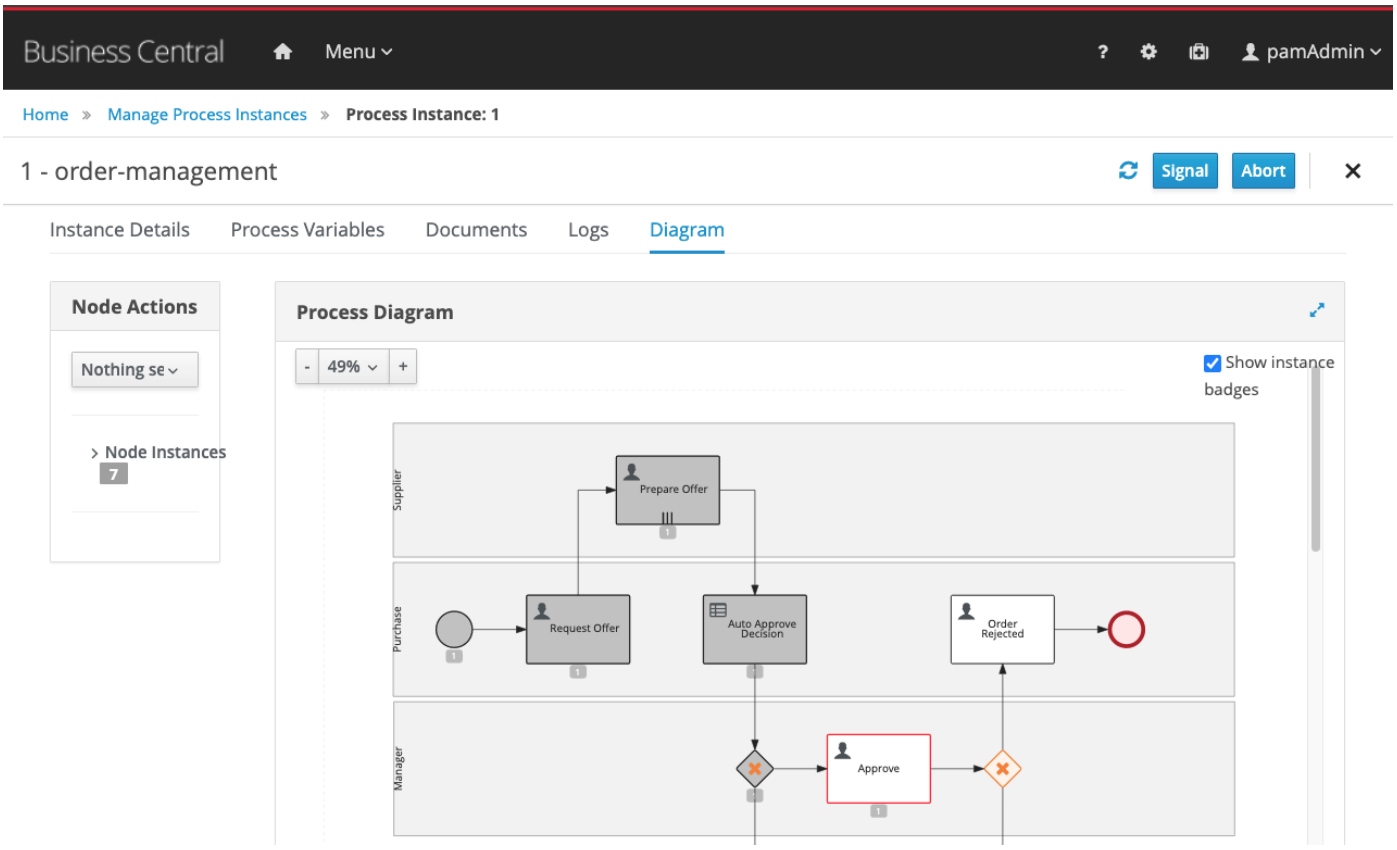
15. Click "Start" blue button, inform any date, and the best offer as **1000**. Click on complete.



16. At this point, the automatic approval was already taken, and our request was not automatically approved. You can confirm this by visualizing the process instance. On the kebab, select "View Process"



17. You'll be redirected to the list of process instances. Select the process instance with id 1, and then, choose the "Diagram" option:



At this point, you have learned how you manage processes and tasks using Business Central. You know how to start new process instances, how to interact with the process tasks and how to complete them.

What about finishing this process by your own? Following the same idea, In Business Central, you can reprove the request, reject the order and reach the end of this process instance.

17.4 Conclusion

Congratulations, you successfully concluded a Hello World in IBM Business Automation Open Edition 8.0.

In this guide, we installed Red Hat PAM, imported a project directly from GitHub, checked out the a process definition modeled and an automation decision.

We wrapped up our tutorial by deploying and testing our services using Business Central UI. If you want to know more about the Order Management demo, we recommend you take a look at the project's instructions at the github repository located here.

Last update: 2023-12-06

3.6.2 18. Overview of Order Management Process

This is a Process Management lab in which will implement an Order Management process. The process will use BPMN2 constructs like **Swimlanes**, **User Tasks**, **Gateways**, combined with decision-based routing based on a **DMN Model** (Decision Model & Notation). It also introduces more dynamic concepts of the IBM Business Automation Open Edition 8.0 process engine, like dynamic assignments of tasks based on process instance data.

18.1 Goals

- Create an Order Management project in IBM Business Automation Open Edition 8.0
- Define and create the process' domain model using the platform’s Data Modeller.
- Implement an order management process in the process designer
- Implement decision logic in a DMN model.
- Create forms with the platform’s Form Modeller.
- Deploy the project to the platform’s Execution Server.
- Execute the end-to-end process.

18.2 Pre-reqs

- Successful completion of the *Environment Setup Lab* or
- An existing, accessible, DM/PAM 7.3+ environment.

18.3 Problem Statement

In this lab we will create an Order Management process that manages the process of ordering a new phone or laptop.

- Start the process by providing the order information.
- The supplier sends an offer stating the expected delivery date and its best offer.
- Depending on the urgency of the urgency and the price, the order can be auto-approved by a DMN decision.
- If the order is not auto-approved, the manager needs to complete an approval step.

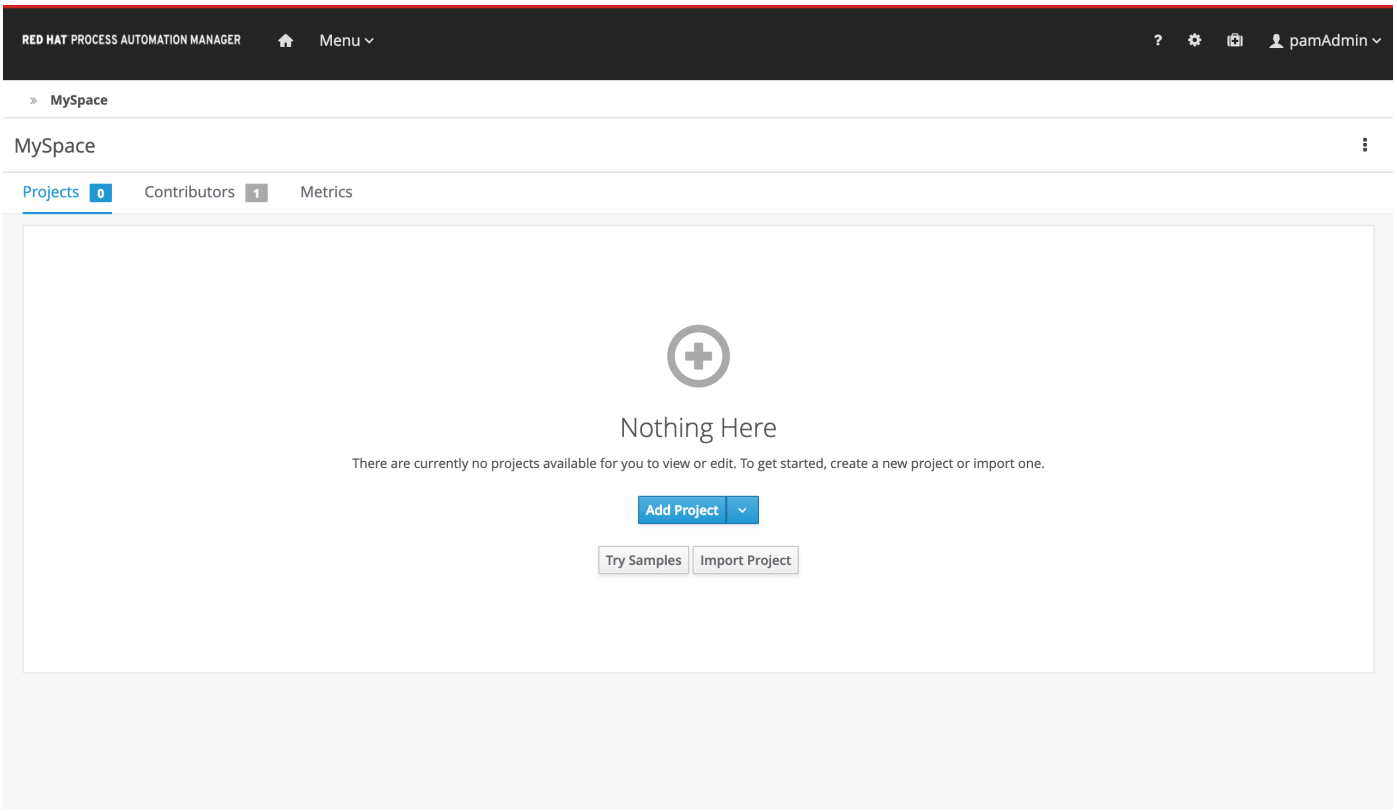
Last update: 2023-12-06

3.6.3 19. Lab Walk Through

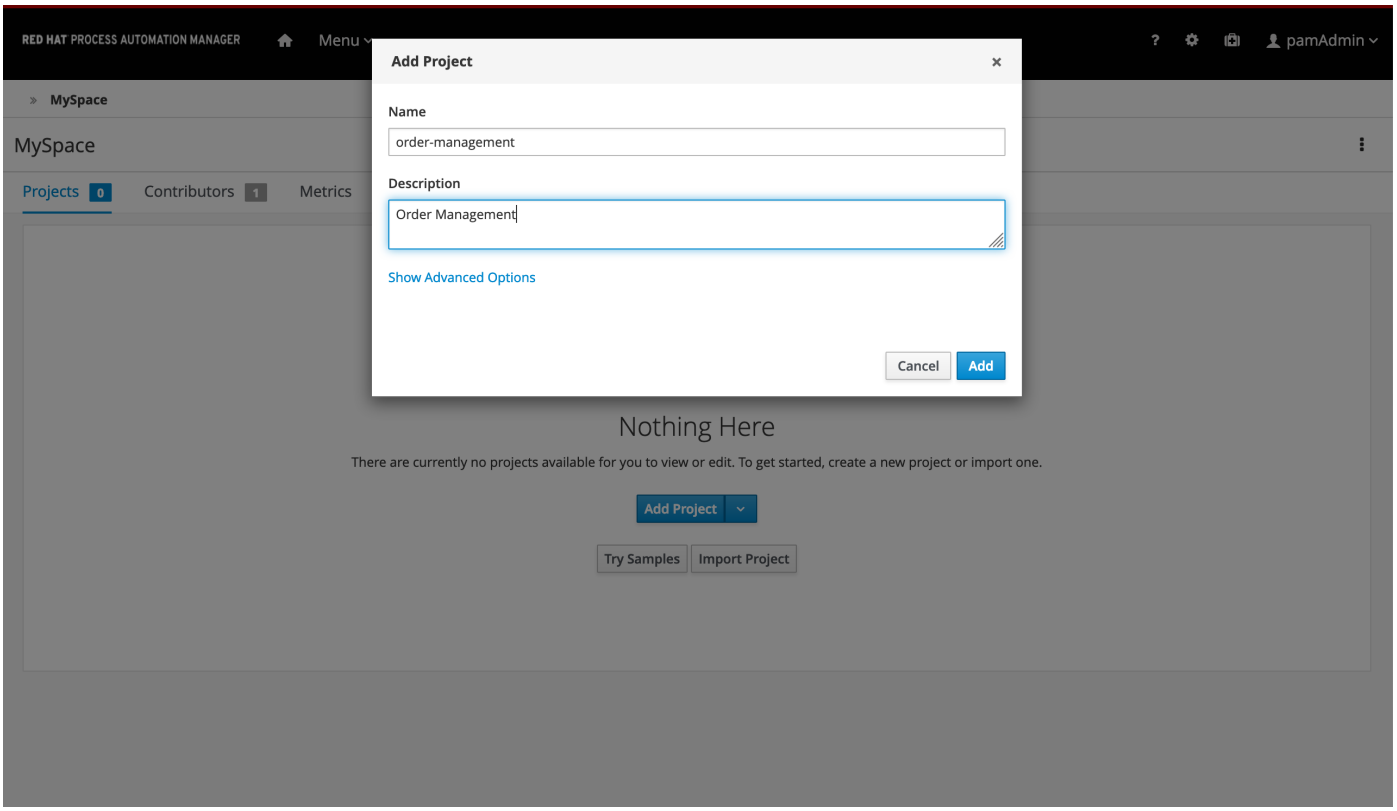
19.1 Create a Project

To define and deploy a business process, we first need to create a new project in which we can store the BPMN2 model, our domain model and the forms required for user interaction. To create a new project:

1. Navigate to Business Central
2. Login to the platform with the provided username and password.
3. Click on **Design** to navigate to the Design perspective.



4. In the Design perspective, create a new project. If your space is empty, this can be done by clicking on the blue **Add Project** button in the center of the page. If you already have projects in your space, you can click on the blue **Add Project** icon at the top right of the page.
5. Give the project the name `order-management`, and the description "Order Management".



With the project created, we can now start building our solution.

19.2 Lab Walk through

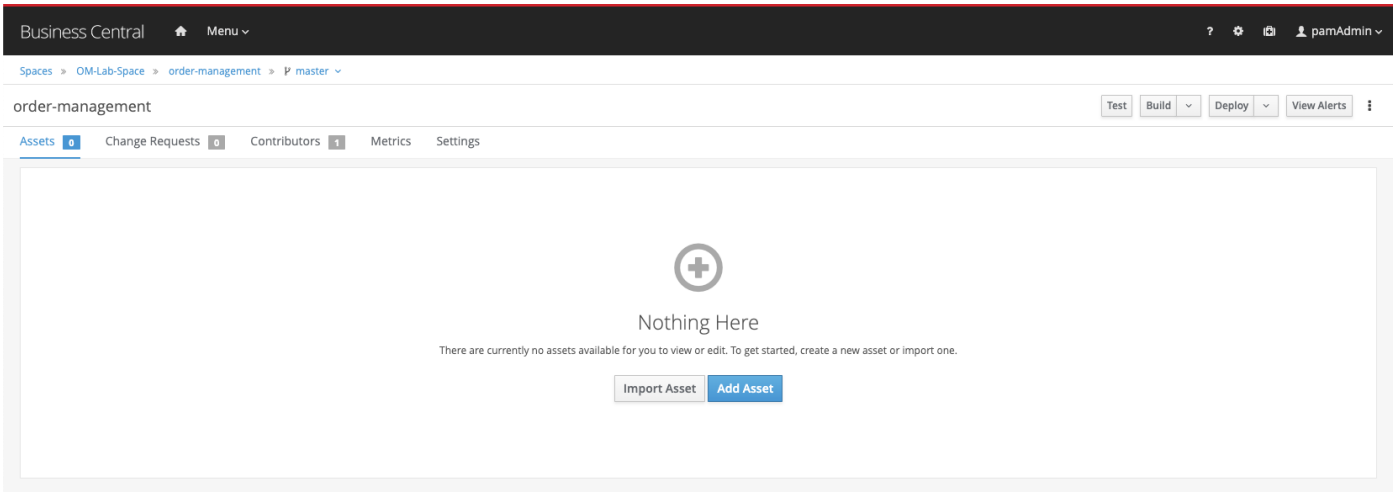
In this section we will first create the Domain Model within Business Central and then walk through the creation of the assets associated with the Process.

19.2.1 THE DOMAIN MODEL

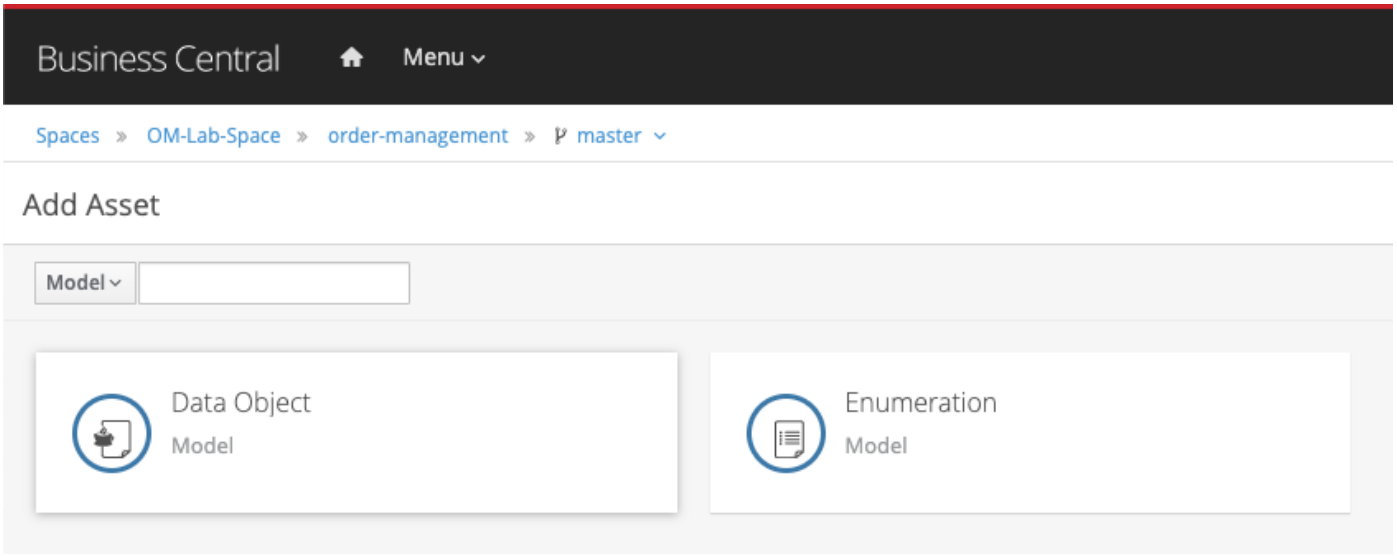
The business process will collect and carry data through the execution of the process. This data is stored in a data model or domain model. In this lab, we collect two types of data:

- `OrderInfo` : contains information about the order, like the item and the price.
- `SupplierInfo` : contains information about the supplier, like the name and the expected delivery date.

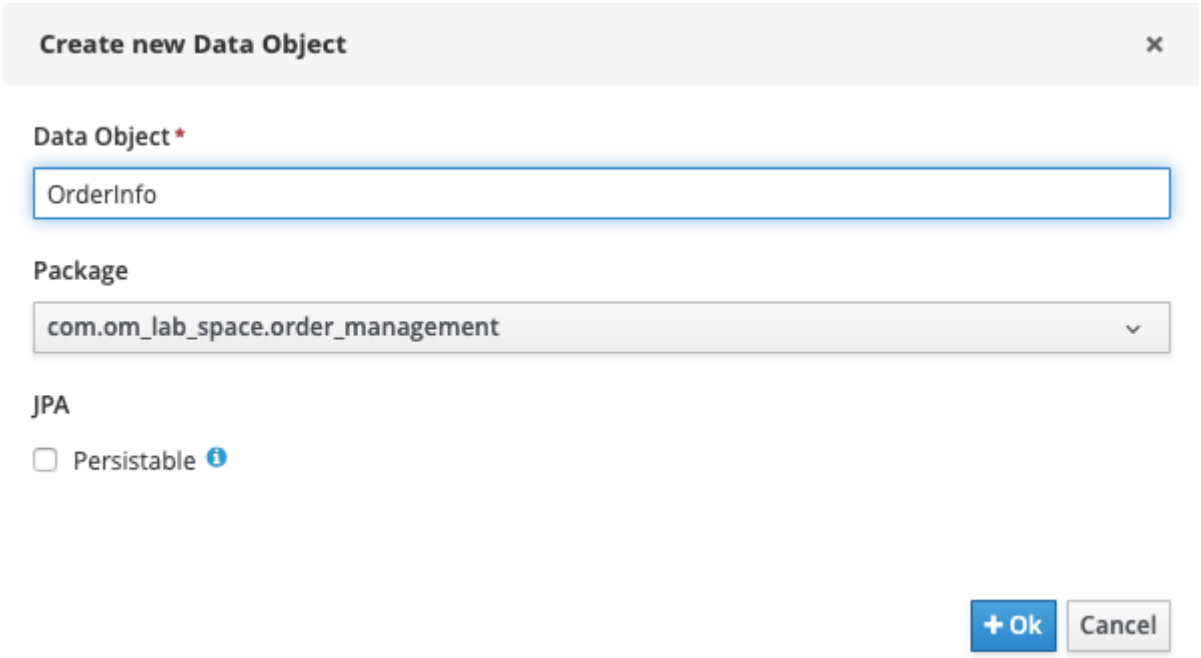
1. In your project, click on the *Add Asset* button in the middle of the screen.



2. In the drop-down menu in the upper-left corner, select `Model`. Click on the *Data Object* tile.



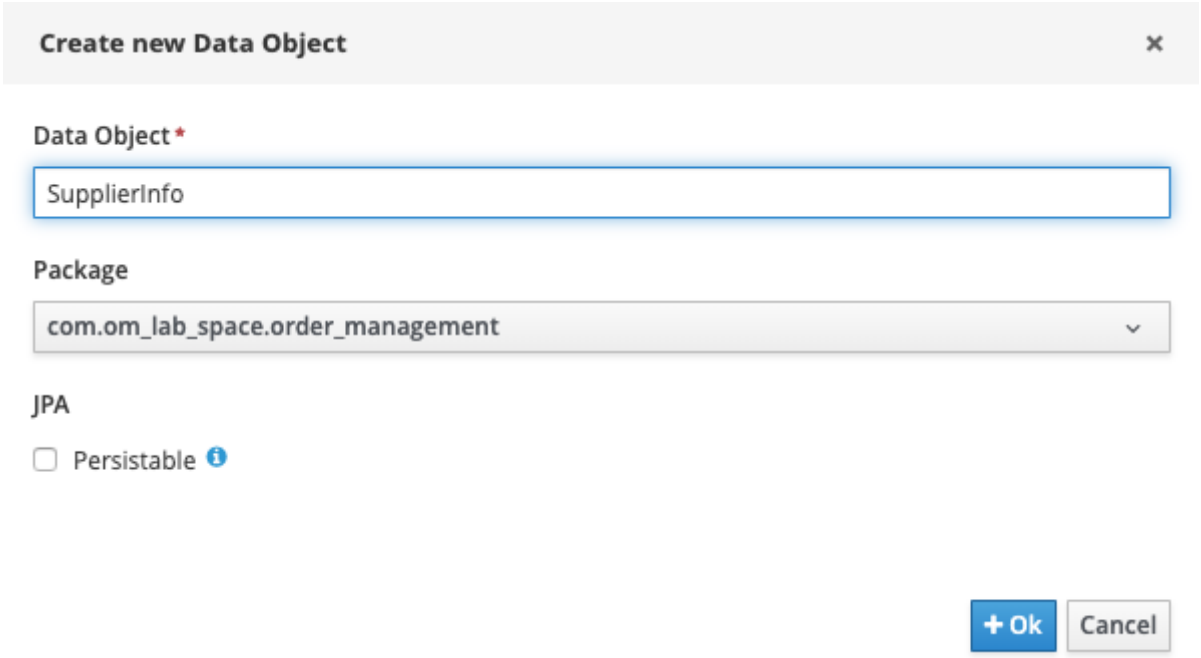
3. Give the *Data Object* the name `OrderInfo`. Leave the package set to default.



4. Add the following fields to the `OrderInfo` data object:

Identifier	Label	Type
item	item name	String
urgency	urgency	String
targetPrice	target price	double
managerApproval	approved	Boolean

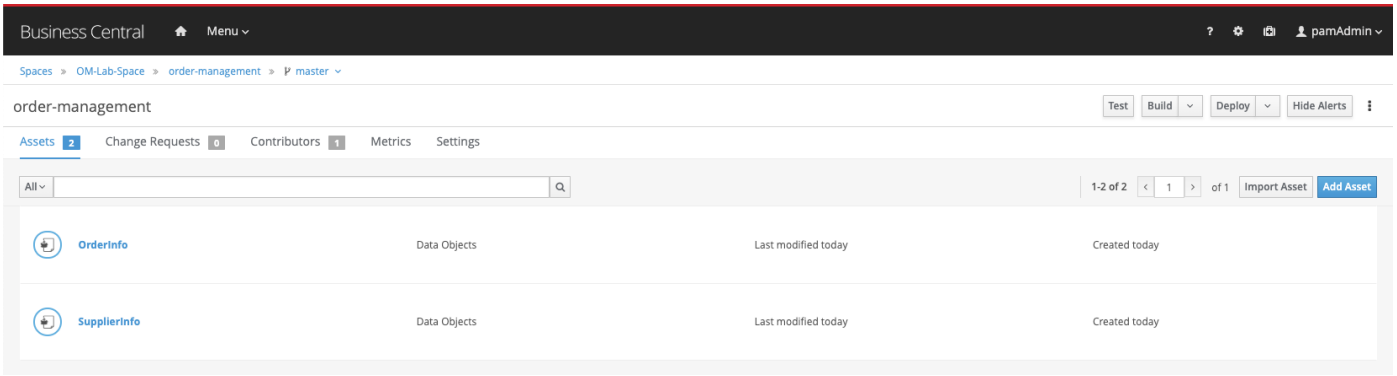
5. When you've added the fields, save the data object by clicking on the *Save* button in the top menu.
6. Use the _breadcrumb` navigator at the top-left of the screen to navigate back to our `order-management` project.
7. Click on the blue *Add Asset* button in the top-right corner and create a new *Data Object*
8. Give it the name `SupplierInfo`



9. Give the `SupplierInfo` object the following fields:

Identifier	Label	Type
offer	best offer	double
deliveryDate	delivery date	Date
user	user	String

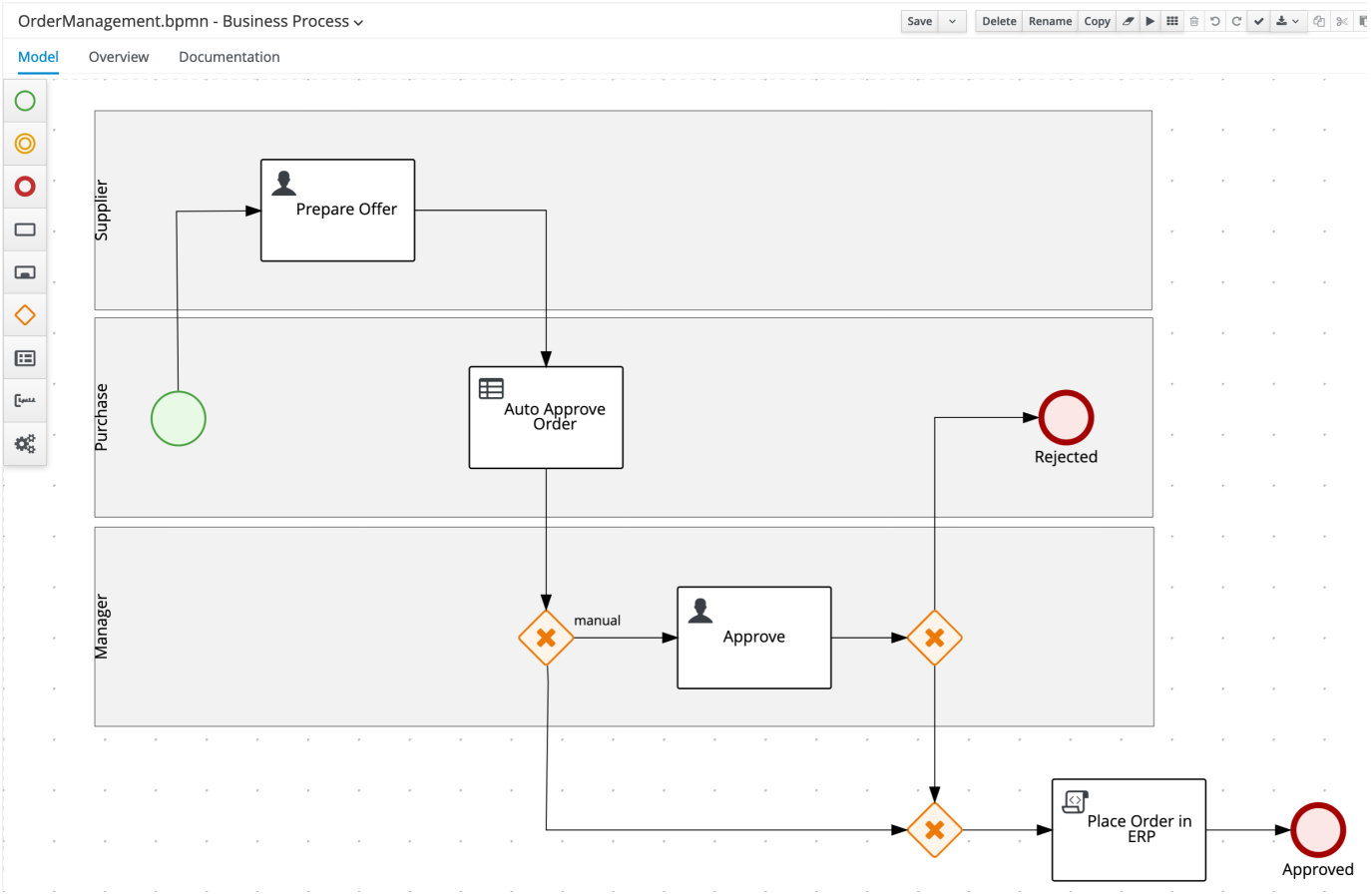
10. We're done creating our data model.



We can now start with our process design.

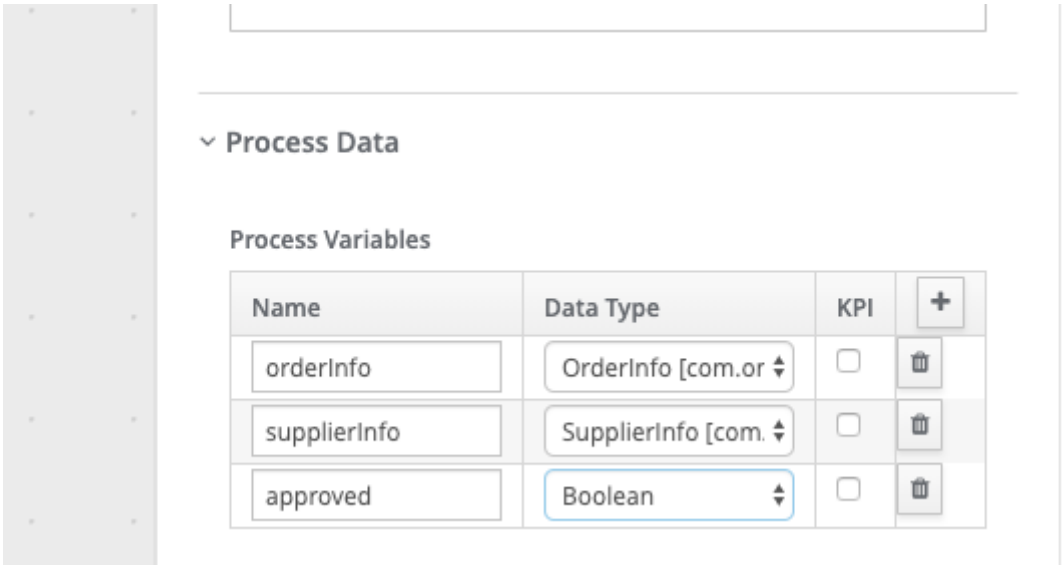
19.3 Process Design

With the domain model defined, we can now sketch out the main flow of the process, the actors, the user task nodes and the required automation decisions.


OrderManagement.bpmn - Business Process
Save
Delete
Rename
Copy
Model
Overview
Documentation
Supplier
Prepare Offer
Purchase
Auto Approve Order
Rejected
Manager
manual
Approve
Place Order in ERP
Approved

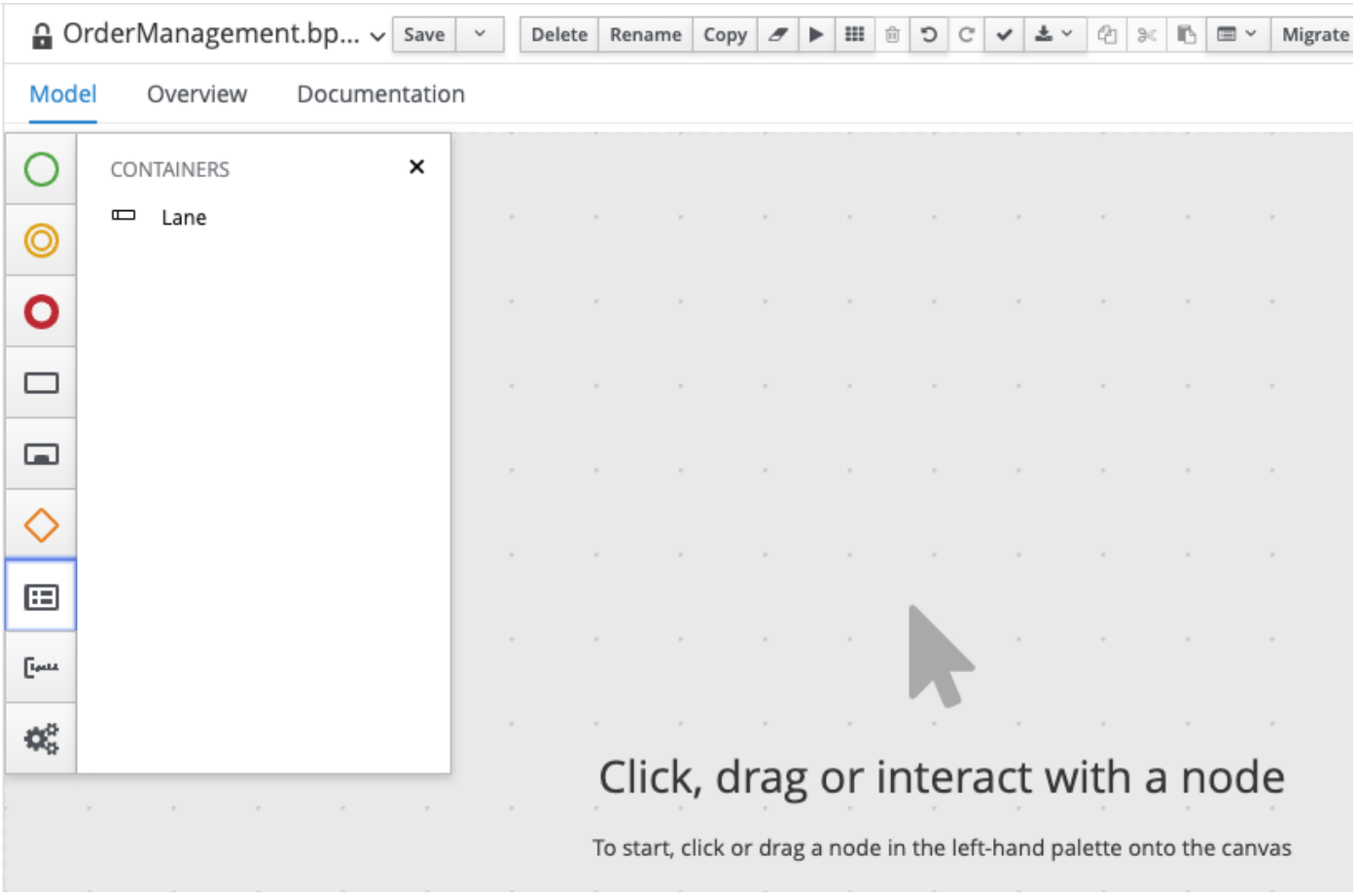
1. Create a new `Business Process` asset. Name it `OrderManagement`. You can do this by clicking `Add an Asset` and then selecting `Business Process` and then setting the name as `OrderManagement`.
2. When the process designer opens, scroll down in the property panel on the right side of the screen, until you see the section *Process Data*.
3. Expand the *Process Data* section and add the following 3 *Process Variables* by clicking on the + sign.

Name	Data Type
orderInfo	OrderInfo
supplierInfo	SupplierInfo
approved	Boolean

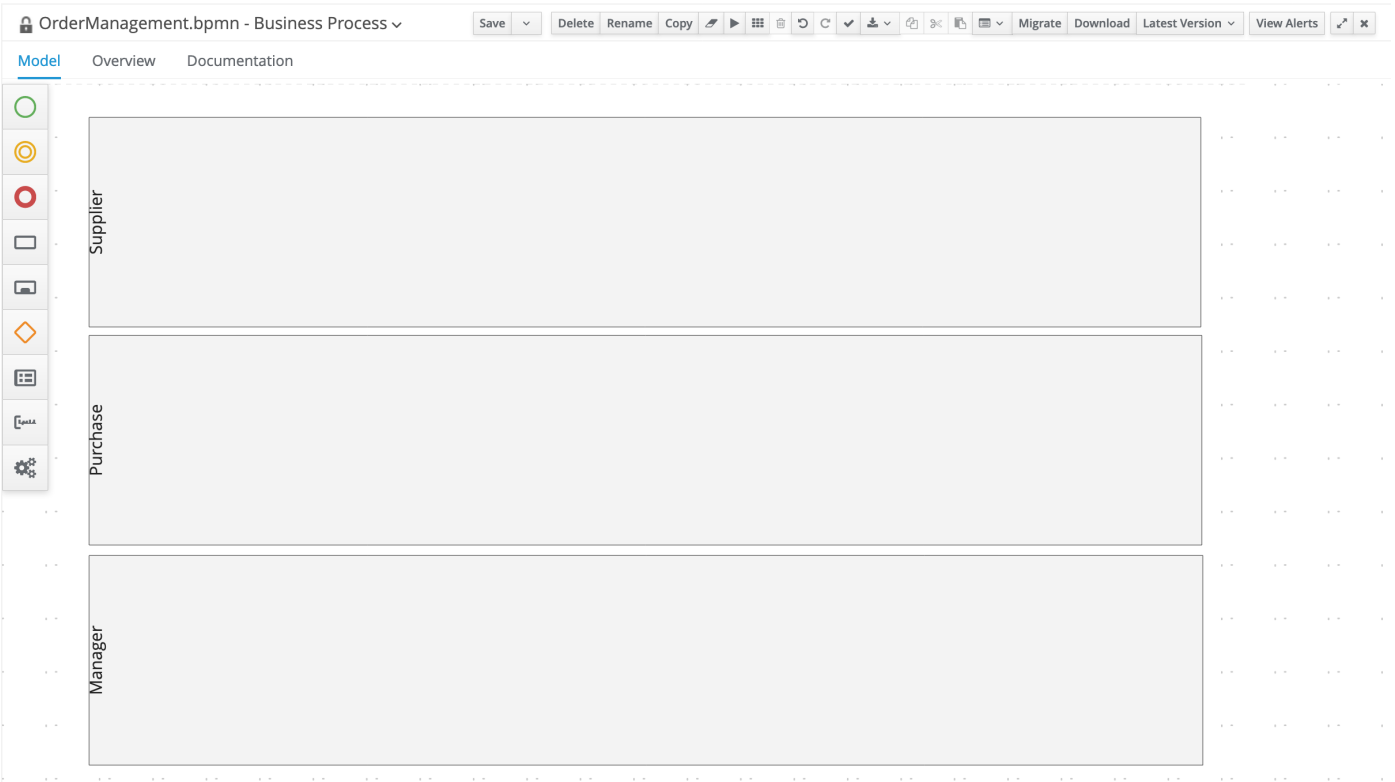


19.3.1 PREPARE OFFER

1. In the palette on the left-side of the editor, select the `Lane` component:



2. Create the following 3 swimlanes: **Supplier** , **Purchase** , **Manager**



3. Create the **Start Event** node in the `Purchase` swimlane.

4. Create the `Prepare Offer` **User Task** node in the `Supplier` swimlane and connect it to the **Start Event** node. Set the following properties on the node via the properties panel on the right side of the screen:

a. Task Name: `PrepareOffer`

b. Subject: `Prepare Offer for #{orderInfo.item}`

c. Actors: `#{supplierInfo.user}`

d. Input:

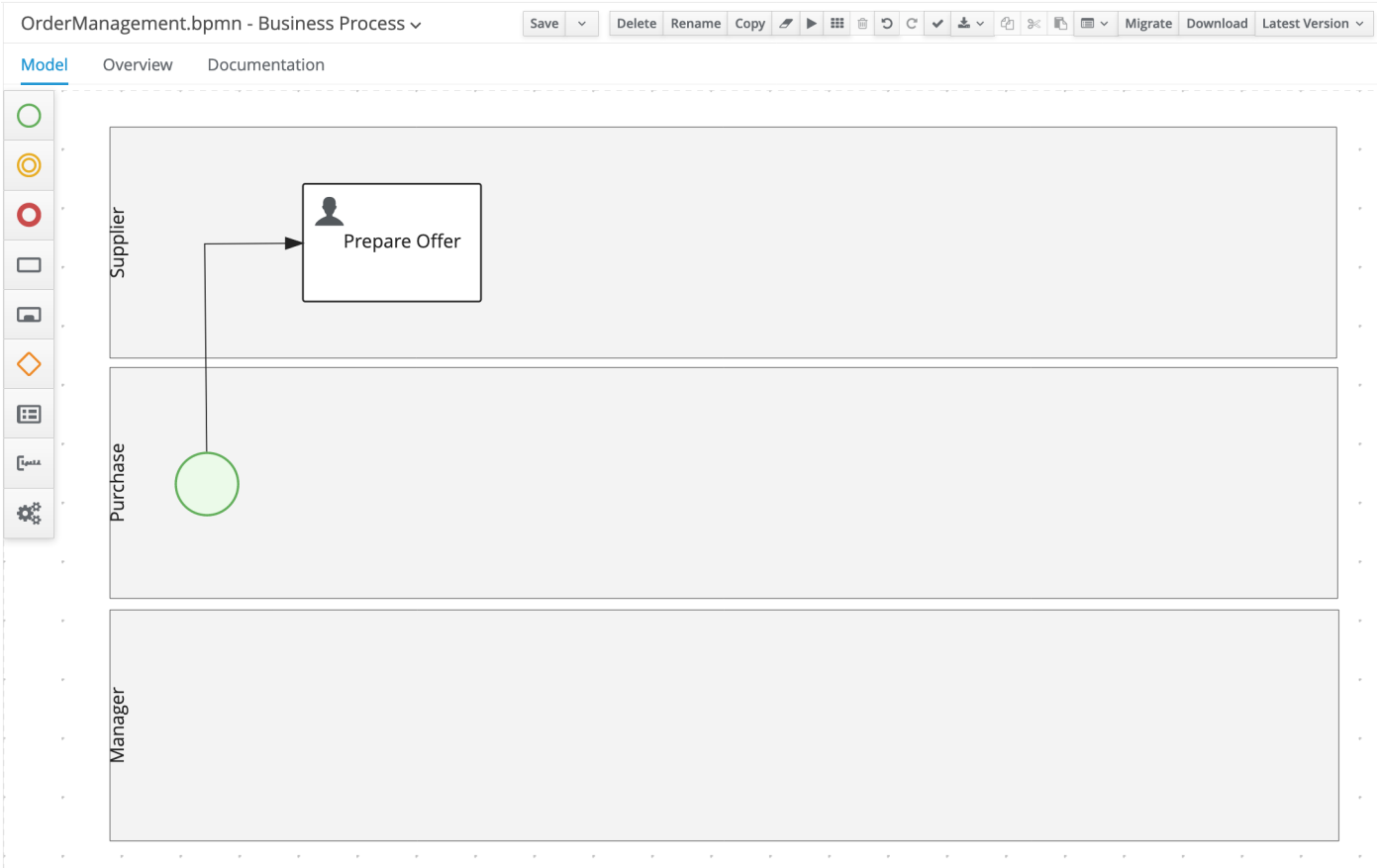
Data Inputs and Assignments

Name	Data Type	Source
orderInfo	OrderInfo	orderInfo
supplierInfo	SupplierInfo	supplierInfo

a. Output

Data Outputs and Assignments

Name	Data Type	Source
supplierInfo	SupplierInfo	supplierInfo



5. Create the `Auto Approve Order` **Business Rule** node in the `Purchase` swimlane and connect it to the `Prepare Offer` node. Set the following properties:

6. Rule language: `DMN`

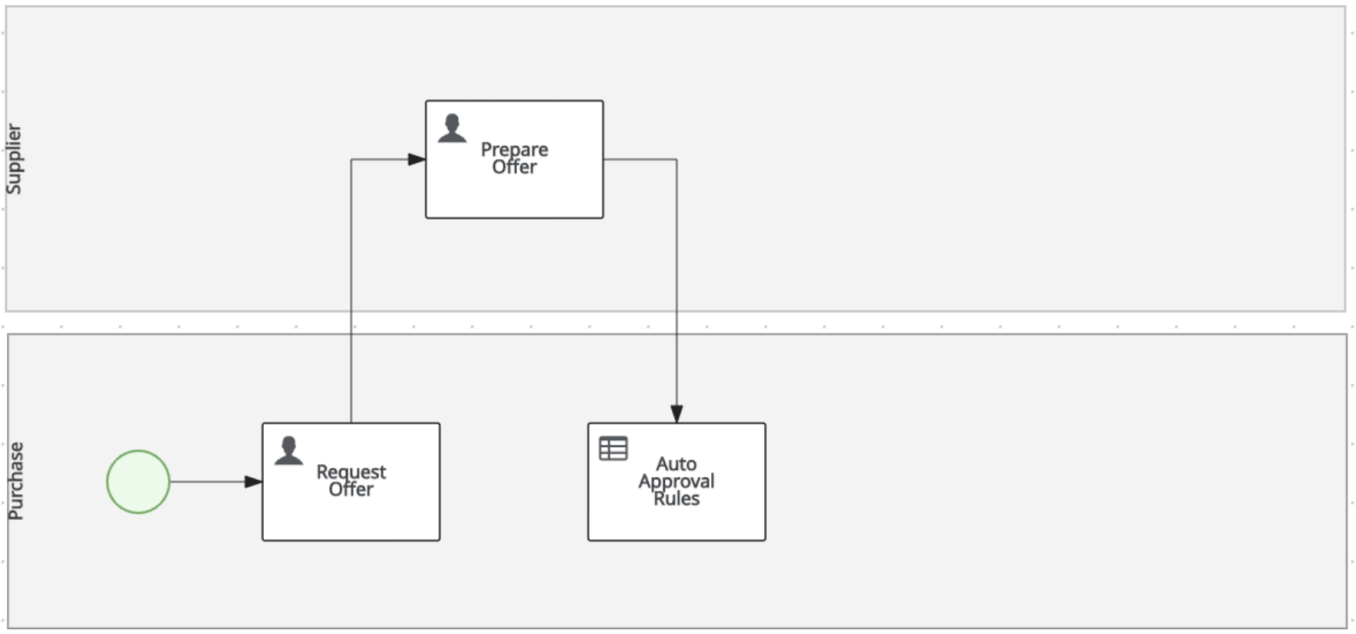
7. Assigments:

Data Inputs and Assignments

Name	Data Type	Source
Order Information	OrderInfo	orderInfo
Supplier Information	SupplierInfo	supplierInfo

Data Outputs and Assignments

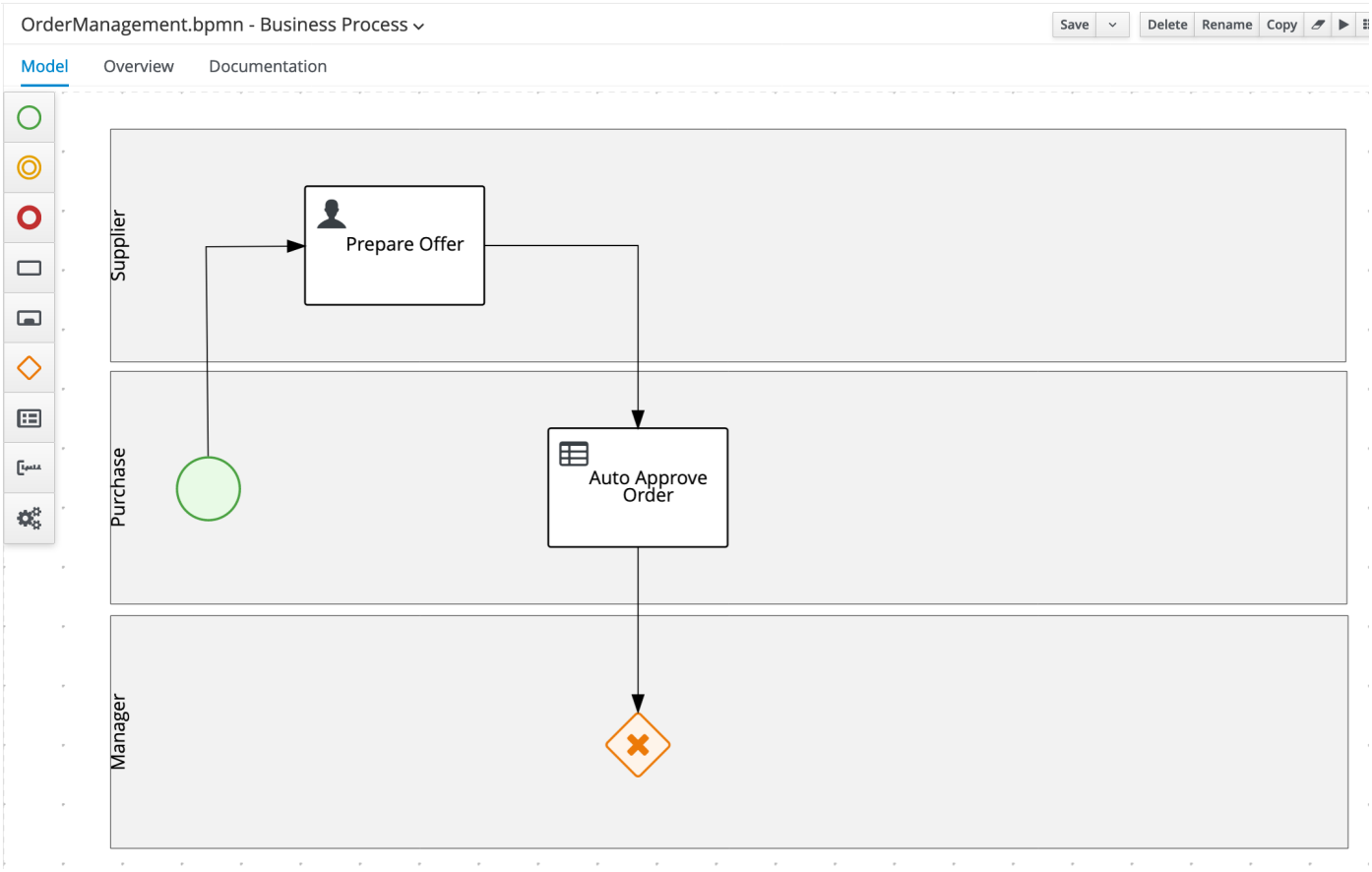
Name	Data Type	Target
Approve	Boolean	approved



📘 INFO: After we've created our DMN Decision Model, we will revisit the configuration of this node to reference this DMN model via its `name` and `namespace` properties.

19.3.2 EXCLUSIVE GATEWAY

1. Create an **X-OR Gateway/Exclusive Gateway** in the `Manager` swimlane, below the `Auto Approve Order` node and connect it to that node.



2. Create the `Approve` **User Task** in the `Manager` swimlane and connect it to the **X-OR** gateway. Set the following properties:

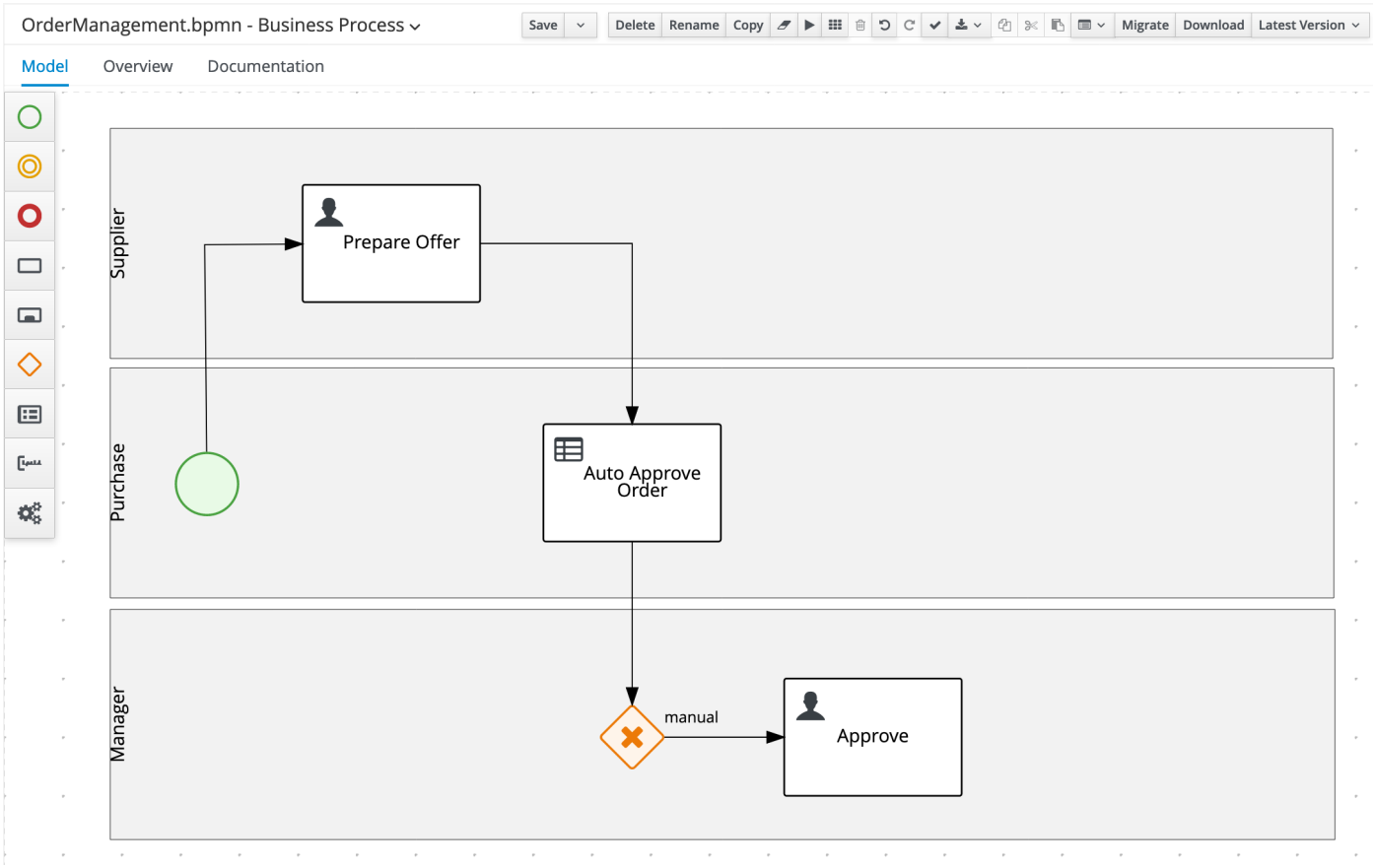
- Task Name: `Approve`
- Subject: `Approve Order of #{orderInfo.item}`
- group: `rest-all`
- Assignments:

Data Inputs and Assignments

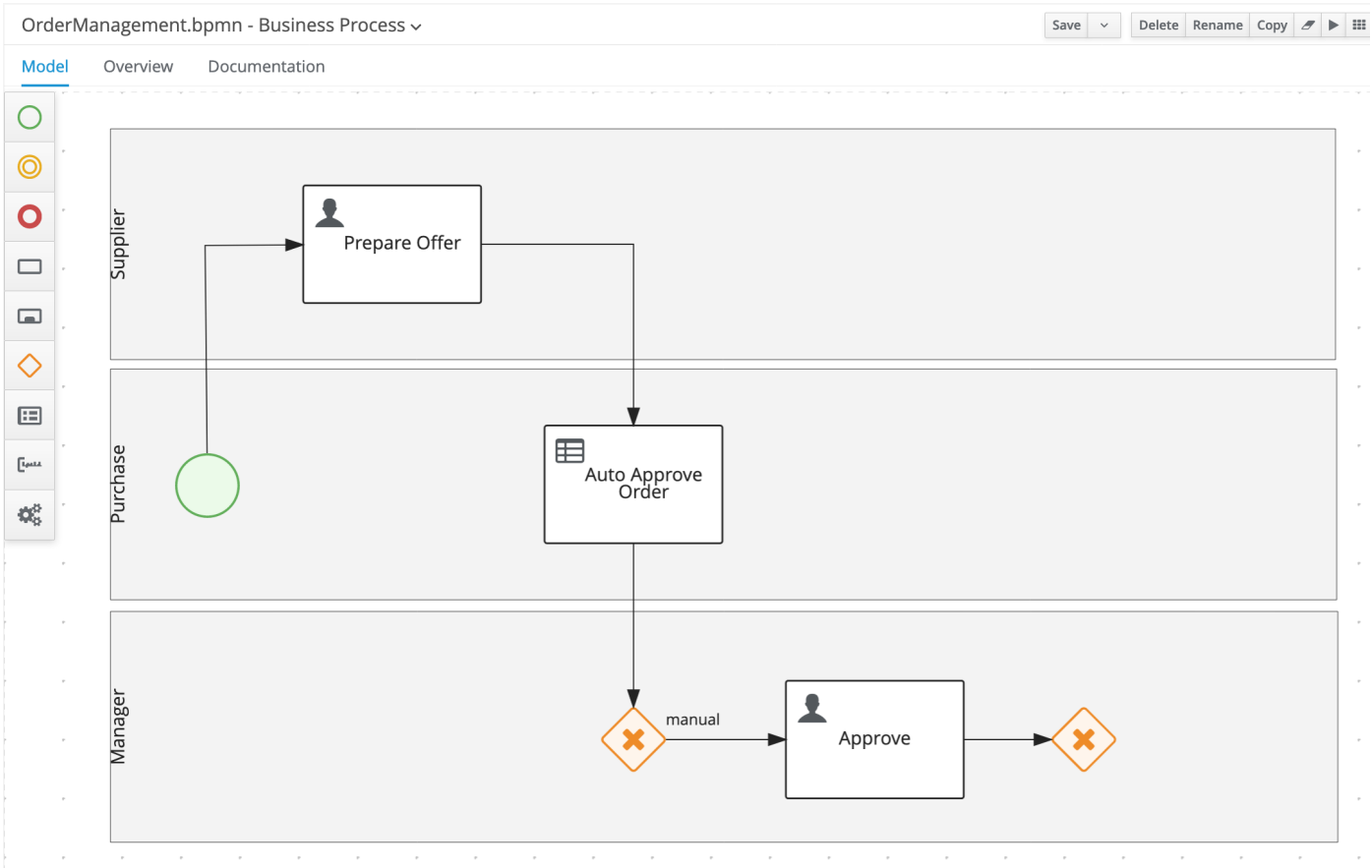
Name	Data Type	Source
orderInfo	OrderInfo	orderInfo
supplierInfo	SupplierInfo	supplierInfo

Data Outputs and Assignments

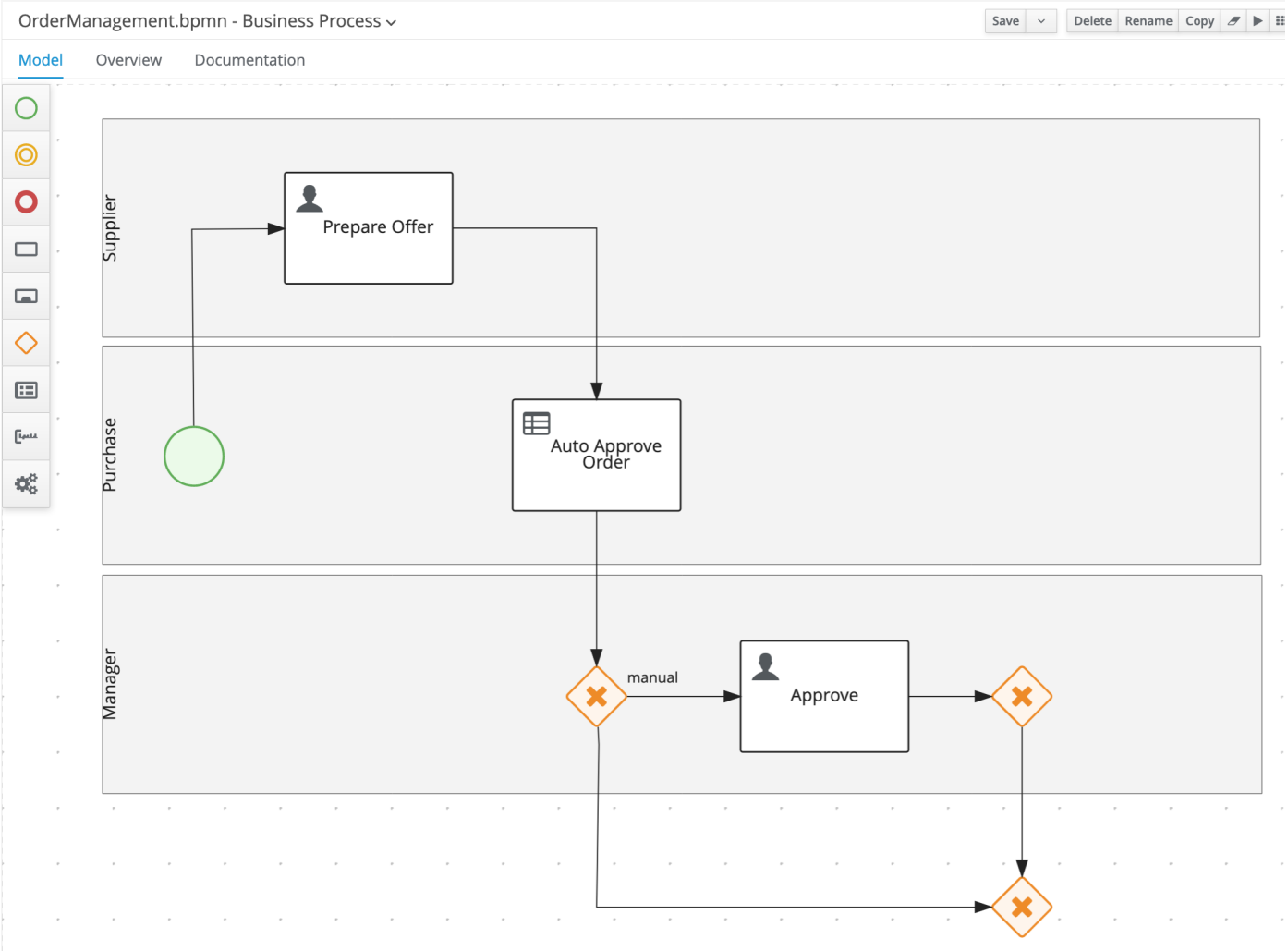
Name	Data Type	Target
orderInfo	OrderInfo	orderInfo



3. Create an **X-OR Gateway/Exclusive Gateway** in the `Manager` swimlane, after the `Approve` node and connect it to that node.

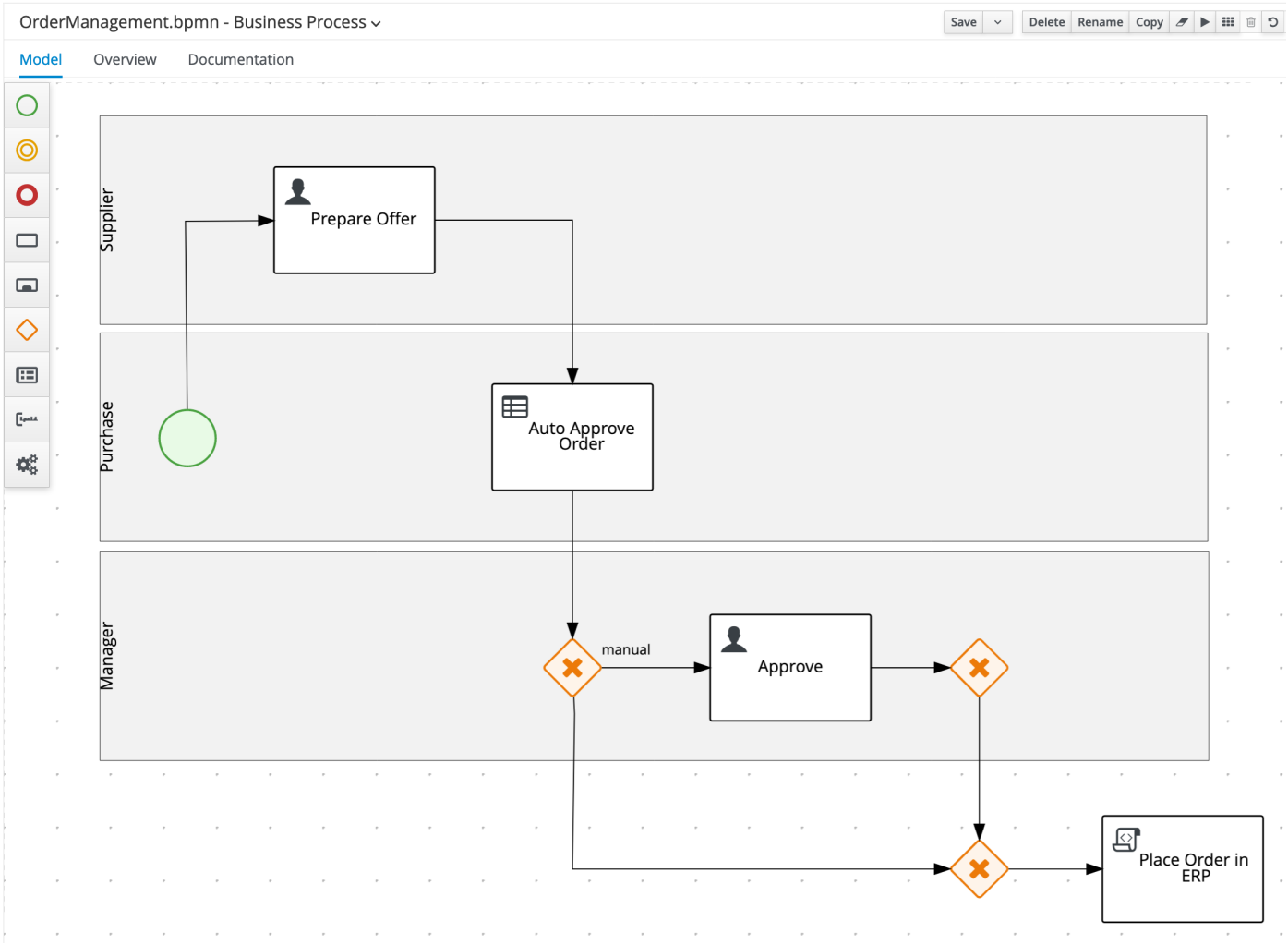


4. Create another **X-OR Gateway/Exclusive Gateway** under the `Manager` swimlane (so outside of the swimlane) and connect it to the two other **X-OR Gateways/Exclusive Gateways** as shown in image below:

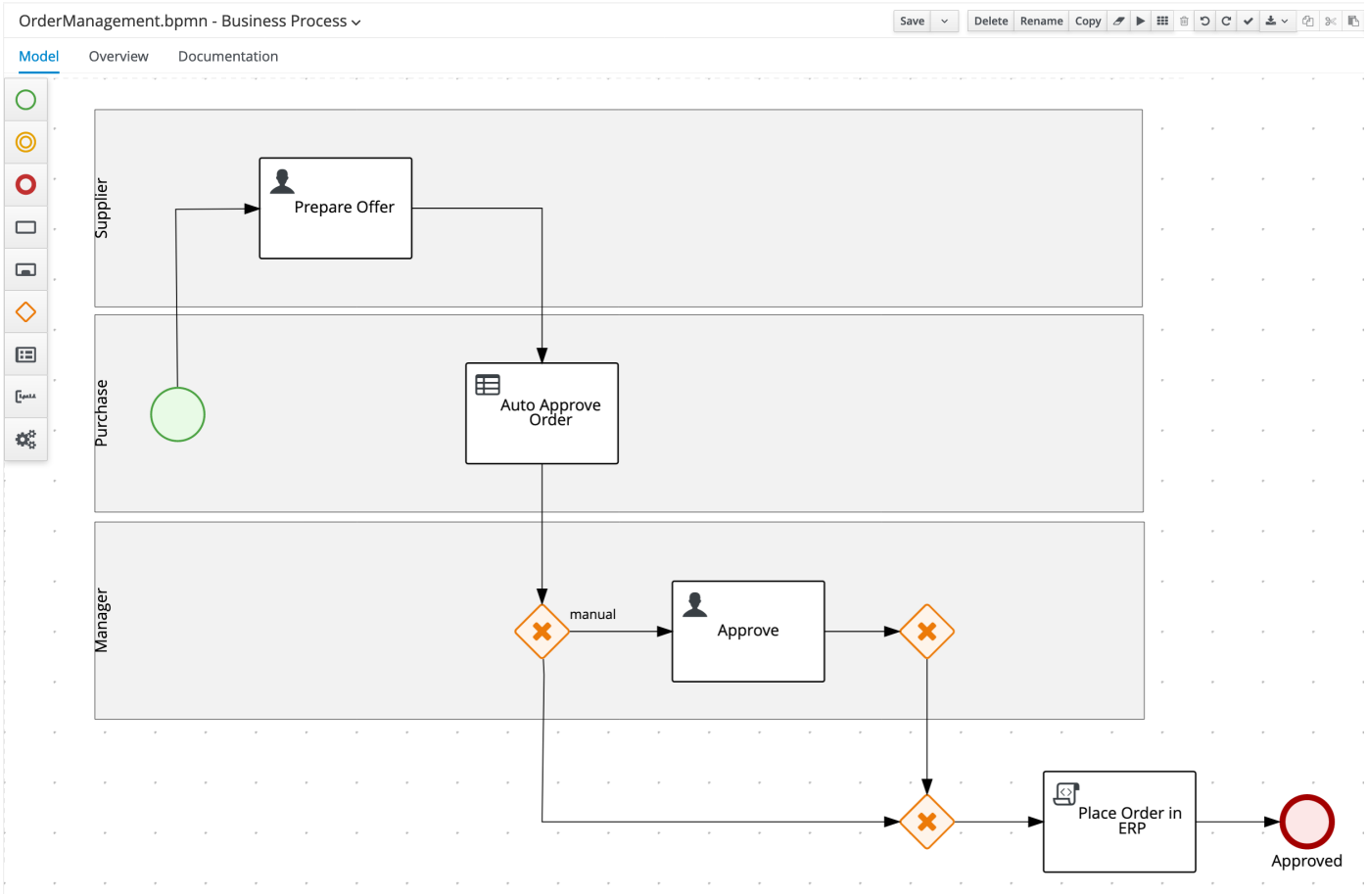


5. Create the `Place Order in ERP` **Script Task** under the `Manager` swimlane (so outside of the swimlanes) and connect it to the **X-OR Gateway** we created earlier. Set the following script in the node's properties properties:

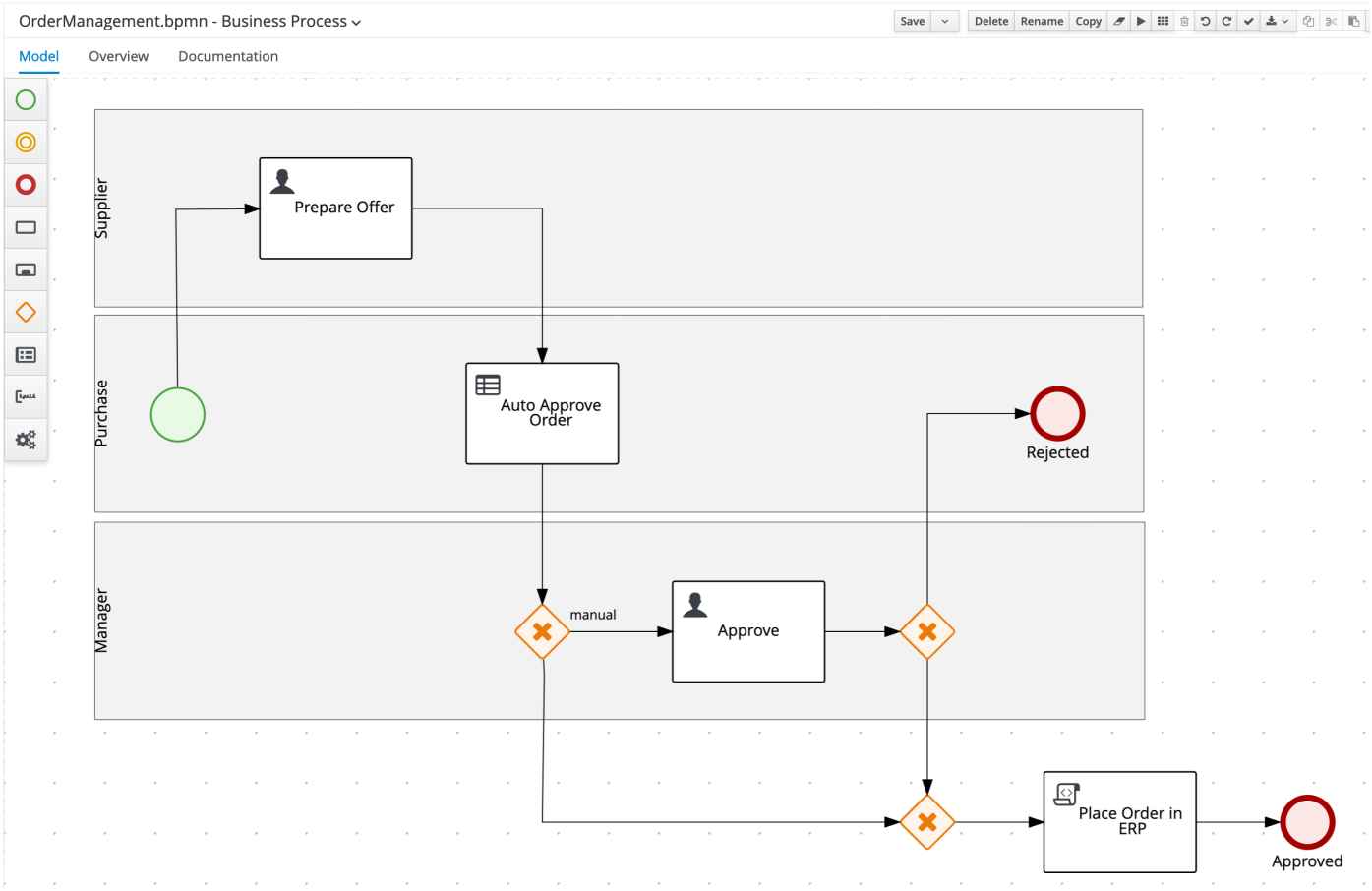
```
System.out.println("Place Order in ERP");
```



6. Create an **End Event** node under the `Manager` swimlane (so outside of the swimlanes) and connect it to the `Place Order in ERP` node. Name it `Approved`.

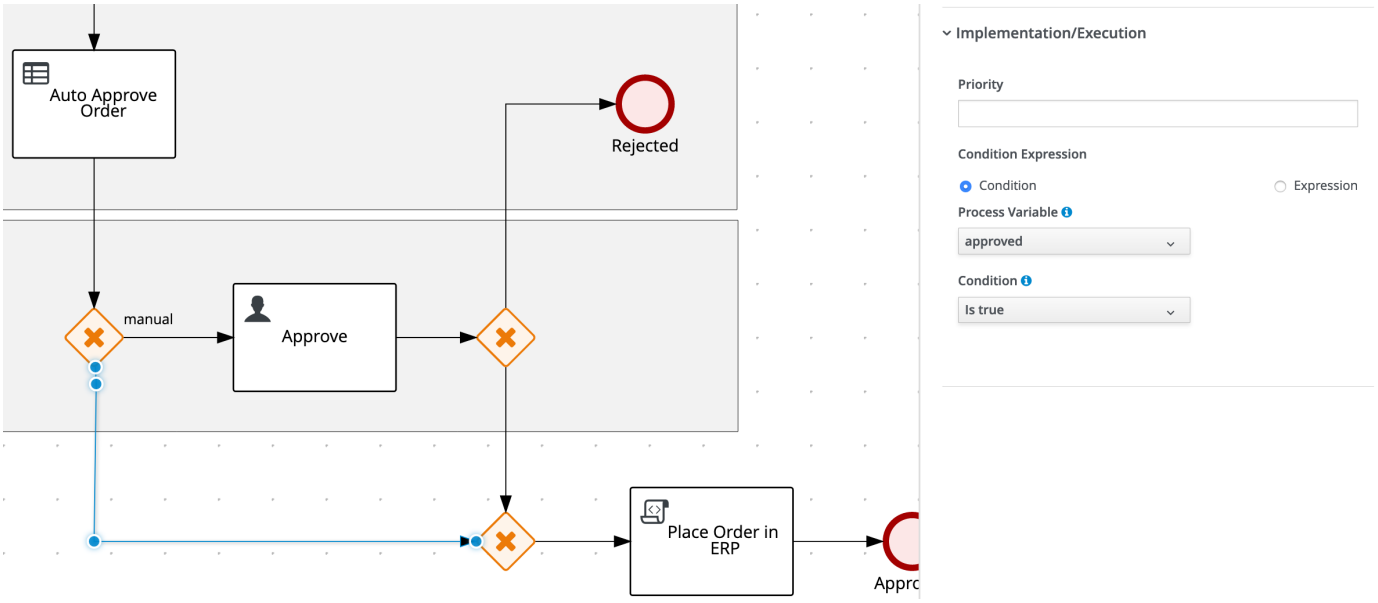


7. Create an **End Event** node in the `Purchase` swimlane and connect it to the **X-OR Gateway**. Name it `Rejected`.

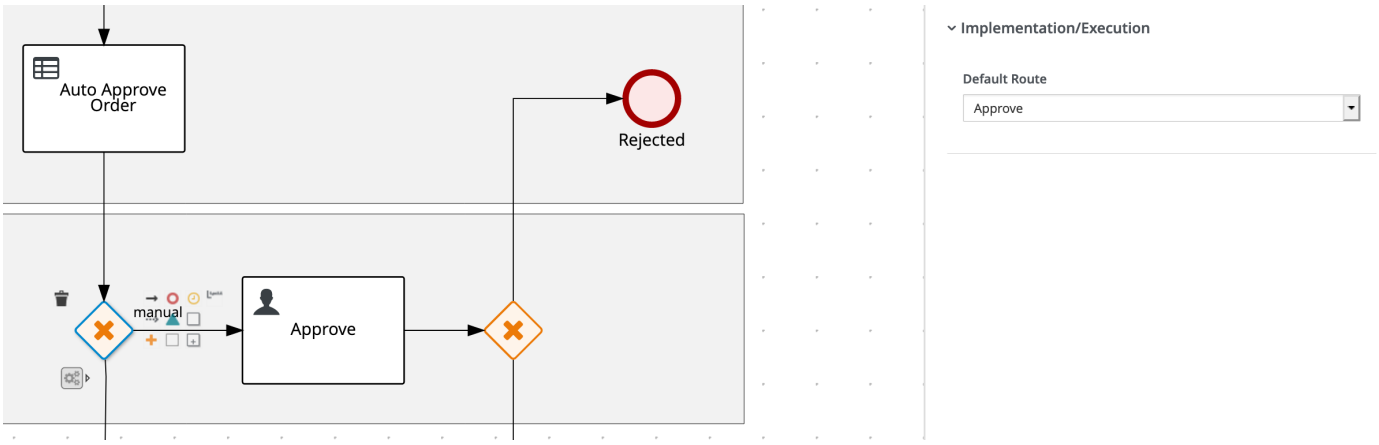


8. On the **Sequence Flow** from the **X/OR Gateway** before the `Approve` node that is connnected ot the other **X/OR Gateway**, set the following condition, which tells the process engine that this path should be taken when the order is not automatically approved:

- Process Variable: `approved`
- Condition: `Is true`

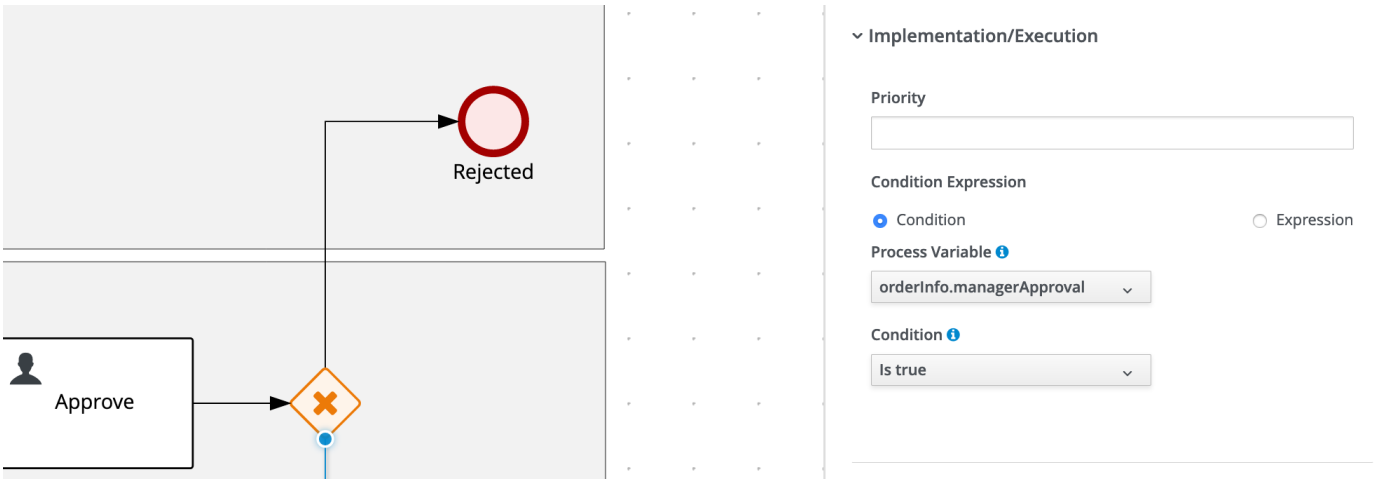


9. On the **Gateway** before the `Approve node`, set the **Default Route** property to `Approve`.

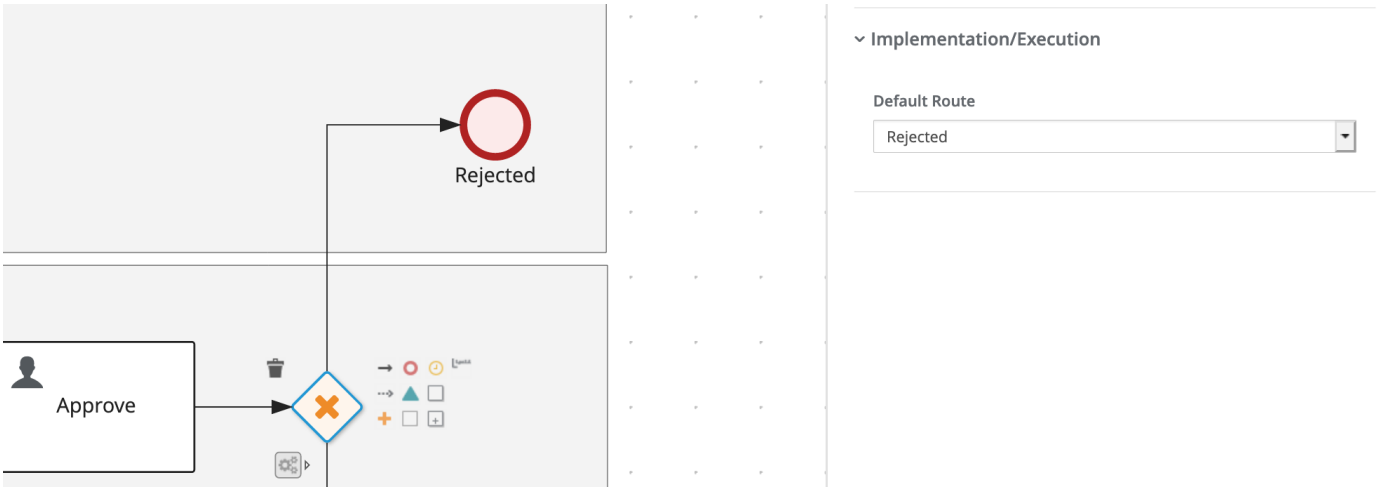


10. On the **Sequence Flow** from the **X/OR Gateway** after the `Approve` task, which is connected to the **X/OR Gateway** before the `Place Order in ERP` task, set the following condition:

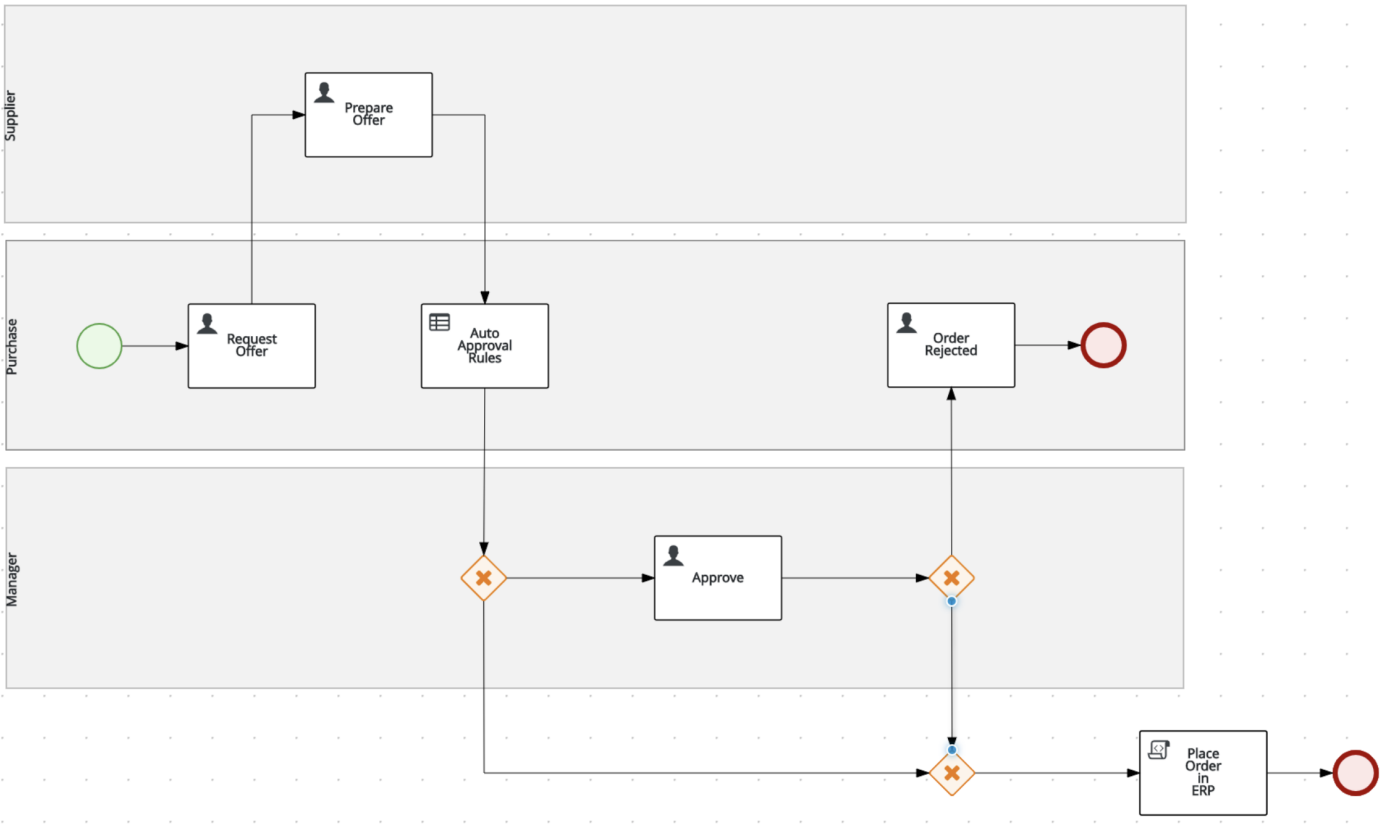
- Process Variable: `orderInfo.managerApproval`
- Condition: `Is true`



11. On the **X/OR Gateway** after the `Approval` node , set the **Default Route** to `Rejected`.



12. Save the process definition.



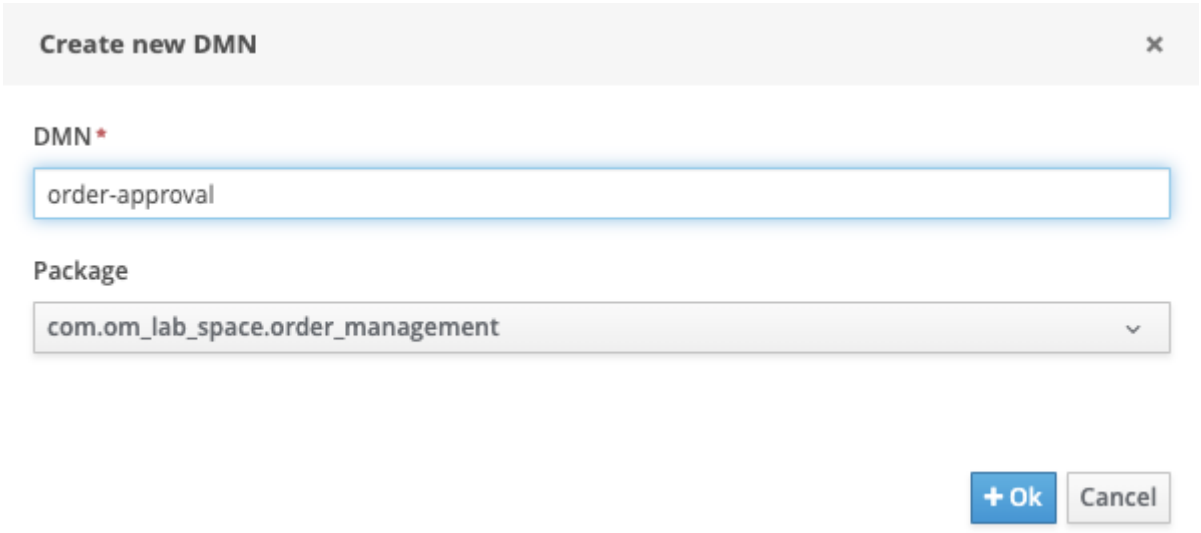
With the overall layout of the process definition complete, the routing logic implemented, and the I/O assignments defined, we can now implement the business rules of our automated approval decision.

19.4 Business Rules and Decisions

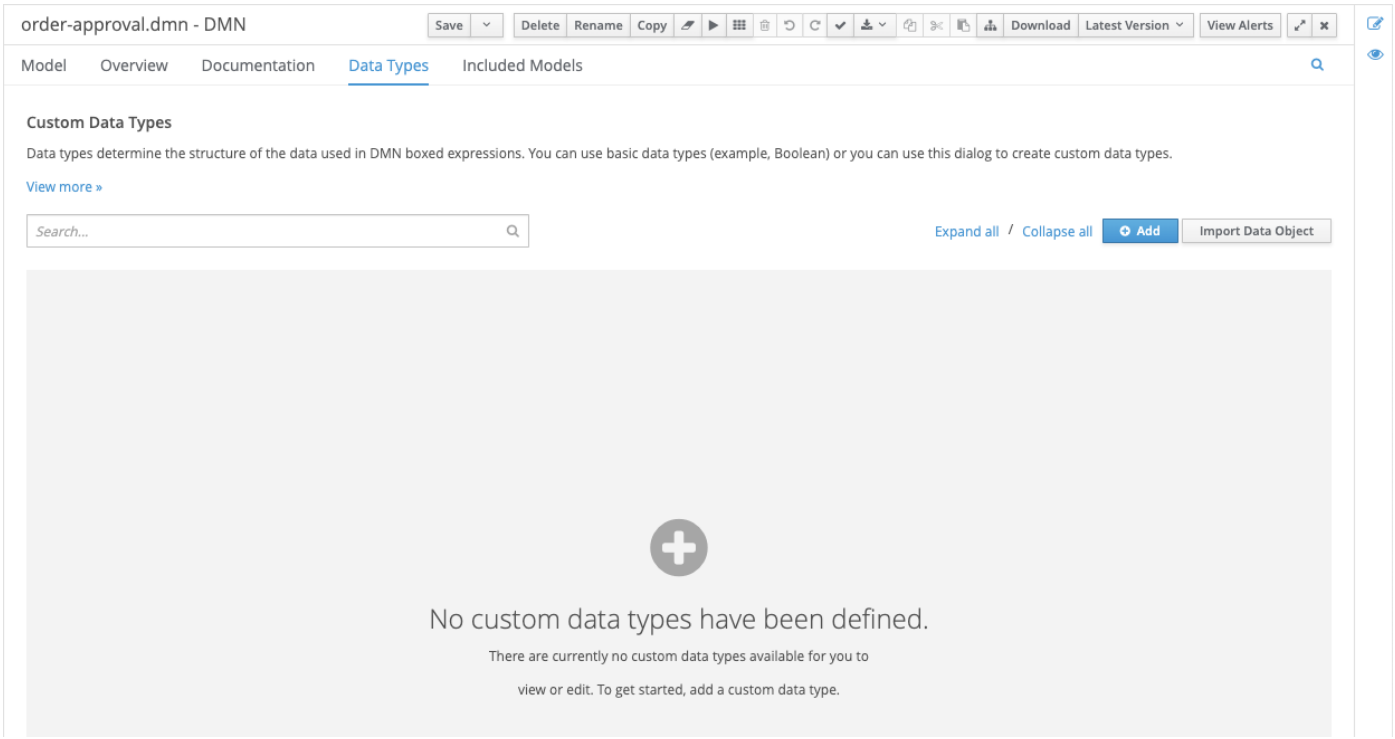
Our **Order Management** process contains a **Business Rule Task**, but we have not yet defined the *Decision Model* that will be used in the task. In this paragraph we will implement the automatic approval rules in the form of a DMN model.

19.4.1 CREATING THE DMN INPUTS AND BKM

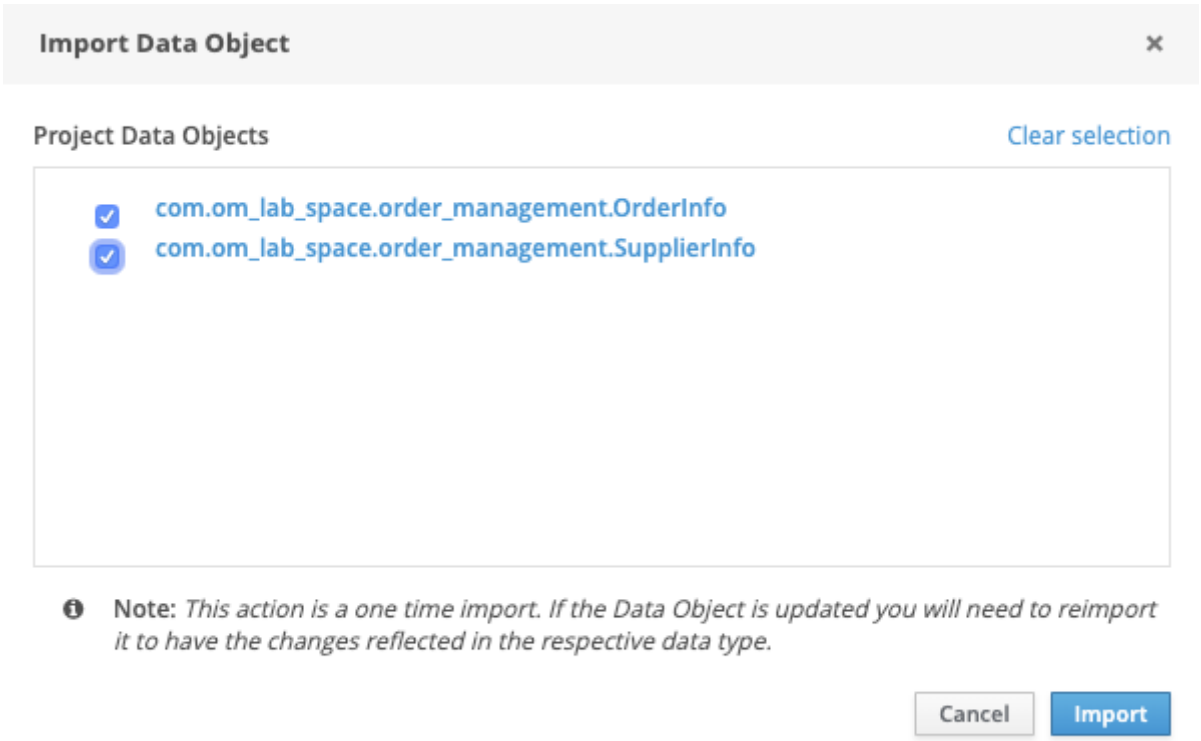
1. In the main project page, the so called **library view**, click on the **Add Asset** button.
2. In the next screen, set the drop-down filter to **Decision**. Select the **DMN** asset. Give it the name `order-approval`.



3. In the DMN editor, open the property-panel on the right-side of the screen and set the *Namespace* property to: `http://www.redhat.com/dmn/demo/order-management-dmn` . First we need to import our data-model, so we can use it in our DMN decisions. In the DMN editor, click on the *Data Types* tab and click on the *Import Data Object* button at the right-hand side of the screen:

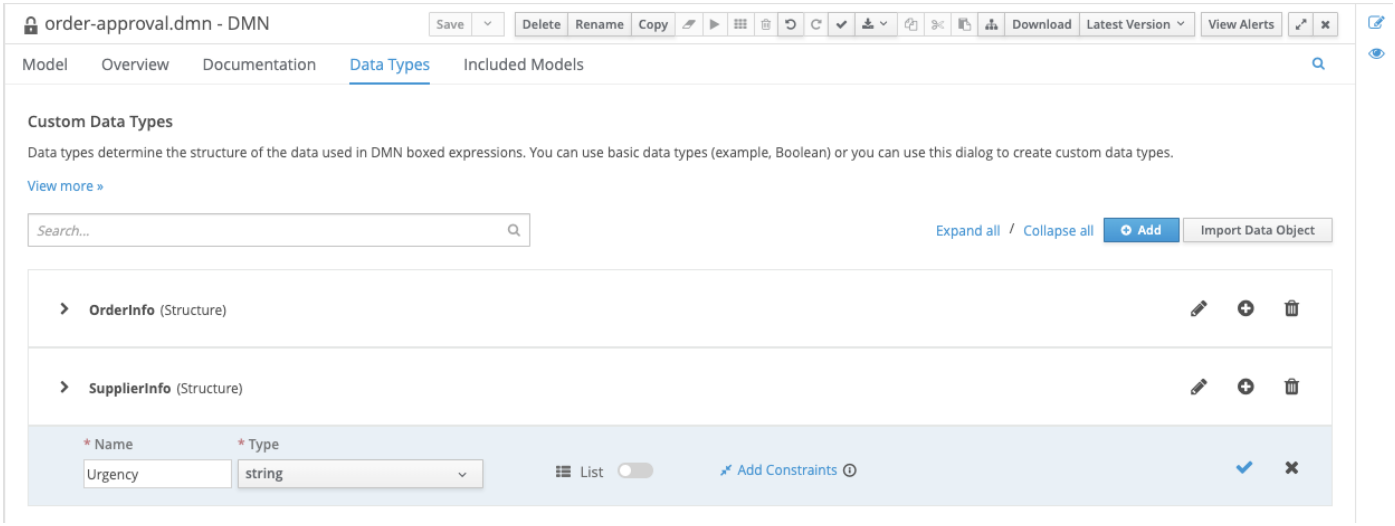


4. Select both the `OrderInfo` and `SupplierInfo` objects and click on the *Import* button:

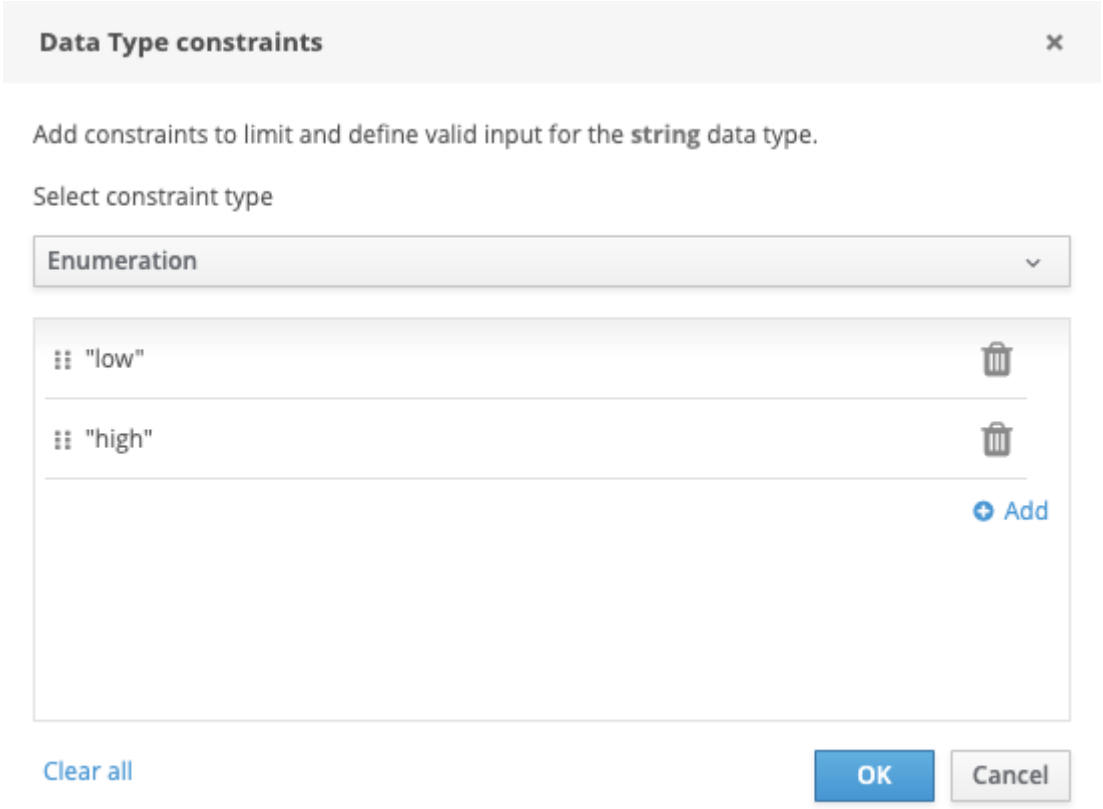


With the 2 datatypes imported, we need to create a third type that will hold the possible values for the `urgency` field of our `Order Information`. Click on the blue *Add* button in the top-right corner.

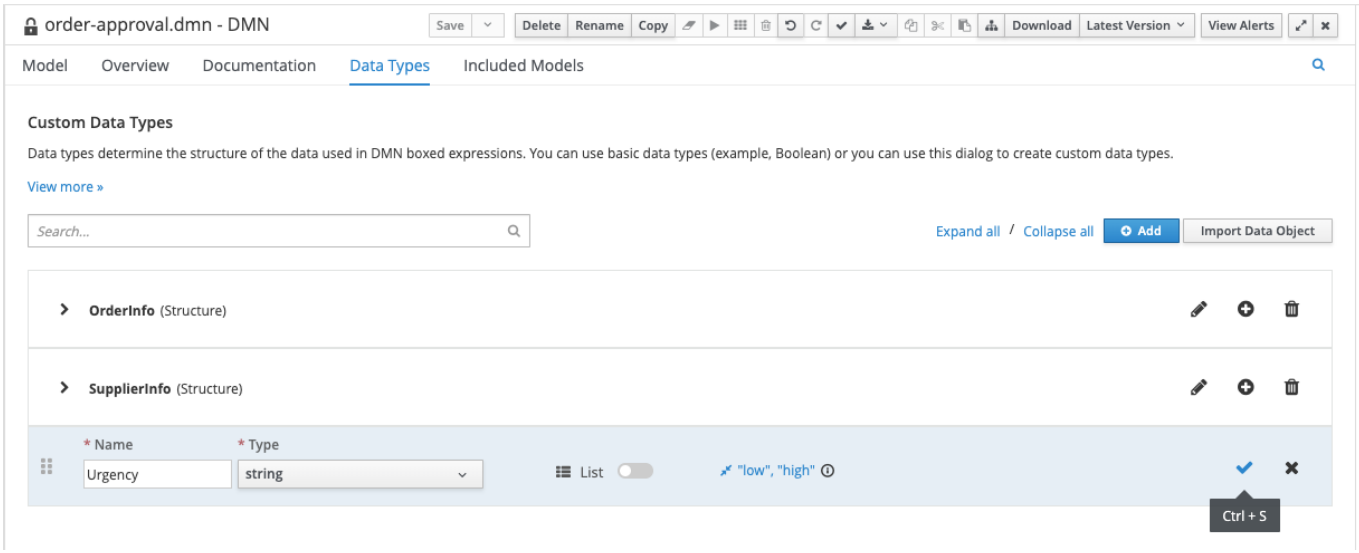
1. In the entry that opens, give the data type the *Name* `Urgency` and the *Type* `string`:



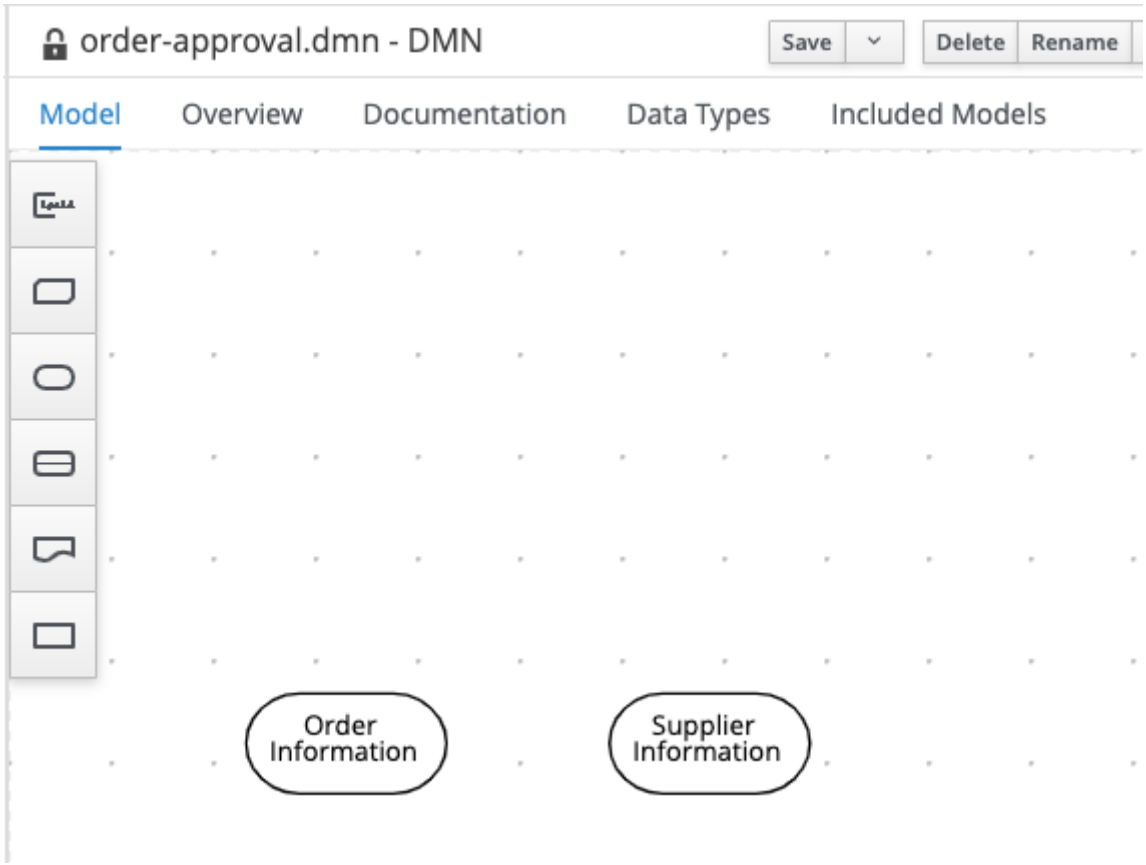
2. Click on the *Add Constraints* button, select `Enumeration` as the *constraint type*, and set the values low `and` high`.



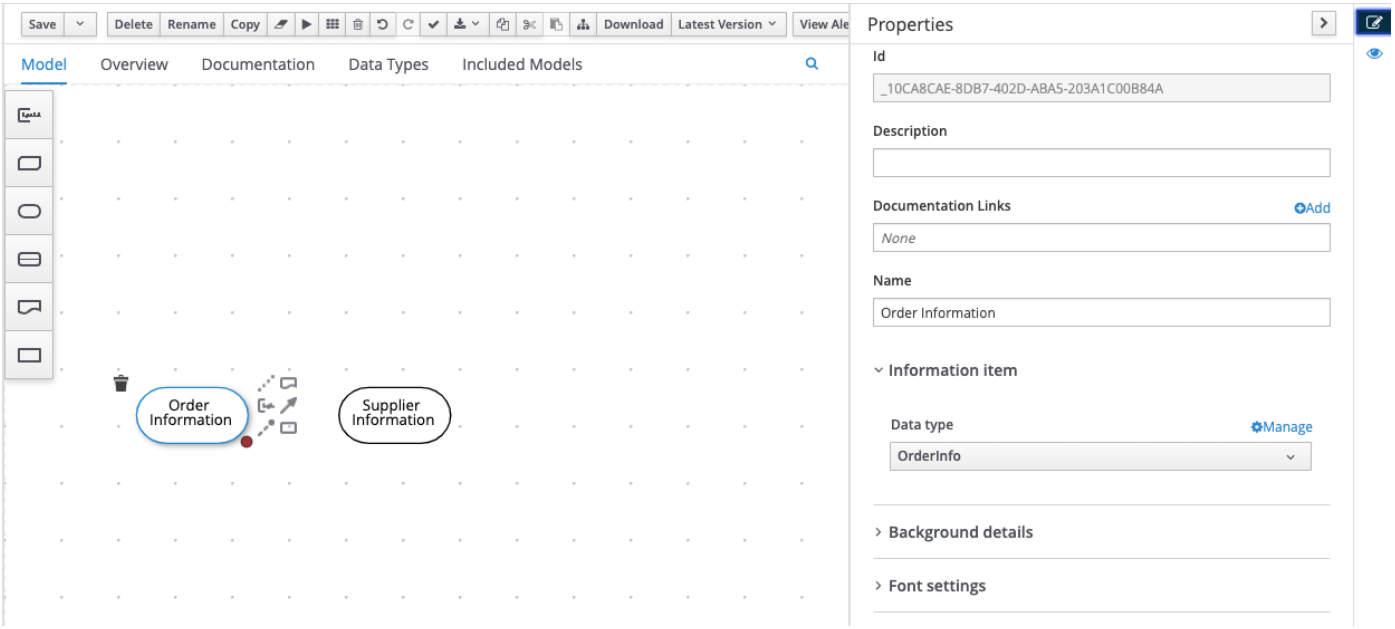
3. Click on the blue checkmark button to save the type.



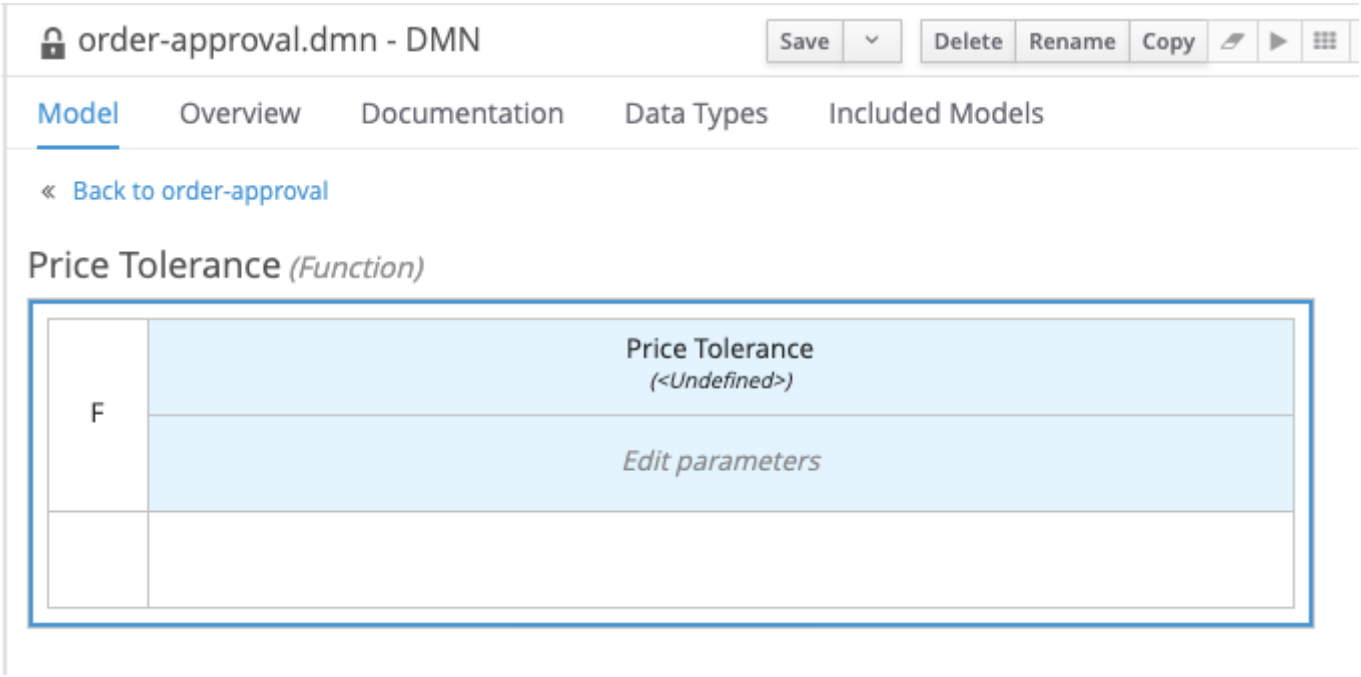
4. Navigate back to the model via the *Model* tab. Add 2 `Input` nodes to the model and name them `Order Information` and `Supplier Information`



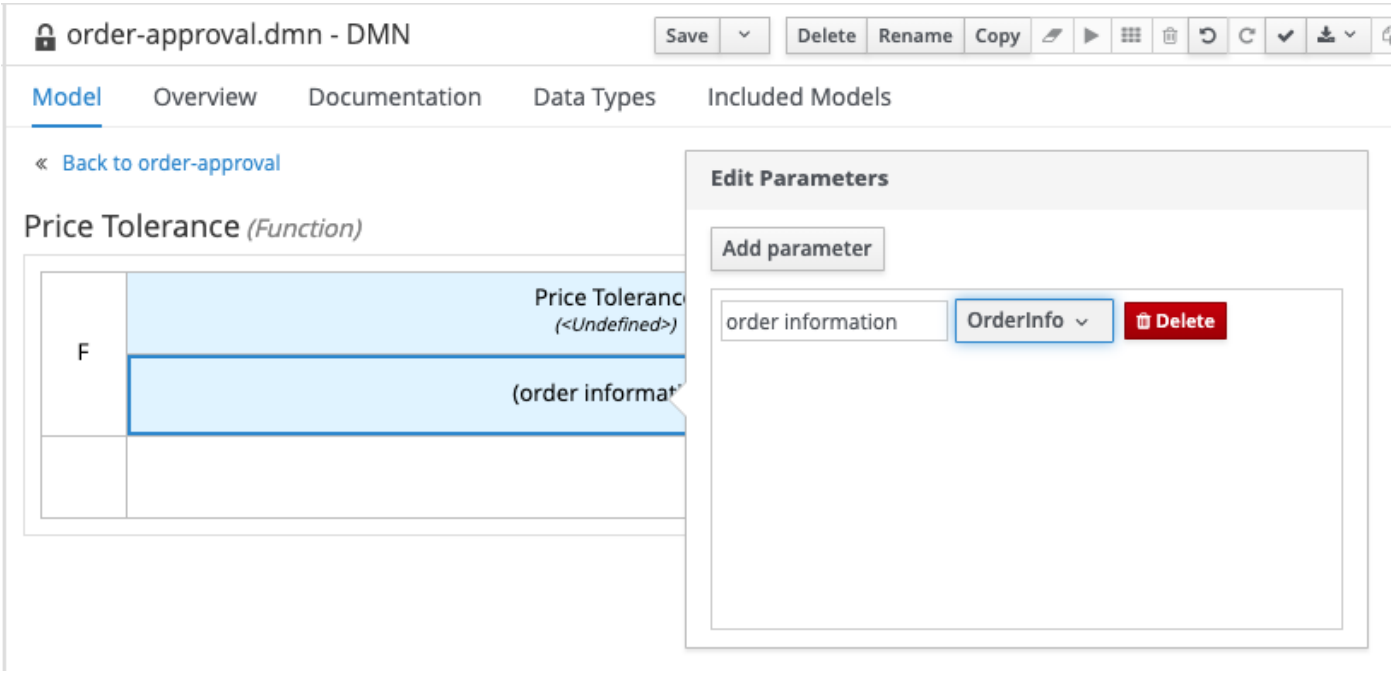
5. Select the `Order Information` node. Open the properties panel on the right-hand side of the screen, and set the *Data type* to `OrderInfo`.



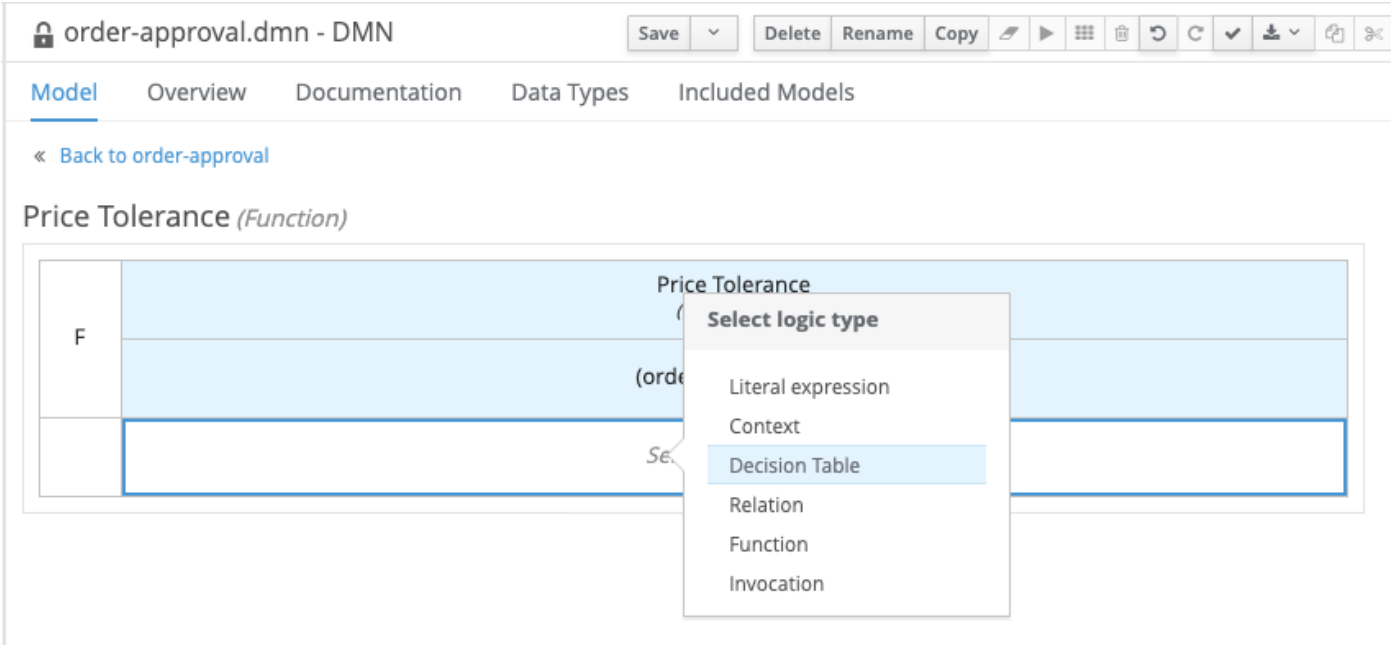
6. Do the same for the `Supplier Information` node. Set the *Data type* to `SupplierInfo`. Create a new `Business Knowledge Model` node, name it `Price Tolerance`.
7. Click on the node, and click on the *Edit* button to start editting the node:



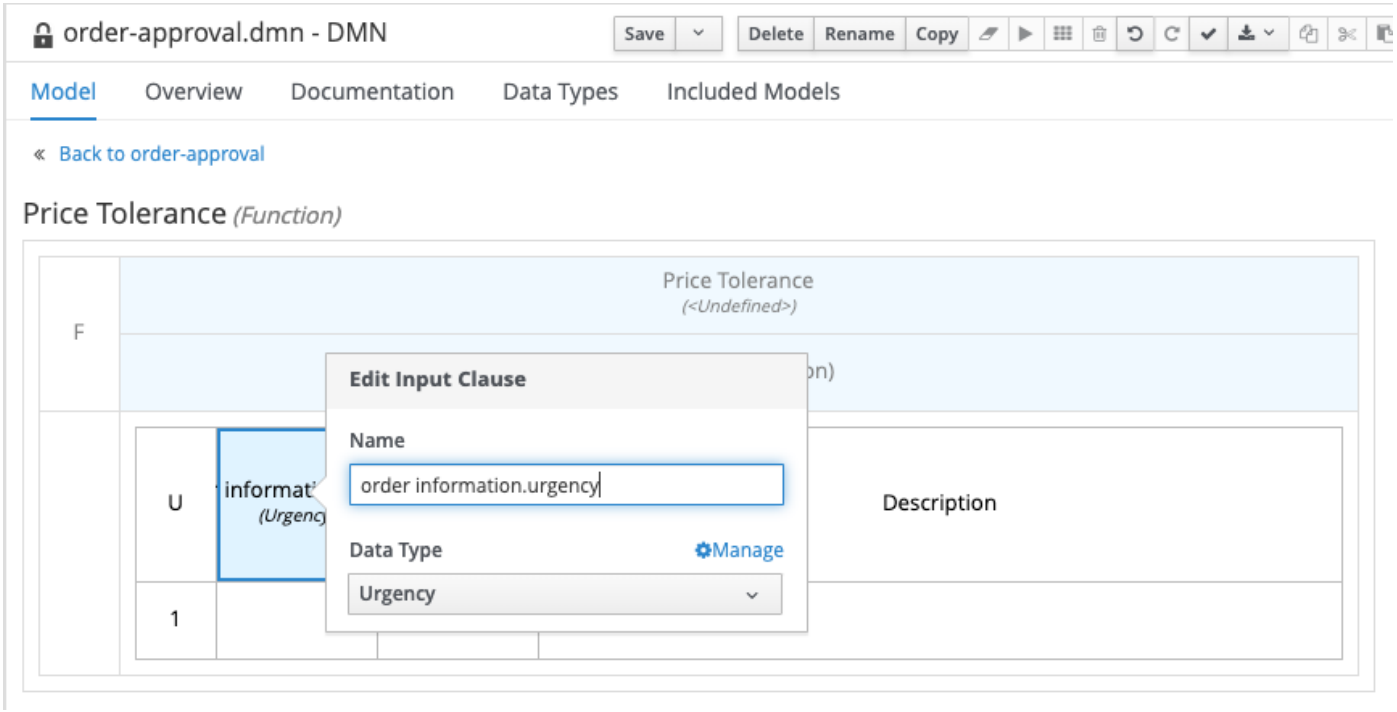
8. Click in the *Edit parameters*. An editor will open. Click on *Add parameter*. Name the parameter `order information` and set the type to `OrderInfo`.



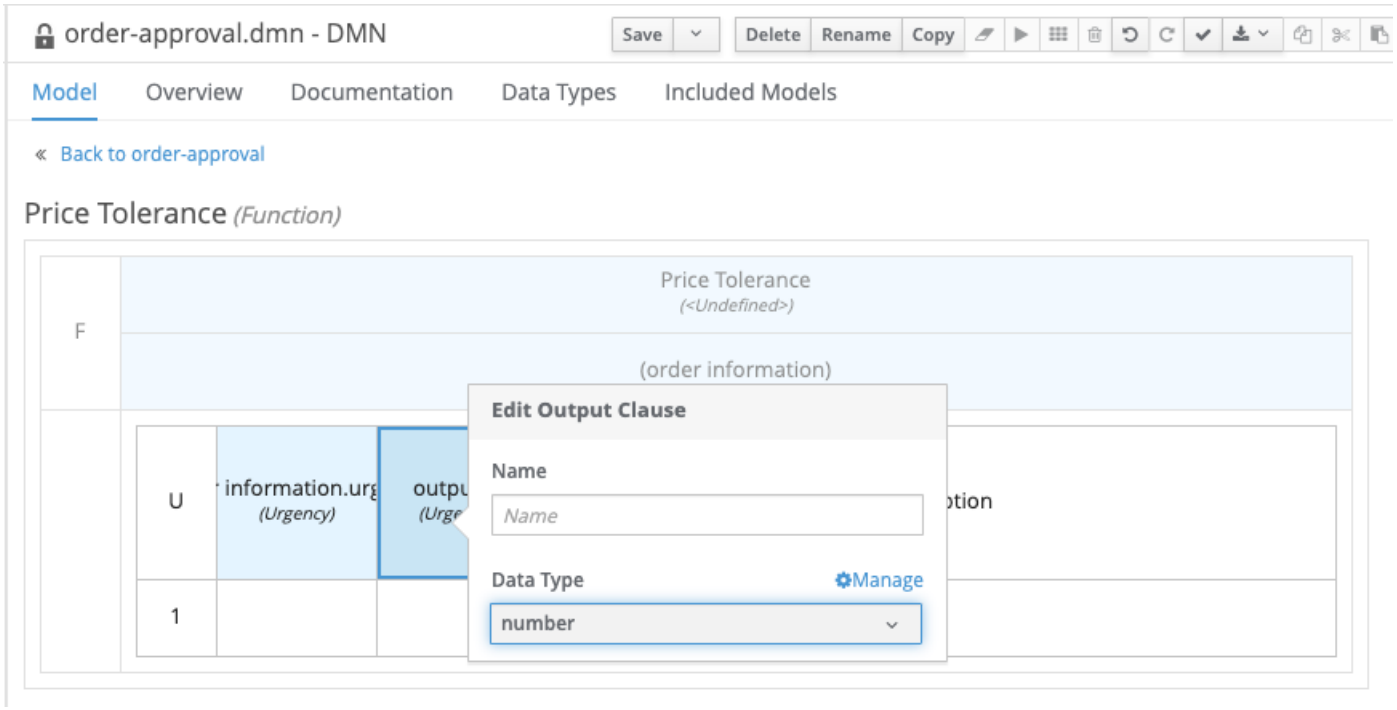
9. Right click in the empty white cell under the parameter definitions and select *Clear*. The text *Select expression* will appear in the cell. Click on the cell and select `Decision Table`.



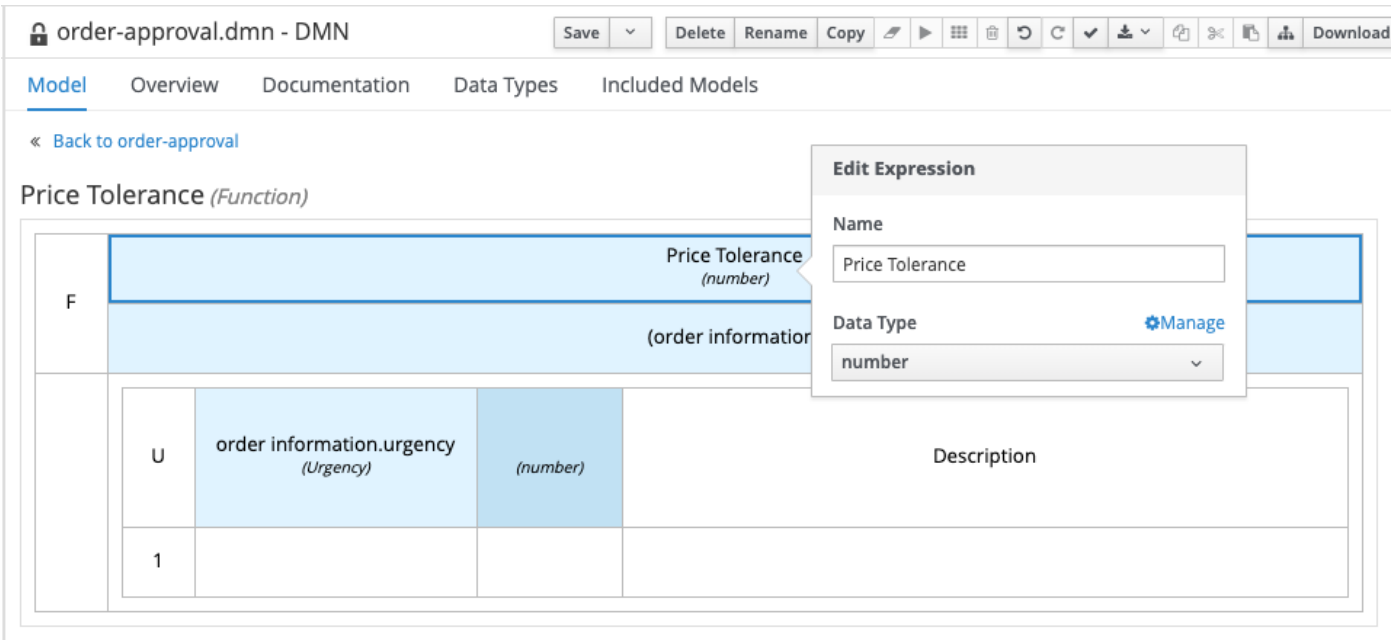
10. Add an *input clause* to the decision table. The name of the *input clause* is `order information.urgency`, which references the `urgency` attribute of the `order information` parameter. Set the type to `Urgency`, which references the `Urgency` enumeration we created earlier.



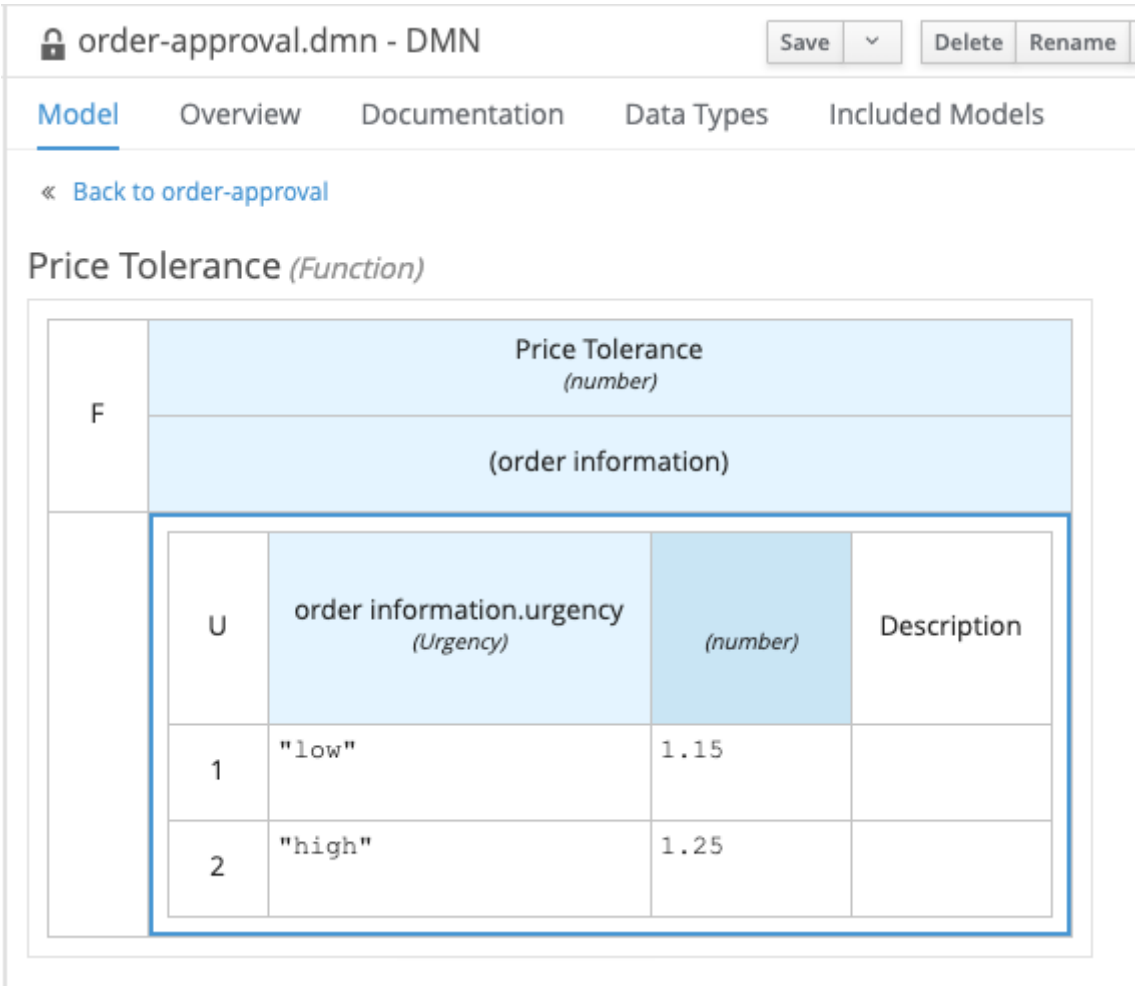
11. Set the *output clause* data type to `number`. Leave the name empty.



12. Click on the `Price Tolerance` cell (top cell of the table), and set the data type to `number`.



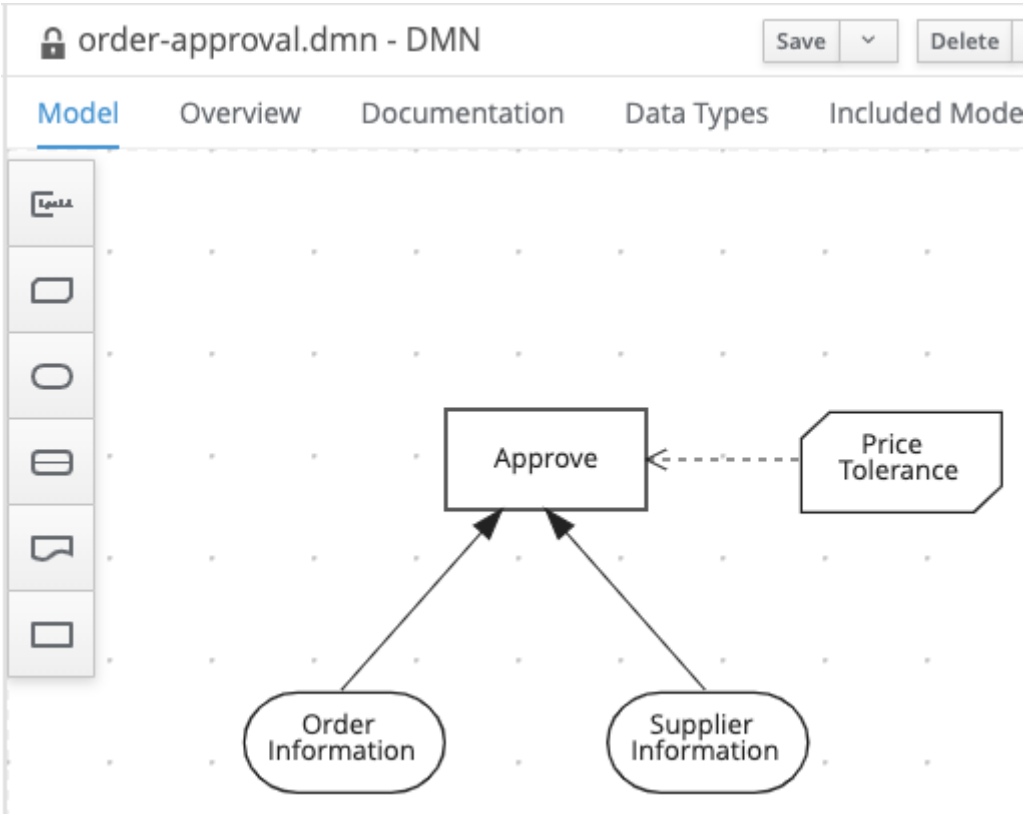
13. Implement the rest of the decision table as shown below. And save the DMN model.



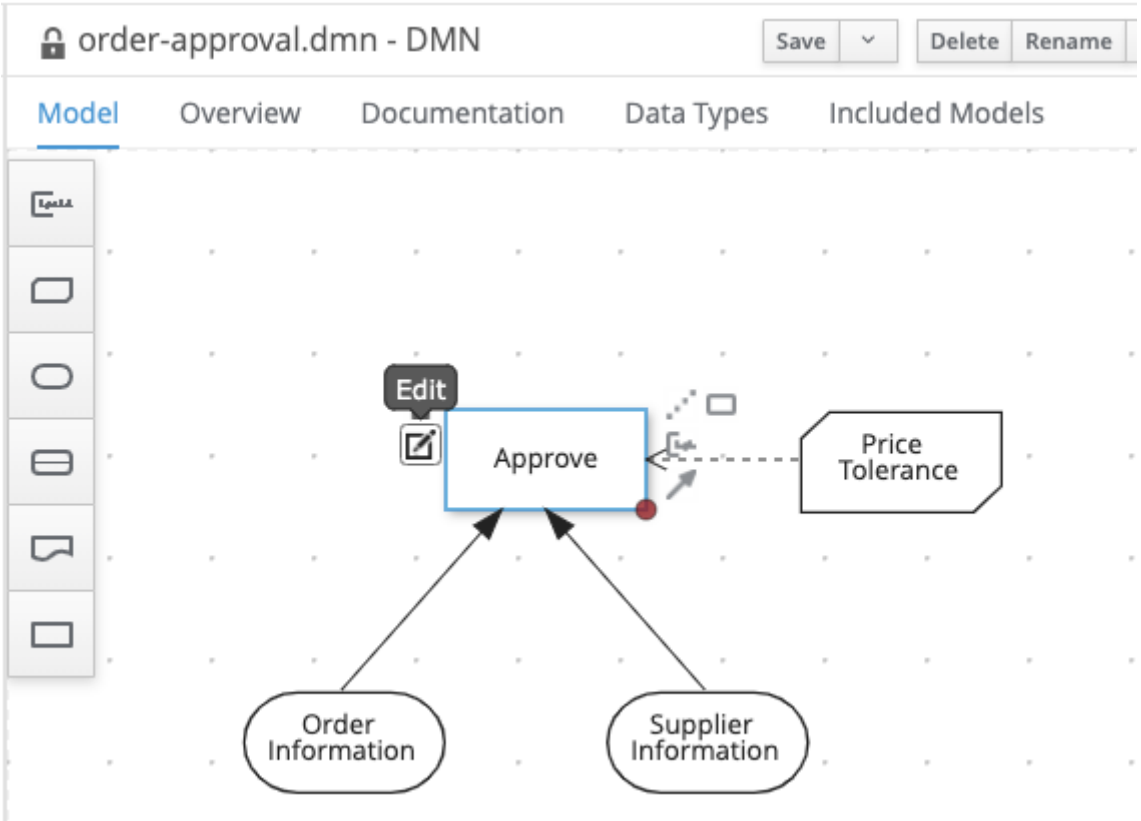
19.4.2 WRITING THE DMN DECISION

In this section we will complete the writing of the DMN decision.

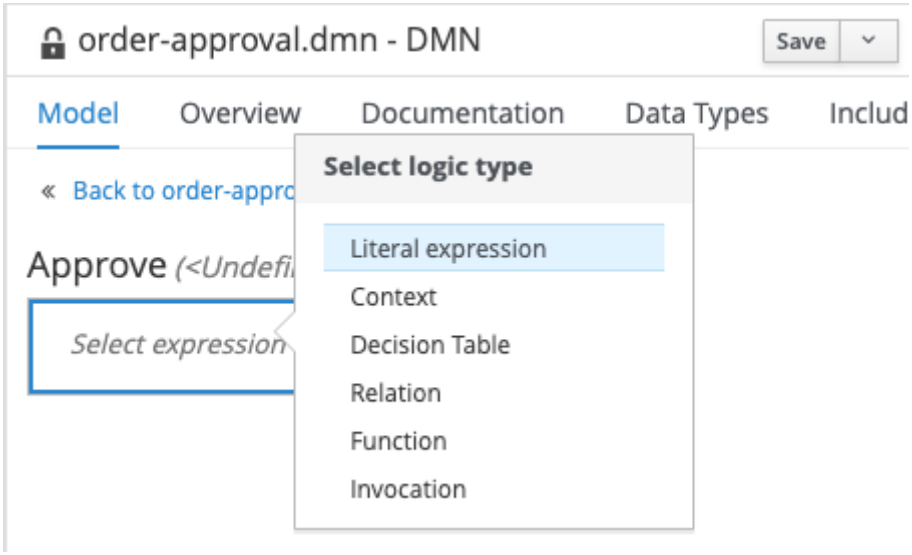
1. Navigate back to the model by clicking on the *Back to order-approval* link at the top-left of the editor. Create a new *Decision Node* and name it `Approve`. Connect the 2 input nodes and out `Price Tolerance` busines knowledge model node to the new decision node.



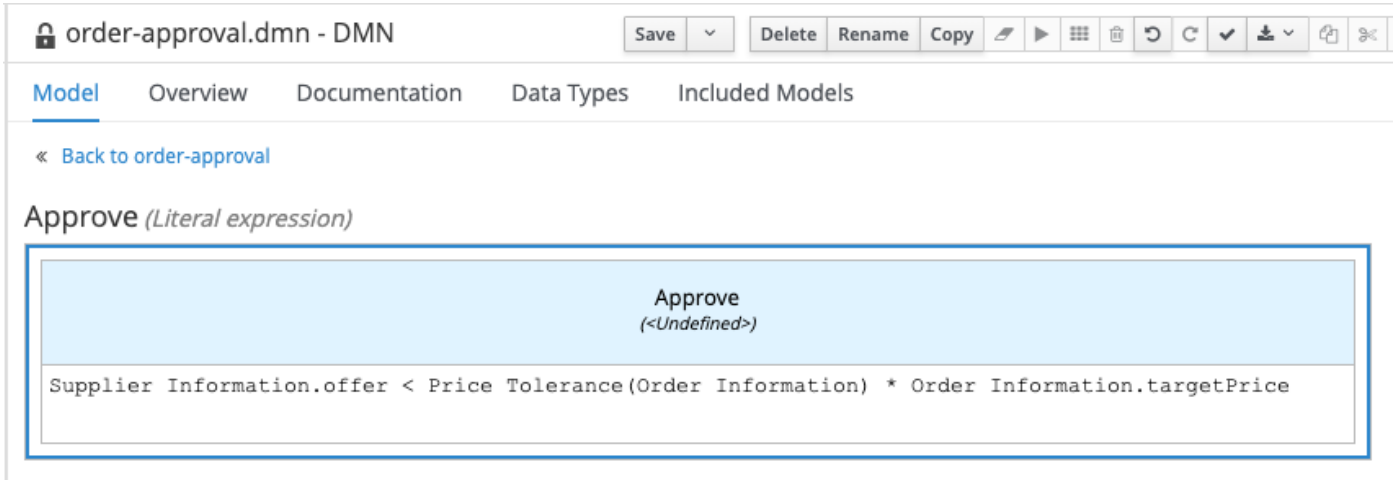
2. Select the `Approve` decision node and click on the edit button.



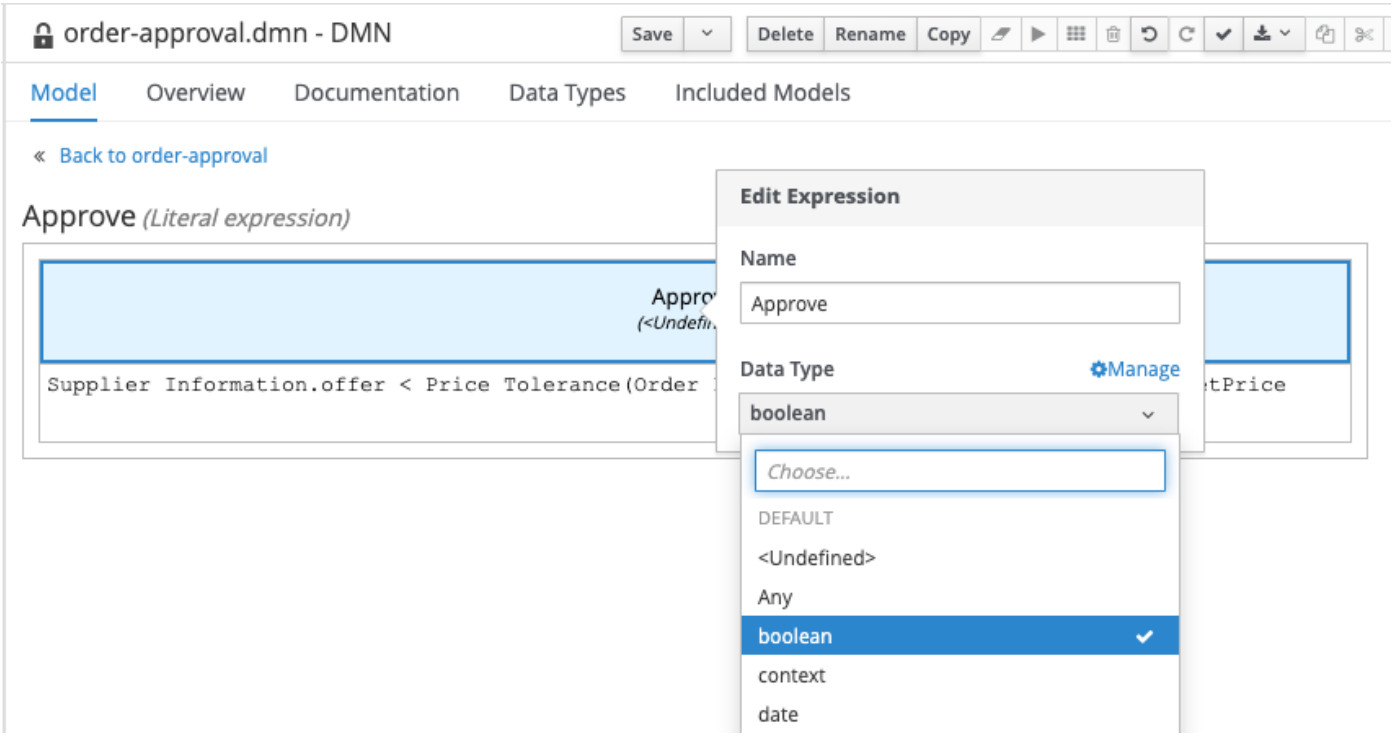
3. Click on _Select Expression, and set the logic type to `Literal Expression`.



4. Enter the following expression: `Supplier Information.offer < Price Tolerance(Order  Information) * Order Information.targetPrice`



5. Click on the `Approve` cell (top cell of the table), and set the data type to `boolean`.

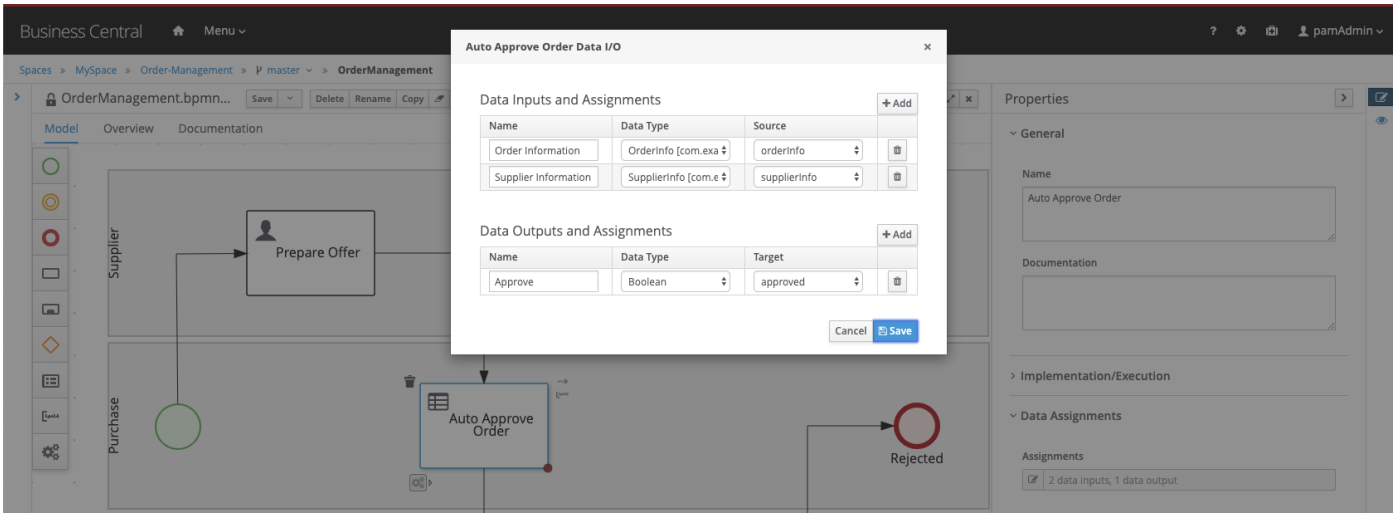


19.5 Connecting the Decision to the Process

1. Navigate back to the model by clicking on the *Back to order-approval* link at the top-left of the editor.
2. Our DMN model is now complete. Make sure to save your model.
3. With our DMN model implemented, we can now revisit our **Business Rules Task** in our BPMN2 model. Open the `order-management` process definition and click on the `Auto Approval Order` node.
4. Open the node's properties in the property-panel on the right side of the editor, open the **Implementation/Execution** section and set:

- Namespace: `http://www.redhat.com/dmn/lab/order-approval-dmn`
- Name: `order-approval`

5. In the same properties panel, expand the *Data Assignments* section and open the *Assignments* editor
6. Implement the following data input and output assignments.



7. Our BPMN model is now complete. Make sure to save the model.

Now, we should be able to create and implement our forms.

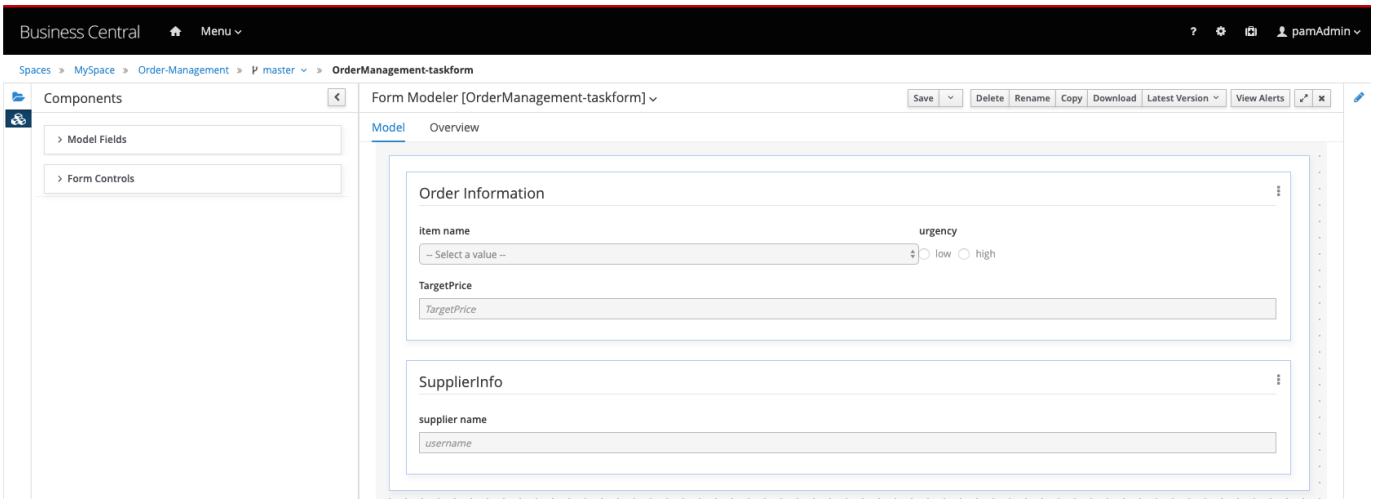
19.6 Creating Forms

In this section we are going to create the process start and user-task forms. We could simply generate these forms with the click of a button, which gives us some standard forms based on the process and task data.

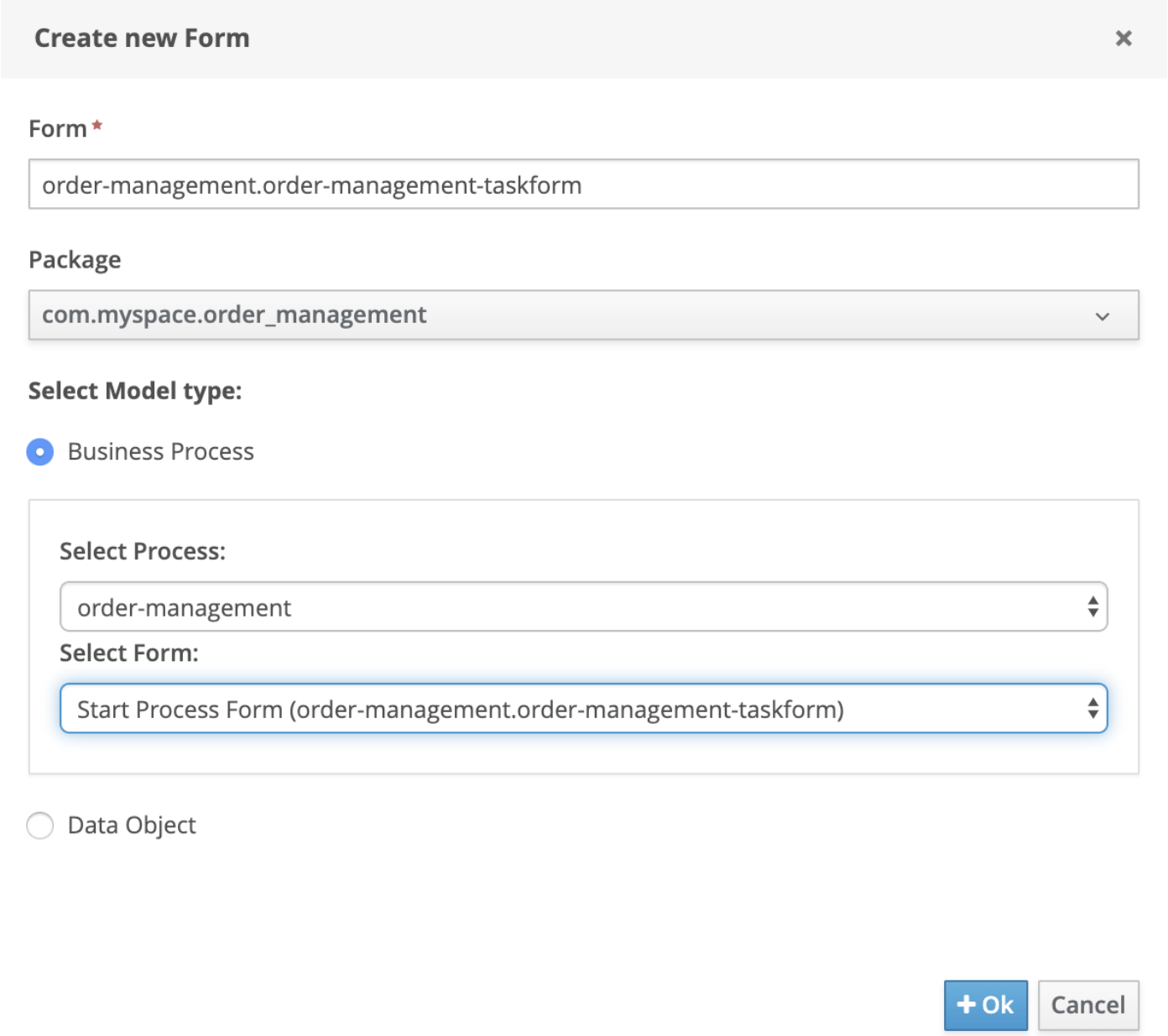
In this lab however, we will be creating these forms using the **Form Modeler** tool. This allows us to design these forms to our specific needs.

19.6.1 PROCESS START FORM

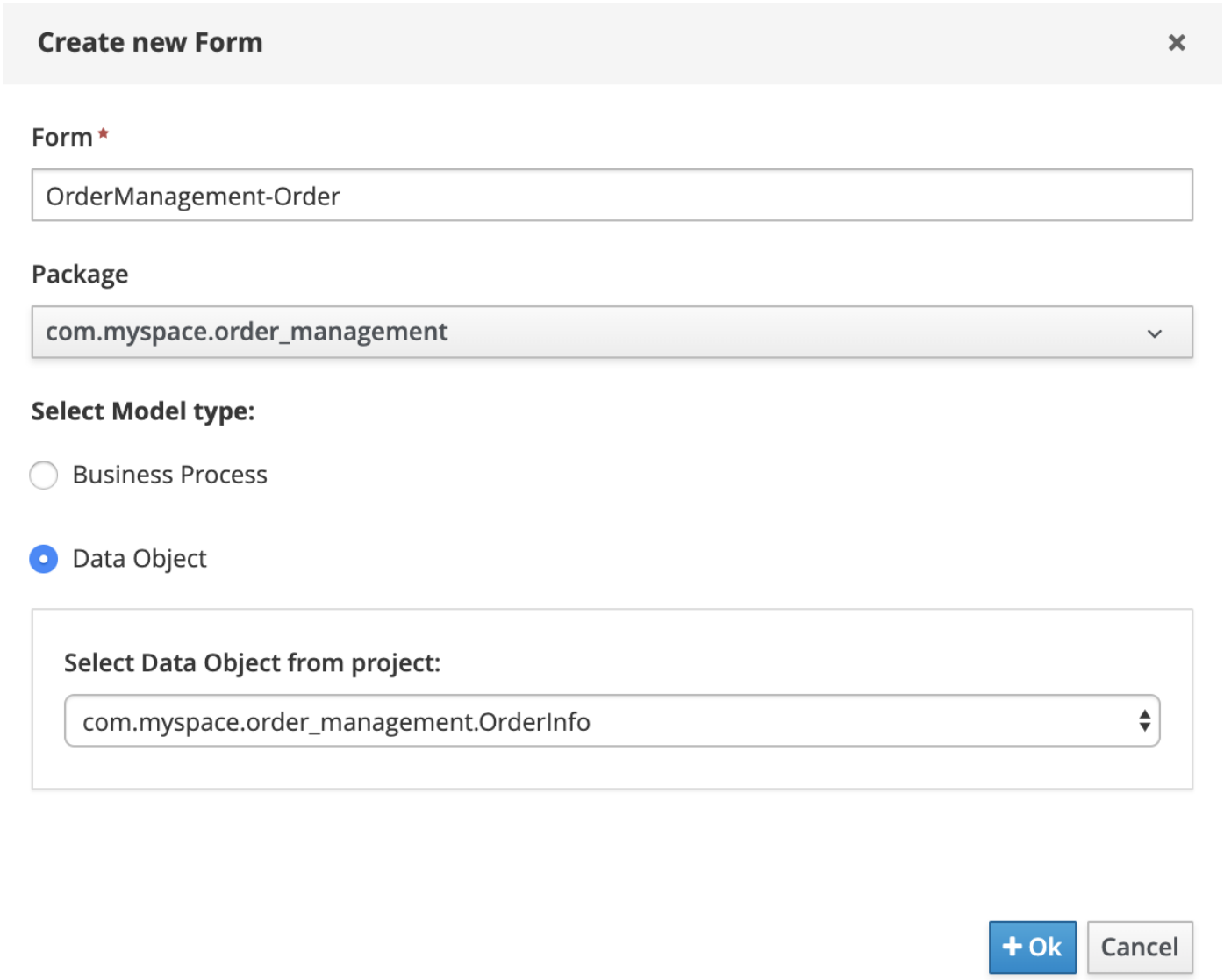
Let’s start with the process start form. We want to create the following form:


Business Central
Menu
pamAdmin
Spaces » MySpace » Order-Management » master » OrderManagement-taskform
Components
Model Fields
Form Controls
Form Modeler [OrderManagement-taskform]
Save
Delete
Rename
Copy
Download
Latest Version
View Alerts
Model
Overview
Order Information
item name
-- Select a value --
urgency
low
high
TargetPrice
TargetPrice
SupplierInfo
supplier name
username

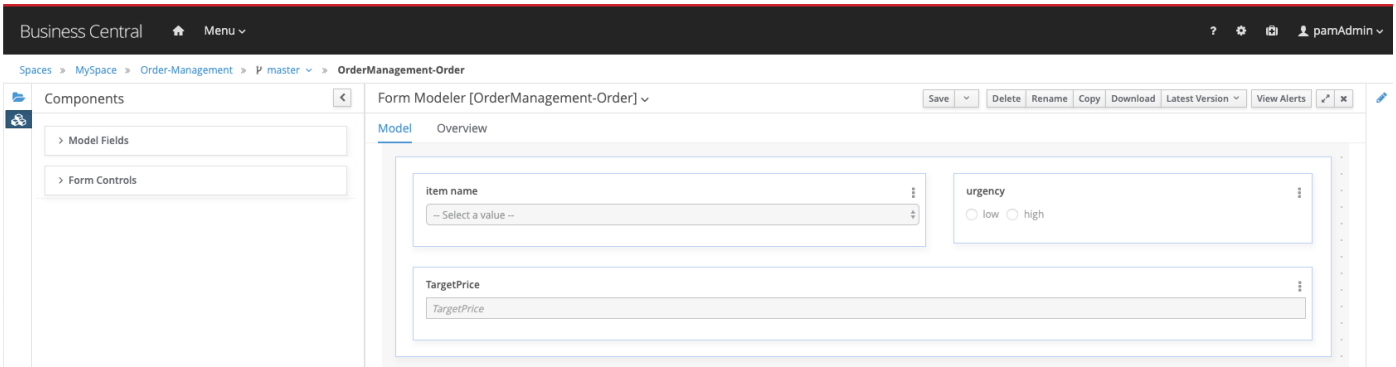
1. In the project's library view, click on **Add Asset**. Filter on **Form**, click on the **Form** tile. Enter the details as shown in the screenshot below:



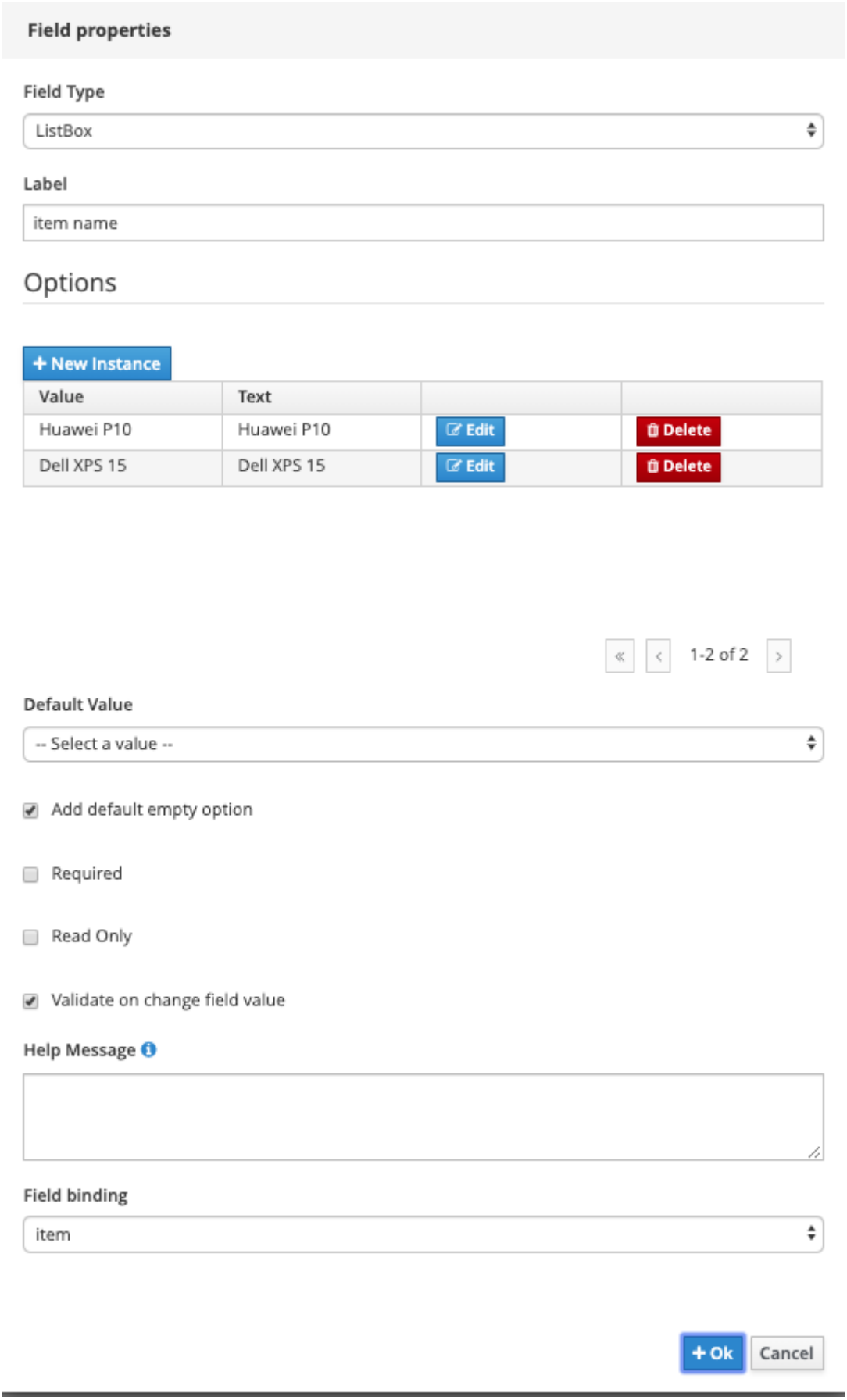
2. On this form we want to specify the initial order. We therefore require fields from the `orderInfo` and `supplierInfo` process variable. When we expand the `Model Fields` section, we can see our 2 process variables (`orderInfo` and `supplierInfo`). These are both complex objects. To work with complex objects (as opposed to simple types like integers and booleans), we require a data-form for that specific object. We therefore first need to create a data-form for our `OrderInfo` and `SupplierInfo` objects.
3. Go back to the project's library view, click again on **Add Asset** and create a new form. Use the following details:



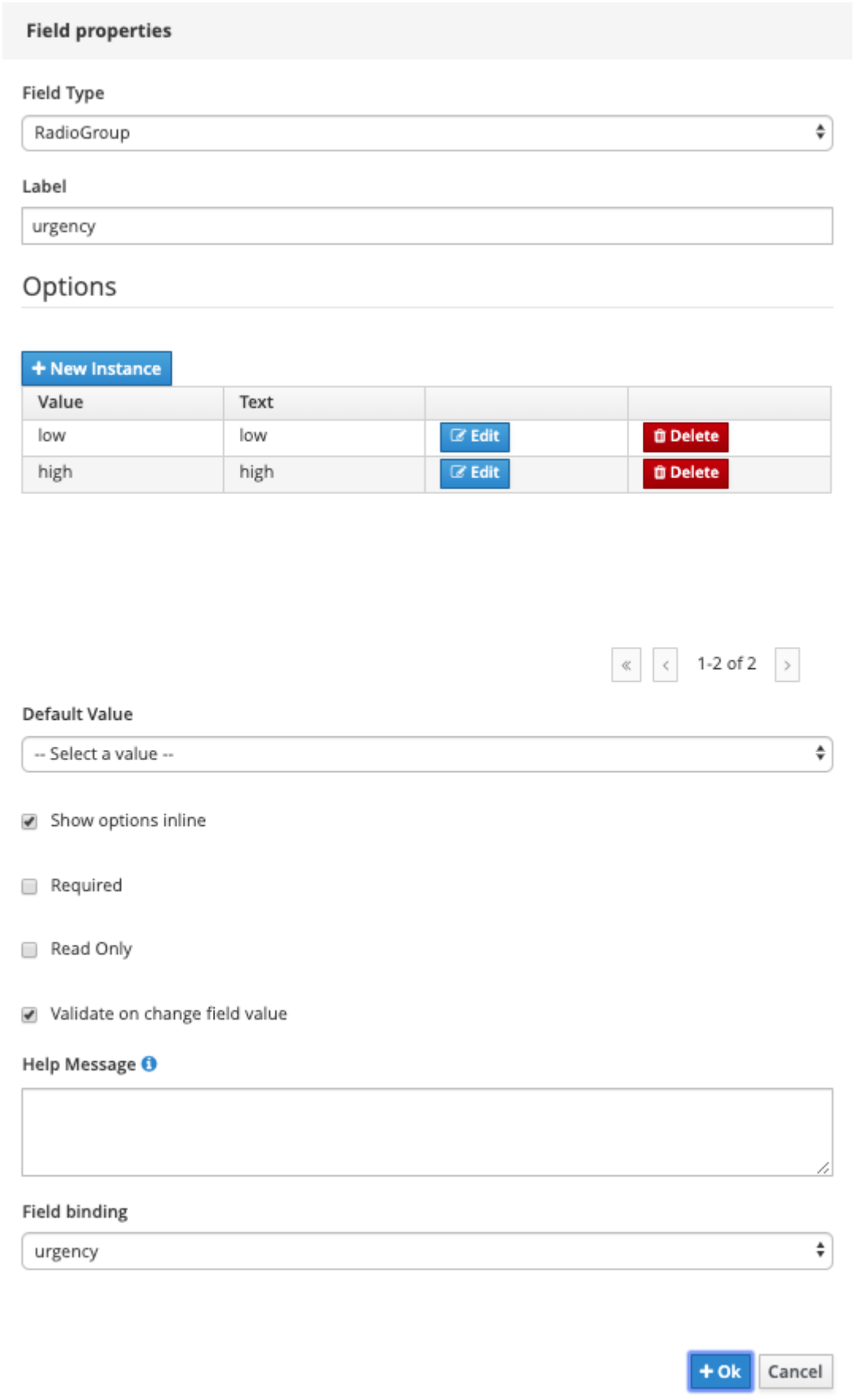
4. Using the Form Modeler constructs, create the following form:



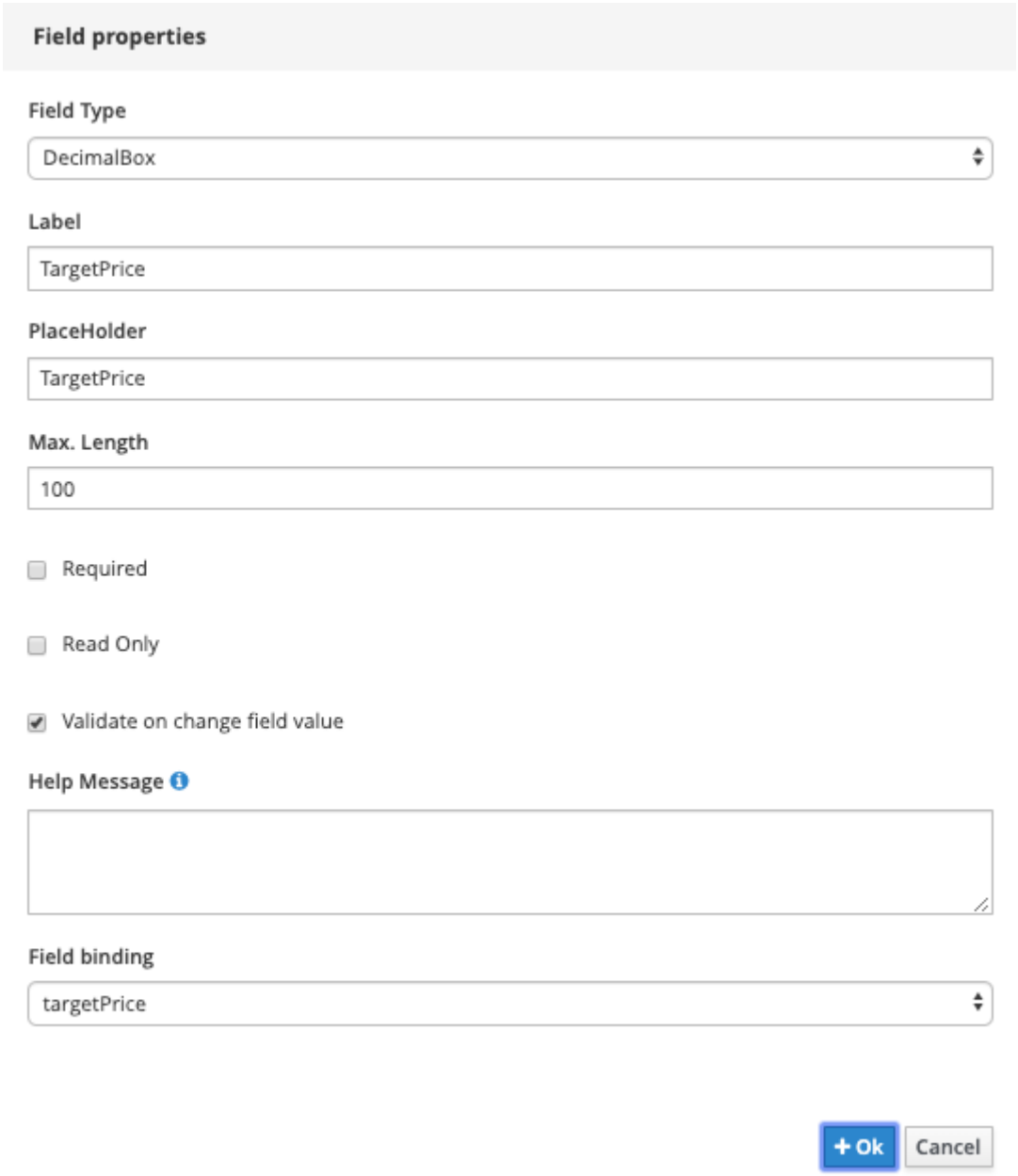
5. To create this form, drag both the `item`, `urgency` and `targetPrice` onto the canvas and configure them as follows.
6. List Box:



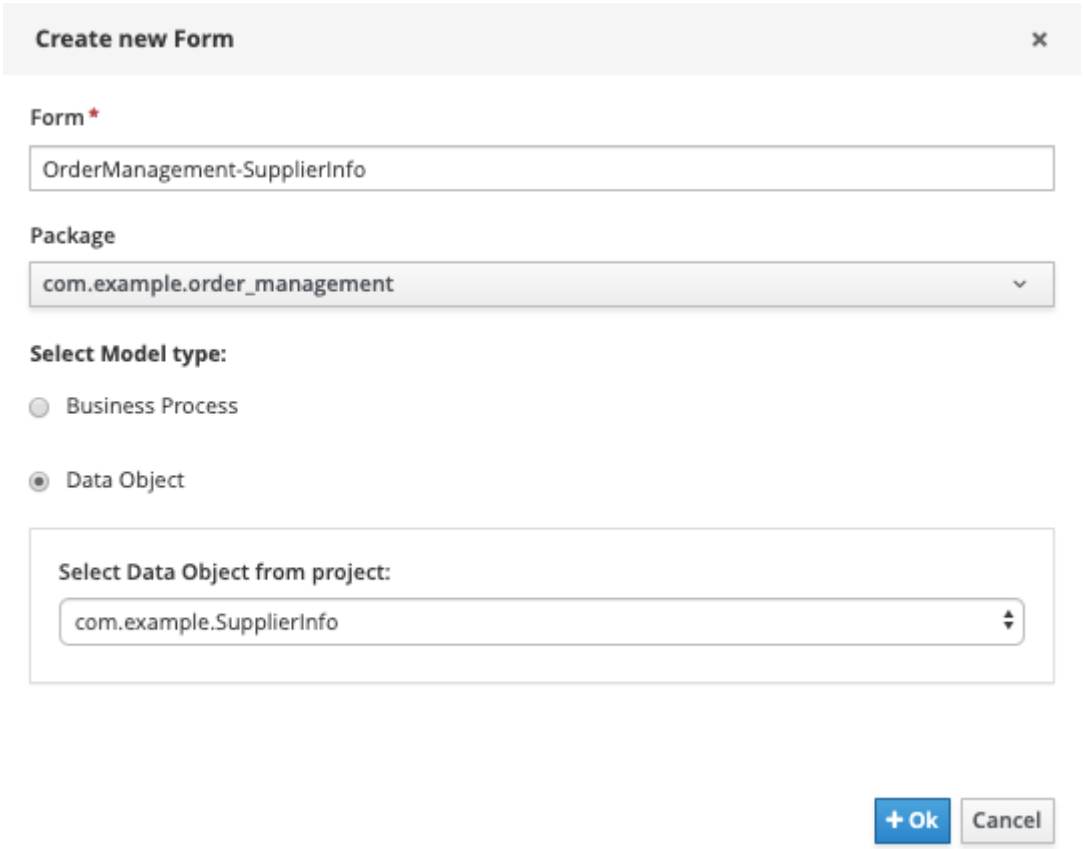
7. Radio Group:



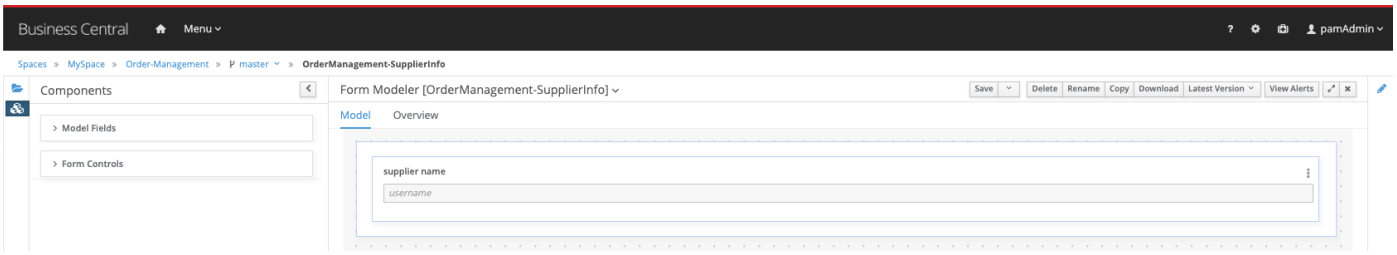
8. Decimal Box:



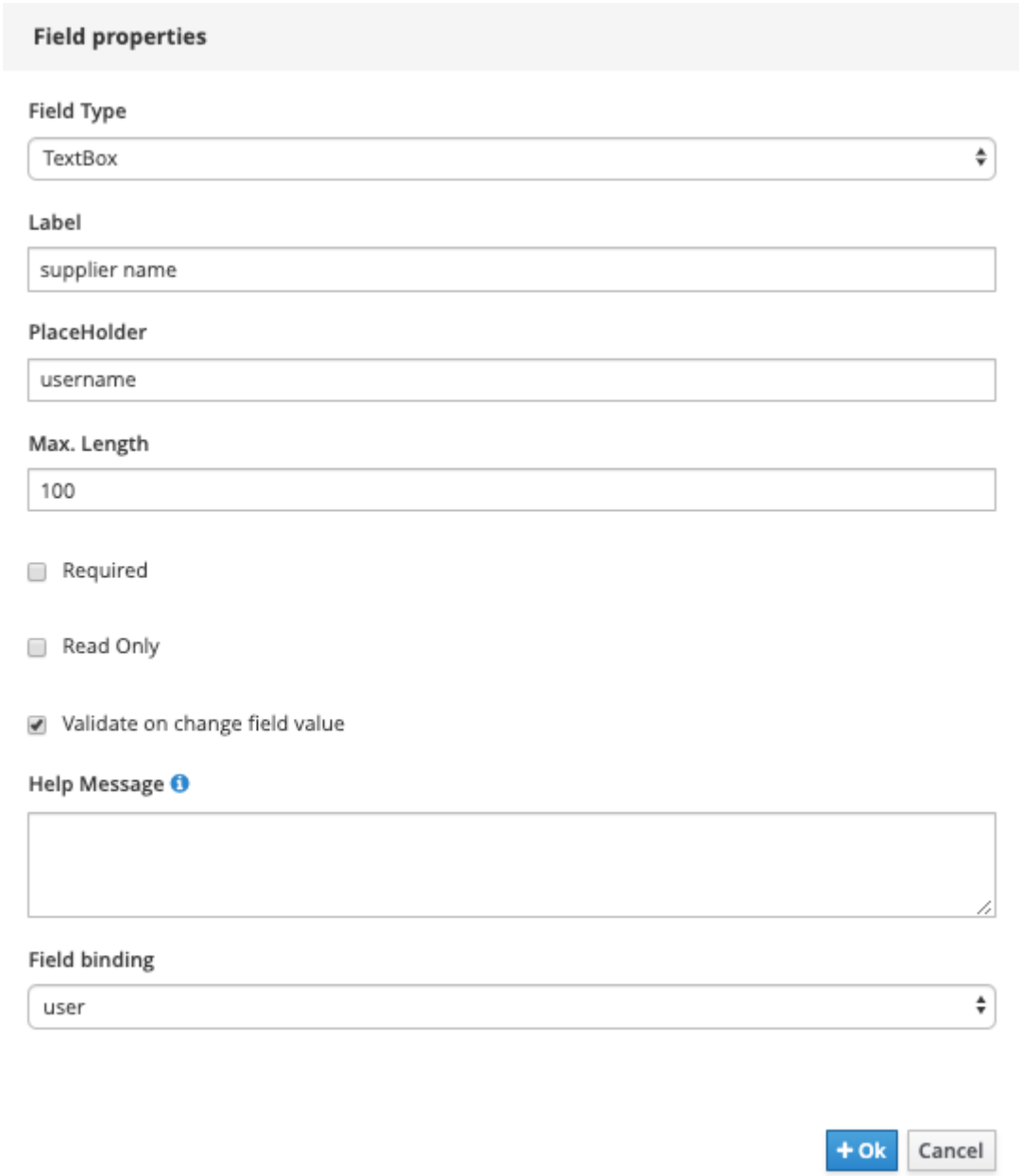
9. Save the form and create another new form for our `supplierInfo`. Use the following details.



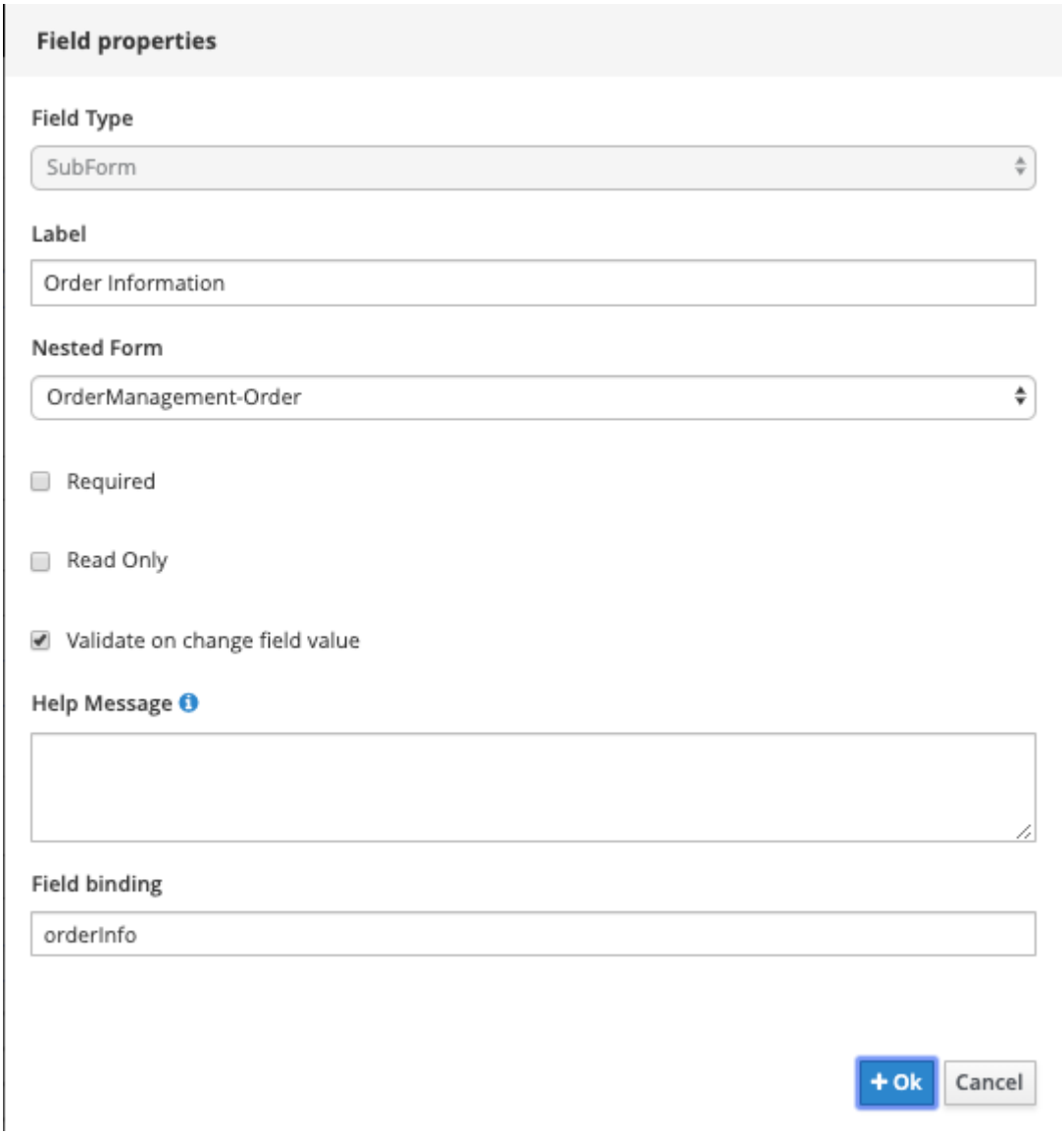
10. Using the Form Modeler constructs, create the following form:



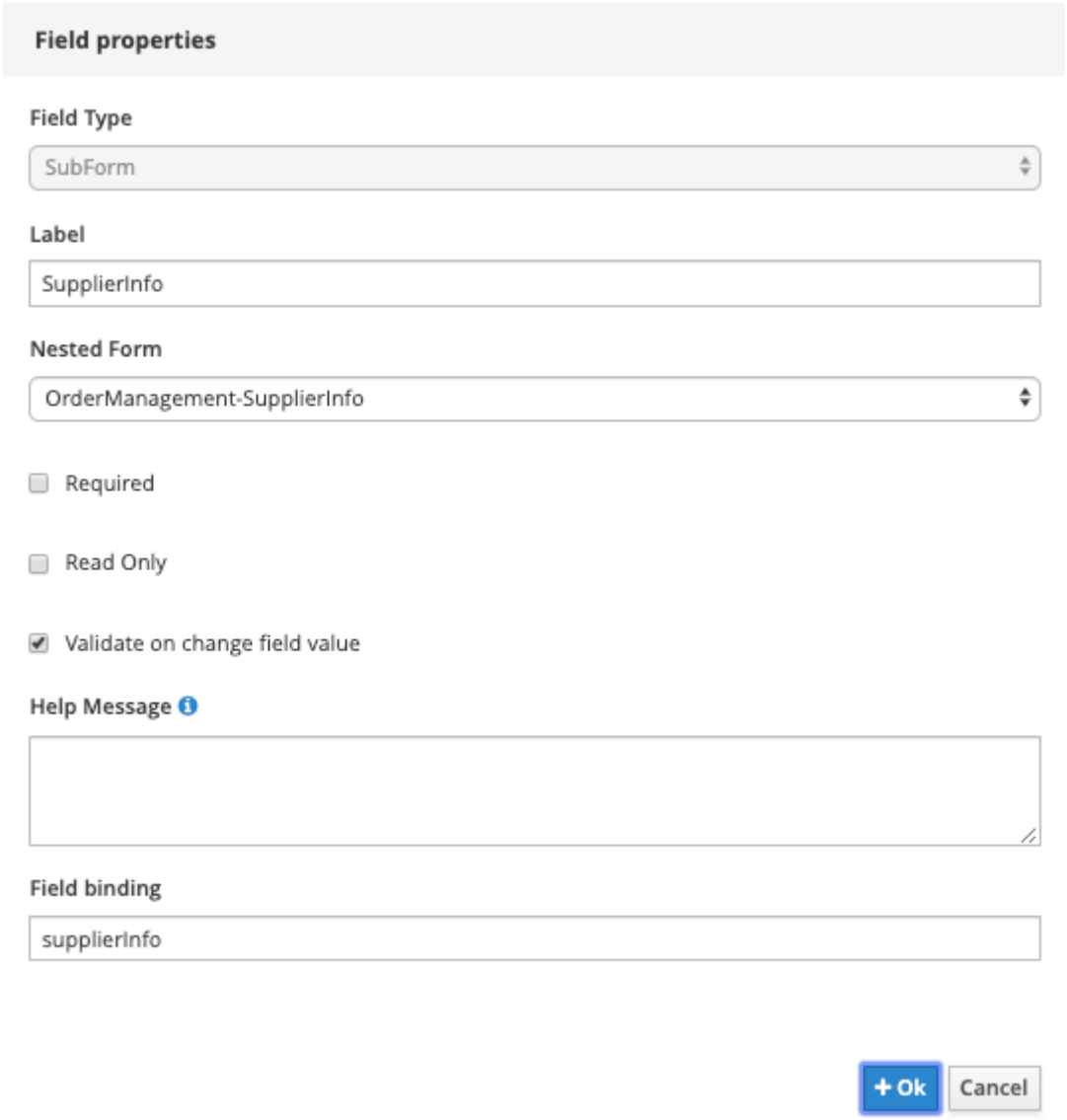
11. To create this form, drag the `user` field onto the canvas and configure it as follows.



12. Save the form and open the `OrderManagement` form (the first form we created).
13. Drag the `orderInfo` process variable onto the canvas. In the pop-up form, set the `OrderManagement-Order` form we just created as the **Nested Form**:



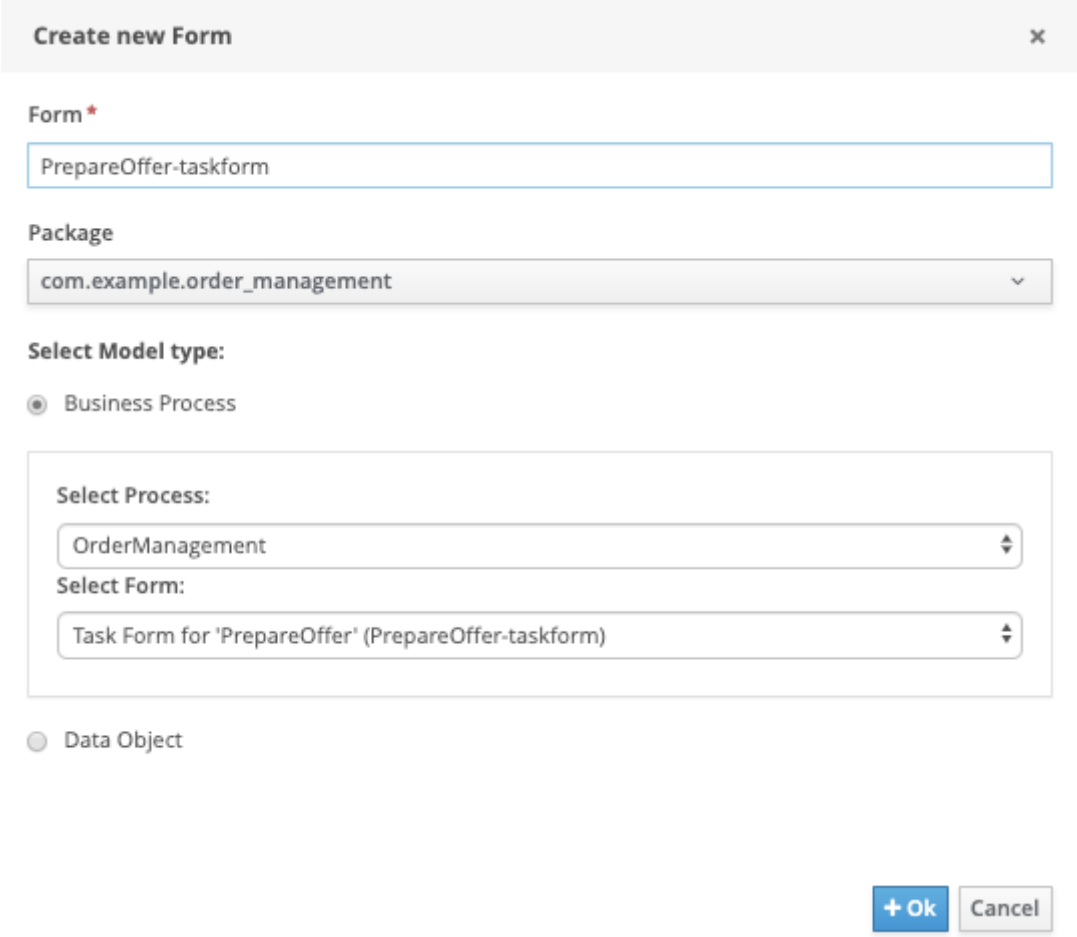
14. Drag the `supplierInfo` process variable ontoo the canvas. In the pop-up form, set the `OrderManagement-SupplierInfo` form we just created as the **Nested Form**:


Field properties
Field Type
SubForm
Label
SupplierInfo
Nested Form
OrderManagement-SupplierInfo
Required
Read Only
Validate on change field value
Help Message
Field binding
supplierInfo
+ Ok
Cancel

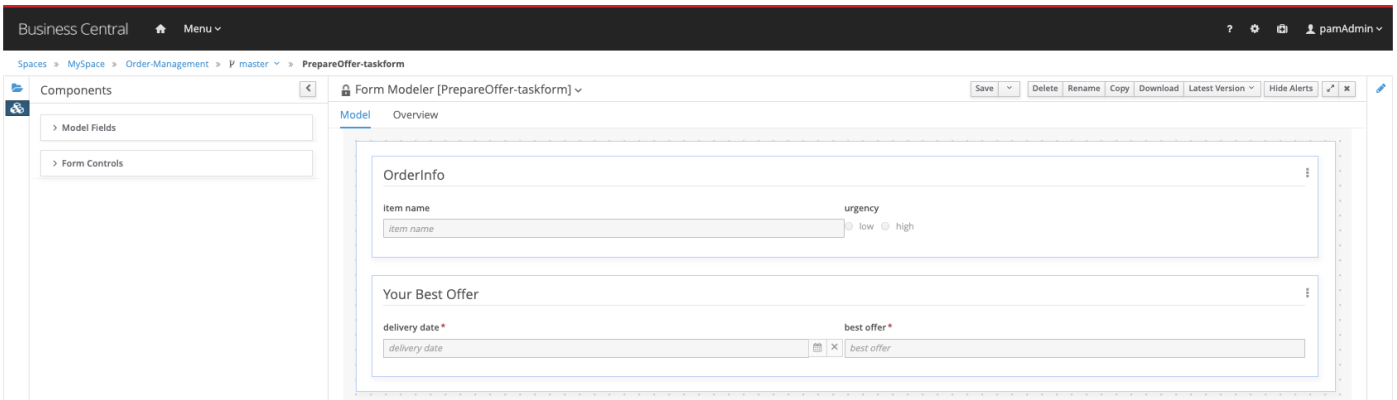
19.6.2 PREPARE OFFER FORM

Next, we will create the form for the `Prepare Offer` **User Task**.

1. Create a new form. Provide the following details:

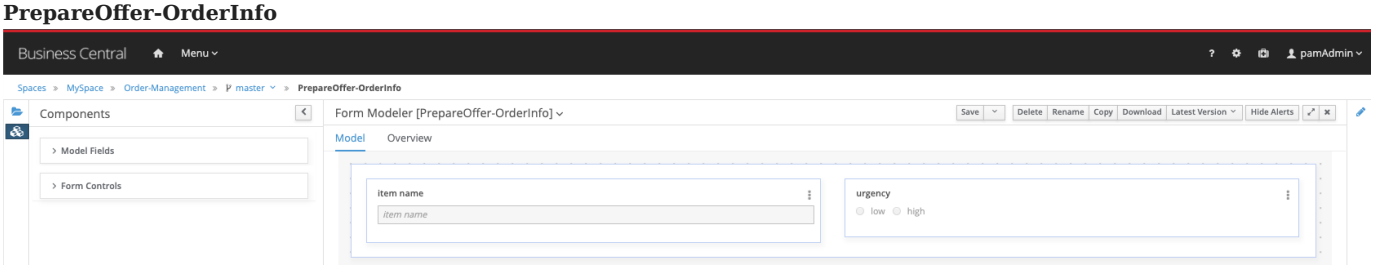


2. Our aim is to create a form that looks as such:



3. As with the process start form, this user-task form operates on 2 variables, `orderInfo` and `supplierInfo`. And, as with the process start form, we need to create a data-object form for each of these variables. Technically, data-object forms for a certain data-object can be reused in multiple task-forms. However, creating a data-object form per task-form allows us to design these data-object forms aimed for that specific task.

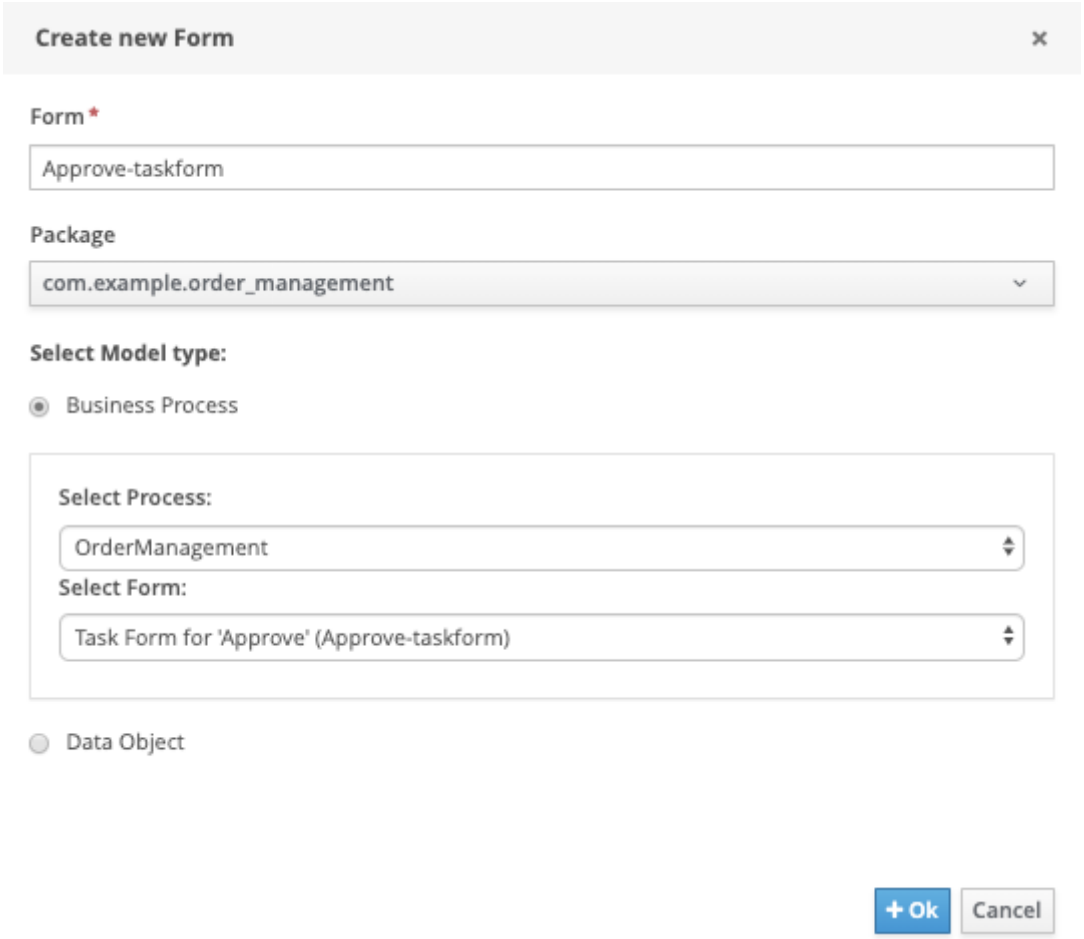
PrepareOffer-OrderInfo



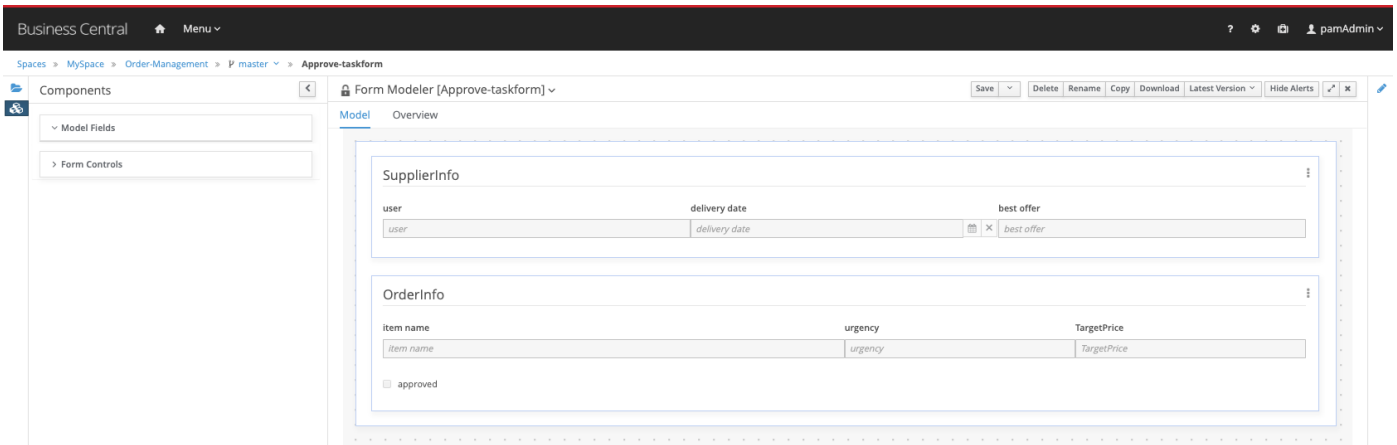
PrepareOffer-SupplierInfo

Finally, we need to create the task form for the `Approve` task.

1. Create a new form. Provide the following details.

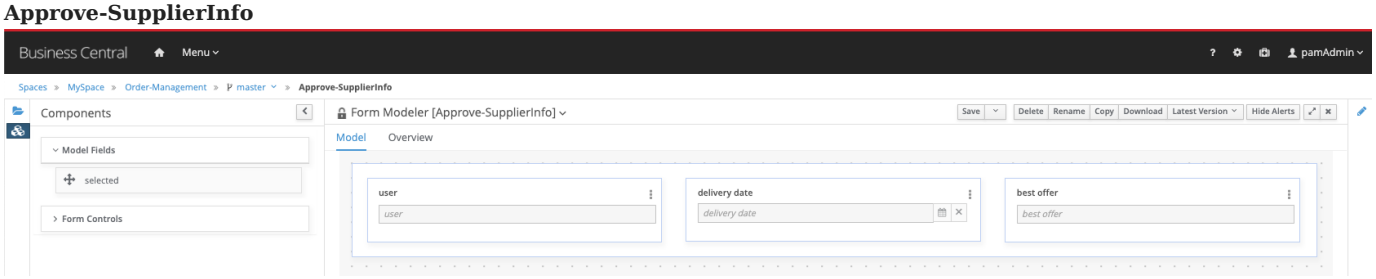


2. Our aim is create a form that looks like this:

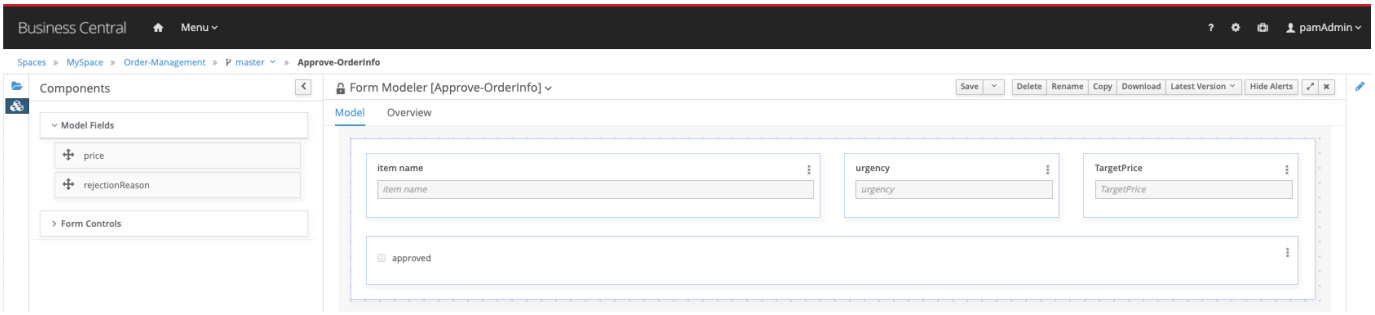


3. As with the other forms, this user-task form operates on 2 variables, `orderInfo`, `supplierInfo`. And, as with the other forms, we need to create a data-object form for each of these variables.

Approve-SupplierInfo



Approve-OrderInfo



Don’t forget to save all your forms!!!

The implementation of our process is complete. It’s now time to deploy and test our application.

19.7 Deploying the Process Service

With our **Order Management** project’s process, decisions and forms completed, we can now package our project in a Deployment Unit (KJAR) and deploy it on the Execution Server. To do this:

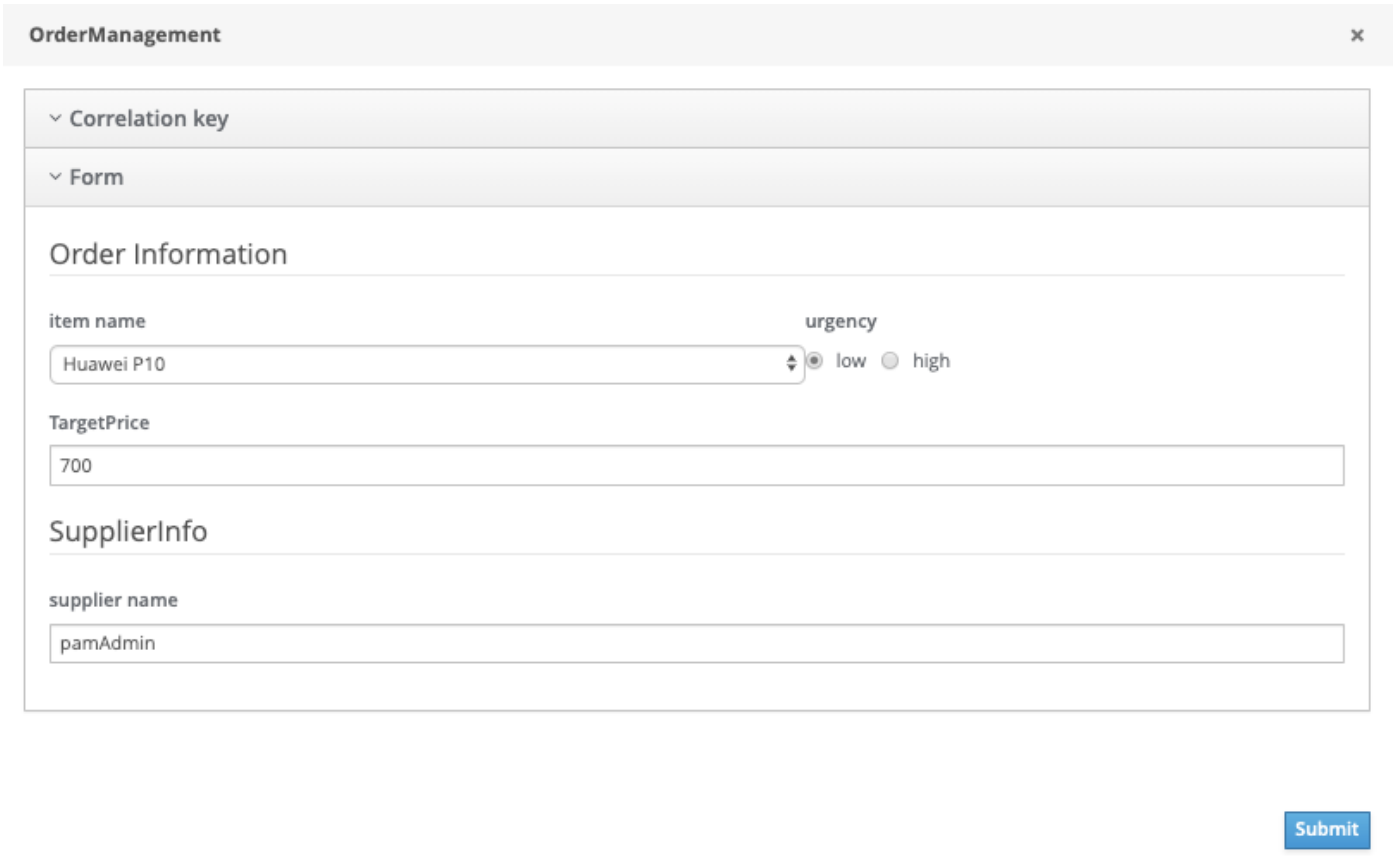
1. Go back to our project’s Library View (for example by clicking on the `Order Management` link in the breadcrumb navigation in the upper-left of the screen).
2. Click on the **Deploy** button in the upper-right corner of the screen. This will package our project in a Deployment Unit (KJAR) and deploy it onto the Execution Server (KIE-Server).
3. Go to the **Execution Servers** perspective by clicking on "Menu → Deploy → Execution Servers". You will see the **Deployment Unit** deployed on the Execution Server.

19.8 Execute the process

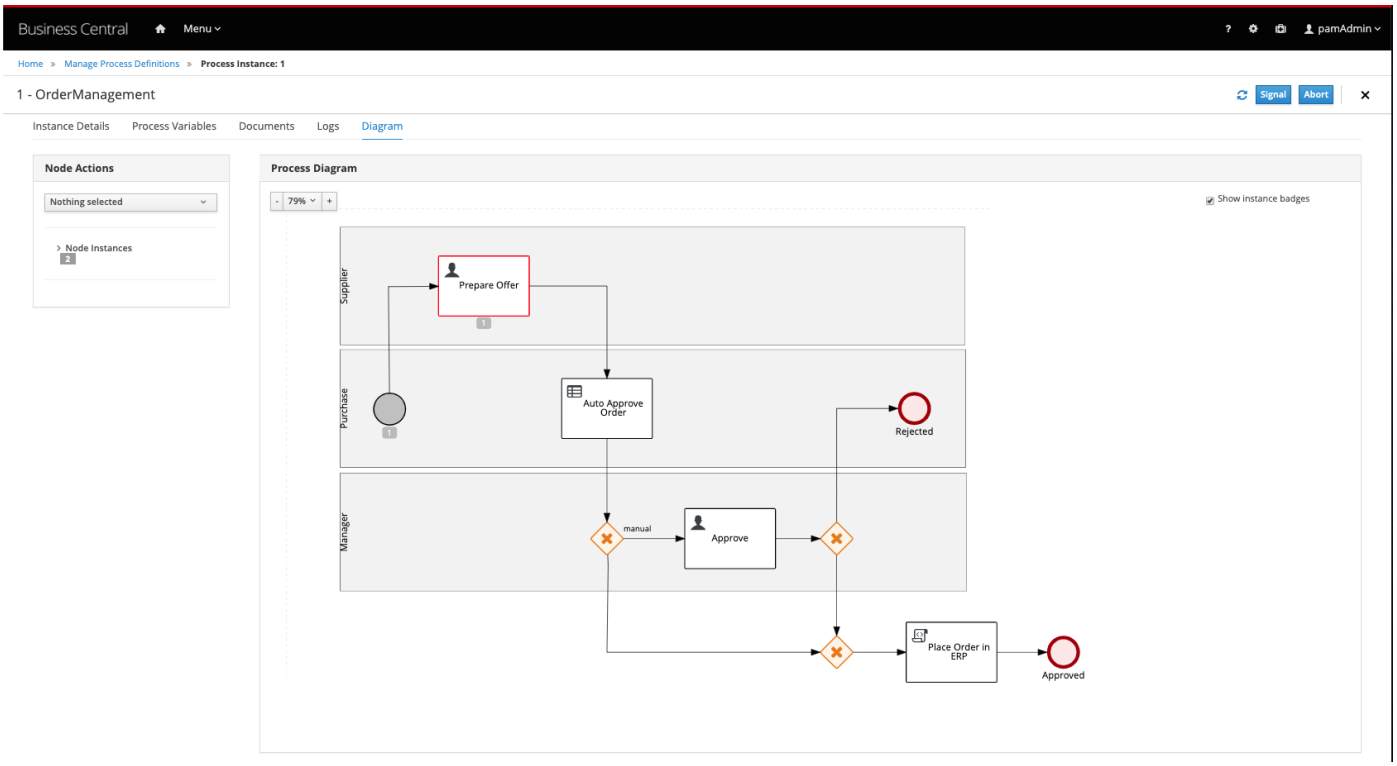
In this section, you will execute the process deployed on the Process Execution Server via the Business Central workbench.

1. Navigate to **Menu → Manage → Process Definitions**. If everything is correct, the `order-management` process will be listed. Click on the kebab icon of the `order-management` process and click on **Start**.

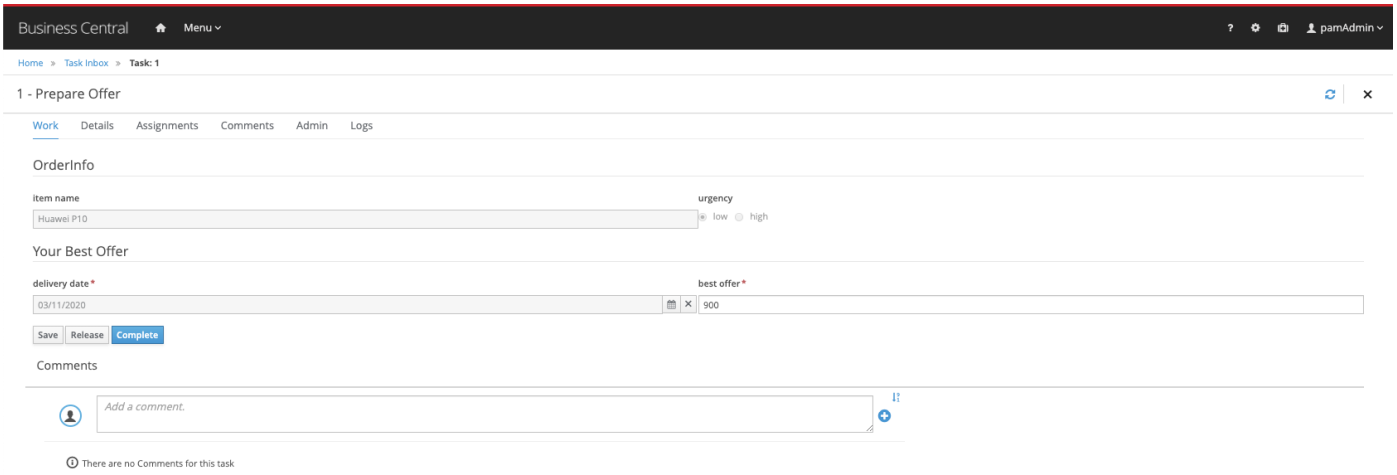
2. In the form that opens, pick the **Huawei P10 Phone** as the item and set the urgency to **low**. Set the target price to **700** and set the supplier name to the name of your own Business Central user (e.g. `bamAmdmin`). Click on **Submit**.



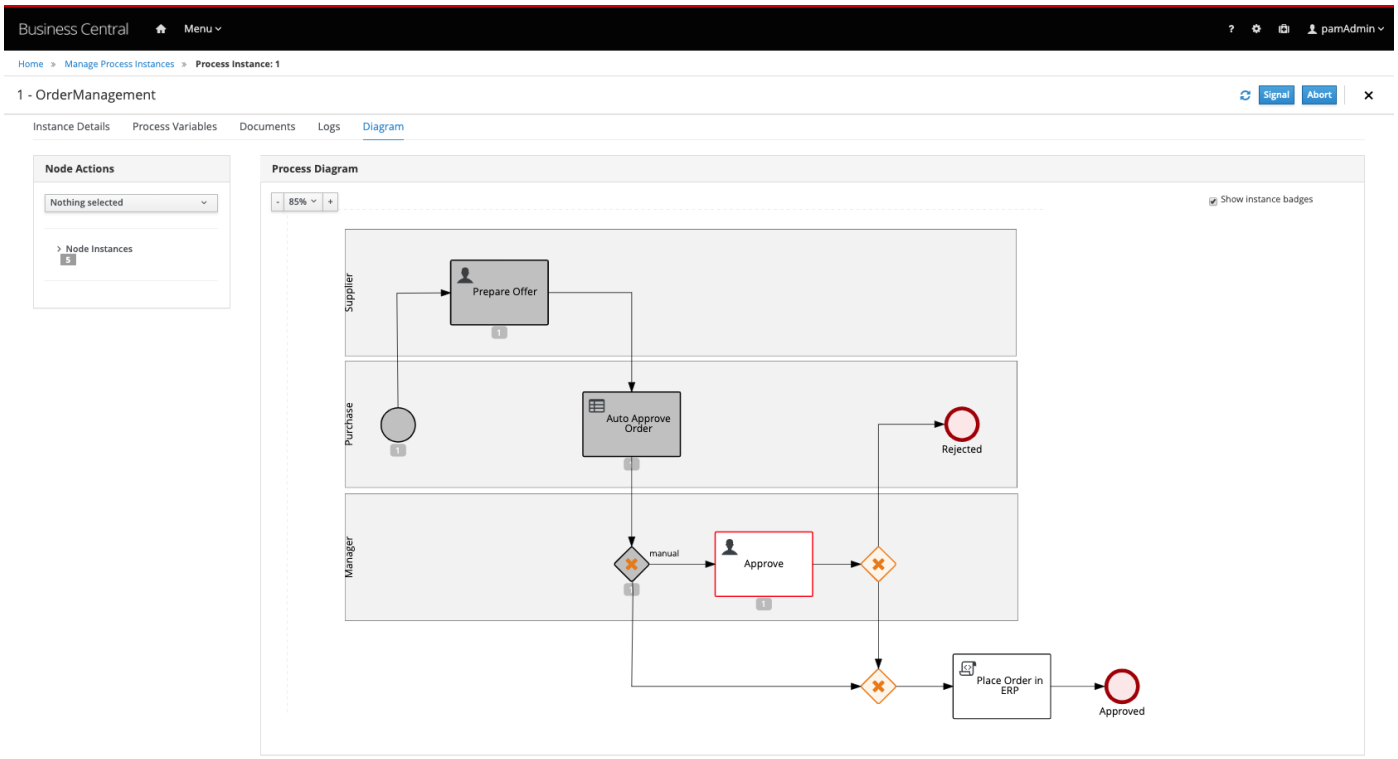
3. In the process instance details screen that opens, click on the **Diagram** tab to open the process instance diagram, which shows the current state of the process.



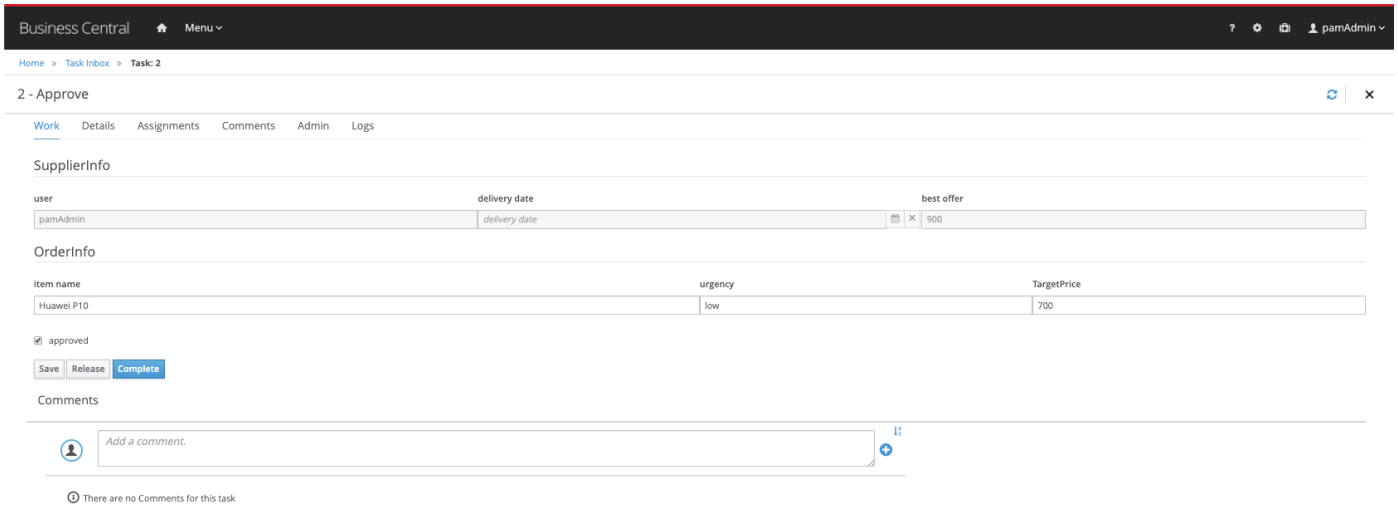
4. The process is in a wait state at the `Prepare Offer` task. Navigateto **Menu → Track** Task Inbox**. Click on the `Prepare Offer` task to open its task window.
5. Click on the **Start** button to start working on the task. Because the task has been assigned to a single user (via #{supplierInfo.user}), you don't have to first *claim* the task.
6. Select a random delivery date. Set the best offer to **900**. Click on **Complete**.



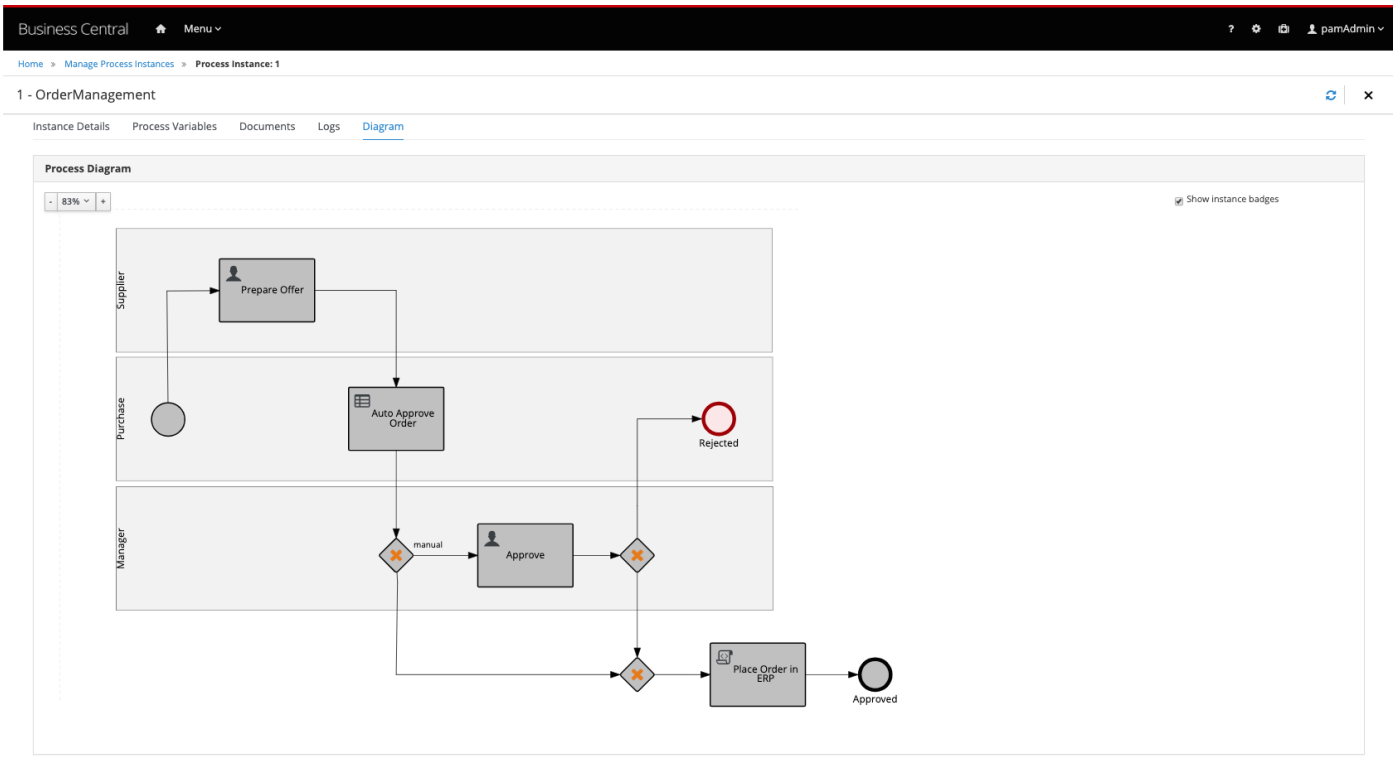
7. The process will continue to the `Auto Approve Order` decision node. Because of the target prices set, and the offered price, the decision will evaluale to `false`. Hence, the process will continue to the `Approve` task.



8. Go back to the **Task Inbox** and open the `Approve` task. Click on **Claim** and on **Start**. In this form we can approve or disapprove the order via the **approved** checkbox, and specify a **rejection reason** if we reject the order. Approve the task by checking the **approved** checkbox and clicking on **Complete**:



9. Go back to the process instance view and observe that the process instance is gone.
10. Enable the **Completed** checkbox in the **State** filter on the left-hand-side of the screen. Observe that we can see our process instance in the list.
11. Open the process instance, open it's **Diagram** tab. Observe that the order has been accepted:



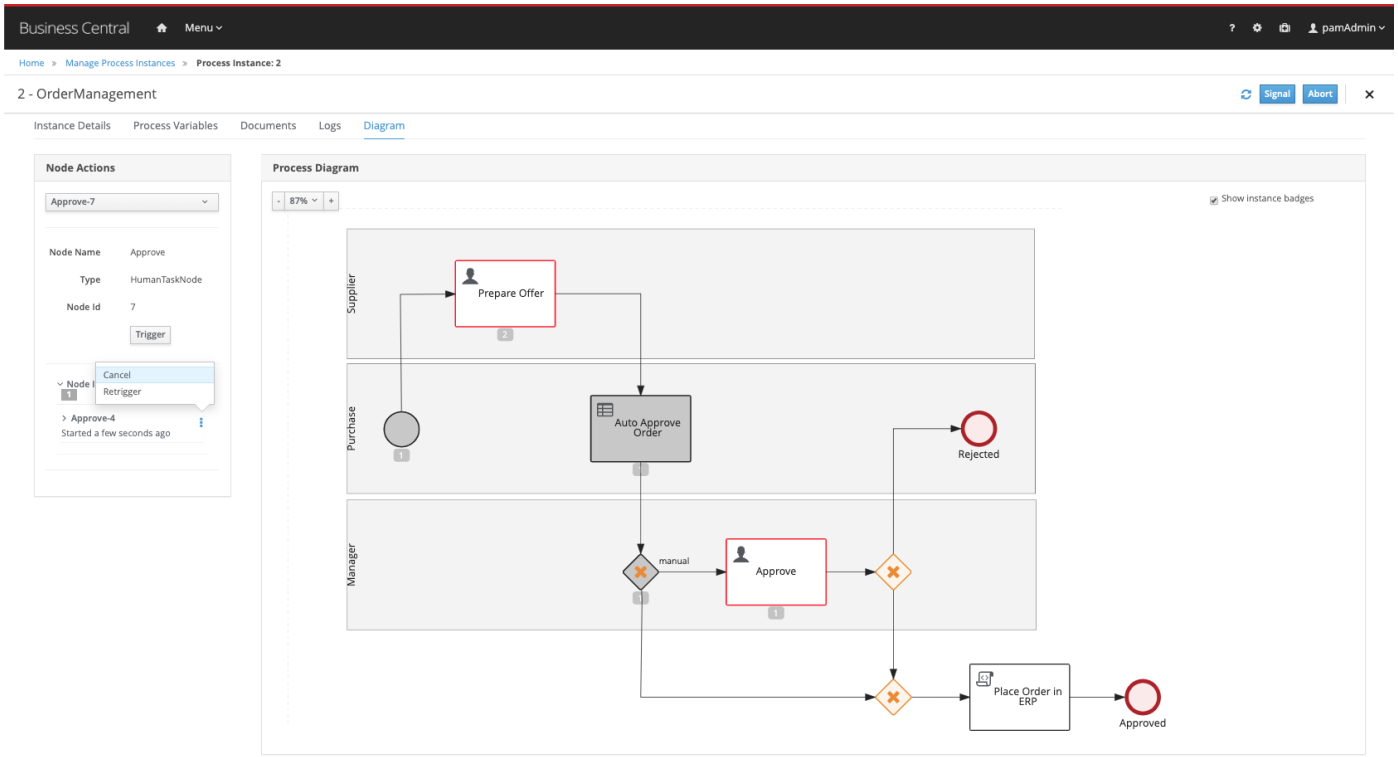
Run a couple more process instances with different values to test, for example, the functionality of the `Automated Approval Rules`.

19.9 Correcting problems and errors

During process instance execution, a lot of things can go wrong. Users might fill in incorrect data, remote services are not available, etc. In an ideal world, the process definition takes a lot of these possible problems into account in its design. E.g. the process definition might contain exception handling logic via boundary catching error events and retry-loops. However, there are situations in which an operator or administrator would like to manually change the process to another statem for example,

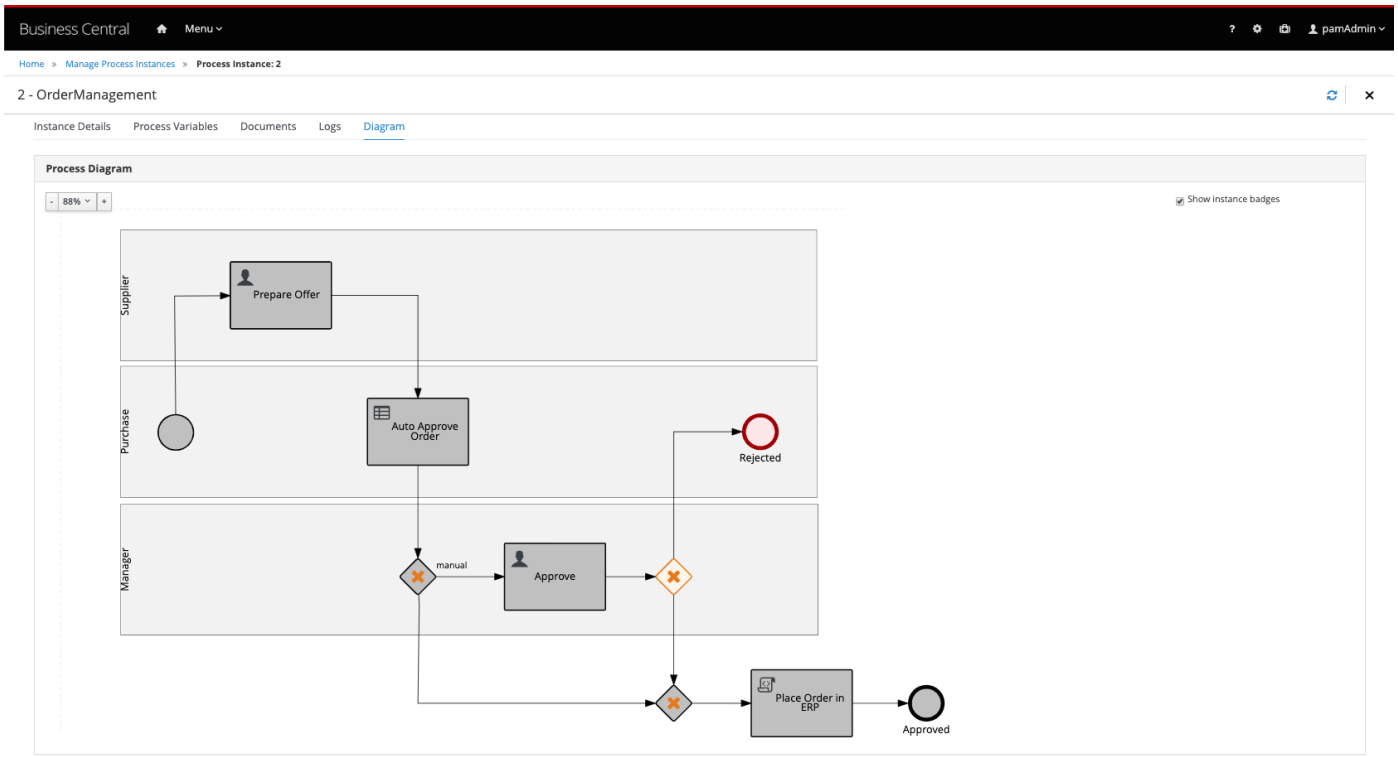
restart an already completed **User Task**. In the latest version of IBM Business Automation Open Edition 8.0 this is now possible via the **Process Instance interface** in Business Central.

1. Start a new process instance of our **Order Management** process.
2. Complete the `Prepare Offer` task in such a way that the order is not automatically approved and the process will hit the `Approve` *User Task* wait state.
3. Go to the **Process Instances** view and select the process instance. Navigate to the **Diagram** tab. Observe that the process is waiting in the `Approve` **User Task**.
4. Click on the `Prepare Offer` node to select it. In the **Node Actions** panel on the left-hand-side of the screen, verify that the `Prepare Offer` node is selected and click on **Trigger**. Observe that the `Prepare Offer` **User Task** has been activated.
5. Although we have re-activated the `Prepare Offer` node, we have not yet de-activated the `Approve` task. Click on the active `Approve` task and expand the **Node Instances** section in the **Node Actions** panel. Click on the kebab icon of the active `Approve` instance and click on **Cancel**:



6. Open the **Task Inbox**. Observe that the `Approve` **User Task** is gone and that we have a new `Prepare Offer` task.

- Open the `Prepare Offer` task, set the price to a price which will trigger the rules to automatically approve the order, and complete the task. Go to the process instances view and observe that the process instance has been completed. Enable the **Completed** filter in the **State** filter panel on the left-hand-side of the screen. Open the completed process instance and open its *Diagram* tab.

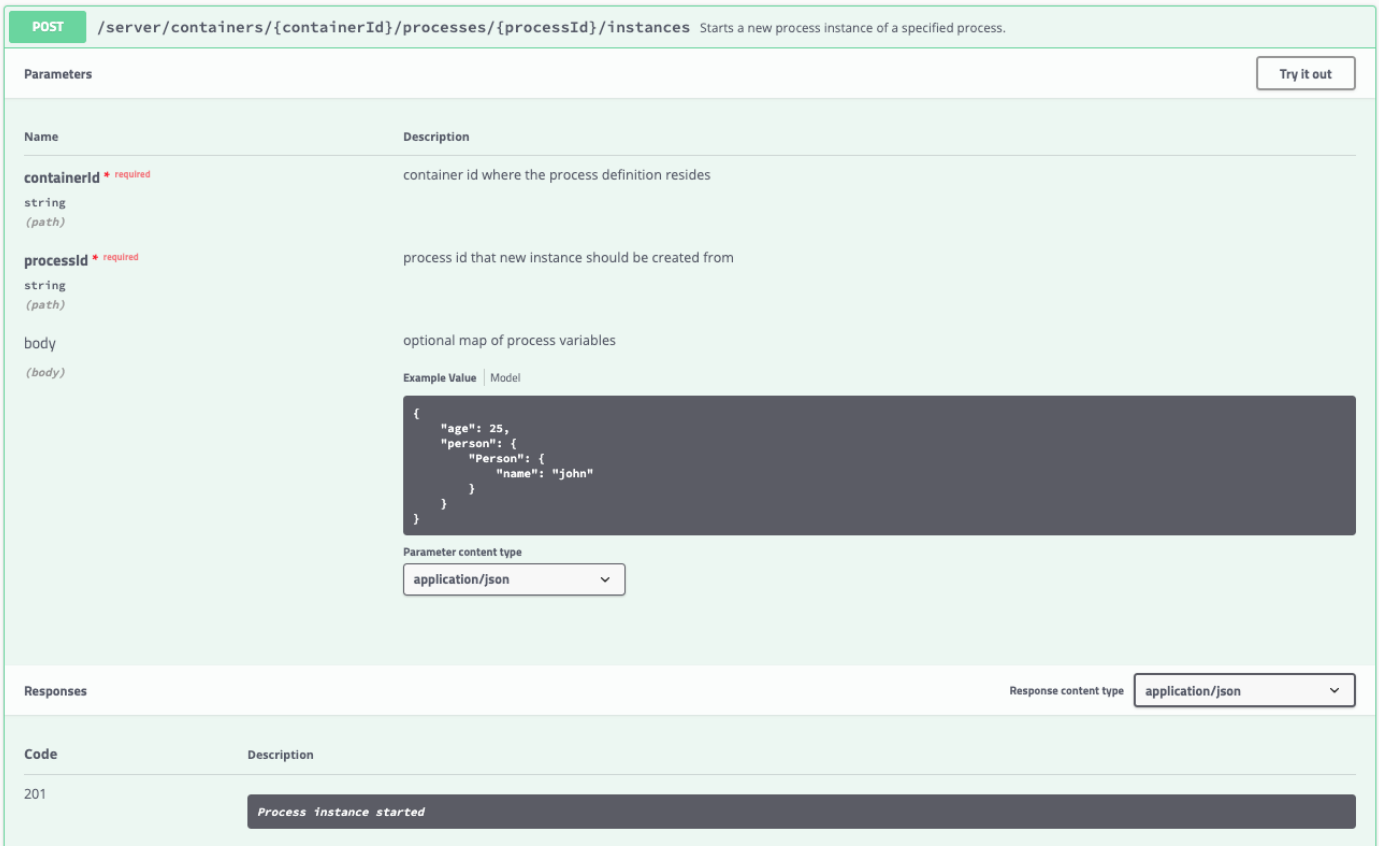


19.10 Execute the process via APIs

The Execution Server provides a rich RESTful API that allows user to interact with the process engine and deployed processes via a REST. This powerful feature allows users to create modern user interface and applications in their technology of choice (e.g. Entando DXP, ReactJS/Redux, AngularJS, etc.) and integrate these applications with the process engine to create modern, process driven, enterprise applications.

The Swagger interface provides the description and documentation of the Execution Server’s RESTful API. At the same time, it allows the APIs to be called from the UI. This enables developers and users to quickly test a, in this case, a deployed business process.

1. Navigate to the KIE Server Swagger Page
2. Locate the **Process instances** section. The Process Instances API provides a vast array of operations to interact with the process engine.
3. Locate the **POST** operation for the resource `/server/containers/{containerId}/processes/{processId}/instances`. This is the RESTful operation with which we can start a new process instance. Expand the operation:

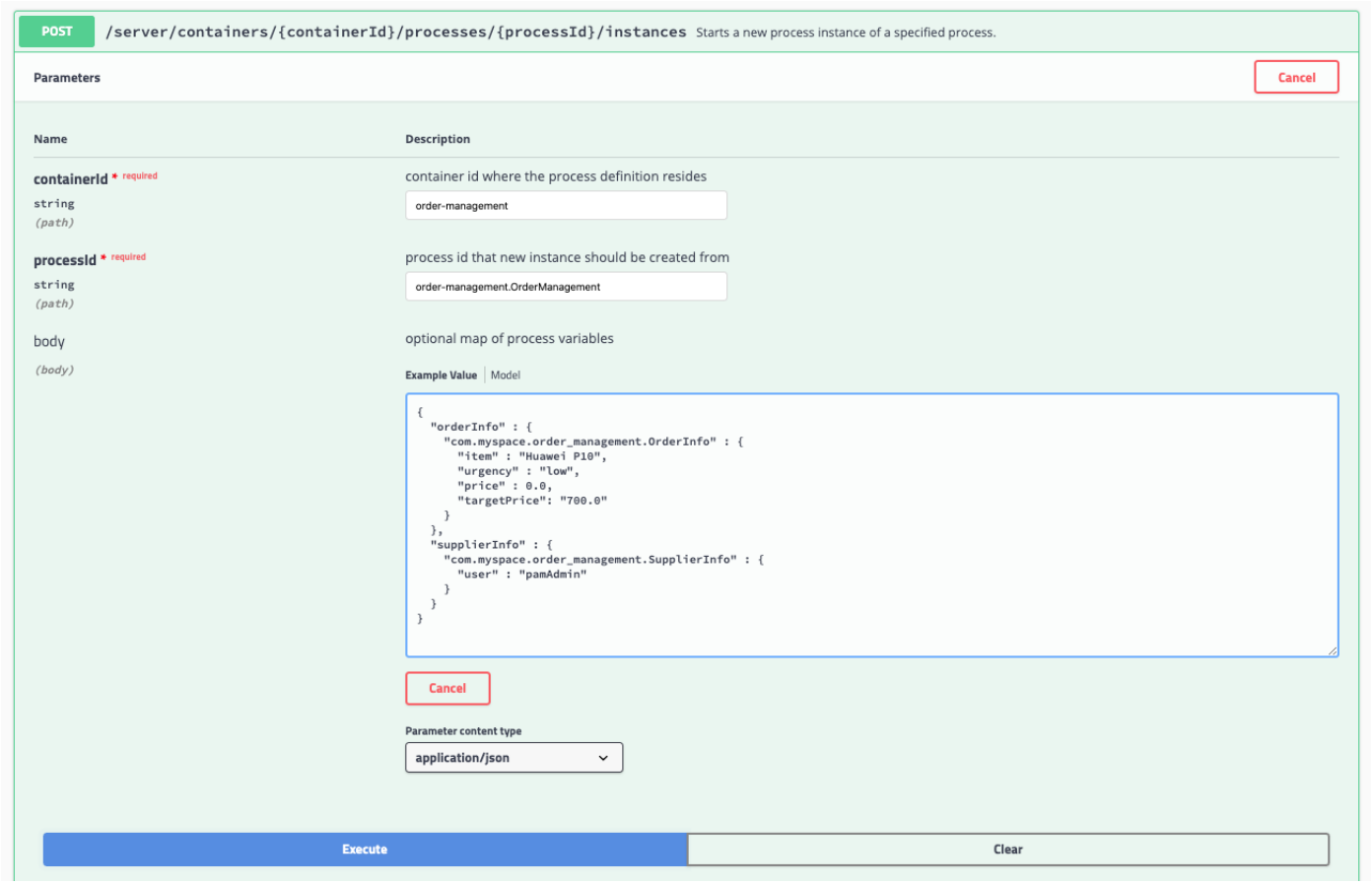


4. Click on the **Try it out** button.

- Set the **containerId** to `order-management` (in this case we use the alias of the container).
- Set the **processId** to `order-management.OrderManagement`.
- Set **Parameter content type** to `application/json`.

5. Set the **Response content type** to `application/json`.
6. Set the **body** to:

```
   {
     "orderInfo" : {
     "com.myspace.order\_management.OrderInfo" : {
         "item" : "Huawei P10", "urgency" : "low", "price" : 0.0, "targetPrice": "700.0"
      }
},
     "supplierInfo" : {
     "com.myspace.order\_management.SupplierInfo" : { "user" : "bamAdmin" }
      }
   }
```

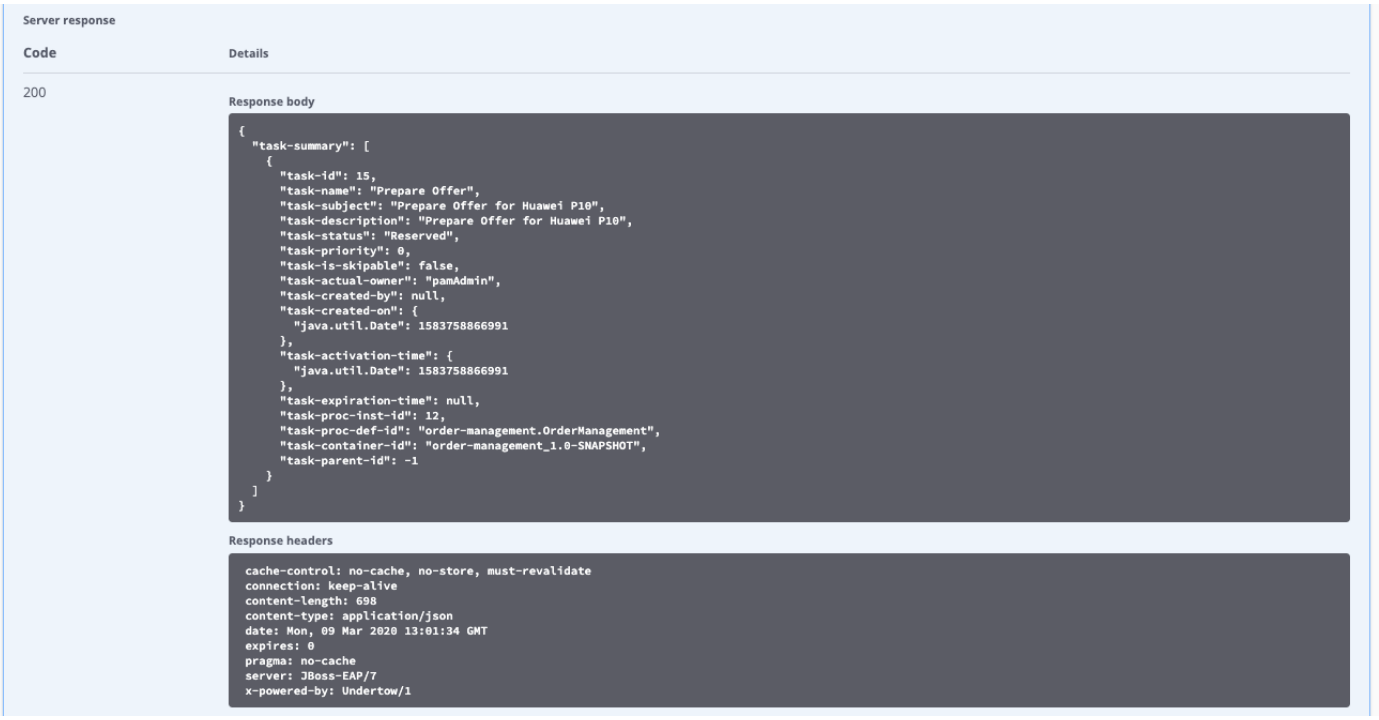


7. Click on the *Execute* button.
8. If requested, provide the username and password of your **Business Central** and **KIE-Server** user (in this example we have been using u: `bamAdmin`, p: `ibmpam1!`).

   📘 INFO: If you're using the Linux environment on Skytap use the *pamadmin:pamadm1n* information
9. Inspect the response. Note that the operation returns the process instance id of the started process.
10. Go back to the Business Central workbench. Go the process instances view and inspect the process instance we have just started.

The RESTful API provides many more operations. Let’s use the API to fetch our **Task List** and complete the `Request Offer` task.

1. In the Swagger API, navigate to the **Process queries** section.
2. Find the **GET** operation for the resource `/server/queries/tasks/instances/pot-owners`. Expand the operation and click on the **Try it out** button.
3. Make sure the ***Response content type** is set to `application/json`. Leave all the other fields set to their default values.
4. Click on the **Execute** button. This will return all the tasks for our user (in the case of this example this is the `bamAdmin` user).



5. We can see the `Prepare Offer` task that is available in our inbox. Let's complete this task.
6. Go to the **Task Instances** section in the Swagger interface and locate the **PUT** operation of the `/server/containers/{containerId}/tasks/{taskInstanceId}/states/completed` resource. This is the operation with which we can complete a task.

- Set the **containerId** to `order-management`.
- Set the **taskInstanceId** to the id of the task instance you want to complete. The task instance id an be found in the list of task instances we got back from our previous REST operation.
- Set **auto-progress** to `true`. This controls the auto progression of the taks through the various states of the task lifecycle (i.e. claimed, started, etc.)
- Set the **Parameter content type** to `application/json`.
- Set the **Response content type** to `application/json`.
- Set the **body** to:

```
  {
"supplierInfo": {
      "com.myspace.order\_management.SupplierInfo" : {
   "user": "bamAdmin",
      "offer": "900",
   "deliveryDate":"2020-03-11T12:00:00.000Z"
    }
   }
  }
```

ℹ️ INFO: If you're using the Linux environment on Skytap use the following.

```
  {
"supplierInfo": {
      "com.myspace.order\_management.SupplierInfo" : {
   "user": "pamadmin",
      "offer": "900",
   "deliveryDate":"2020-03-11T12:00:00.000Z"
    }
```

```
    }
  }
```

- Click on the **Execute** button. If you've entered everything correctly, the task will be completed and the process will move to the next wait state, the `Prepare Offer` task. . Go back to the Business Central workbench. Go to the process instances view. Select the process instance of the task you've just completed. Observe that the `Prepare Offer` task has been completed and that the process is now waiting on the `Approve` **User Task**.

The rest of the tasks can be completed in the same way via the API.

19.11 Using the KIE-Server Client

IBM Business Automation Open Edition 8.0 provides a KIE-Server Client API that allows the user to interact with the KIE-Server from a Java client using a higher level API. It abstracts the data marshalling and unmarshalling and the creation and execution of the RESTful commands from the developer, allowing him/her to focus on developing business logic.

In this section we will create a simple Java client for our Order Management process.

1. Create a new Maven Java JAR project in your favourite IDE (e.g. IntelliJ, Eclipse, Visual Studio Code).
2. Add the following dependency to your project:

```
<dependency>
 <groupid>org.kie.server</groupid>
  <artifactId>kie-server-client</artifactId>
  <version>7.67.2.Final-redhat-00006</version>
  <scope>compile</scope>
</dependency>
```

3. Create a Java package in your `src/main/java` folder with the name `com.myspace.order_management`.
4. Download the `OrderInfo.java` file from this location and add it to the package you've just created.
5. Download the *SupplierInfo.java* file from this location and add it to the package.
6. Create a new Java class called `Main`. Add a `public static void main(String[] args)` method to your main class.
7. Before we implement our method, we first define a number of constants that we will need when implementing our method (note that the values of your constants can be different depending on your environment, model namespace, etc.):

```
private static final String KIE_SERVER_URL = "http://localhost:8080/kie-server/services/rest/server";
private static final String CONTAINER_ID = "order-management";
private static final String USERNAME = "bamAdmin";
private static final String PASSWORD = "ibmpam1!";
private static final String PROCESS_ID = "order-management.OrderManagement";
```

📘 INFO: If you're using the Linux environment on Skytap use the following.

```
private static final String KIE_SERVER_URL = "http://localhost:8080/kie-server/services/rest/server";
private static final String CONTAINER_ID = "order-management";
private static final String USERNAME = "pamadmin";
private static final String PASSWORD = "pamadm1n";
private static final String PROCESS_ID = "order-management.OrderManagement";
```

8. KIE-Server client API classes can mostly be retrieved from the `KieServicesFactory` class. We first need to create a `KieServicesConfiguration` instance that will hold our credentials and defines how we want our client to communicate with the server:

```
KieServicesConfiguration kieServicesConfig = KieServicesFactory.newRestConfiguration(KIE_SERVER_URL, new EnteredCredentialsProvider(USERNAME, PASSWORD));
```

9. To allow the KIE-Server Client's marshaller to marshall and unmarshall instances of our domain model, we need to add our domain model classes to the `KieServicesConfiguration`.

```
Set<Class<?>> extraClasses = new HashSet<>();
extraClasses.add(OrderInfo.class);
extraClasses.add(SupplierInfo.class);
kieServicesConfig.addExtraClasses(extraClasses);
```

10. Next, we create the `KieServicesClient`:

    ~~~java KieServicesClient kieServicesClient = KieServicesFactory.newKieServicesClient(kieServicesConfig); ~~

11. From this client we retrieve our `ProcessServicesClient`:

```
ProcessServicesClient processServicesClient = kieServicesClient.getServicesClient(ProcessServicesClient.class);
```

12. We now create a `Map` which we will use to pass the process input variables. We create a new `OrderInfo` instance and `SupplierInfo` instance and put them in the `Map`.

```
Map<String, Object>inputData = new HashMap<>();
OrderInfo orderInfo = new OrderInfo();
orderInfo.setItem("Huawei P10");
orderInfo.setUrgency("low");
inputData.put("orderInfo", orderInfo);

SupplierInfo supplierInfo = new SupplierInfo();
supplierInfo.setUser("bamAdmin"); inputData.put("supplierInfo", supplierInfo);
```

📘 INFO: If you're using the Linux environment on Skytap use *pamadmin*:*pamadm1n* as the username password

```
Map<String, Object>inputData = new HashMap<>();
OrderInfo orderInfo = new OrderInfo();
orderInfo.setItem("Huawei P10");
orderInfo.setUrgency("low");
inputData.put("orderInfo", orderInfo);
```
    ~~~

```
SupplierInfo supplierInfo = new SupplierInfo();
supplierInfo.setUser("pamadmin"); inputData.put("supplierInfo", supplierInfo);
```

13. We can now start a new process instance via the `ProcessServicesClient`.

```
Long processInstanceId = processServicesClient.startProcess(CONTAINER_ID, PROCESS_ID, inputData);
```

14. Finally, we can print the process instance id to `System.out`.

```
System.out.println("New *Order Management* process instance started with instance-id: " + processInstanceId);
```

15. Compile your project and run it. Observe the output in the console, which should say: **New *Order Management* process instance started with instance-id**

The complete project can be found here: https://github.com/timwuthenow/rhpam7-order-management-demo-repo

The KIE-Server Client provides more services to interact with the Execution Server:

- `UserTaskServicesClient`: provides functionality to interact with the **UserTask** services, for example to claim, start and complete a **User Task**.
- `CaseServicesClient`: provides functionality to interact with the **Case Management** features of the Execution Server.
- `ProcessAdminServicesClient`: provides the administration API for processes.
- etc.

We leave as an exercise to the reader to try to complete a **User Task**, of the process instance we've just created, using the `UserTaskServicesClient`.

Last update: 2023-12-06

3.7 Working with event driven processes in IBAMOE

3.7.1 20. Introduction

In this guided lab let’s see in practice how we can use process automation applications that fits within event-driven architectures. We can list at least three ways to adjust our business application fit within EDA:

- We can build processes that can react to events that happen in the ecosystem;
- From within the process, we can emit events to notify the ecosystem about key activities in the business process and interact with external services via events;
- We can track every transaction committed either for business processes, cases (case management), or human tasks by publishing events for.

20.1 The alignment of tech evolution and business standards like BMPN

When providing an implementation for a specification, each provider has the opportunity to deliver the solution of choice. It is not different for the BPMN specification. It allows different implementations for its diagram elements, and this is how IBAMOE delivers the most recent tech concepts by still allowing business users to use the modeling notation they are used to.

In IBAMOE (a.k.a. jBPM), it is possible to make use of message events (starting, intermediate or ending) to interact via events. In this case, the KIE Server Kafka extension makes sure the communication occurs effectively with the event streaming brokers.

In the upcoming labs we will learn how to model the processes and when and how to add configurations to the business project and KIE Server.

Last update: 2023-12-06

3.7.2 21. IBAMOE 9.0 Kafka extension

In order to be able to start processes based on new events, we will need to configure the IBAMOEKafka extension.

The IBAMOE Kafka extension allows the KIE Server (process and decision engine) to react to events and publish events to kafka topics.

📘 INFO: There are several options in IBAMOE to customize the Kafka address, topic names, etc. In our case, we're using the default Kafka address, which is, localhost:9092. More customization information can be found in the official Red Hat product documentation: Configuring a KIE Server to send and receive Kafka messages from the process.

In this setup steps, we will configure IBAMOE only in the *server level - we are not yet configuring the business project*. We will see how to configure the project as we move forward on the labs.

21.1 Enabling the Kafka extension

We can configure the engine to support different capabilities. In order to enable processes to be started through eventing, we only need to enable the extension via system property.

1. With IBAMOE up and running, execute the following, where `$JBOSS_HOME` is the installation directory of the JBoss EAP instance you're running KIE Server from:

```
$JBOSS_HOME/bin/jboss-cli.sh -c
[standalone@localhost:9990 /] /system-property=org.kie.kafka.server.ext.disabled:add(value=false)
[standalone@localhost:9990 /] :shutdown(restart=true)
```

The first command will enable the Kafka extension. Next, we're restarting EAP so that the new configuration is active. You can check EAP logs to confirm it is restarting.

The following output will show up in IBAMOE logs:

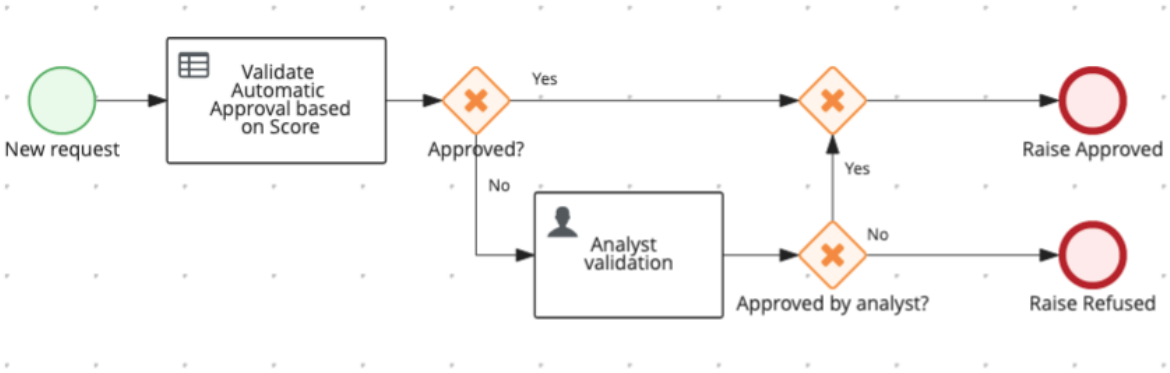
```
INFO  [org.kie.server.services.impl.KieServerImpl] (ServerService Thread Pool -- 74) Kafka KIE Server extension has been successfully registered as server
extension
```

This is the only configuration you will need in a server level to be able to start processes using events.

Last update: 2023-12-06

3.7.3 22. The Credit Card Raise Approval Project

In this use case we would like to handle the automation of a credit limit increase approval process. Most card issuers allow customers to request an increased credit limit through various entry points such as: websites, their mobile applications or over the phone with customer service. Let’s consider we need to deliver this automation for a bank that wants to achieve a similar use case within an event-driven architecture.



The existing process is started via REST. It has a step for automatic request validation using DMN, and if the request not approved, it goes to a manual review queue. If approved, the service responsible for updating the cc limit is invoked via REST (the diagram only represents this REST call with a script task since this is not relevant for this lab's scenario). Finally, the process ends either with an approved or denied request.

Now, with the architecture shift, the service responsible for increasing the credit card limit should not be invoked via REST anymore. The external service now listens to the topic “request-approved” in order to track when to execute the limit raise. The business process should get started based on events, and whenever the process finishes, it should post a message to a specific topic depending on whether the request was approved or not.

Process v2.

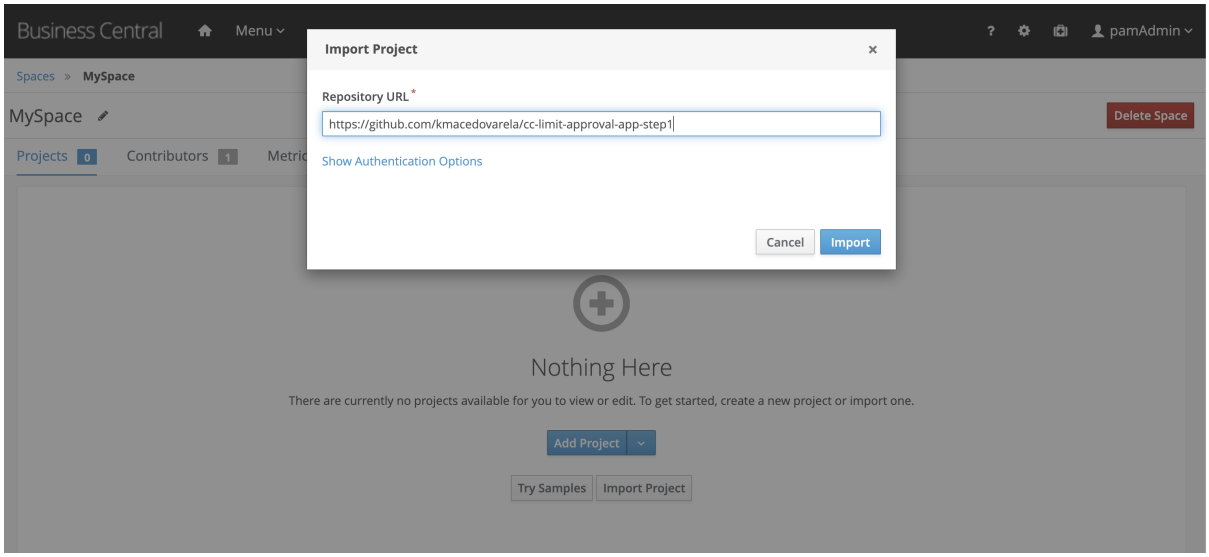
Whenever a new event happens in a topic, a new instance will be triggered. Depending on how this process ends, an event is published in a different topic, therefore, different services can react based on the approval status.

In this strategy we have a resilient way of communication between services where the broker is responsible for storing and providing the events. Adding to that, the tech team can evolve the solutions by using the features available in Kafka itself, like the possibility to replay all the events that happened in a specific time, in chronological order.

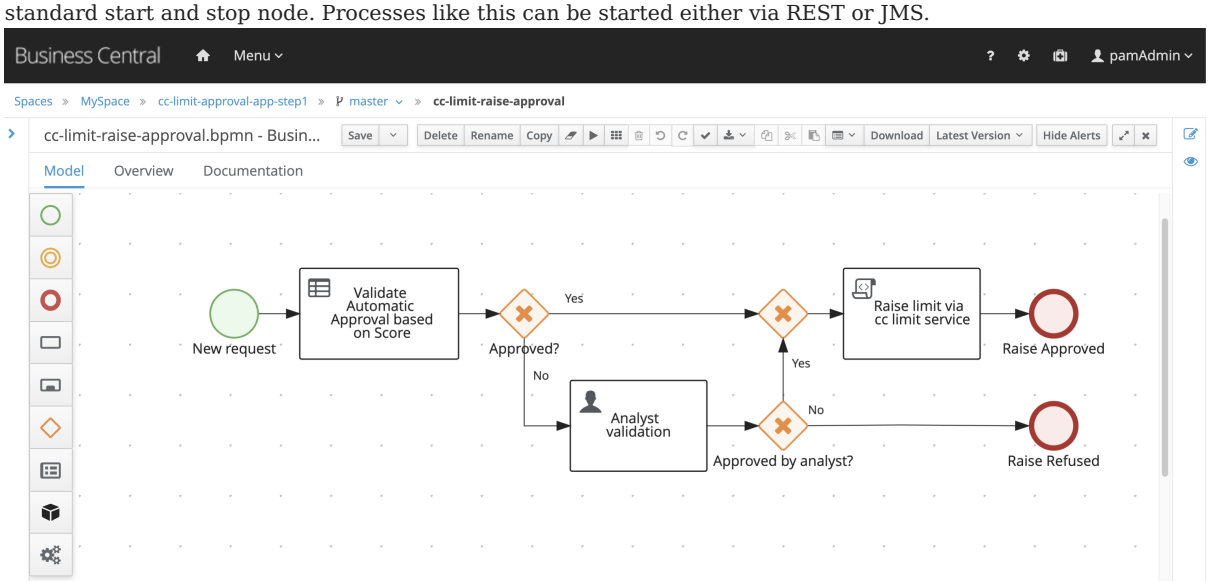
22.1 Importing the project

Let's import the existing project so we can start implementing the eventing capabilities.

1. Access Business Central, and import the following project: https://github.com/kmacedovarela/cc-limit-approval-app-step1



2. Let's check the existing project. Open the `cc-limit-raise-approval` process. Notice that currently it is a traditional process, with a standard start and stop node. Processes like this can be started either via REST or JMS.

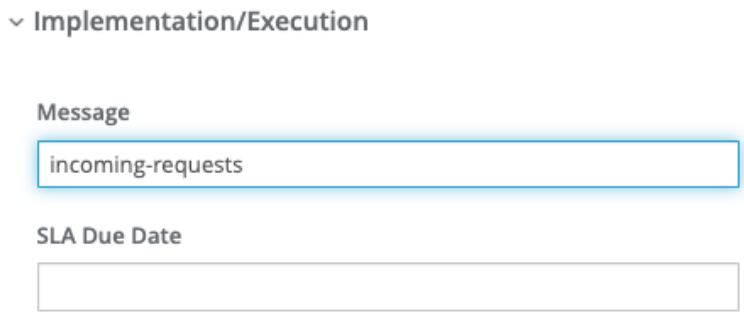


22.2 Reacting to events

The first task we'll do, is to enable the existing process to react to events that are published in a specific topic. Whenever a new event is published, a new process instance should be created.

1. To allow this process definition to be started with events, the first step is to change the start event to a *Start Message Event* by clicking the node in the editor and selecting the *envelope* icon to "Convert into Start Message":

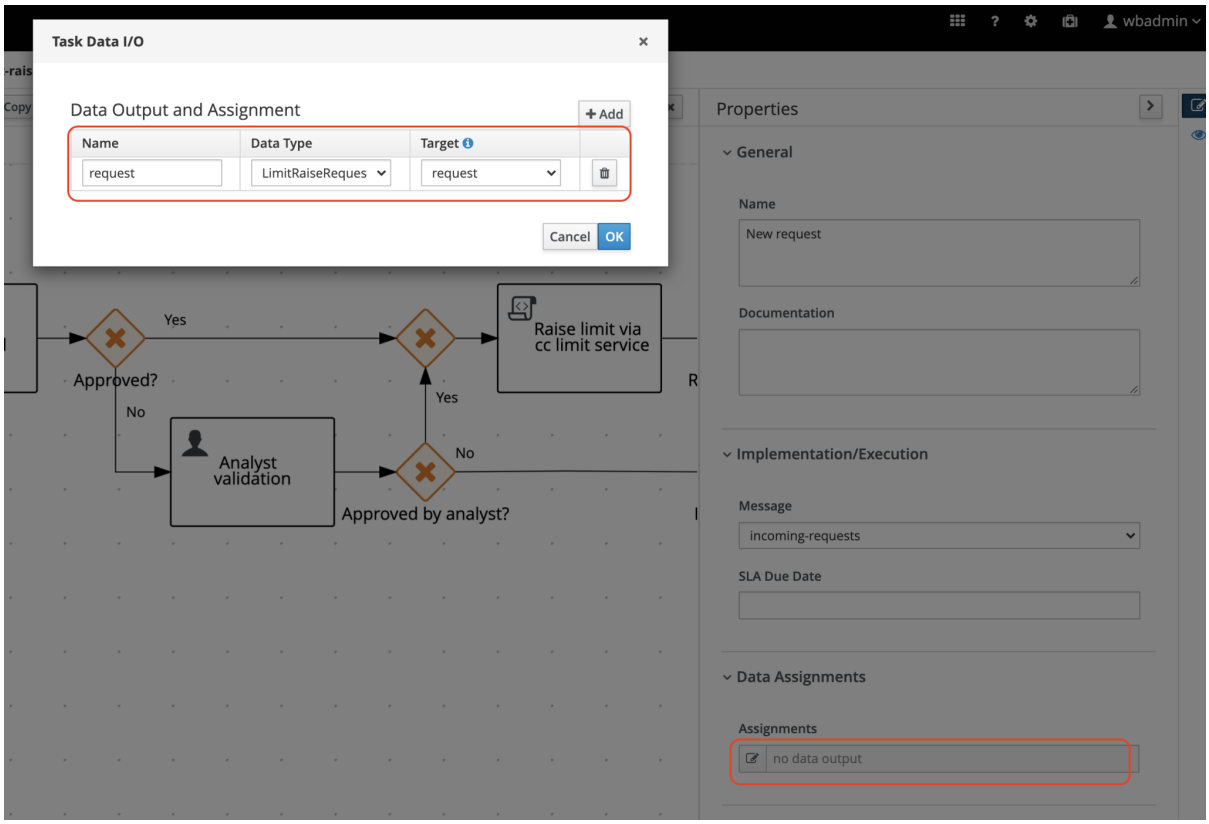
2. Whenever a customer make a new request (independently of the channel used) an event should be published on the `incoming-requests` Kafka `topic`. This way as new channels are ready to be added, they just need to point to this request instead of modifying for the process end point. With that, a new process instance should be started whenever a new event is published in this topic. Let's configure the *Start Message Event* with the `incoming-requests` topic:



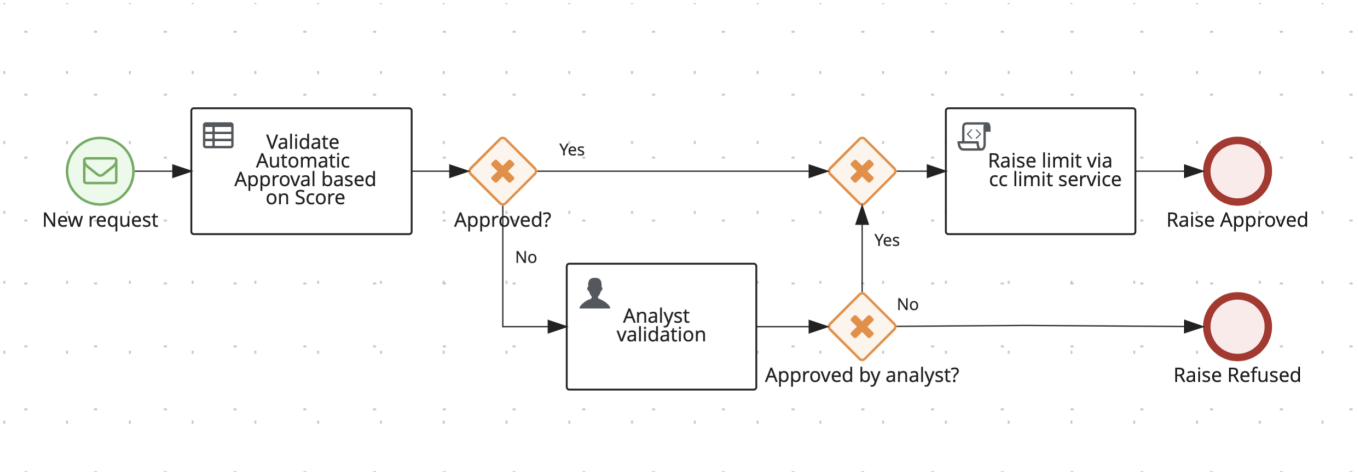
🚧 **WARN:** we need to receive the data that is the event data. The KIE Server provides automatic marshalling to help us mapping the input directly to a *Data Object* (a POJO). This project has an object named `LimitRaiseRequest.java` which we will use to receive the incoming data and feed it in the process.

3. On the properties panel of the *Start Message Event*, configure the input data:

- Name: request
- Data Type: `LimitRaiseRequest`
- Target: request



4. Save the process. Your process should now look like this:



22.3 Deploying the project

Now, let's deploy and test the project.

1. On the breadcrumb, click on "cc-limit-approval-app-step1" to go back to the Project Explorer view.
2. Click on the "Deploy" button.

22.4 Testing the project

Let's publish a new event in the `incoming-requests` topic using the Kafka producer CLI tool.

1. Open a new tab in your terminal and access the `strimzi-all-in-one` project folder.

```
cd ~/enablement/amq-examples/strimzi-all-in-one
```

2. Next, use the Kafka producer to publish new messages on the topic `incoming-requests`.

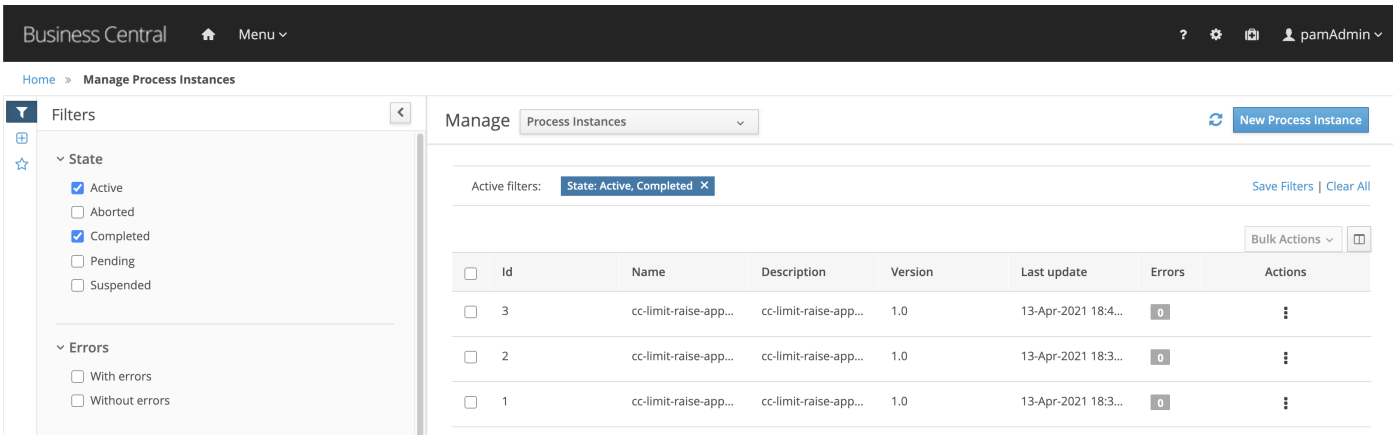
```
docker-compose exec kafka bin/kafka-console-producer.sh --topic incoming-requests --bootstrap-server localhost:9092
```

3. You can send the following data, and press enter:

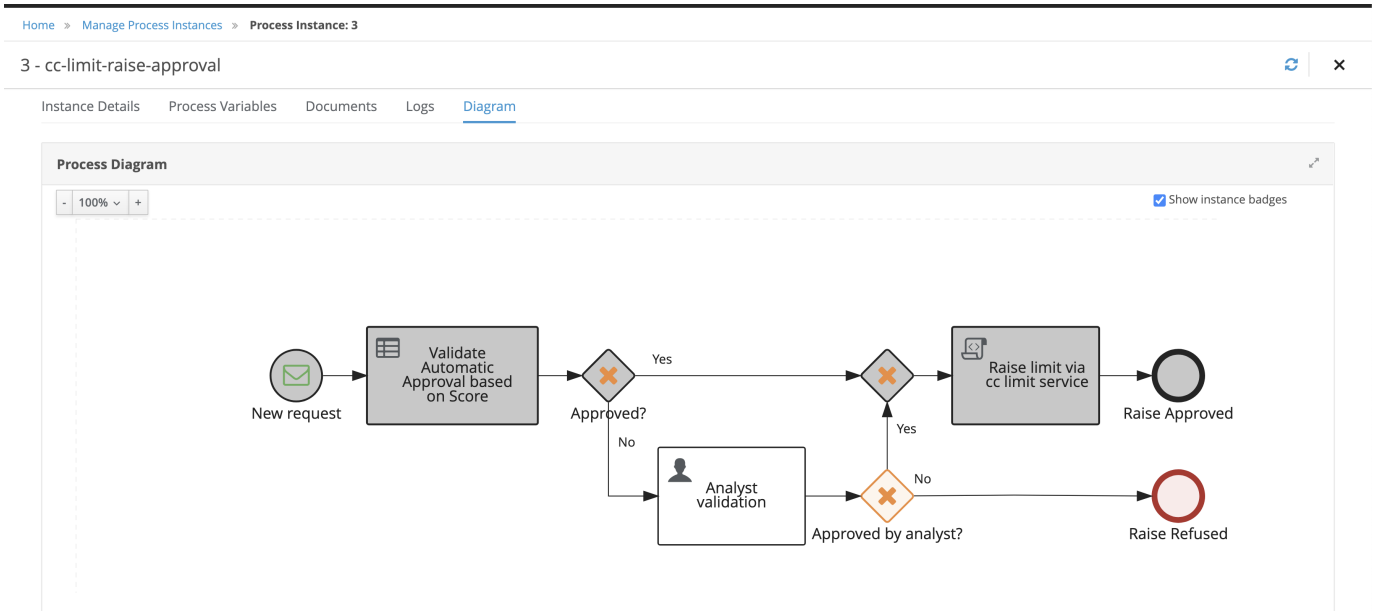
```
{"customerId": 1, "customerScore": 250, "requestedValue":1500}
```

```
± |master ✓| → docker-compose exec kafka bin/kafka-console-producer.sh --topic incoming-request
s --bootstrap-server localhost:9092
>{"data" : {"customerId": 1, "customerScore": 250, "requestedValue":1500}}
>
```

4. Back to the browser, open Business Central. On the top menu, go to **Menu -> Manage -> Process Instances**.
5. On the left column, filter by "Completed" State. You should see as many instances as the number of events you published on Kafka:



6. Select a process instance, and next, select the tab `Diagram`. You should see something like:



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3.7.4 23. Emmitting Events from Business Processes

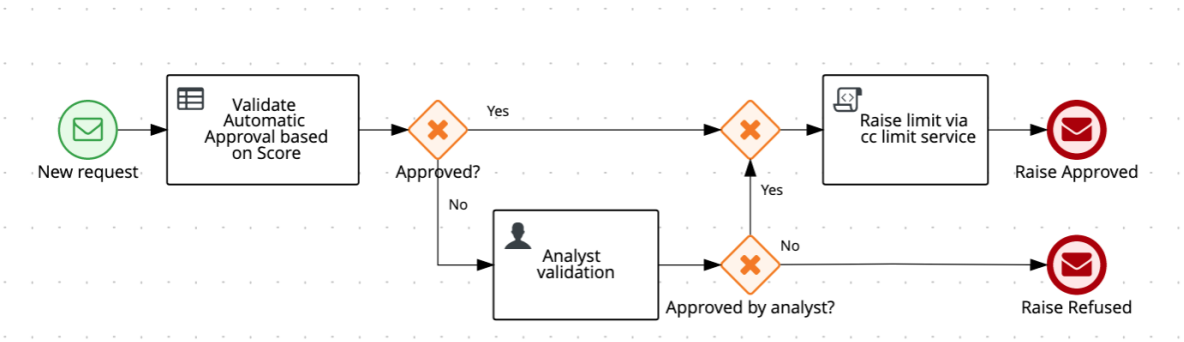
In order to be able to finish processes based on new events, we will need to set up our environment.

In this setup we will:

- Check the required configuration in the business project
- Add bpmn components to emit messages

23.1 Emitting events in a business process

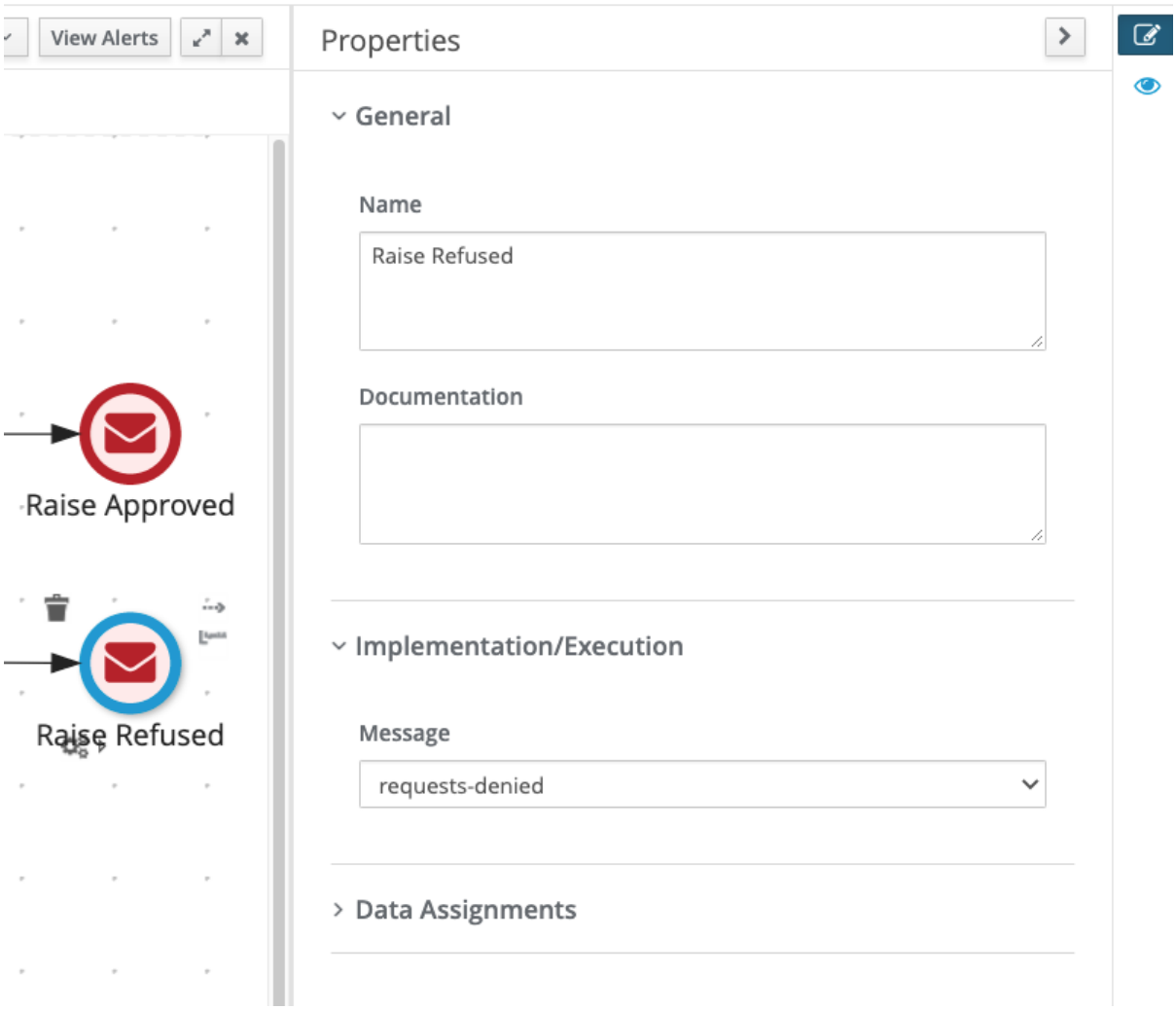
1. Now, we need to *End Message Events* instead of two *End Events*. In Business Central, open the `cc-limit-approval-app` process.
2. Convert the two *End Events* to *End Message Events*. It should look like this:



1. Next, configure the Kafka topic name in the message name for both nodes as following:

- `Raise Approved` message name: `requests-approved`
- `Raise Denied` message name: `requests-denied`

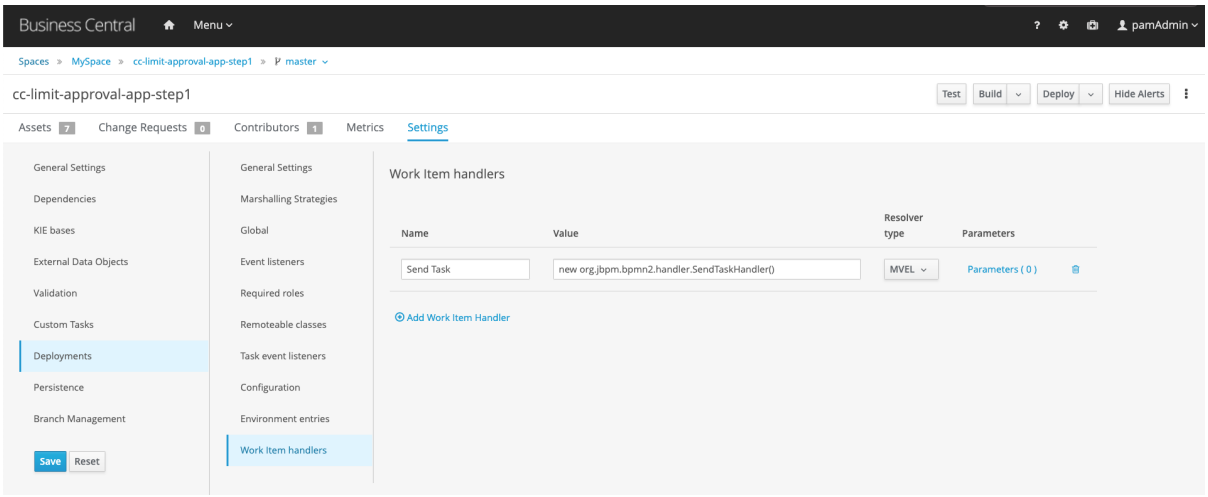
  See below one of the nodes, the *Raise Denied* node configuration:



2. Save the process definition.
3. On the breadcrumb, click on "cc-limit-approval-app-step1" to go back to the Project Explorer view.
4. Click on the "Deploy" button.

23.2 Configuring the business application

1. In Business Central, navigate to the **Project Settings -> Deployments -> Work Item handlers**:



   Observe that there is a task configured named `Send Task`. In IBAMOE {{ version }} you need this configuration to be able to use any `Message Events` (ending and throwing) that would emit events.

23.3 Consuming the events from Kafka topic using Kafka Consumer CLI

In order to validate if our process is emitting processes as we expect, we need to listen to the Kafka topics `requests-approved` and `requests-denied` to validate if the messages were emitted correctly.

1. Open a new terminal tab, and navigate to the Kafka project folder.

```
cd ~/enablement/amq-examples/strimzi-all-in-one/
```

2. Start the Kafka command line tool that allows us to consume events that happen in a topic, and therefore, will allow us to know if IBAMOE published the events when the process ended. The tool is `kafka-console-consumer.sh`. Let's check if the process emitted events on the topic `requests-approved`.

```
docker-compose exec kafka bin/kafka-console-consumer.sh --topic requests-approved --from-beginning --bootstrap-server localhost:9092
```

23.4 Testing the solution

To test the solution, we will start a new process instance that will start, be automatically approved, and end without any human interaction. A new process instance should get started whenever you publish a new event on the `incoming-requests` topic, and,

when there is an automatic approval, the process will end and publish an event to the `requests-approved` topic. Let's see this in action:

1. Like we did on the first lab, let's start a new process instance by publishing a message in the `incoming-requests` topic. If you canceled the execution of the kafka producer, here's how you can start it:

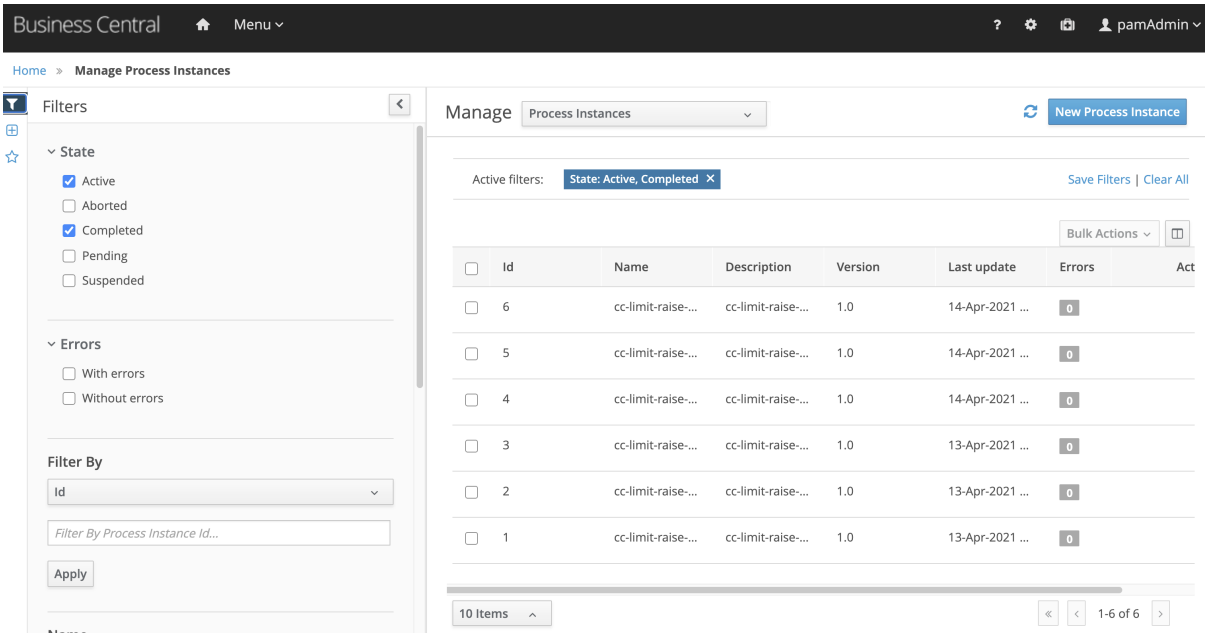
```
docker-compose exec kafka bin/kafka-console-producer.sh --topic incoming-requests --bootstrap-server localhost:9092
```

   You can use the following data in your event: `{"data" : {"customerId": 1, "customerScore": 250, "requestedValue":1500}}`

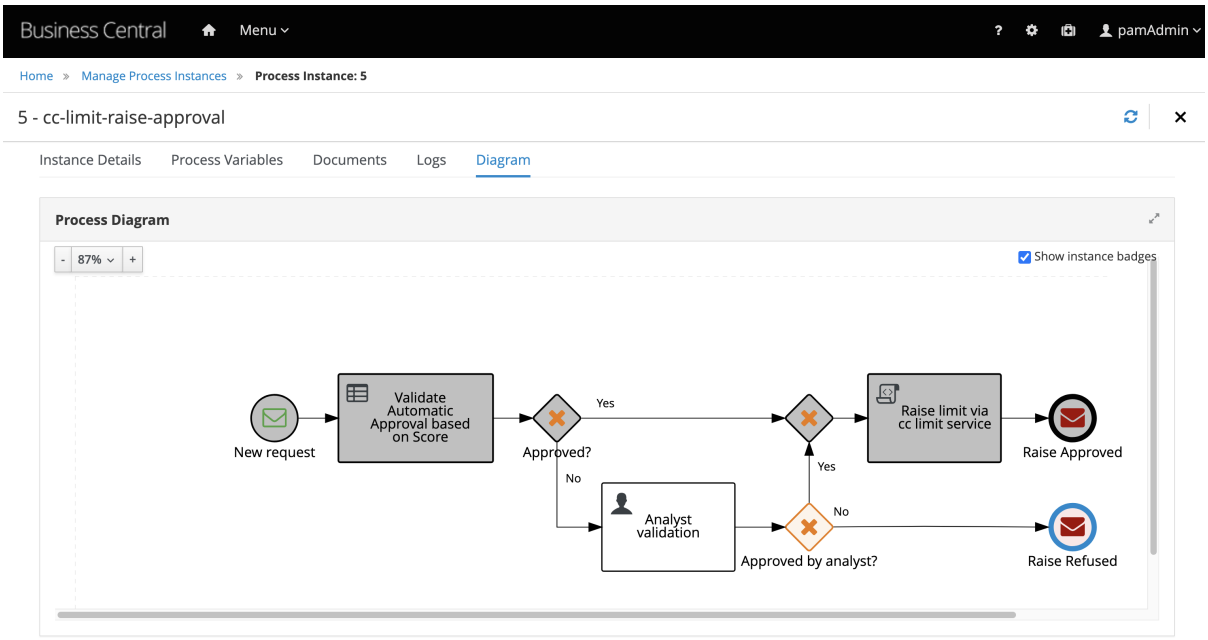
2. When you hit return, the data is published to the `incoming-requests` topic
3. Kafka reads the event from the `incoming-requests` and automatically instantiates a new process is with this data.
4. Now check the terminal where you are consuming the messages in the `requests-approved` topic. You should see a new event published by your process. The event will look like this (though not on multiple lines):

```
{
"specversion":"1.0",
"time":"2021-04-14T18:04:42.532-0300",
"id":"25ba2dd0-a8d0-4cfc-9ba4-d2e556ffb4d0",
"type":"empty",
"source":"/process/cc-limit-approval-app.cc-limit-raise-approval/5",
"data":null
}
```

5. Identify the process ID on the event above. In this example, the process instance that emitted this event was process of ID **5**.
6. Let's check this same process instance in Business Central. In Business Central, open the **Menu -> Manage -> Process Instances**.
7. On the left column, filter by "Completed" State. You should see as many instances as the number of events you published on Kafka.



8. Identify your process instance ID. In this example, instance with id **5**. Select the process instance.
9. Next, select the tab `Diagram`. You should see something like:



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3.7.5 24. Auditing with Kafka

When using the Kafka extension in IBM Business Automation Open Edition 8.0, every transaction for processes, cases and tasks execution can be tracked via events. For each of these categories, we'll have an event emitted to a Kafka topic, in other words, we'll have three topics here: `jbpm-processes-events`, `jbpm-tasks-events`, `jbpm-cases-events`.

To enable this feature, you need to add the `jbpm-event-emitters-kafka` library to the engine, KIE Server. This can either be downloaded in the community repository for jBPM or via the Red Hat customer portal: rhpam-7.10.0-maven-repository.zip.

The maven repository have ~1.5GB. In order to facilitate the execution of this lab, you can download the `jbpm-event-emmiters-kafka` for IBAMOE {{ version }} here; **FIGURE OUT THE REPLACEMENT**

1. Stop IBAMOE.
2. Download the `jbpm-event-emitters-kafka`. It's name will be similar to `jbpm-event-emitters-kafka-7.x.x.Final-redhat-x.jar`.
3. Since this is a behavior only needed by the engine, place the library inside the `kie-server.war` folder, inside the `WEB-INF` directory.

TIP: If you downloaded the maven repository zip file in the Red Hat Customer Portal, you can find the jar inside the folder `maven-repository/org/jbpm/jbpm-event-emitters-kafka/7.67.2.Final-redhat-00006/jbpm-event-emitters-kafka-7.67.2.Final-redhat-00006.jar`

```
cp jbpm-event-emitters-kafka-7.67.2.Final-redhat-00006.jar $JBOSS_EAP/standalone/deployments/kie-server.war/WEB-INF/lib/
```

4. Next,startIBAMOE server.

Let's check the auditing behavior.

24.1 Testing the feature

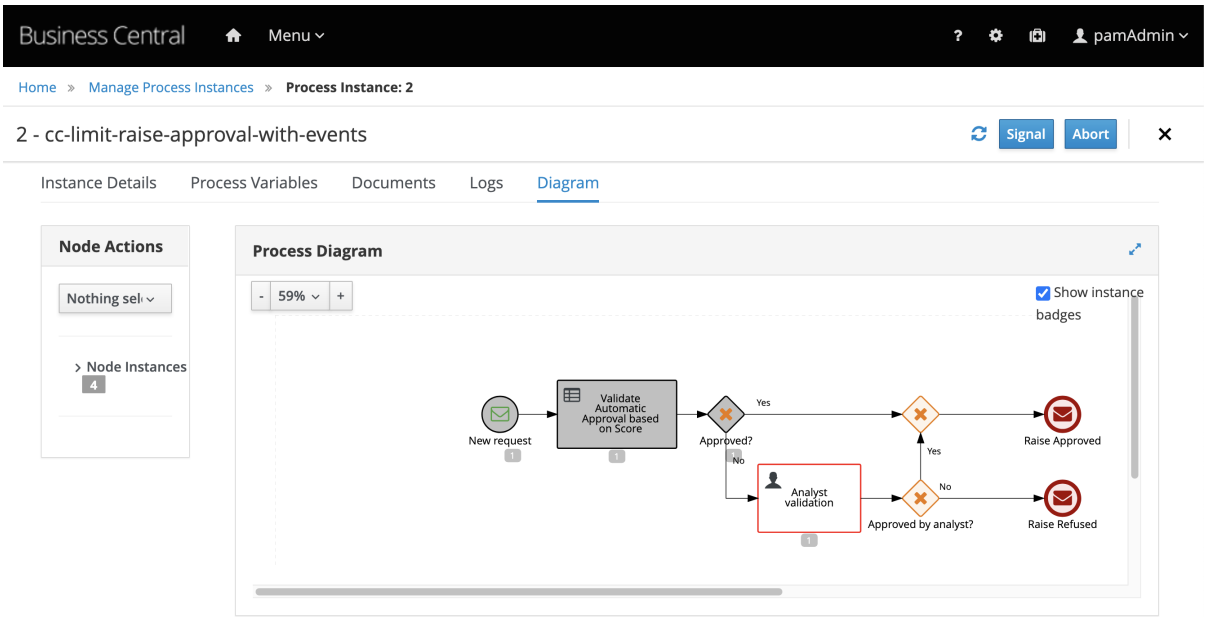
To check the auditing capabilities you can start new processes, interact with human tasks and track the events that are being published on the `jbpm-tasks-events` and `jbpm-processes-events` topics. The event tracking are active also for processes that doesn't use *message events* elements.

In this example we will check the behavior for our event driven business application.

1. Start a new process by emitting an event. Let's start a process that will not be automatically approved. In this way, we will also have a human task created. You can emit the following event to the `incoming-requests` topic:

```
{"customerId": 1, "customerScore":100, "requestedValue": 1200}
```

2. You should be able to see a new process instance can be seen in Business Central in the following status:



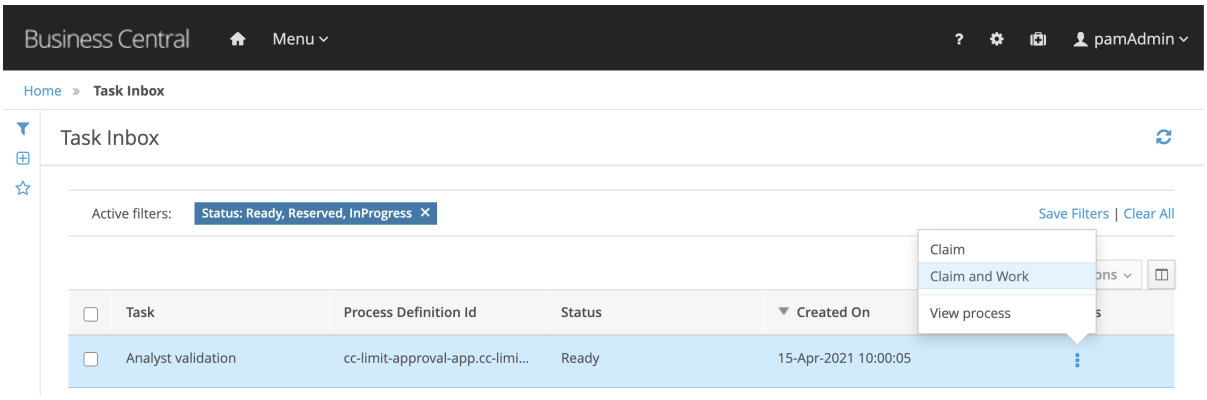
1. You can use the kafka consumer CLI script to check the messages that were emitted on the topics: `jbpm-processes-events` and `jbpm-tasks-events`.
2. You should be able to see an event like this published on the `jbpm-process-events`:


```
{"specversion":"1.0","time":"2022-09-15T10:00:05.609-0300","id":"28e13bc0-1c92-42fd-8909-b48a206325d3","type":"process","source":"/process/cc-limit-approval-app.cc-limit-raise-approval-with-end-events/2","data":{"compositeId":"default-kieserver_2","id":2,"processId":"cc-limit-approval-app.cc-limit-raise-approval-with-end-events","processName":"cc-limit-raise-approval-with-events","processVersion":"1.0","state":1,"containerId":"cc-limit-approval-app_1.0.0-SNAPSHOT","initiator":"unknown","date":"2021-04-15T10:00:05.608-0300","processInstanceDescription":"cc-limit-raise-approval-with-events","correlationKey":"2","parentId":-1,"variables":{"request":{"customerId":1,"requestedValue":1200,"customerScore":100,"denyReason":null},"approval":false,"initiator":"unknown"}}}
```


3. You should be able to see an event like this published on the `jbpm-tasks-events`:


```
{"specversion":"1.0","time":"2022-09-15T10:00:05.612-0300","id":"2ac83d91-40d7-49f3-a114-2b72816a20a4","type":"task","source":"/process/cc-limit-approval-app.cc-limit-raise-approval-with-end-events/2","data":{"compositeId":"default-kieserver_2","id":2,"priority":0,"name":"Analyst validation","subject":"","description":"","taskType":null,"formName":"Task","status":"Ready","actualOwner":null,"createdBy":null,"createdOn":"2021-04-15T10:00:05.52,"processInstanceId":2,"parentId":-1,"processId":"cc-limit-approval-app.cc-limit-raise-approval-with-end-events","containerId":"cc-limit-approval-app_1.0.0-SNAPSHOT","potentialOwners":["kie-server"],"excludedOwners":[],"businessAdmins":["Administrator","Administrators"],"inputData":{"Skippable":"false","request":{"customerId":1,"requestedValue":1200,"customerScore":100,"denyReason":null},"TaskName":"Task","NodeName":"Analyst validation","GroupId":"kie-server"},"outputData":null}}
```


4. Using Business Central, tnteract with the human task `Analyst Validation`, and check the events emitted on the `jbpm-tasks-events`.



You should be able to see at every task change, a new event in the `jbpm-tasks-events`. Also, for every transaction commited for the process, you should see new events on the `jbpm-process-events`.

By now, you have an event-driven process, that can be integrated within an event driven architecture, and furthermore, can be tracked and monitored in an asyncronous way by the usage of events.

The complete project can be found at: https://github.com/timwuthenow/cc-limit-approval-app

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3.8 25. Getting started bc

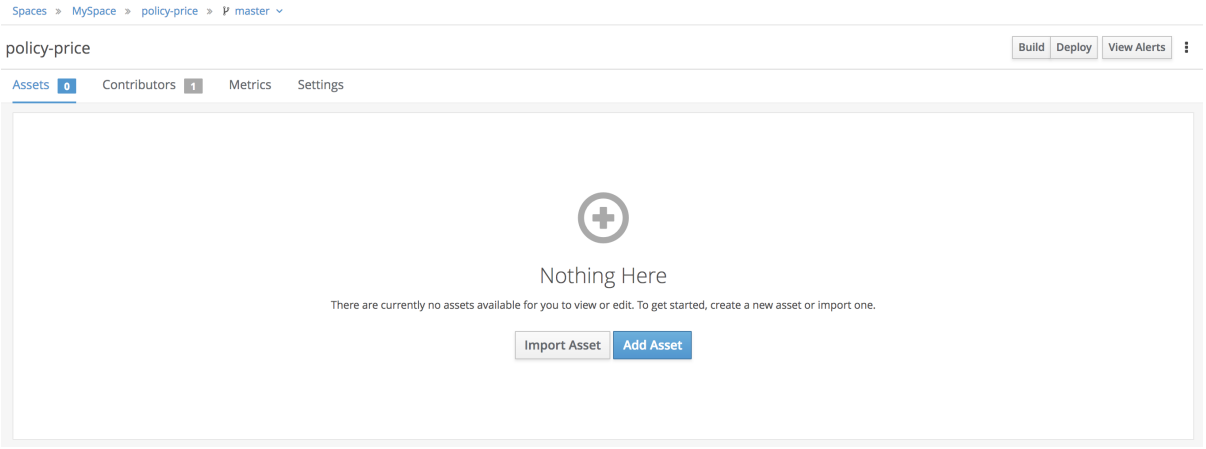
3.8.1 25.1 Importing a DMN in Business Central

If you want to try this in Business Central, you can go through the following steps, but it is not required.

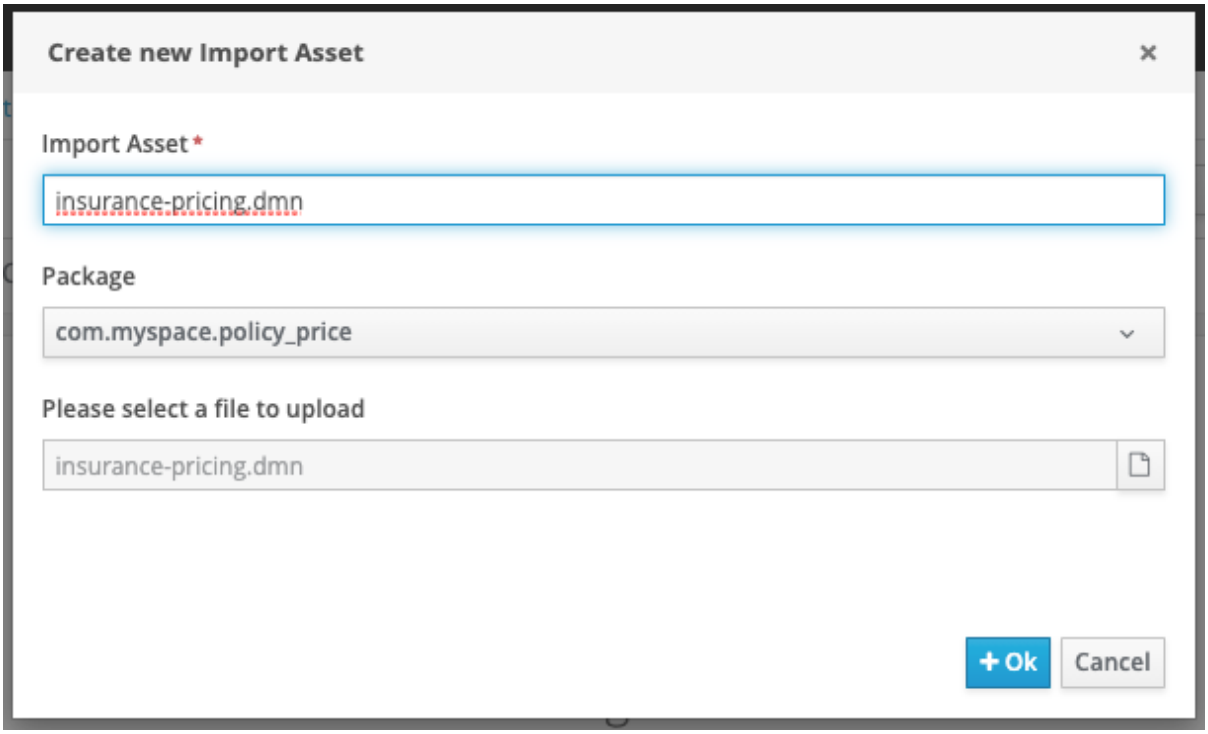
1. From the GitHub web page, click **Clone or download** on the right and then select **Download ZIP**:
2. Using your favorite file system navigation tool, locate the downloaded ZIP file and unzip it to a directory in your file system.

- From this point forward, this location is referred to as `$PROJECT_HOME`.

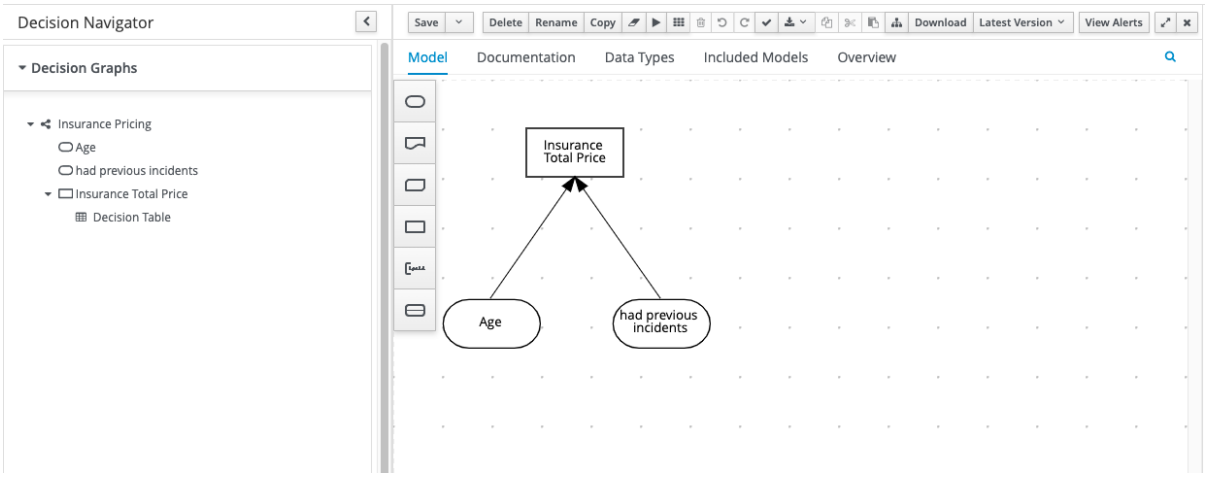
3. Log in to Business Central. You can use either `{{ bamAdmin }}:{{ bamPass }}` to do so or whatever login you have created on your instance.
4. Create a project in Business Central called `policy-price`.
5. In the empty project library view for the `policy-price` project, click **Import Asset**.



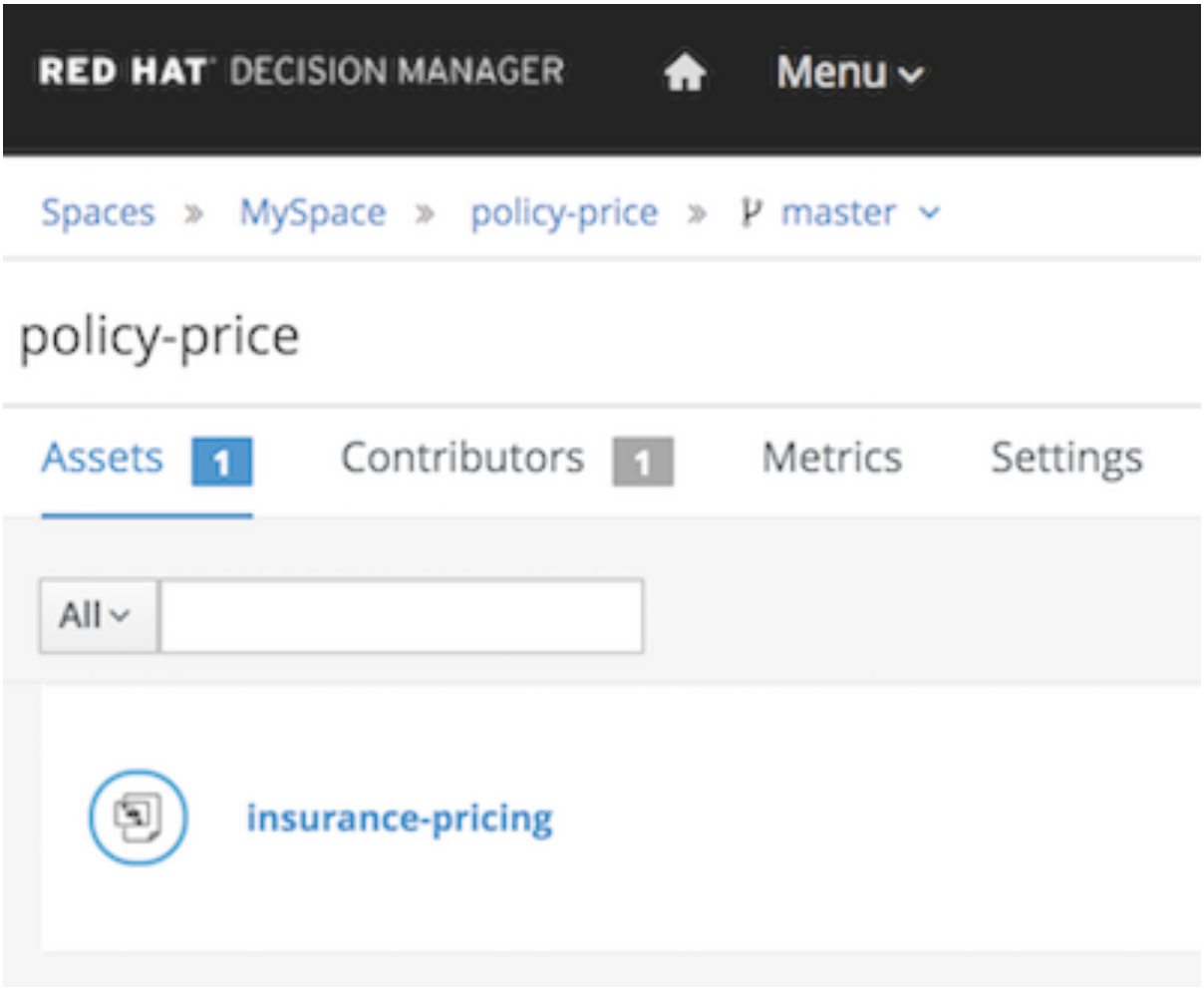
6. In the **Create new Uploaded file** dialog, enter `insurance-pricing.dmn` in the **Uploaded file** field:



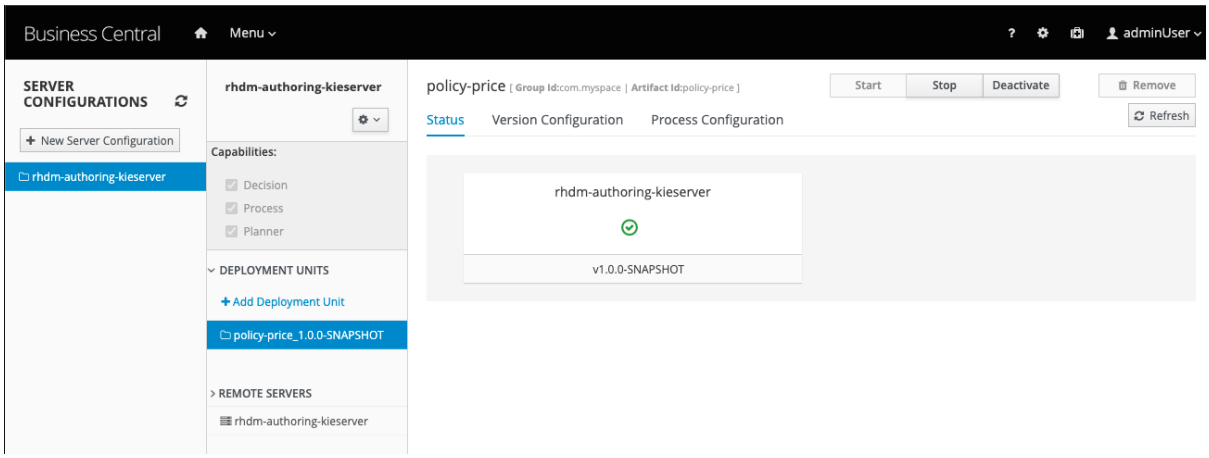
7. Using the browse button at the far right of the field labeled **Please select a file to upload**, navigate with the file browser to the `$PROJECT_HOME` directory where the unzipped Git repository is located.
8. Select the `$PROJECT_HOME\policy-price\insurance-pricing.dmn` file.
9. Click **Ok** to import the DMN asset.
10. The diagram will open and you will be able to see the DRD. Explore the diagram nodes to check the decision policies of this diagram.



11. Close the diagram. You should now be on the library view for the `policy-price` project.
12. You should see the `insurance-pricing` asset is added to your project assets:



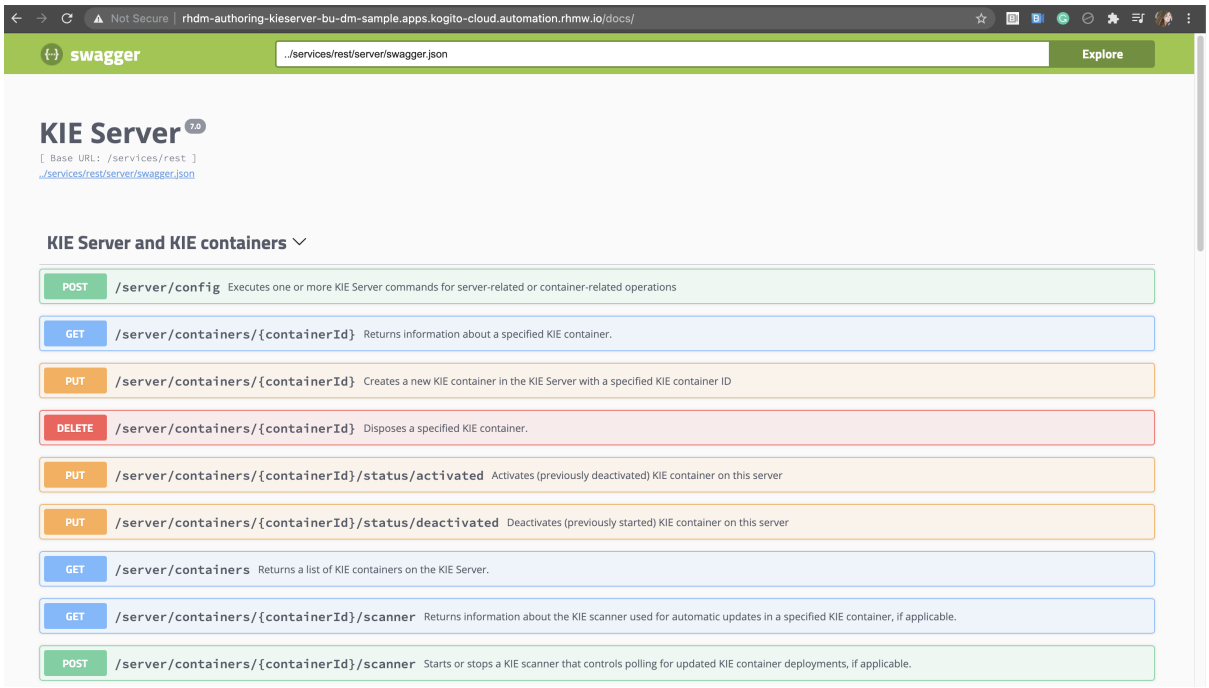
13. From the `policy-price` project's library view, click **Build**, then **Deploy** to deploy the project to the execution server.
14. After receiving the build confirmation, navigate to the container deployment list by clicking the "**View deployment details**" link in the confirmation pop-up, or by selecting **Menu → Deploy → Execution Servers**.
15. Verify that `policy-price_2.0.0` shows a *green* status:



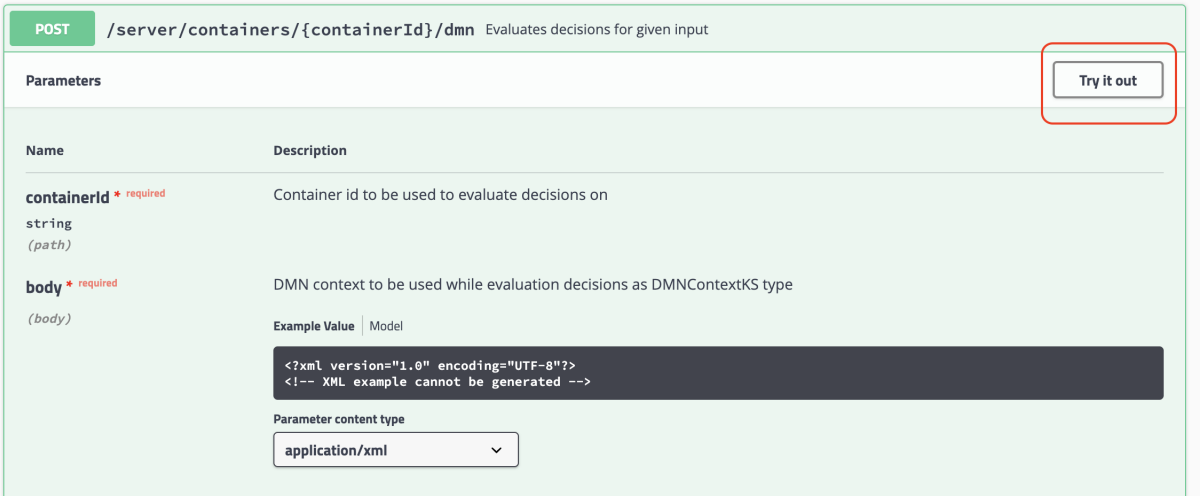
3.8.2 25.2 Testing the Decision Service on KIE Server

In this section, you test the DMN solution using the REST endpoints available in the Decision Server (a.k.a. KIE Server).

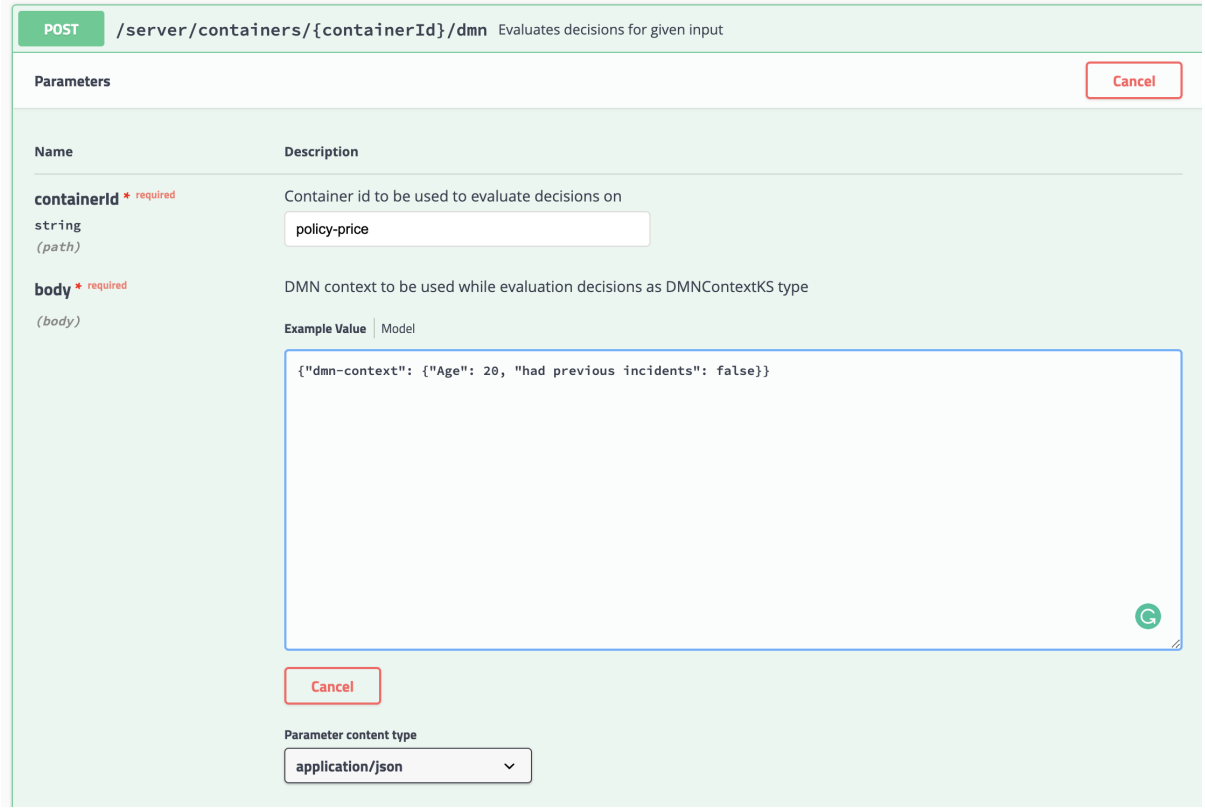
1. Open your Decision Server (a.k.a KIE Server) on the url "/docs". You should see something like this:



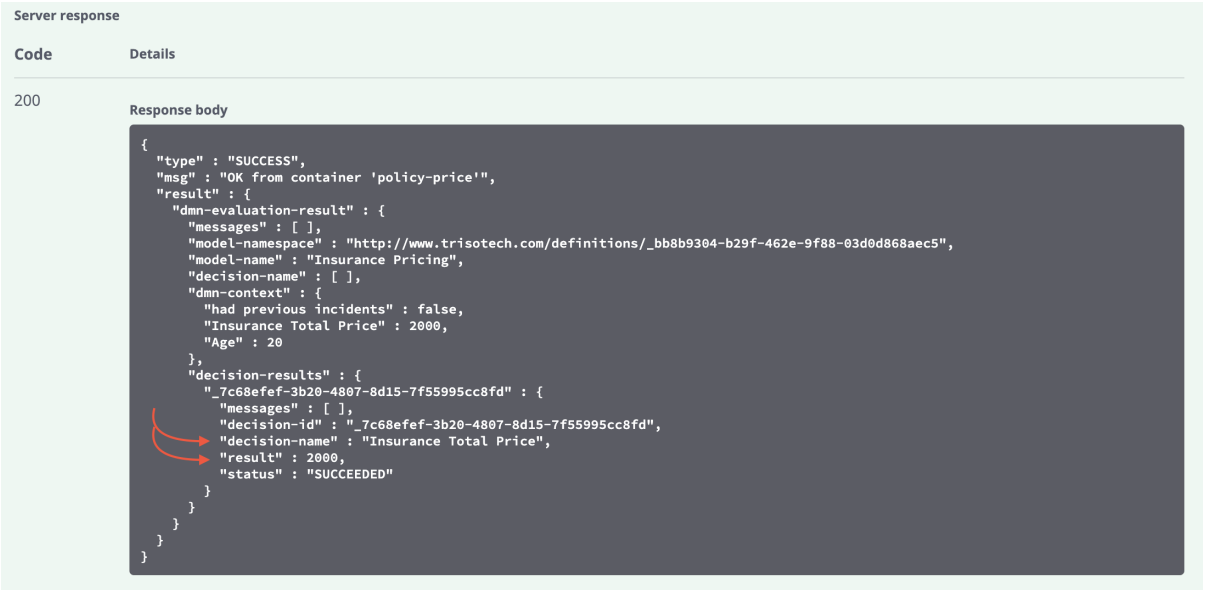
2. Next, under `DMN Models`, click on the `POST /server/containers/{containerId}/dmn"` and select "Try it out":



1. Now use the following data:
2. Container ID: `policy-price`
3. Body (dmn context): `{"dmn-context": {"Age": 20, "had previous incidents": false}}`
4. Parameter content type: `application/json`



1. Click on the **execute** button. You should see the server response `200` and the results of the decision.



2. Try out the Decision with different values for the age and accident history, and compare the results with the decision table:

Insurance Total Price *(Decision Table)*

U	Age *(number)*	had previous incidents *(boolean)*	Insurance Total Price *(number)*	*Enter Text*
1	>25	false	1000	
2	>25	true	1250	
3	[18..25]	false	2000	
4	[18..25]	true	3000	

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3.9 Deploying PAM on OpenShift with Operators

3.9.1 26. Red Hat PAM Operator on OpenShift 4

In this lab we will use the enhanced Business Automation Operator **7.10+** to deploy a number of IBM Business Automation Open Edition 9.0 environments on OpenShift **4.**

26.1 Goal

- Install the Business Automation Operator on OCP 4.
- Use the Business Automation Operator 8.0.4 to deploy a number of IBM Business Automation Open Edition 9.0 environments.
- Change the KIE-App deployment CRDs to show reconciliation.
- Change Operator ConfigMaps to make advanced configuration changes to the KIE-App.

26.2 Problem Statement

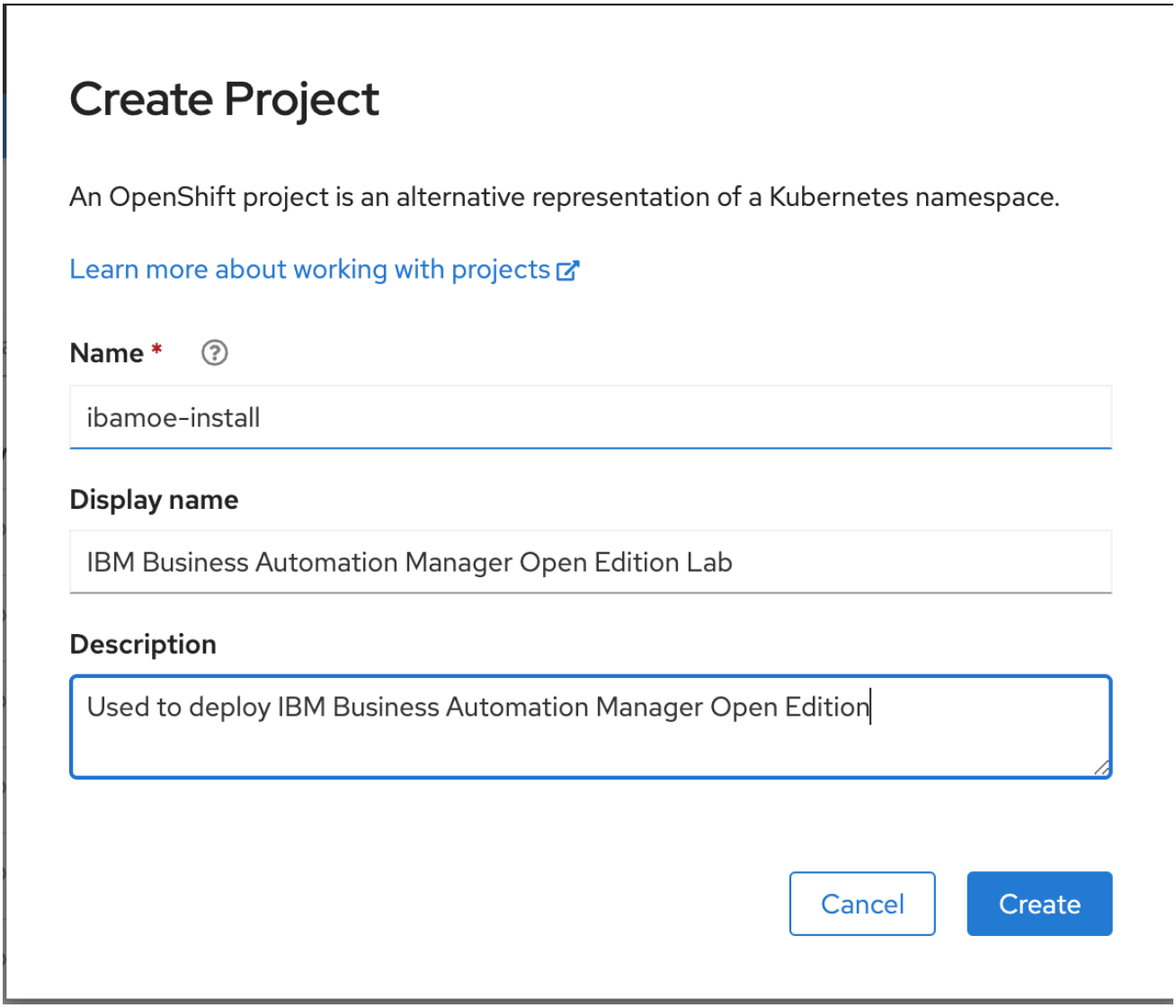
In this lab, the goal is to provision and manage various IBM Business Automation Open Edition 9.0 architectures using the Business Automation Operator on OpenShift 4.

- We deploy an IBAMOE Trial environment, which is a basic ephemeral environment that does not require any form of storage (e.g. persistent volume, database).
- We explore Operator reconciliation features by removing provisioned resources like Services and Deployment Configs.
- We alter the deployment through the Operator to show how the provisioned environment changes.
- We change a KIE configuration parameter in the Business Automation Operator ConfigMap to demonstrate advanced configuration changes.
- We provision a more sophisticated Production environment, to show creation of PVCs, deployment of databases and integration with IBAMOE Smart Router.
- We use the Operator Installer console to install a new KIE-App deployment.

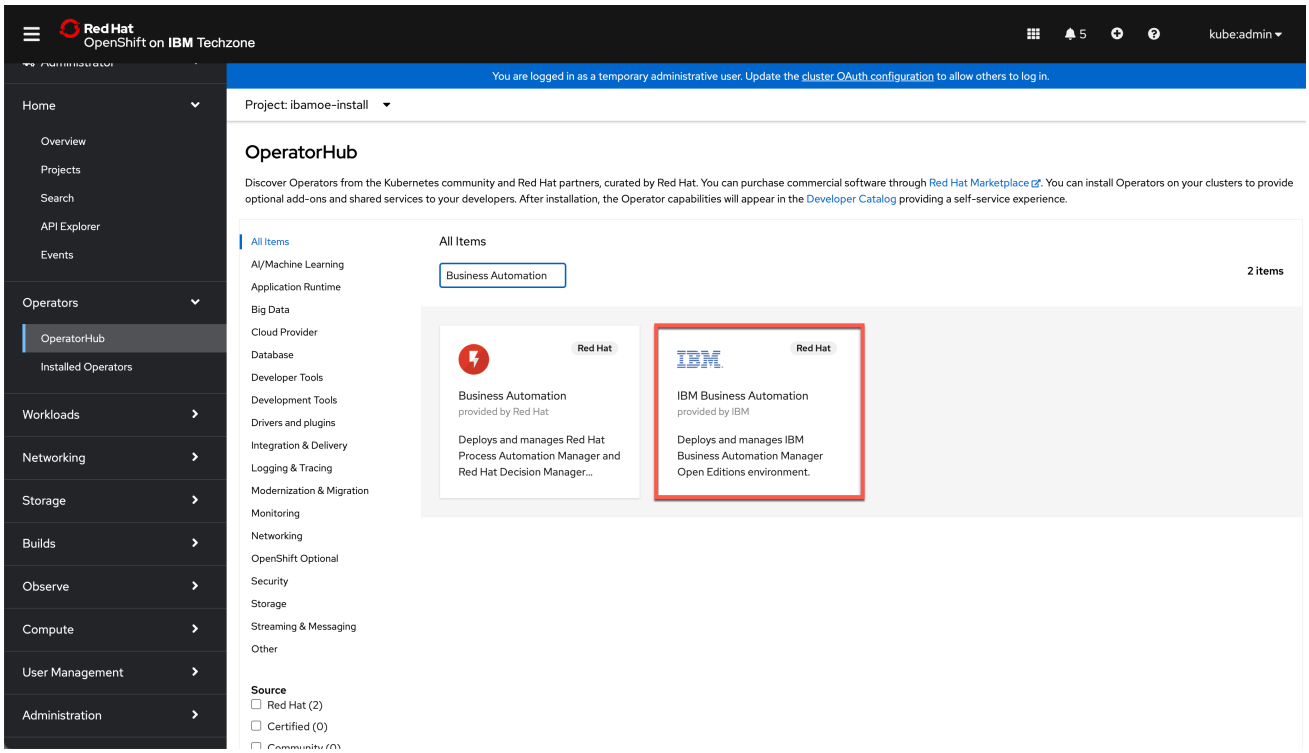
26.3 First steps

If you are using your own OpenShift environment, follow the steps below to create a project and install the operator. If you are trying this lab in an environment provisioned by the Red Hat team, skip to the section `Inspect the Lab environment`.

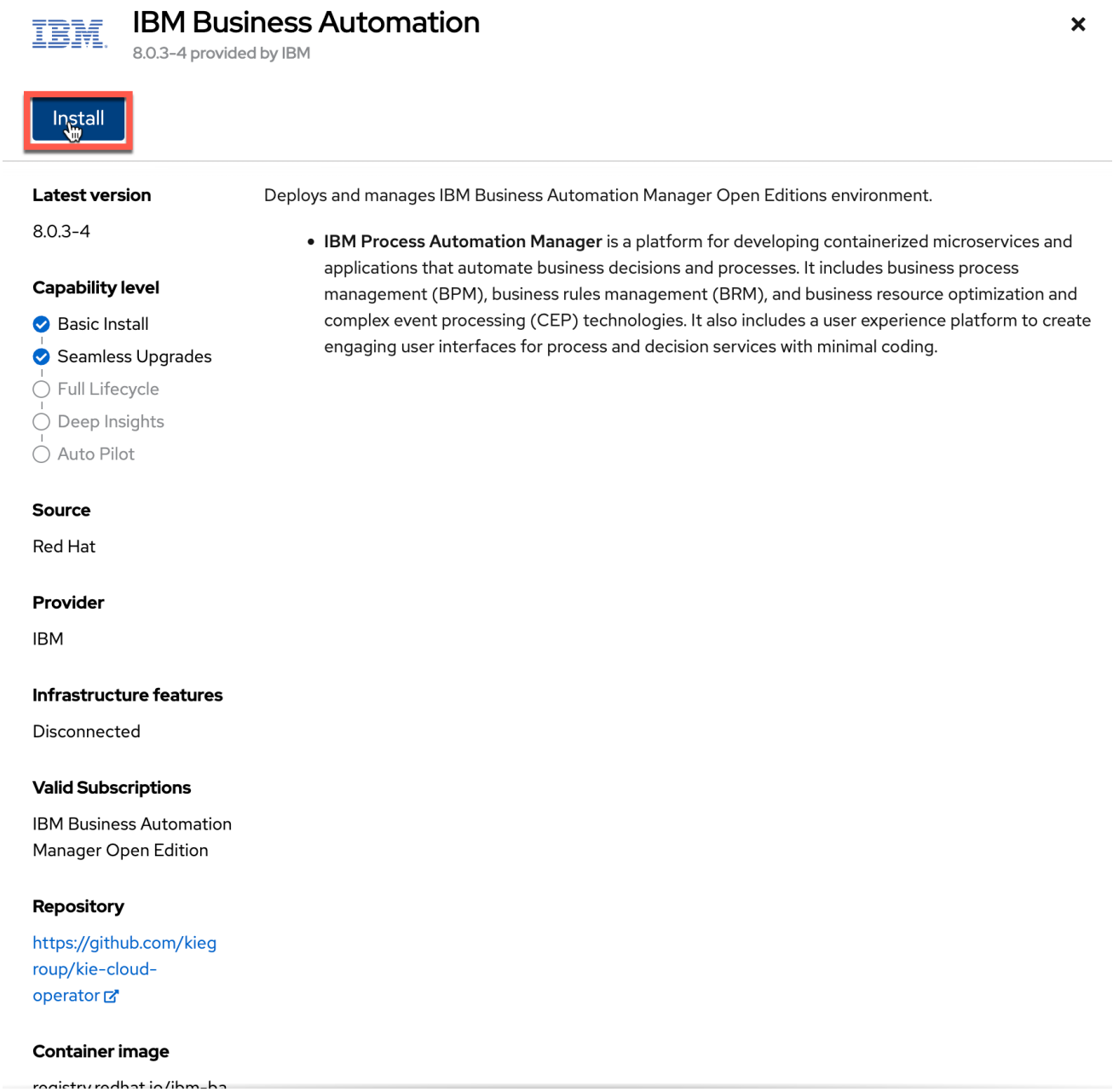
1. Create a new project in OpenShift. We suggest the name `ibamoe-install`.



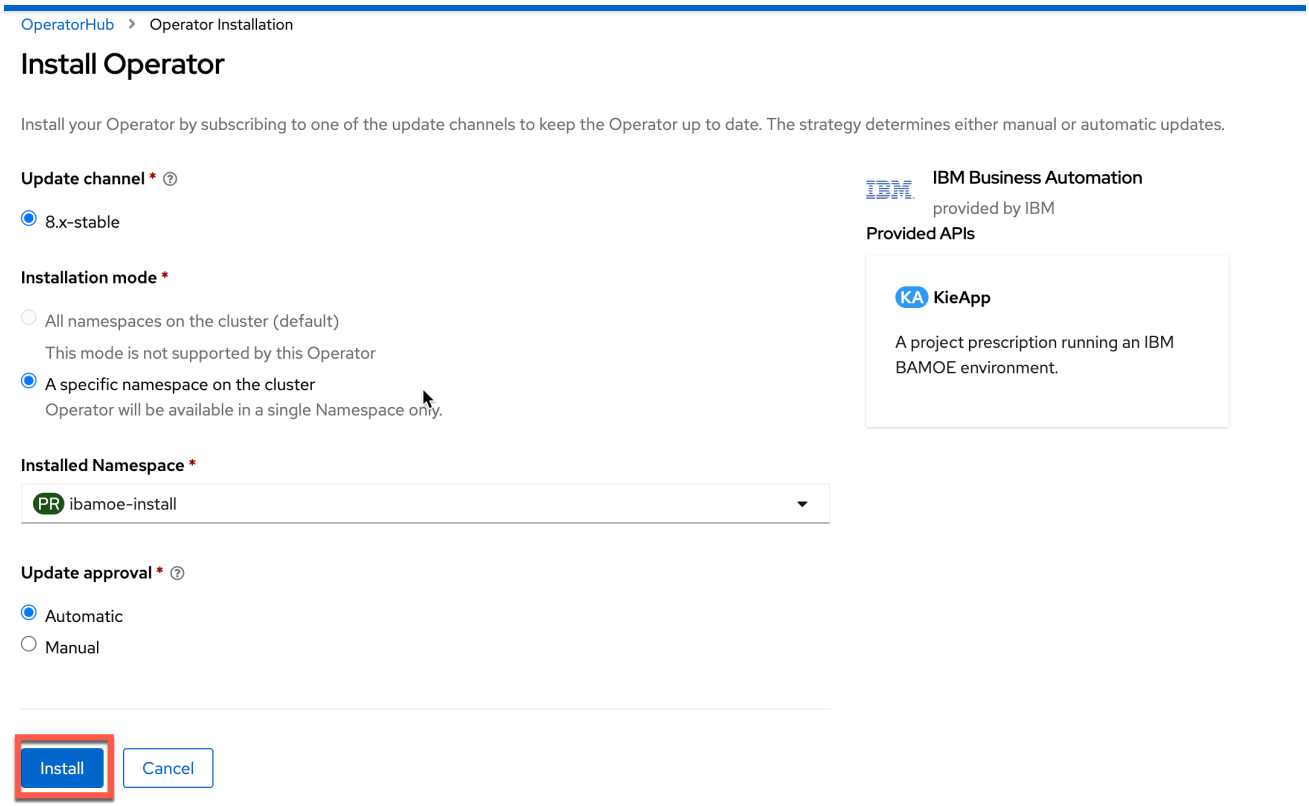
2. Navigate to `Operators`, `Operator Hub`, and search for `Business Automation`:



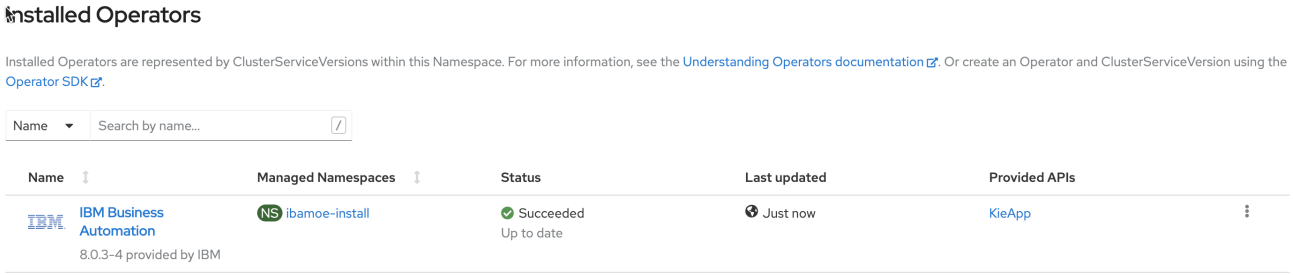
3. Click on the Business Automation and then, click `Install`.



4. You can select the following options, and click on `Submit`:



5. Once subscribed, you should wait for the operator to get provisioned. Then you can proceed with the lab.



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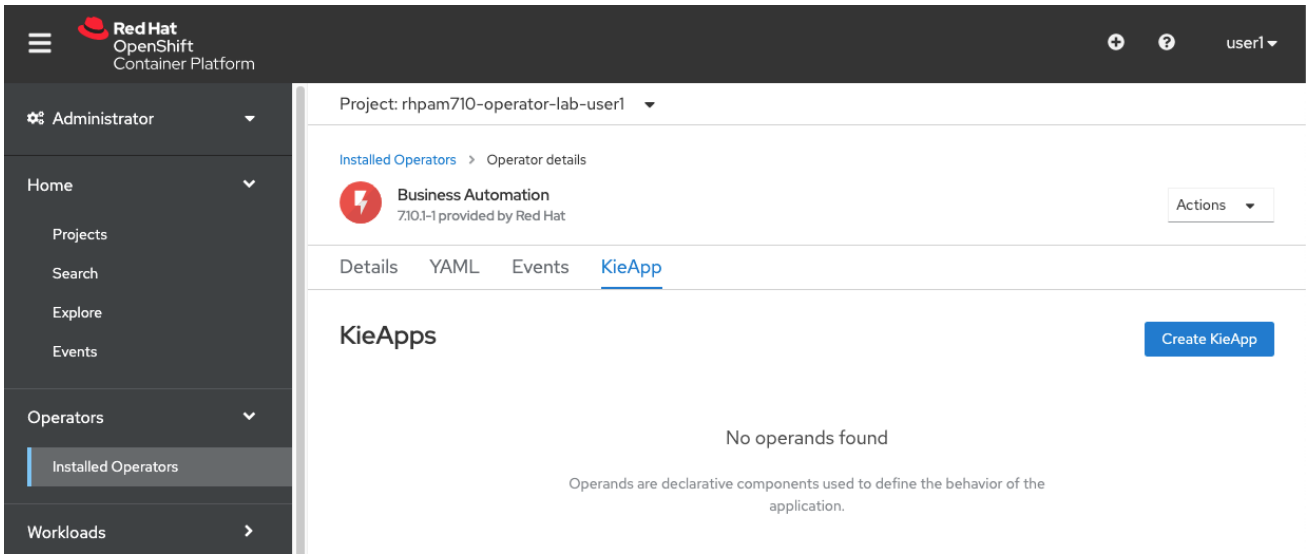
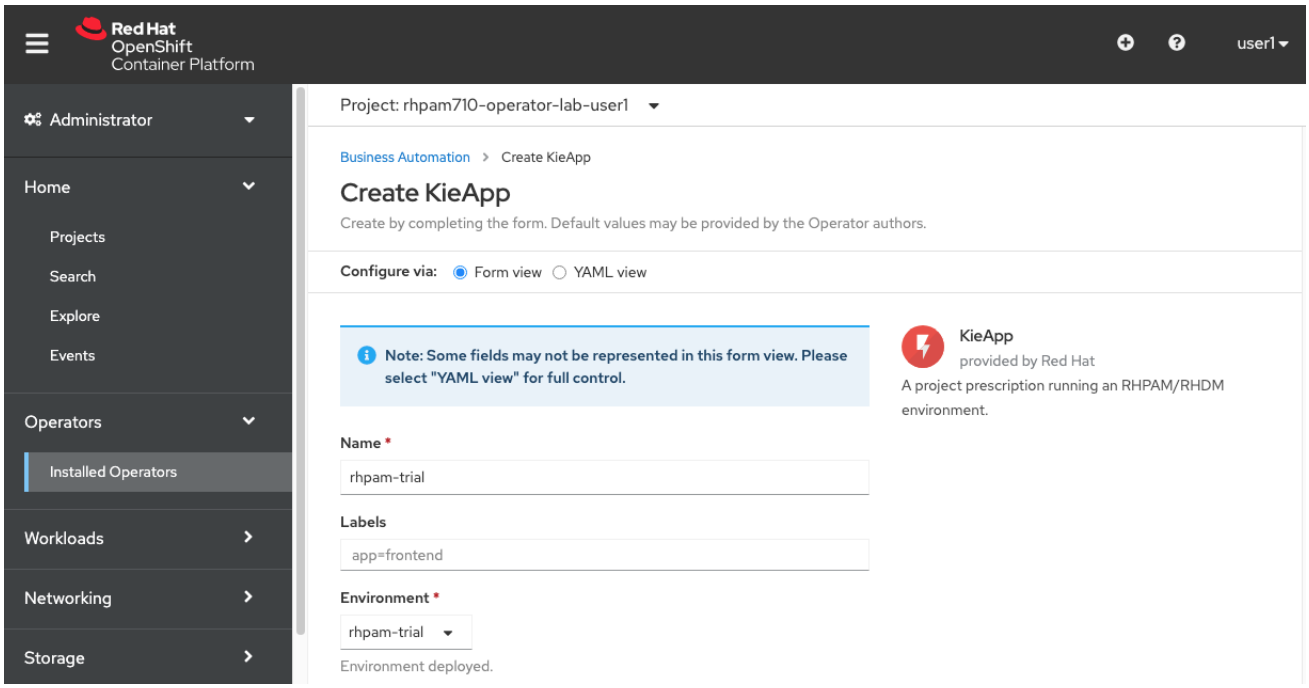
3.9.2 27. Deploying an IBAMOE Trial Environment

1. From the **Business Automation** page in your OpenShift Console, open the **KieApp** tab and click on **Create KieApp**.

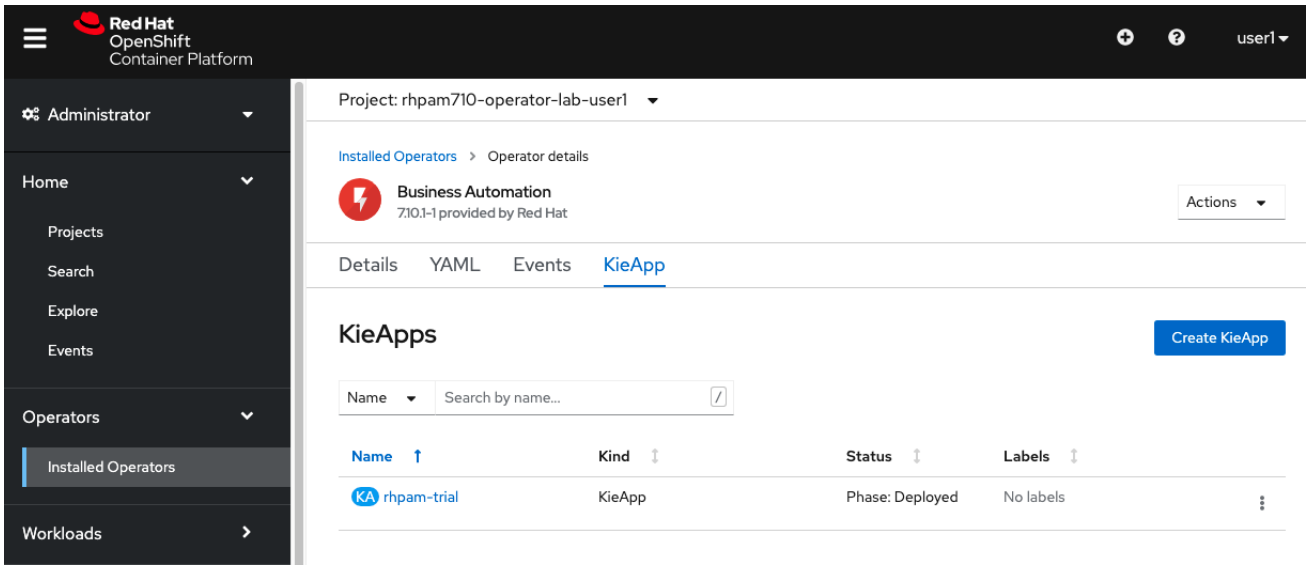


2. A form will be displayed for you to choose which instalation option you want to have. notice the `environment` field. In this field we define the type of the environment we want to provision. In this case we want to provision the **Trial** environment, so we accept the default values.

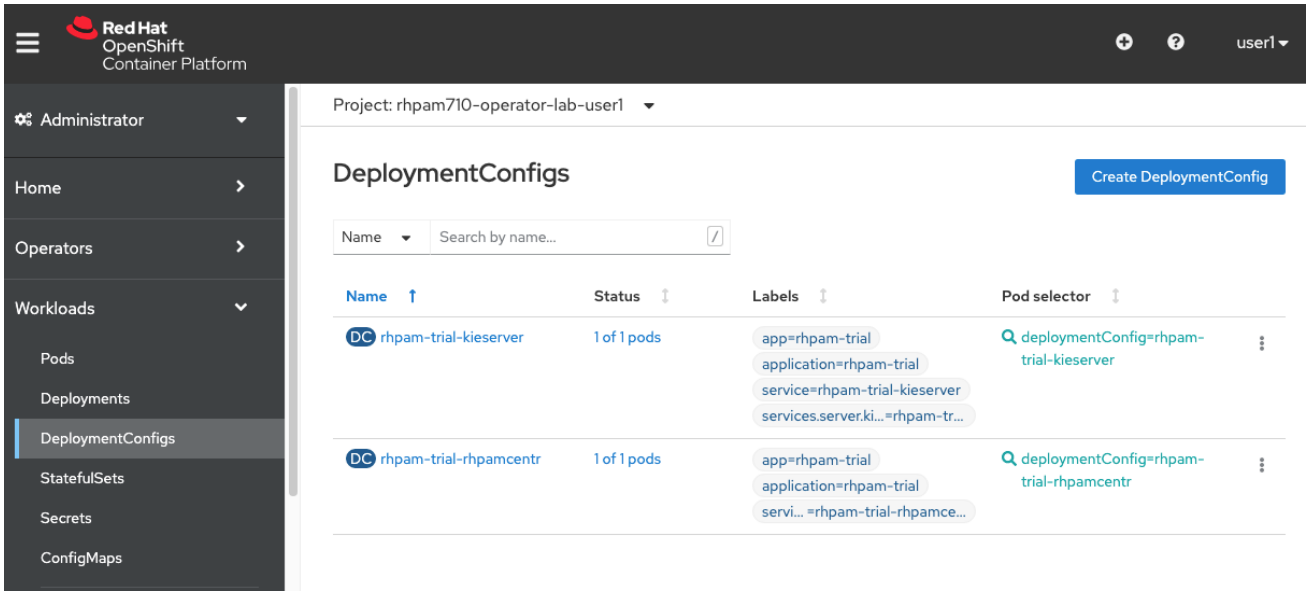


TIP: You also have the YAML definition option if you want to do customizations that are not available in the form above.

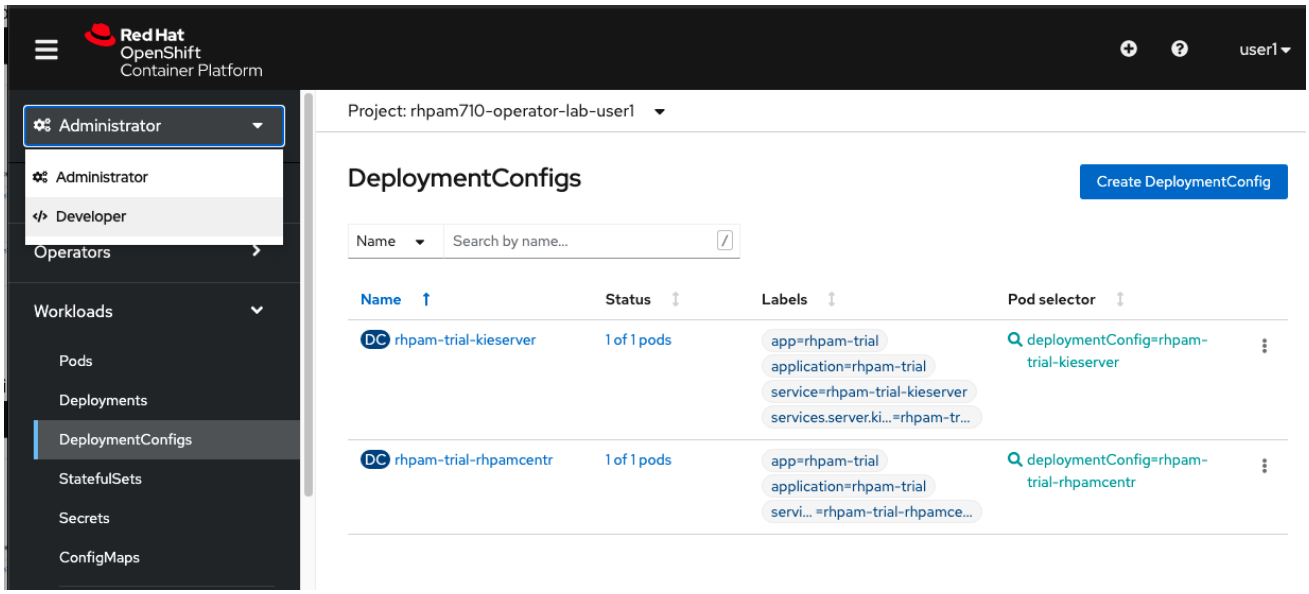
3. Click on the **Create** button at the bottom of the page.
4. In the **KieApp** tab, we can see our new **rhpam-trial** environment being listed.



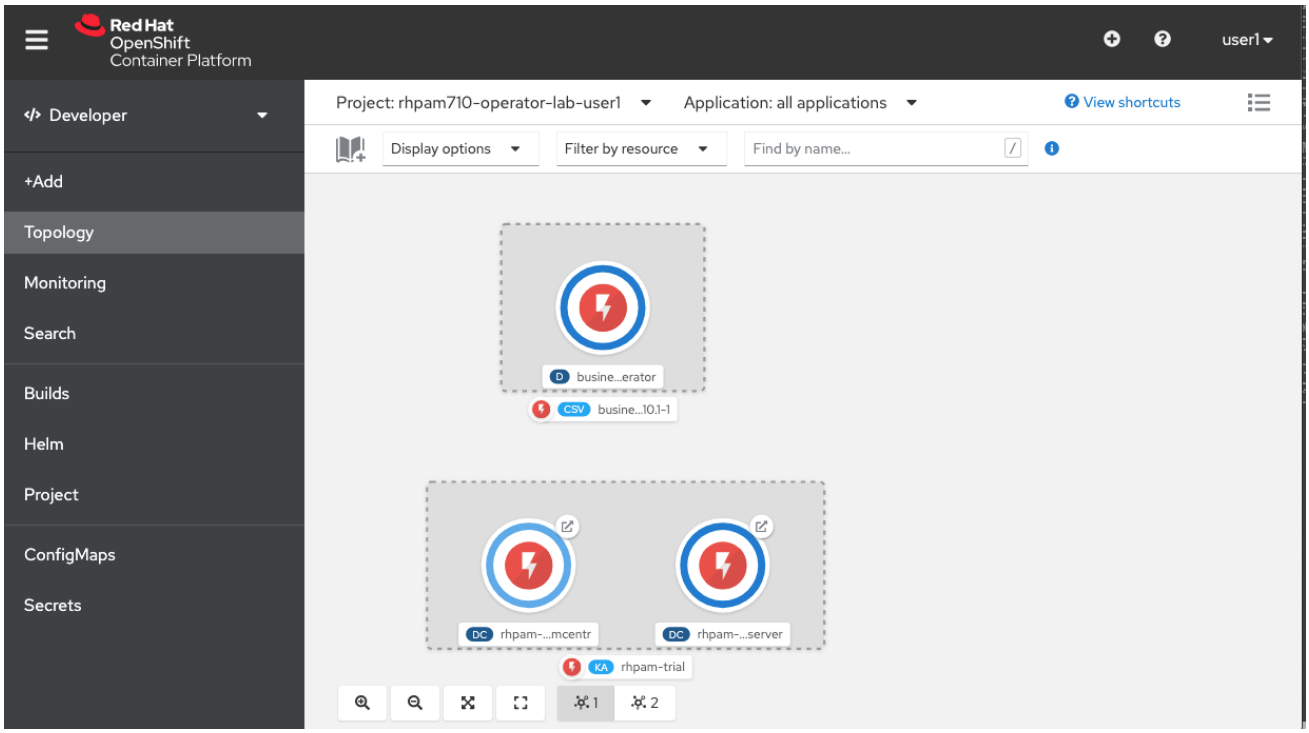
5. Expand the **Workloads** menu on the left side of the screen. Click on **Deployment Configs**. Observe that the Operator has created 2 Deployment Configs, one for Business Central and one for KIE-Server.



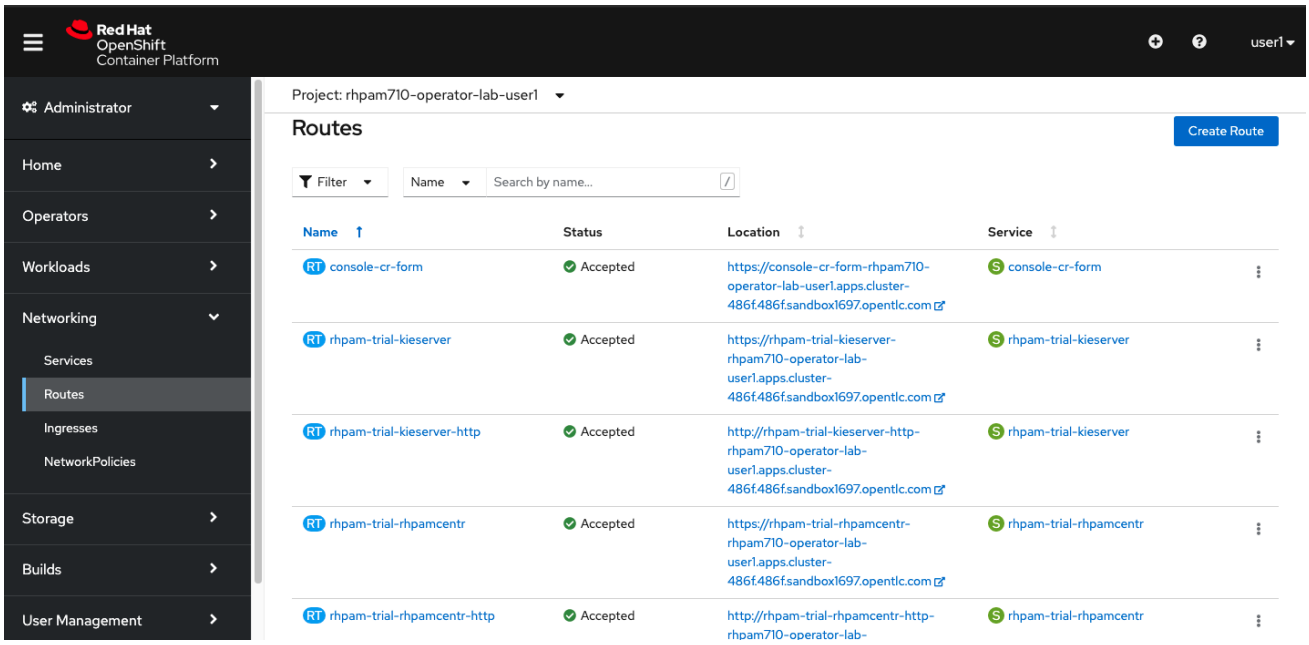
6. Open the **Developer Console** by clicking on the link in the dropdown box at the top left of the screen.



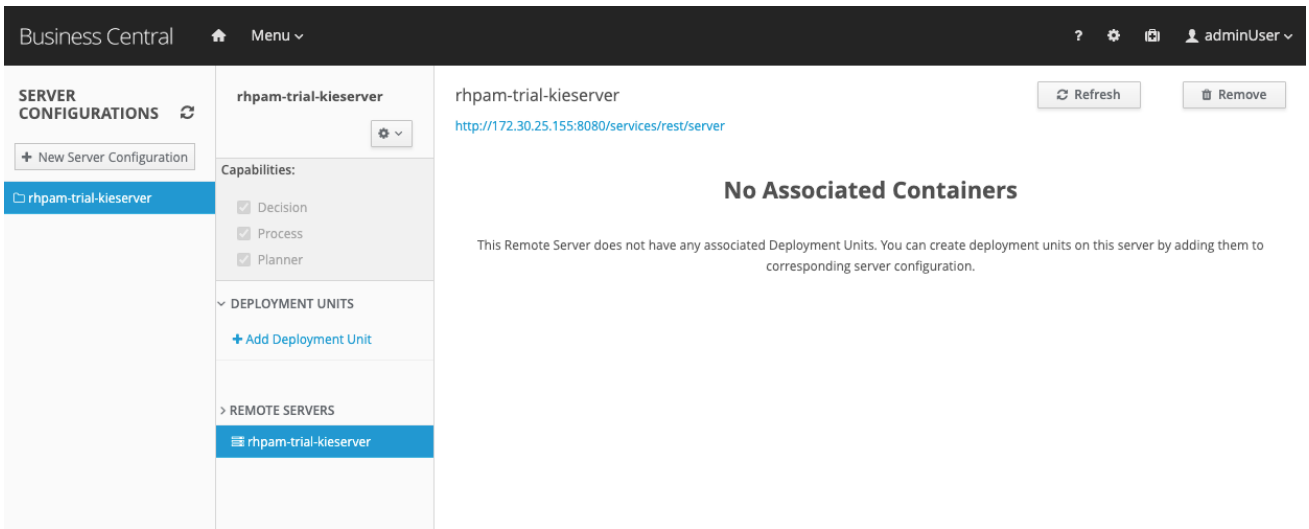
7. Click on the **Topology** link to show a graphical representation of the topology of our namespace, which includes an Operator DC, a Business Central DC, and a KIE-Server DC.



8. Go back to the **Adminstrator** console.
9. Open **Networking → Routes** menu to see all the available routes to our KIE application deployed in this namespace.



10. Identify the **Business/Decision Central URL** link to navigate to the IBAMOE Business Central workbench. It should be named `rhpam-trial-rhpamcentr-http` for the http option, or `rhpam-trial-rhpamcentr` for https.
11. As the Operator is responsible for deployment and configuration of the IBAMOE environment, we can find the details if this deployment in the **KieApp** instance details screen. Open your KieApp in **Operators → Installed Operators → Business Automation → KieApp → rhpam-trial**, and click on the **YAML** tab. CHANGE THIS LINK
12. We can see in the YAML description that the **adminPassword** has been set to `RedHat`. Navigate back to the **Business Central** workbench and login with u: `adminUser` p: `RedHat`.
13. Explore the **Business Central** application. In particular, go to **Menu → Deploy → Execution Servers** to see the **Execution Server** connected to the workbench.



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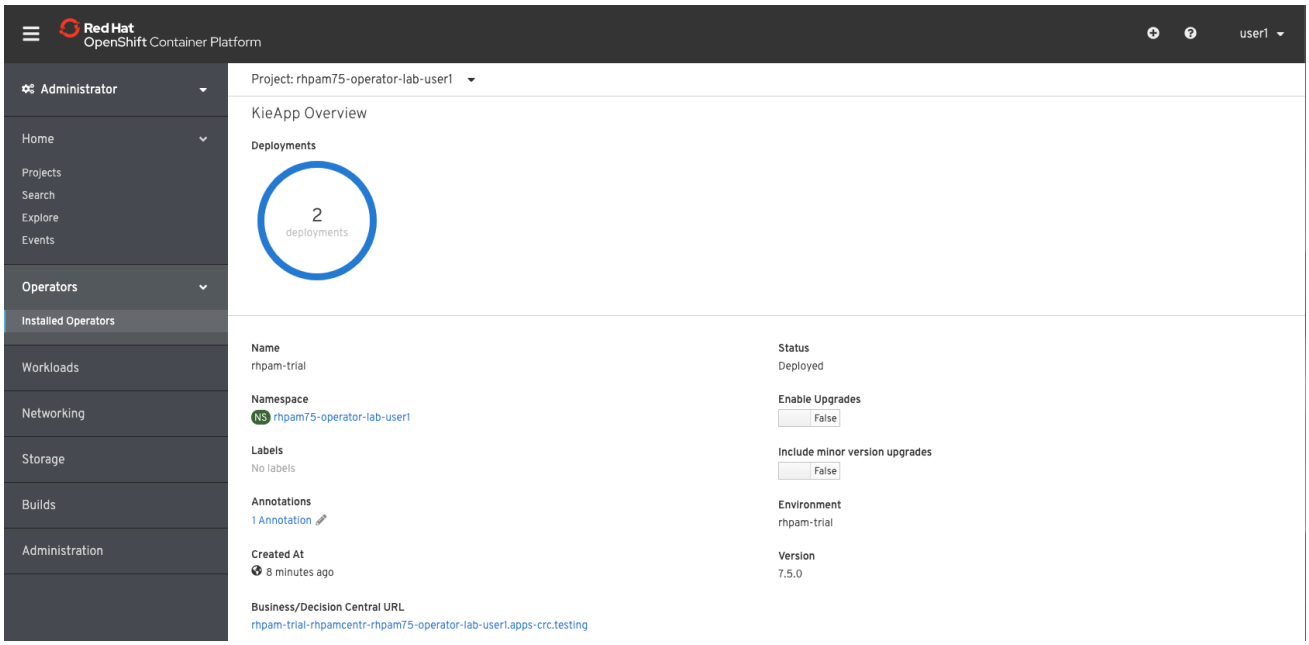
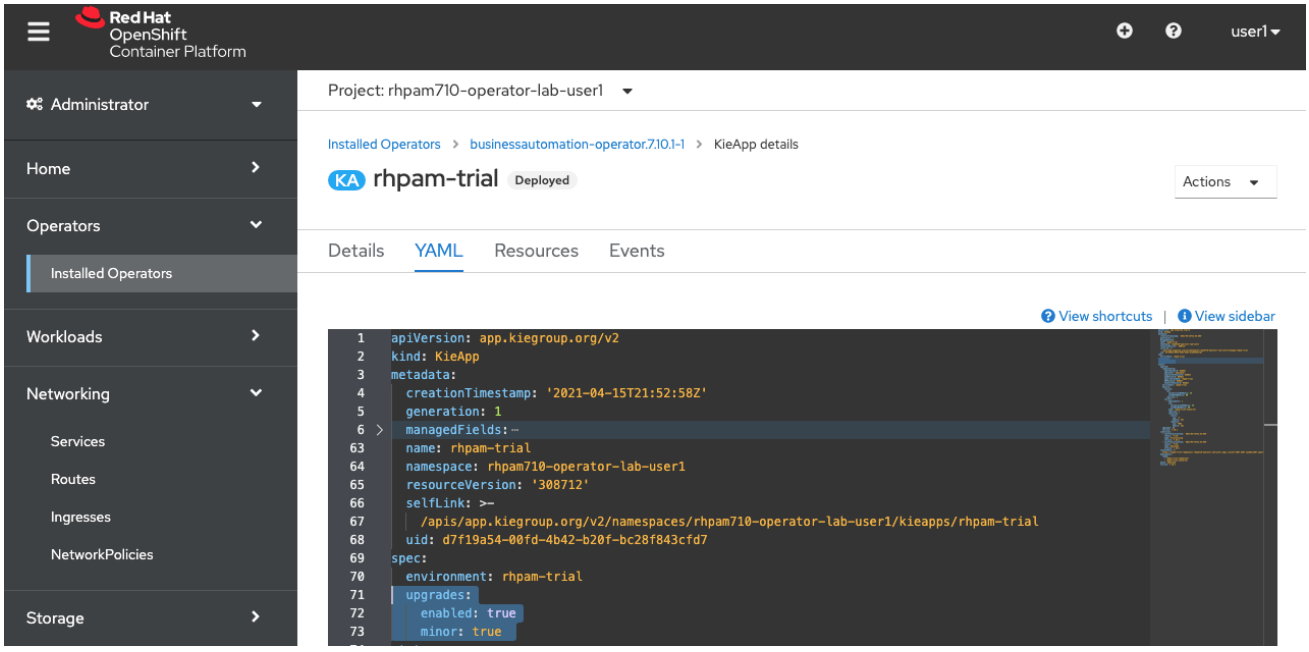
3.9.3 28. Version Upgrades

The Operator of IBAMOE is also capable of doing both patch and minor upgrades. This means that, for example, the Operation can upgrade an IBAMOE environment from 7.10.0 to 7.10.1 or from 7.10.1 to 7.11.0.

1. When creating a new KieApp, you can find the option to enable the version updates.



2. If both the **Enable Upgrades** and **Include minor version upgrades** settings are set to true, the KieApp YAML configuration will include the following spec:



With this configuration the version upgrade mechanism of the Operator should be enabled for the given KieApp.

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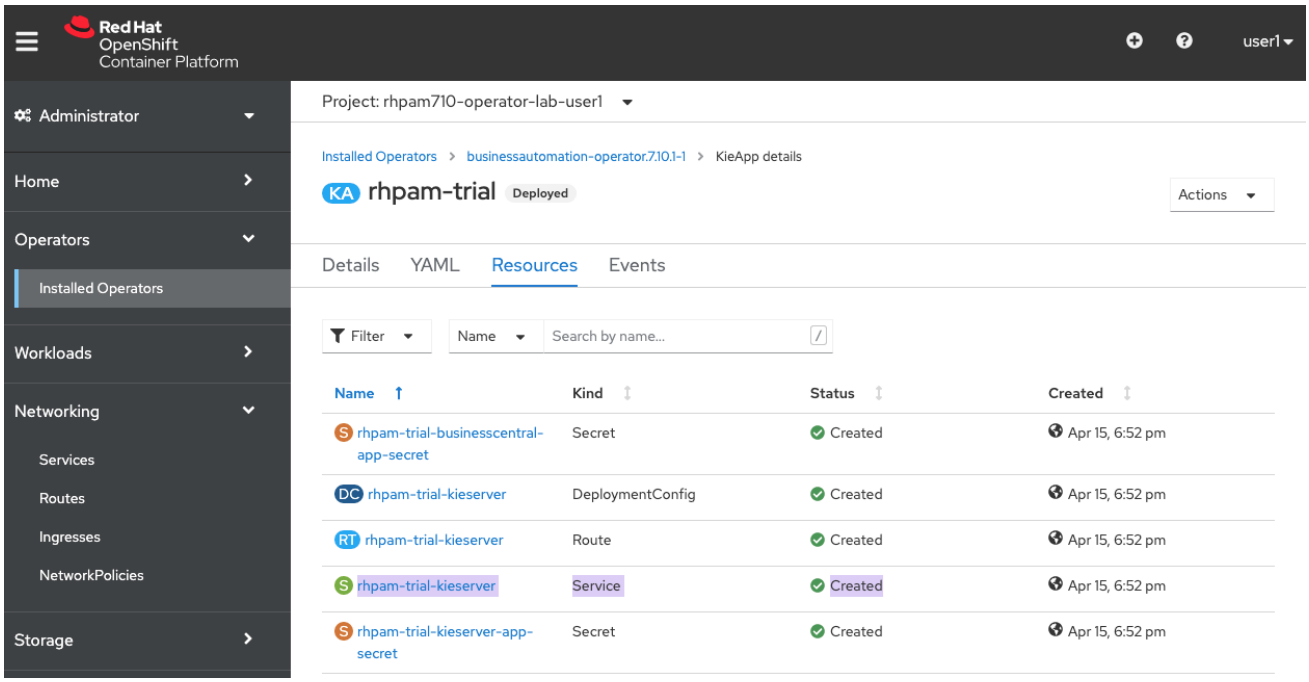
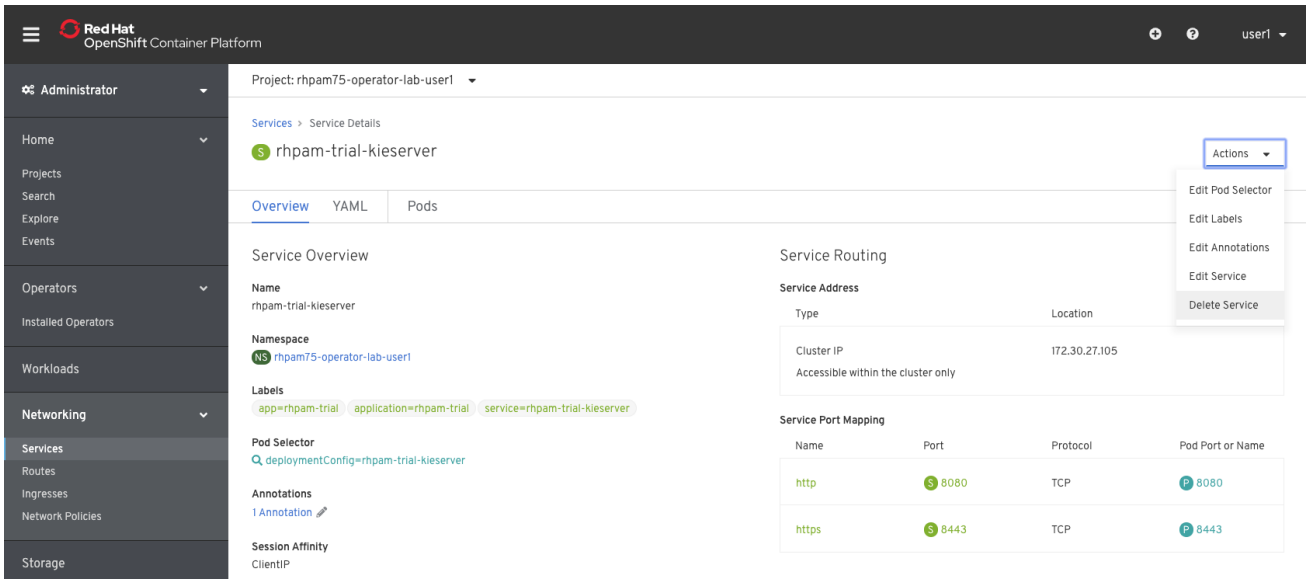
3.9.4 29. Reconciliation

The OpenShift Operators provide functionality to reconciliate an existing environment in order to bring it back to its expected state. We will now test this feature by removing one of the required resources from our deployment.

1. Open the **Resources** tab. This will show all the resources of the application deployed and managed by the Operator.



2. On the fourth row, we can see the `rhpam-trial-kieserver` **Service** resource.
3. In the left menu, go to **Networking → Services**. Open `rhpam-trial-kieserver`.
4. Delete the **Service** by clicking on the **Actions** button at the upper right of the screen and clicking on **Delete**.



5. Notice the **Service** disappearing and immediately reappearing. This is the Operators reconciliation logic at work, bringing the environment back in its expected state.

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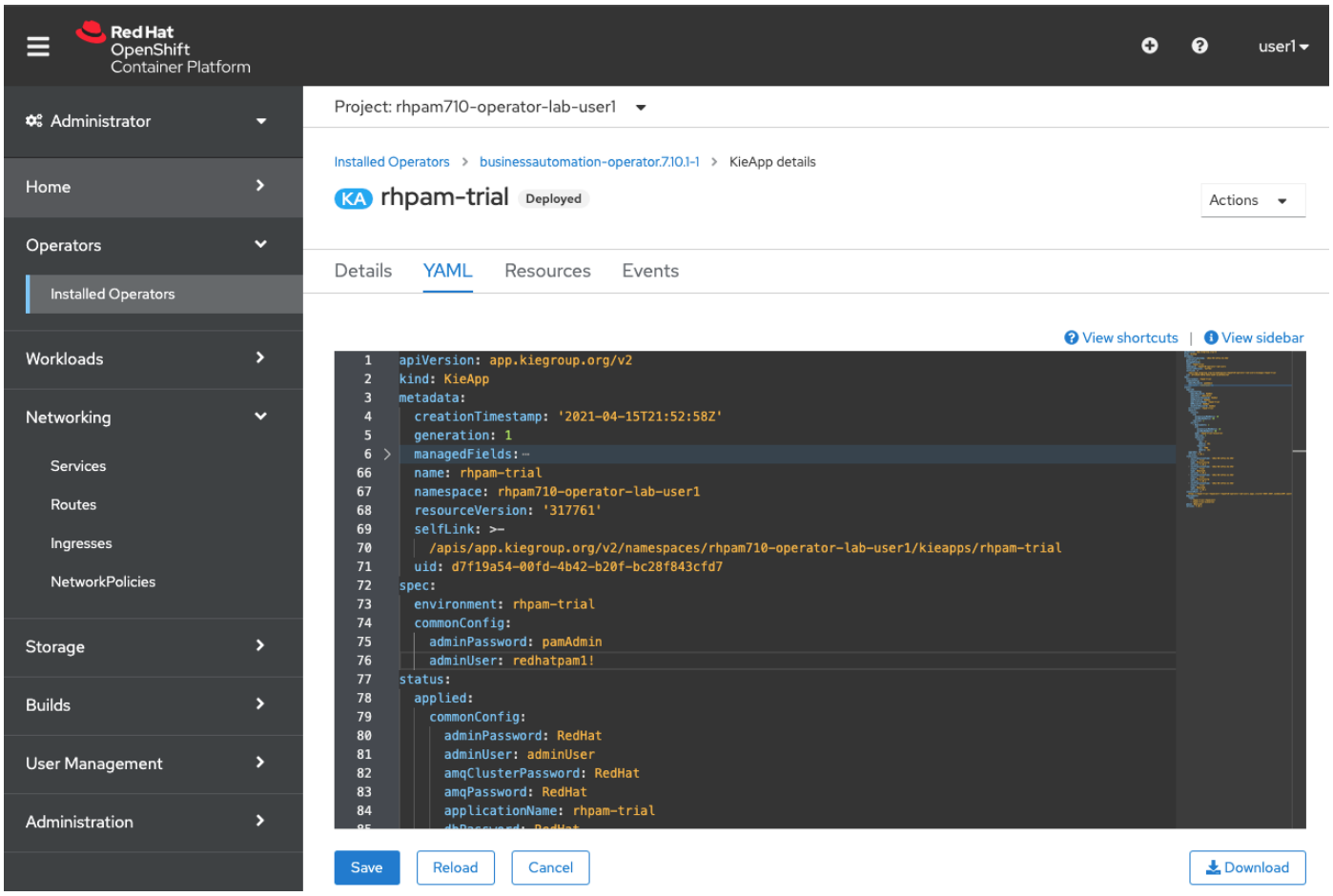
3.9.5 30. KIE App Configuration

The definition of the expected state of KIE-App environment is defined in the YAML definition the KIE-App. In this section we will slightly change this configuration to see how the Operator applies changes in the configuration of your IBM Business Automation Open Edition 9.0 environment.

30.1 Changing Credentials

1. Go back to the YAML definition of your `rhpam-trial` KieApp.
2. Add a `commonConfig` section, with the `adminUser` to the value `bamAdmin`, and the `adminPassword` to `ibmpam1!`. Click on the **Save** button.



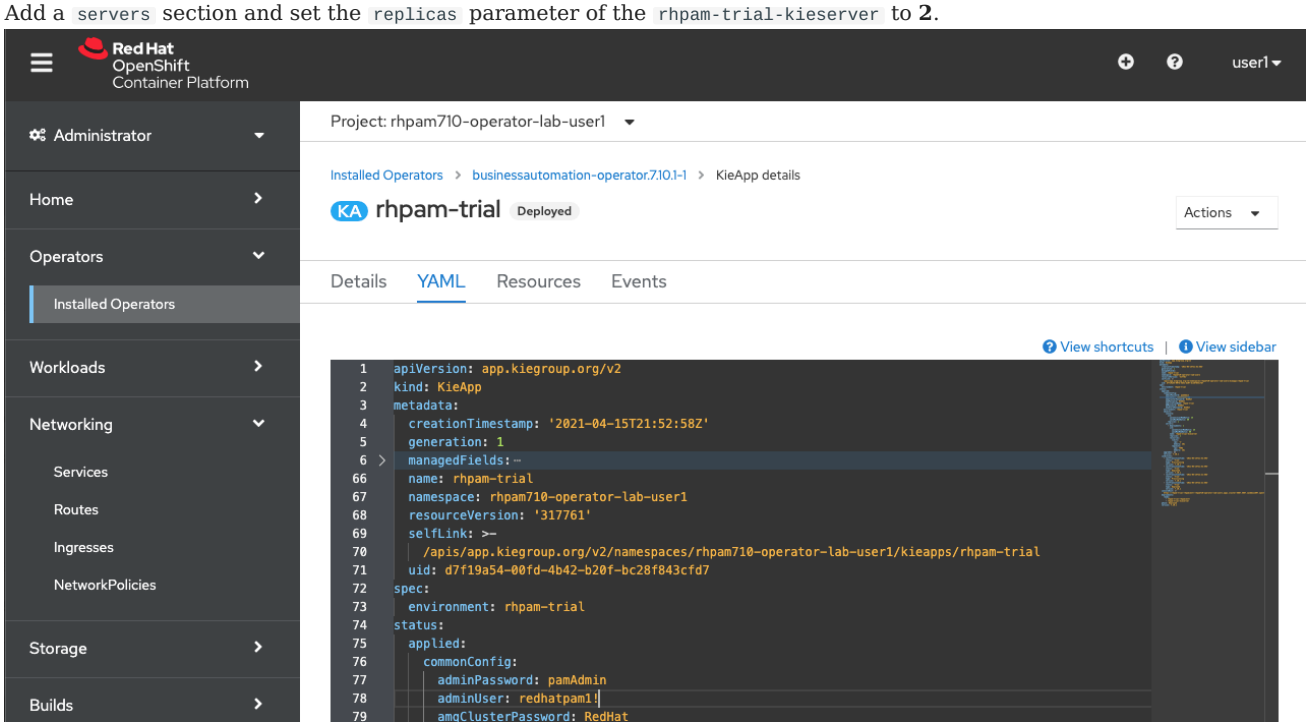

```
spec:
  commonConfig:
    adminPassword: bamAdmin
    adminUser: ibmpam1!
```

3. Click the **Reload** button to reload the YAML view.
4. Click on the **Overview** tab. Notice the deployments re-deploying.
5. Click on the **Business/Central Central URL** to open the Business Central console.
6. Log in with the new username and password: `bamAdmin` / `ibmpam1!`.

30.2 Adding a KIE-Server

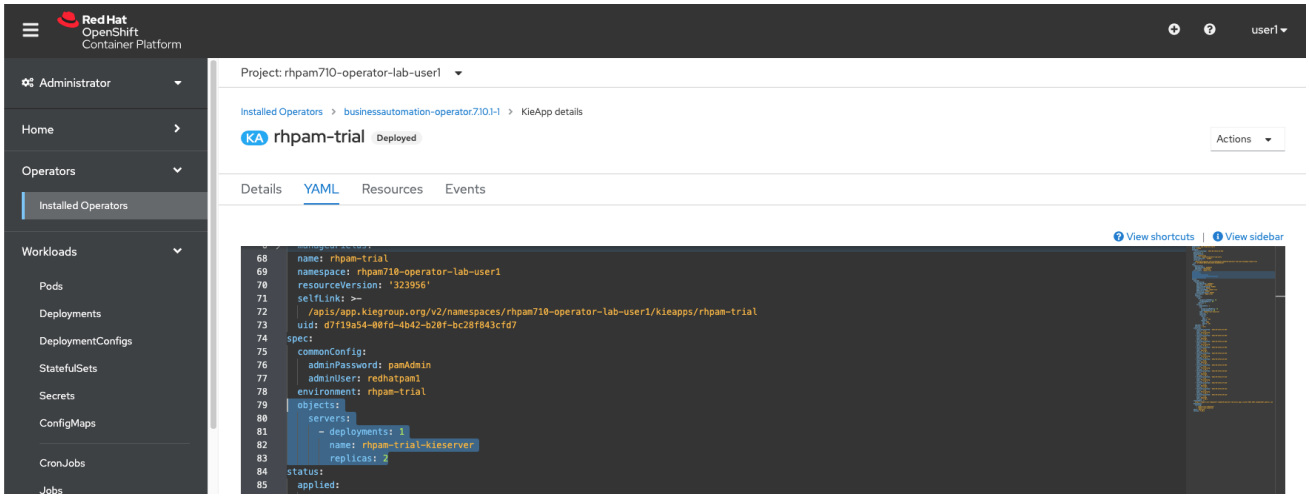
Apart from changing some configuration parameters, we can also change the topology our deployment in the KieApp YAML file.

1. Go back to the YAML definition of your `rhpam-trial` KieApp.
2. Add a `servers` section and set the `replicas` parameter of the `rhpam-trial-kieserver` to **2**.




```
objects:
  servers:
    - deployments: 1
      name: rhpam-trial-kieserver
      replicas: 2
```

3. Click the **Save** button.
4. Go to **Workloads → Deployment Configs**. Note that there are now 2 KIE-Server Deployment Configs.



5. Go back to the YAML definition of your `rhpam-trial` KieApp.
6. Navigate to the `servers` section and add the property `deployments` with the value **2**.

```
objects:
  servers:
    - deployments: 2
      name: rhpam-trial-kieserver
      replicas: 2
```

7. Click the **Save** button.

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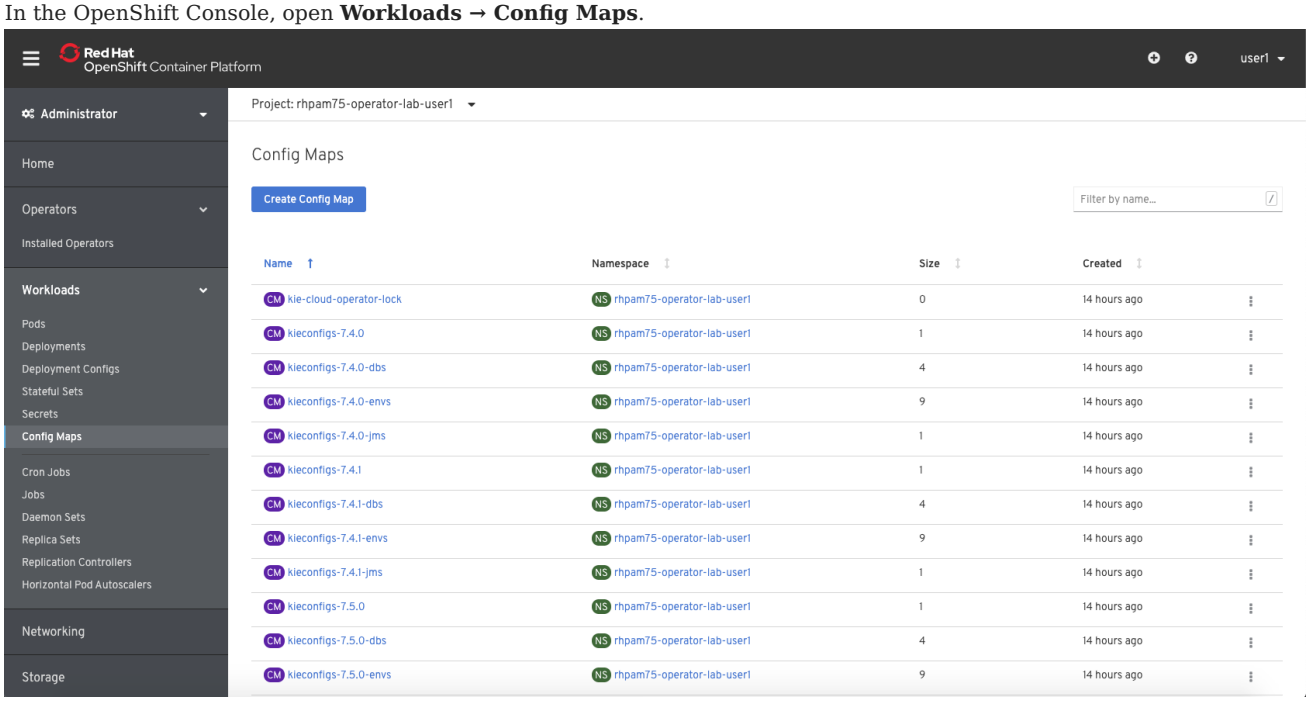
3.9.6 31. ConfigMaps

The Operator stores its configuration in a number of *ConfigurationMaps*. These ConfigurationMaps can be used to change more advanced configurations that can not be configured in the KieApp YAML. In the case the Operator upgrades the version of your IBAMOE environment, the Operator is aware that one of the ConfigMaps has changed and will make a backup of it during the upgrade.

31.1 Viewing and editing ConfigMaps

A powerful feature of OpenShift are ConfigMaps which provide mechanisms to inject containers with configuration data while keeping containers agnostic of OpenShift Container Platform. A ConfigMap can be used to store fine-grained information like individual properties or coarse-grained information like entire configuration files or JSON blobs. In this section, we will modify some of the default health properties that are different than the defaults provided with IBAMOE and we want them to roll out to every container that gets created with the operator.

1. In the OpenShift Console, open **Workloads → Config Maps**.

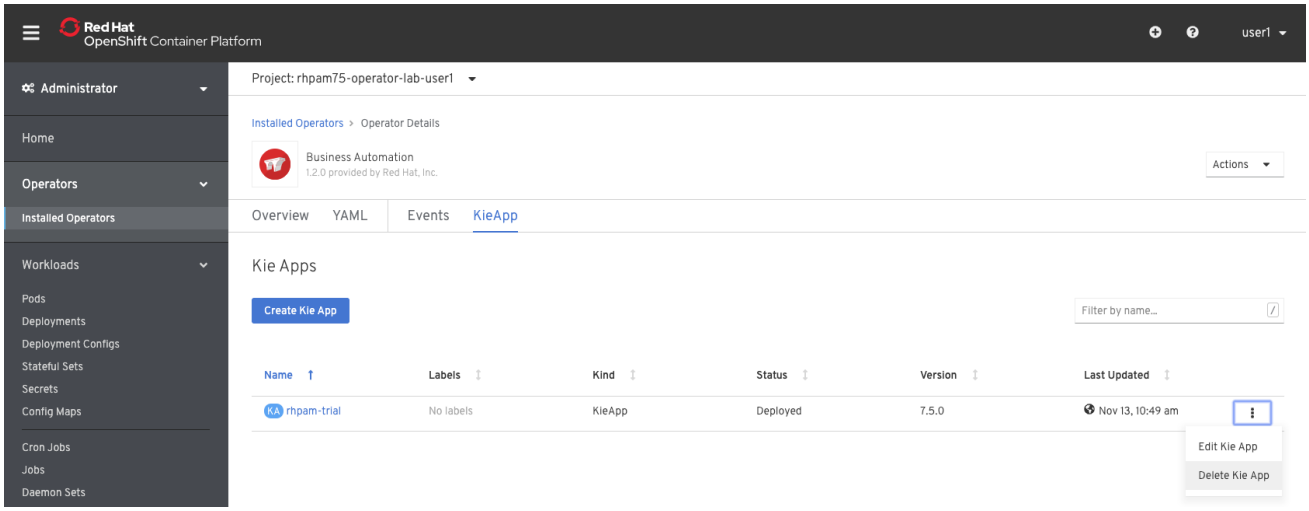


2. Note that the Operator keeps the current ConfigMaps, and the ones of the last 2 versions.
3. Click on the `kieconfigs-7.10.1` ConfigMap and open the YAML tab.
4. Explore the configuration options.
5. Set the `initialDelaySeconds` of the `livenessProbe` of the Business Central console from 180 to 240.
6. Click the **Save** button to save the configuration.
7. Go to "Workloads → Deployment Configs", open the `rhpam-trial-rhpamcentr` Deployment Config and open the YAML tab.
8. Find the LivenessProbe `initialDelaySeconds` configuration and notice that it's still set to 180.
9. Delete the DeploymentConfig. This will have the Operator reconciliation recreate the DC.
10. Open the YAML configuation of this recreated DeploymentConfig.
11. Find the LivenessProbe `initialDelaySeconds` configuration and note that this time it has been set to 240, the value set in the ConfigMap.

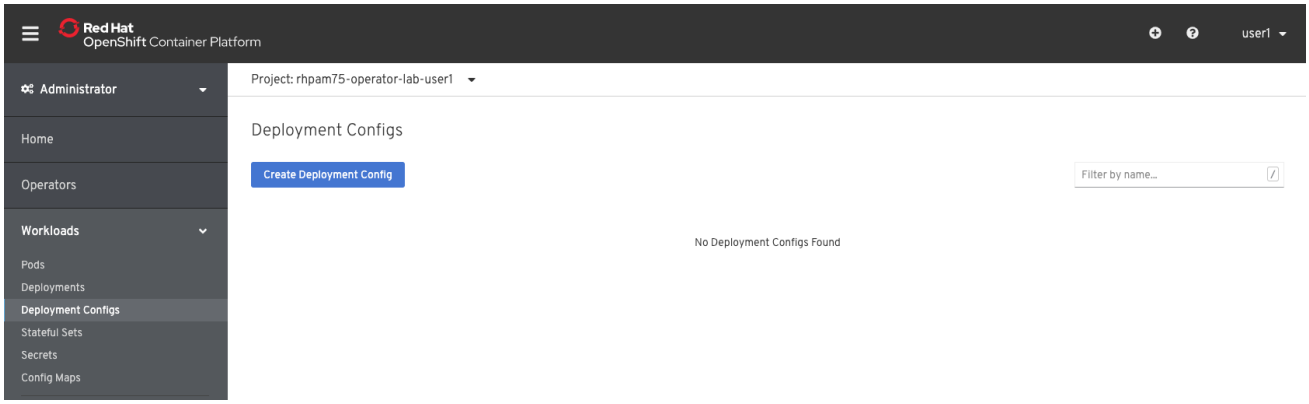
31.2 Deleting an application

Apart from provisioning an IBAMOE application, the Operator also allows us to easily delete an application.

1. Navigate to **Operators → Installed Operators → Business Automation → KieApp**.
2. Click on the kebab icon of the `rhpam-trial` KieApp and click **Delete**.



3. Navigate back to **Workloads → Deployment Configs** and note that the IBAMOE Deployment Configs have been removed.



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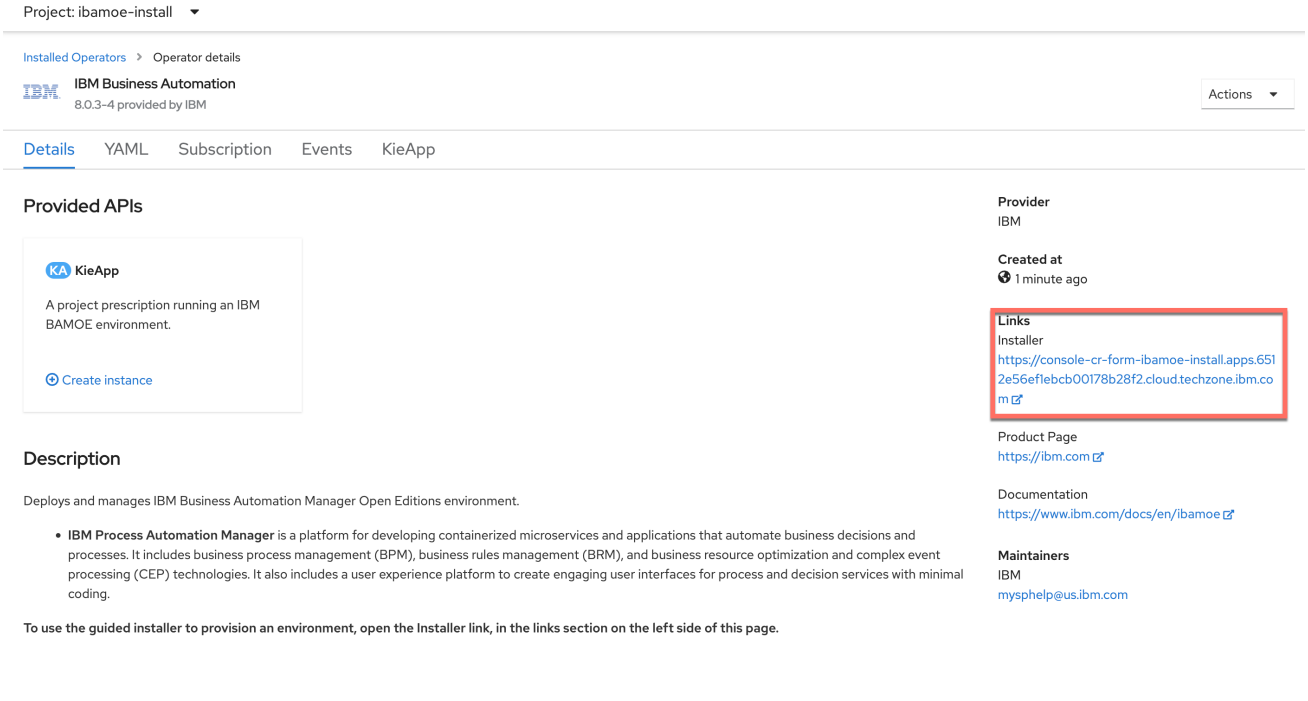
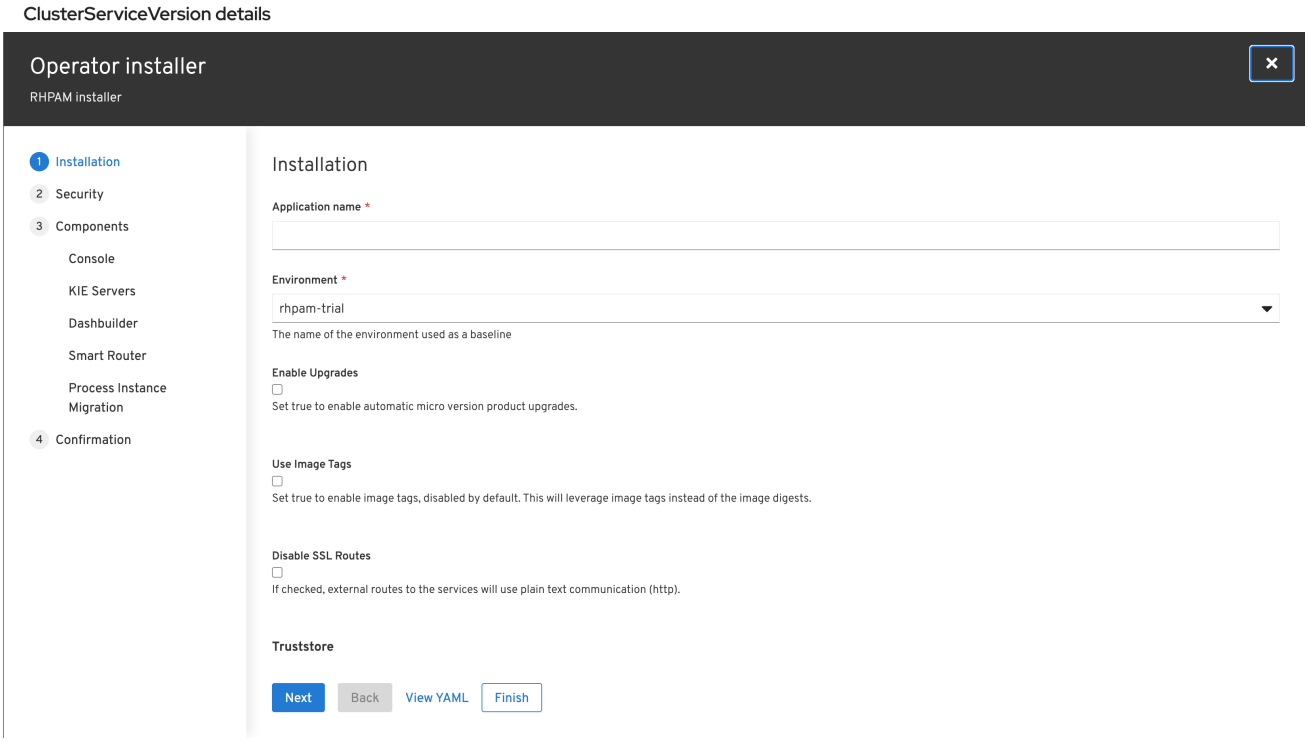
3.9.7 32. Operator Wizard Walkthrough

The Business Automation Operator contains an *Operator Installer Console*. This console gives you a *wizard* experience to deploy IBM Business Automation Open Edition 9.0 environments.

32.1 Wizard walk through

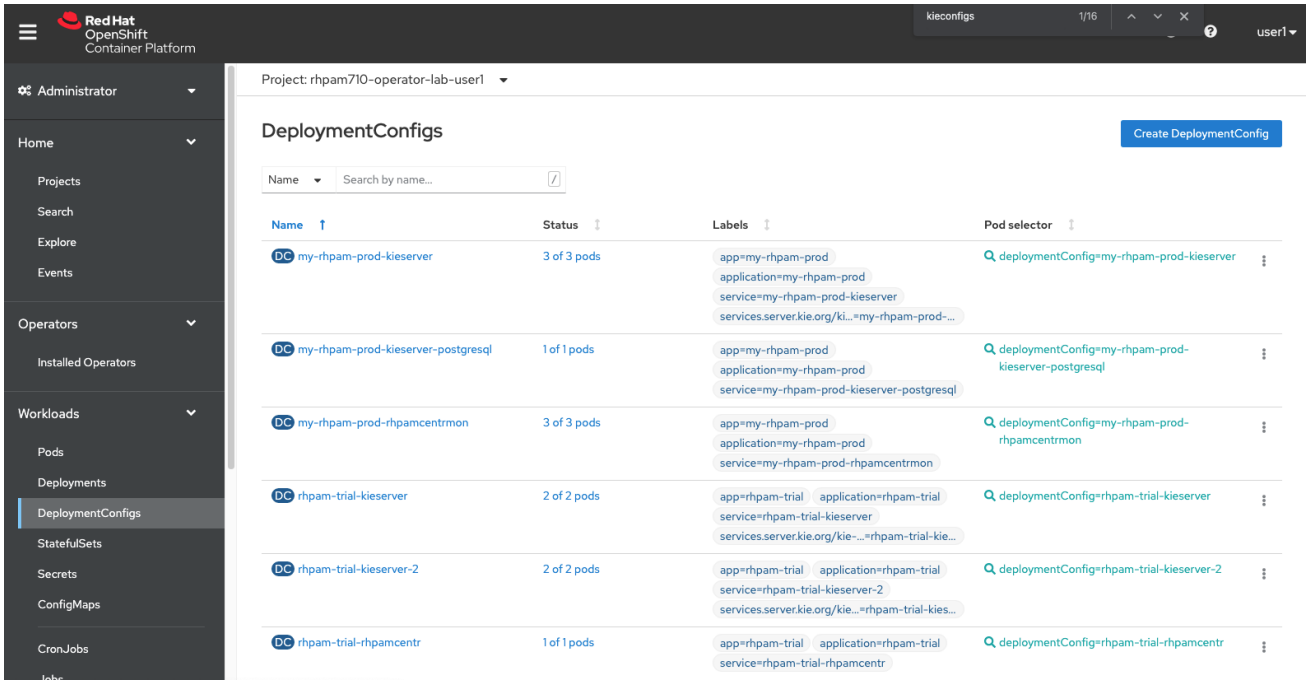
1. Go the Business Automation Operator and click in **Installer** link.





2. Login with Openshift. A page will show up asking for authorization. Select all options and click on "Allow selected permissions".

3. Give the application the name `my-ibamoe-authoring`.
4. Select the `rhpam-authoring` for the Enviroment.
5. Check the **Enable Upgrades** checkbox.
6. Scroll down and set the Username and Password to `bamAdmin` : `ibmpam1`.
7. Click the **Next** button.
8. Don't change any values in the **Security** section. Click on **Next**.
9. Go through the **Components** section of the installer and observe the possible options. Don't change any values for now.
10. Keep clicking next until you reach the **Confirmation** screen and click **Deploy**.
11. Go back to the OpenShift Console.
12. Navigate to **Workloads → Deployment Configs** and observe that a new IBM Business Automation Open Edition 9.0 production environment has been deployed. Note that this environment has a PostgreSQL database deployed. Also note that both the Business Central and KIE-Server Deployment Configs have their ReplicationController set to 3 pods.

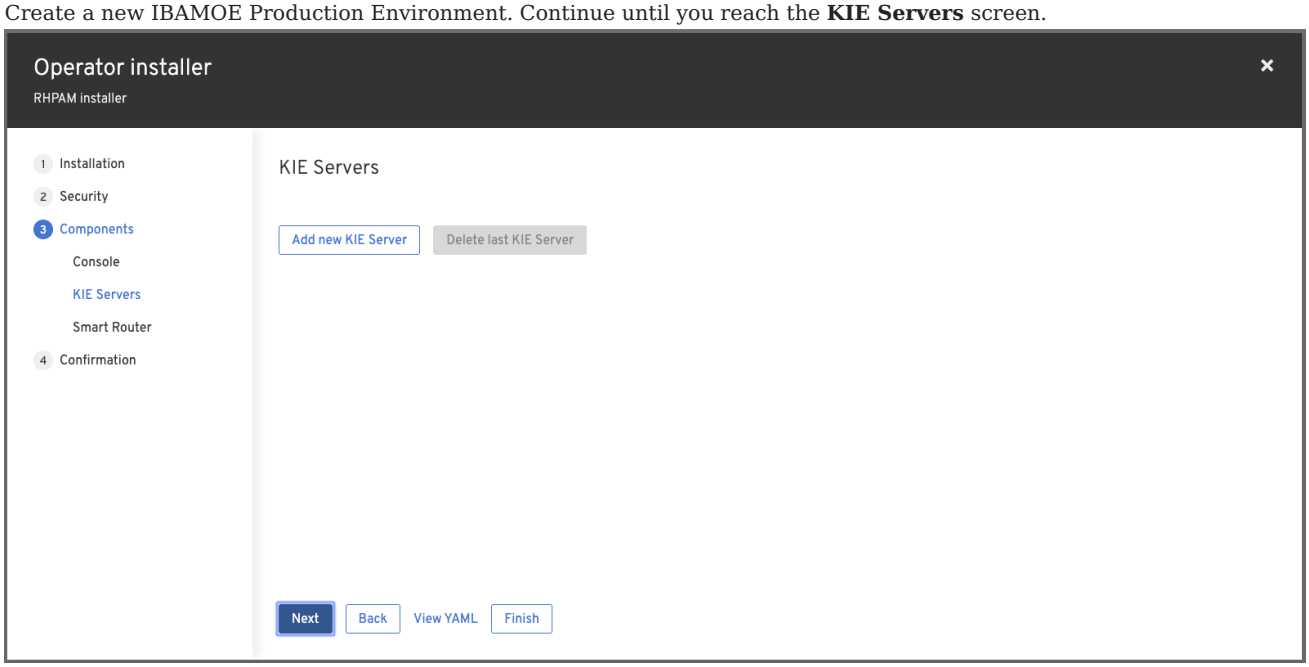


13. Go back to the **Operators → Installed Operators → Business Automation → KieApp**.
14. Delete the `my-rhpam-authoring` we've just deployed with the Installer.

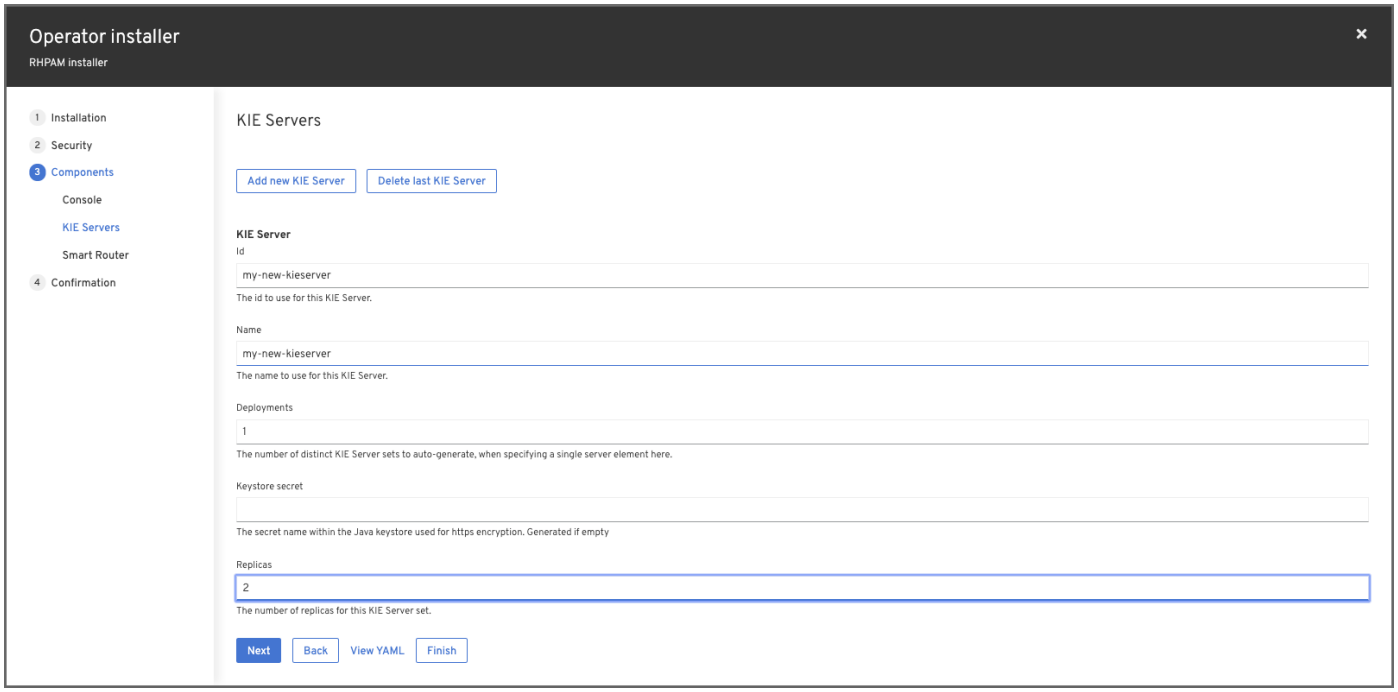
32.2 How to KIE Server with more replicas

We will now deploy a new production environment using the installer, but this time we will configure our KIE-Server in the wizard and set the replications of the KIE-Server to 2 instead of 3.

1. Go back to the Business Automation Operator, and open the Wizard.
2. Create a new IBAMOE Production Environment. Continue until you reach the **KIE Servers** screen.



3. Click **Add new KIE Server** and use the following configuration for your KIE-Server.



4. Click through the rest of the screens until you can press the **Deploy** button to deploy the environment.
5. Navigate to the **Workloads → Deployment Configs** screen to see your IBAMOE production environment, including the KIE-Server you configured.

32.3 Conclusion

This concludes the lab on the Business Automation Operator. If you have time left, feel free to explore more features of the operator.

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3.10 Tools

3.10.1 33. Introduction

This is a series of guided exercises that will allow you to experiment the authoring tools in VSCode and deployment in IBAMOE engine, KIE Server.

33.1 Tooling Set

In Red Hat PAM and DM you can author decisions using:

- Business Central (in IBAMOE) or Decision Central (in RHDM)
- A more business friendly UI;
- Business Automation VSCode Extension
- A developer IDE (Visual Studio Code) extension that allows the visualization and editing of BPMN, DMN and Test Scenarios inside VSCode.

There is also a set of community tooling that's also available for use. All the tools below are backed by IBM and Red Hat:

- DMN FEEL Handbook
- A handbook for the FEEL expression language from the DMN specification, as implemented by the Drools DMN open source engine.
- Learn DMN in 15 minutes
- A guided tour in a website through the elements of DMN
- GitHub Chrome Extension
- A browser extension that allows you to visualize and edit BPMN, DMN and Test Scenario files directly in GitHub.
- Online Editors
- BPMN.new - A free online editor for business processes;
- DMN.new - A free online editor for decision models;
- PMML.new - A free online editor for scorecards;
- Business Modeler Hub
- Allows for the download of the: VSCode extension, GitHub Chrome Extension, and Desktop App

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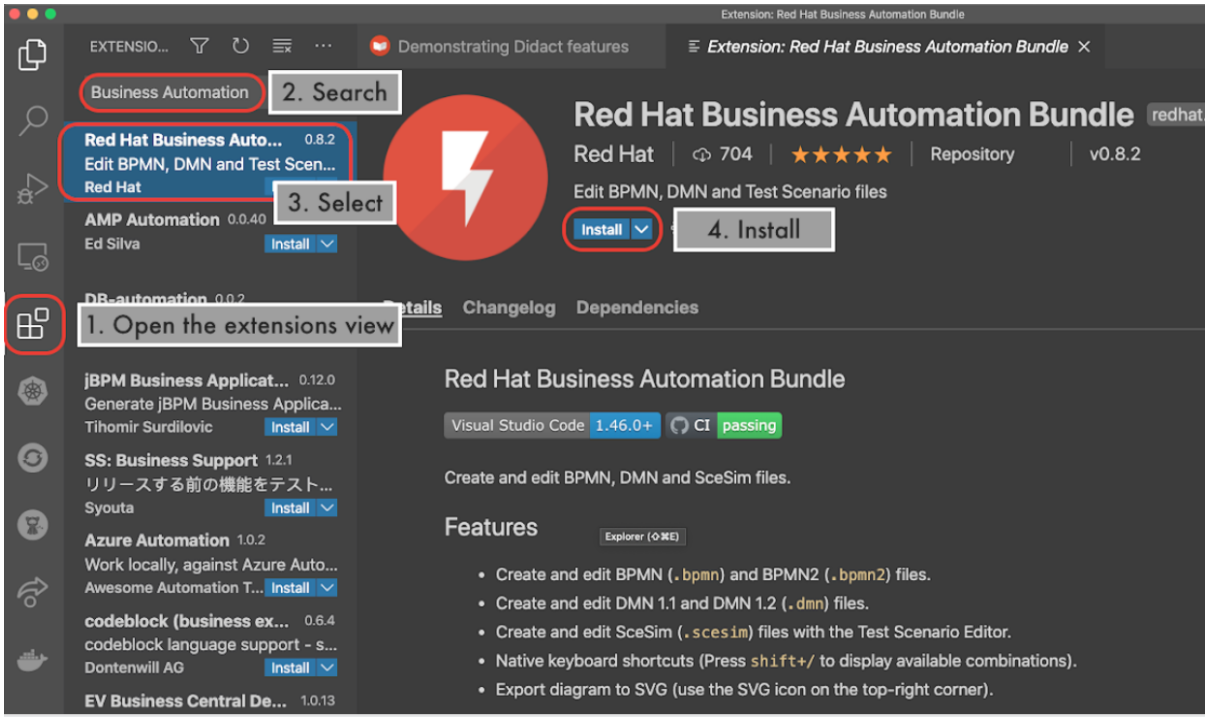
3.10.2 34. Business Automation projects in VSCode

To start working with business automation projects in VSCode, you'll need to install the VSCode Extension that allows you to work with BPMN, DMN and Test Scenarios through graphical editors.

34.1 Installing the VSCode extension

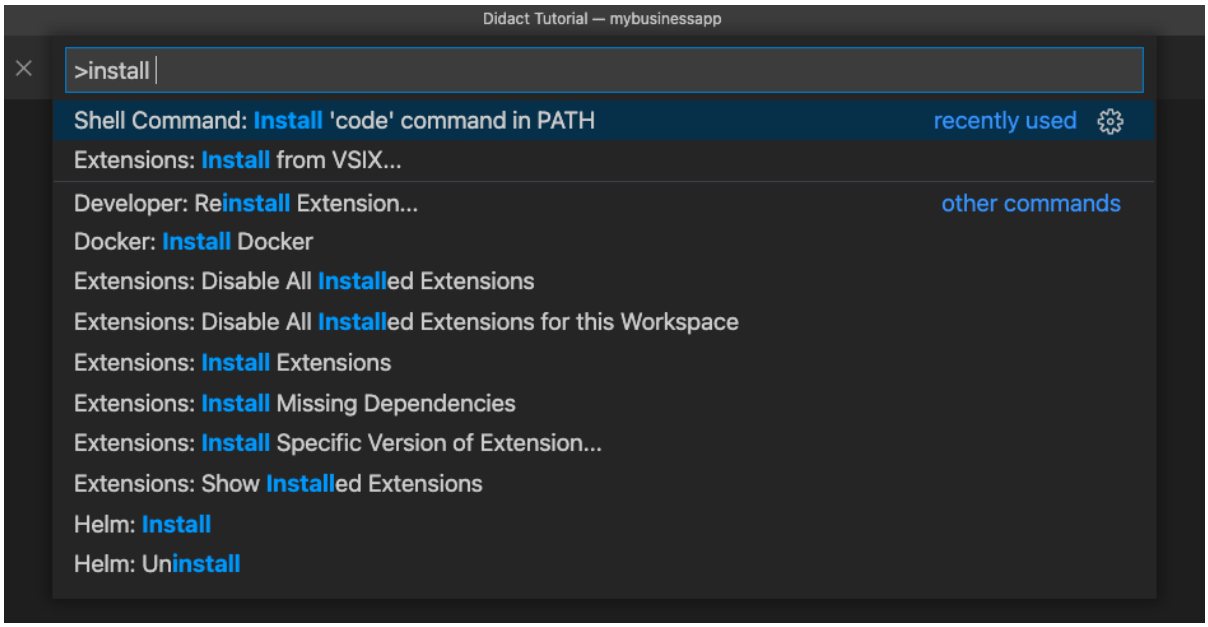
To install the extension in VSCode, open the extensions menu, and search for Business Automation.

You should find the Red Hat Business Automation Bundle.



Click on install.

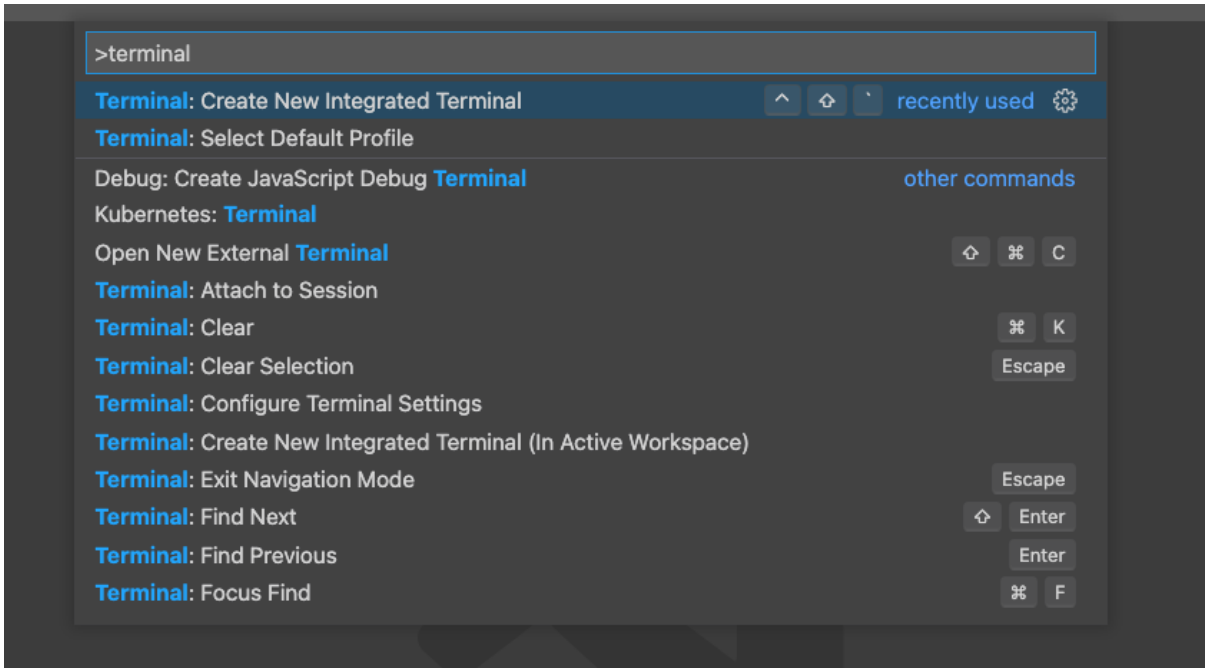
If this is the first time you are using VSCode, it would be interesting to also install the `code` command in path, so that you can open projects directly from the terminal. To do so, press `cmd+shift+p` (or `ctrl+shift+p`) to launch `VSCode Quick Open` menu. And next, search for **Instal code command in PATH**:



34.2 Create new a project

Let's create a new project using the maven archetype. This project should contain the structure and files that Business Central expects, so this project should be editable and authored in both VScode and Business Central.

1. Now we will use the terminal. You can either use your terminal or use the built-in terminal In VScode. To use the terminal in VSCode you can press `cmd+shift+p` (or `ctrl+shift+p`) to launch `VSCode Quick Open` menu. And next, open a `new intergrated terminal`:

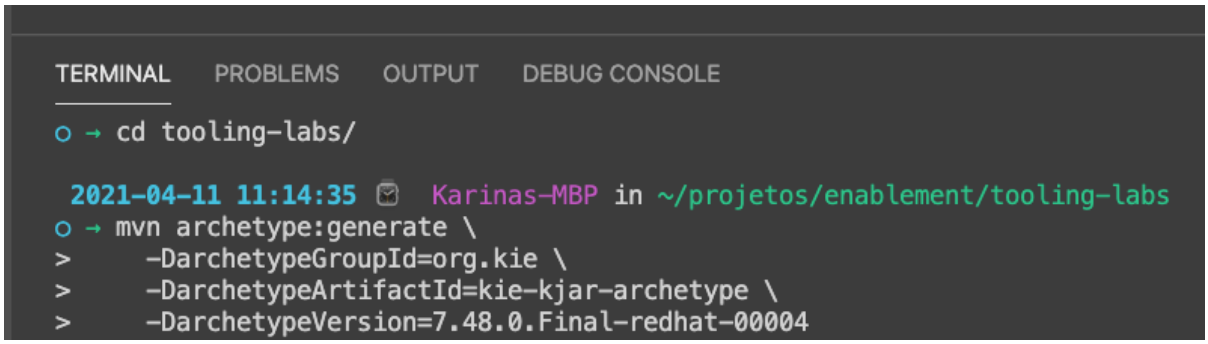


1. Next, in the terminal navigate to the directory where you would like to create the new project. Let's call it $PROJECT_DIR from now on. Create a new folder named `tooling-labs`.

```
$ cd $PROJECT_DIR
$ mkdir tooling-labs
$ cd tooling-labs
```

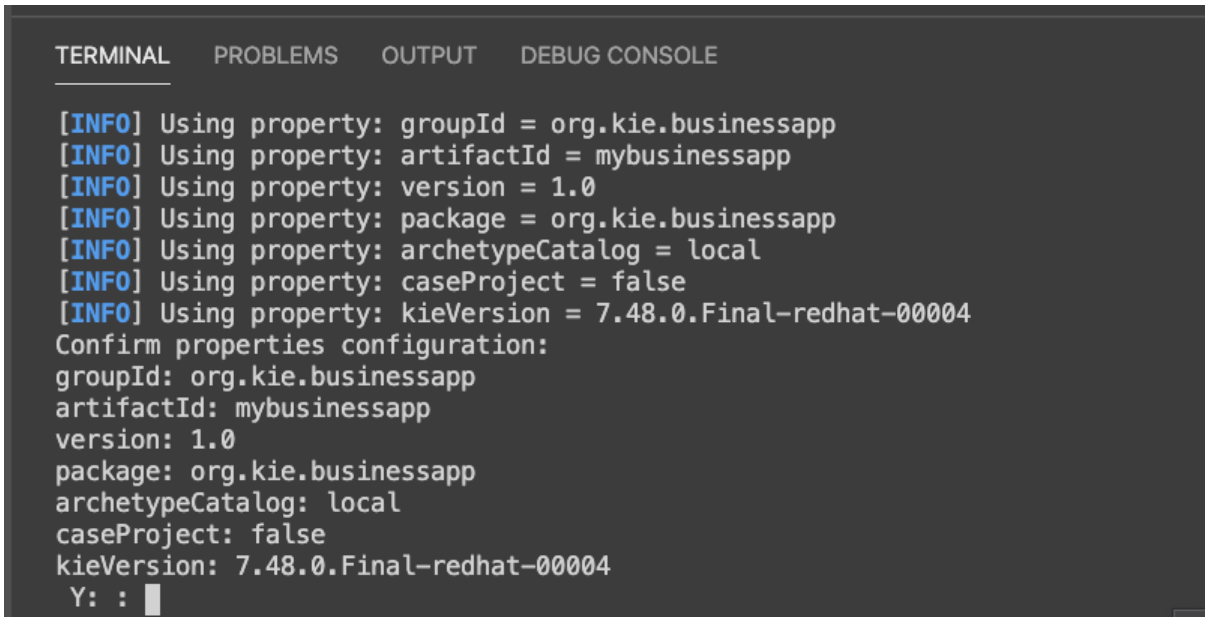
1. Now, use the maven archetype to create a new project in the `tooling-labs` directory:

```
mvn archetype:generate \
    -DarchetypeGroupId=org.kie \
    -DarchetypeArtifactId=kie-kjar-archetype \
    -DarchetypeVersion=7.67.2.Final-redhat-00006
```



TIP: If you need to create a case project, you can use the parameter `-DcaseProject=true`.

1. Maven will download the libraries, and once it finishes, it will confirm if you want to create the project using the default GAV (group:artifact:version). Type "Y" and press enter.



1. You should get a new project named `mybusinessapp`. If you are in VSCode built-in terminal, you can open the project with:

```
$ code -r mybusinessapp/
```

1. In VSCode, navigate through the project structure and confirm that it has a `kie-deployment-descriptor.xml` and a `kmodule.xml`. These are the files that Business Central needs to understand that this is a business project that should be packaged in a kjar. These files are also needed by KIE Server.

34.3 Next Steps

Now, let's author a DMN file, test it and deploy it to KIE Server.

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3.10.3 35. Authoring a Decision

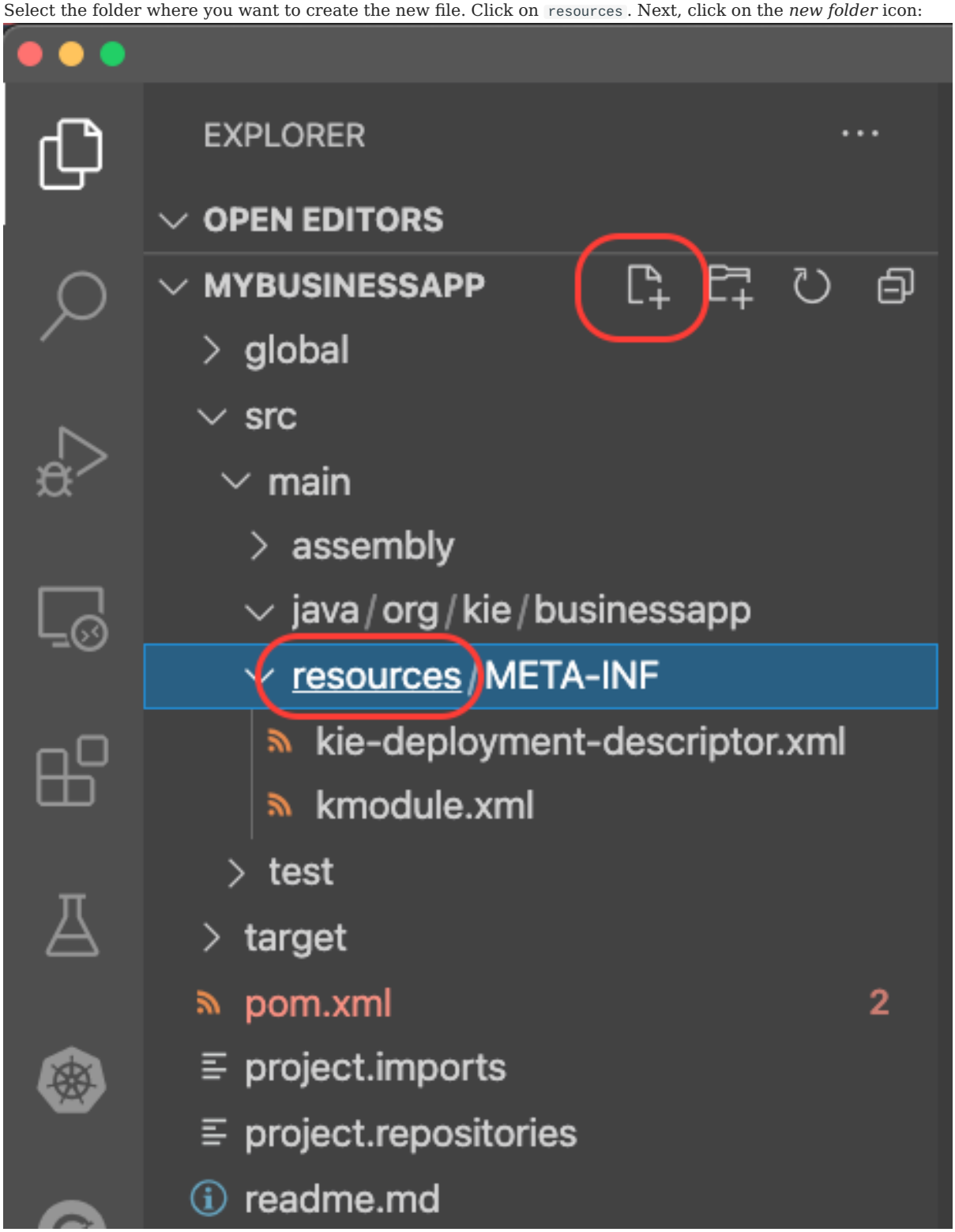
Let's author a simple decision and test it.

The use case we'll try out is the automation of a repeated decision for requests approval.

35.1 Create a new Decision

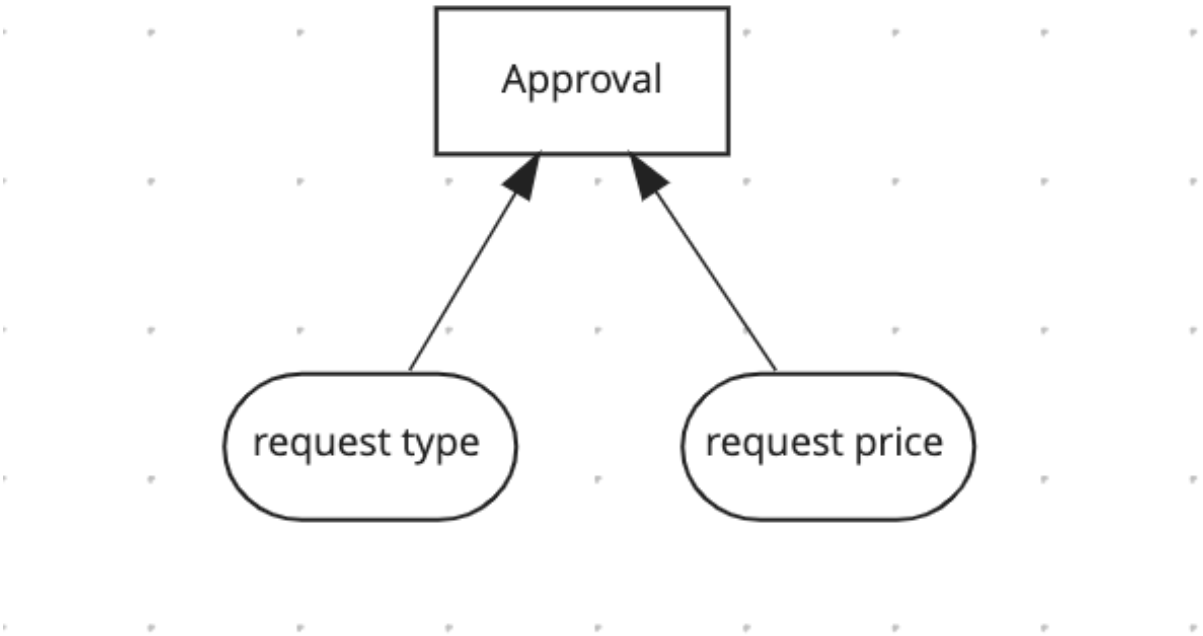
In the project we've just created:

1. Select the folder where you want to create the new file. Click on `resources`. Next, click on the *new folder* icon:



2. Name the file `automated-request-approval.dmn` and press enter. The file should open in the DMN Editor.

3. Create the following DMN:



4. This DRD contains:

- A decision node `Approval` of type `boolean`;
- Two inputs:
- A `request type`, which is `string`
- A `request price`, that is a `number`.

5. Implement the following decision table, in the decision node:

Approval *(Decision Table)*

U	request price *(number)*	request type *(string)*	Approval *(boolean)*	annotation-1
1	<=150	"low","medium","urgent"	true	
2	(150..400]	"medium","urgent"	true	
3	(150..400]	"low"	false	
4	(400..1500]	"urgent"	true	
5	(400..1500]	"medium","low"	false	
6	>1500	-	false	

6. Save the diagram

35.2 Testing the decision

Before deploying the decision service in KIE Server, let's do some unit testing using the Test Scenario Simulation tooling.

35.2.1 CONFIGURING THE PROJECT

In order to use test scenarios, you need to add at least three dependencies to your project:

- `junit:junit`
- `org.drools:drools-scenario-simulation-backend`
- `org.drools:drools-scenario-simulation-api`

Open the `pom.xml` file and add the following dependencies:

```
<dependencies>
  <dependency>
    <groupId>org.drools</groupId>
    <artifactId>drools-scenario-simulation-api</artifactId>
    <version>${version.org.kie}</version>
    <scope>test</scope>
  </dependency>
  <dependency>
    <groupId>org.drools</groupId>
    <artifactId>drools-scenario-simulation-backend</artifactId>
    <version>${version.org.kie}</version>
    <scope>test</scope>
  </dependency>
  <dependency>
    <groupId>junit</groupId>
    <artifactId>junit</artifactId>
    <version>4.12</version>
    <scope>test</scope>
  </dependency>
</dependencies>
```

35.2.2 ADDING THE JUNIT RUNNER

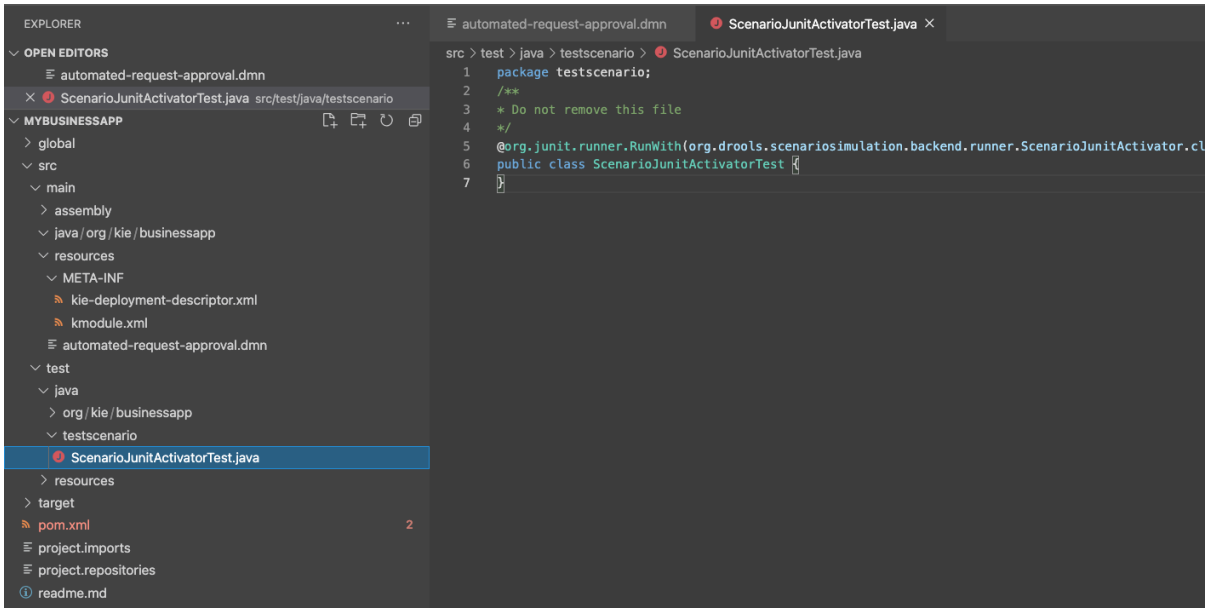
In this scenario, the `version.org.kie` should be compatible with the product version you want to use. In this scenario, we are using IBAMOE 7.10, which would be `<version.org.kie>7.67.2.Final-redhat-00006</version.org.kie>`.

1. Create a new folder testscenario: `/src/test/java/testscenario`
2. In the folder you just created, add a file and name it `ScenarioJunitActivatorTest.java`
3. In this class, you should add a the Scenario Activator. This class allows the test scenarios to run along with the junit tests.

```
package testscenario;
/**
* Do not remove this file
*/

@org.junit.runner.RunWith(org.drools.scenariosimulation.backend.runner.ScenarioJunitActivator.class)
public class ScenarioJunitActivatorTest {
}
```

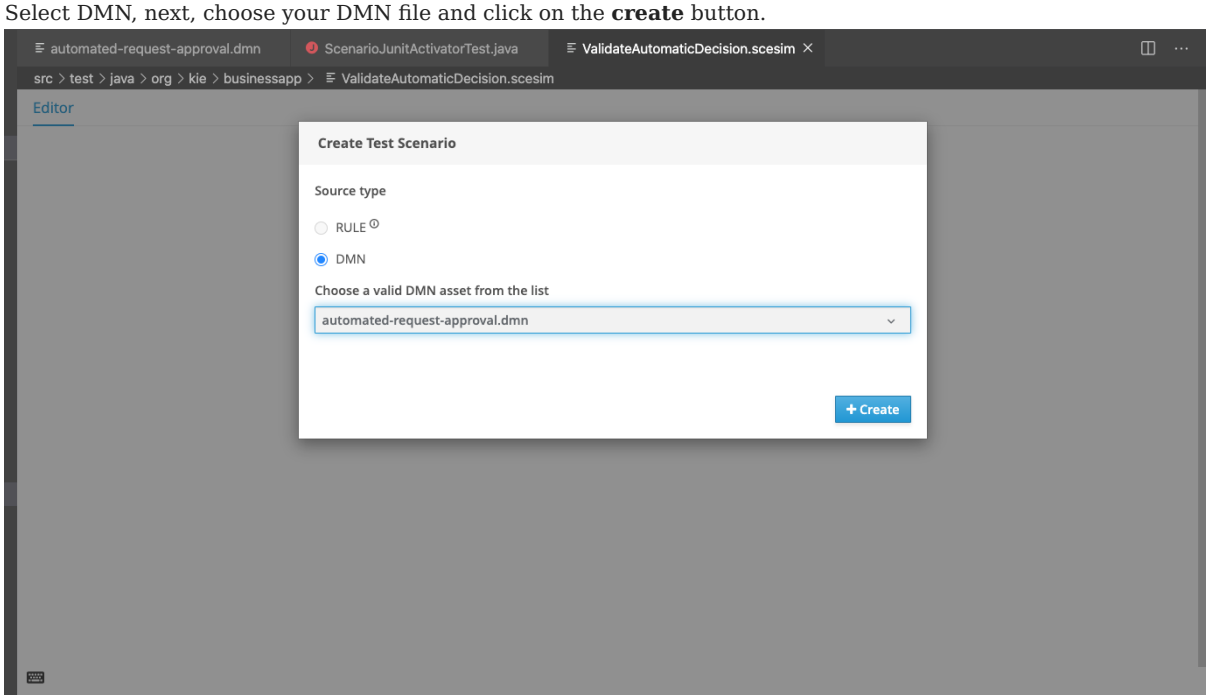
It should look like this:



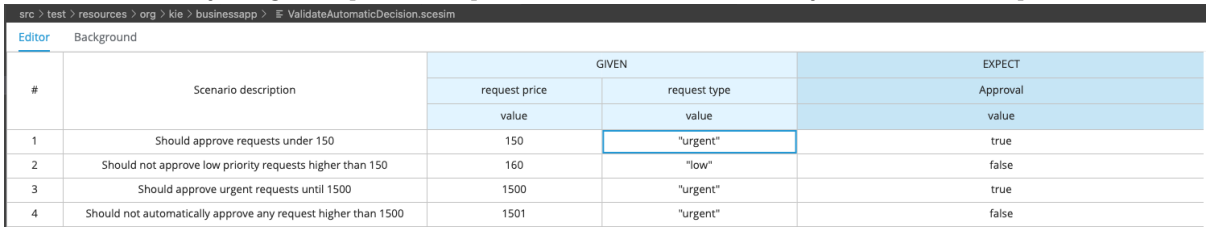
35.2.3 CREATING THE TEST SCENARIO

1. On the folder `src/test/resources/org/kie/businessapp` create a new file named `ValidateAutomaticDecision.scesim`.
2. The editor should open up with the option to choose the **Source type**. This is the type of rule you want to test.

3. Select DMN, next, choose your DMN file and click on the **create** button.



4. The tool will already bring the inputs and expected result columns based on your DMN. Now, implement the following test:



#	Scenario description	GIVEN		EXPECT
		request price	request type	Approval
		value	value	value
1	Should approve requests under 150	150	"urgent"	true
2	Should not approve low priority requests higher than 150	160	"low"	false
3	Should approve urgent requests until 1500	1500	"urgent"	true
4	Should not automatically approve any request higher than 1500	1501	"urgent"	false

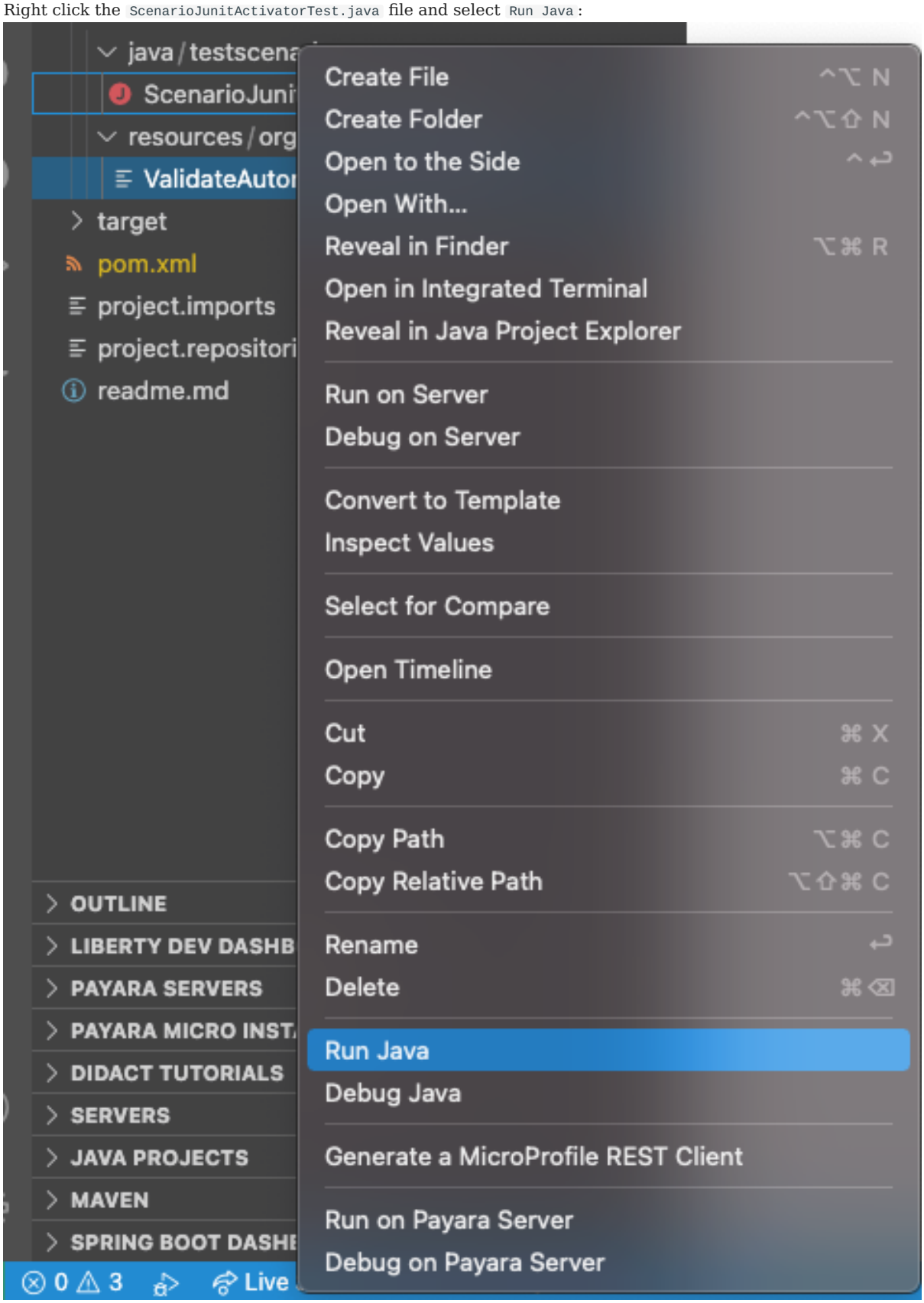
35.2.4 RUNING THE TESTS

You can run the tests in two ways: using maven or the JUnit activator class. To run the test with maven you can for example run:

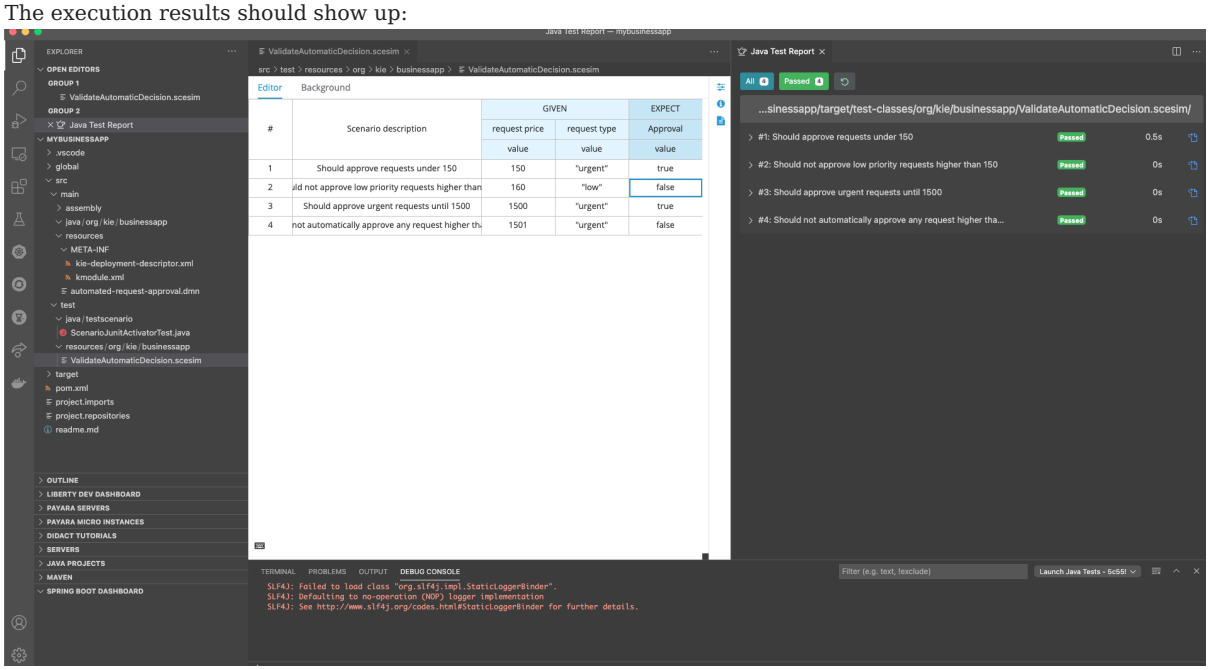
```
mvn test
```

If you want to run the tests using the activator class:

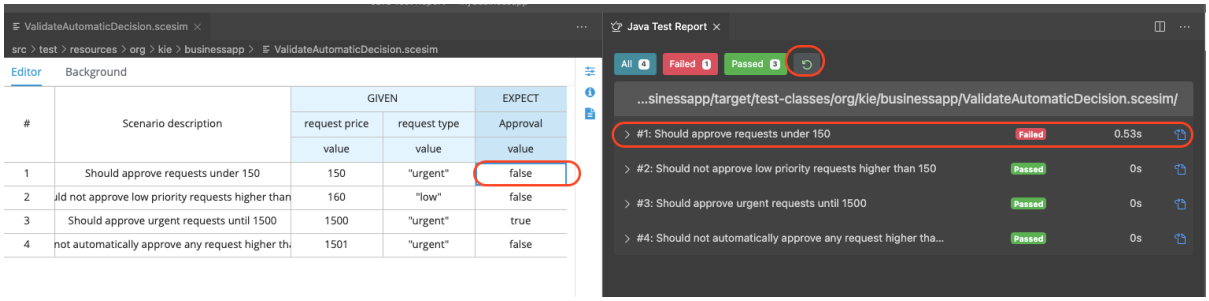
1. Right click the `ScenarioJunitActivatorTest.java` file and select `Run Java`:



2. The execution results should show up:



3. Try changing the line one expected result from `true` to `false`. Click on the re-run button to see the results.



Finally, adjust the tests and make sure that your project can compile when you run:

```
mvn clean install
```

35.3 Next Steps

Now it's time to deploy our project to KIE Server and test it out.

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3.10.4 36. Deploying the project in KIE Server

It's time to deploy our business application in KIE Server.

36.1 Deployment

We can deploy the project directly in KIE Server without the need to use Business Central. To do so, we can use the available REST API.

1. Open KIE Server REST API. (i.e. http://localhost:8080/kie-server/docs)
2. Under “KIE Server and KIE container" category select the following:
3. `PUT /server/containers/{containerId} Creates a new KIE container in the KIE Server with a specified KIE container ID`
4. Click on "Try it out"
5. Insert your project details. The GAV can be found for example, in your `pom.xml`. See an example:
6. **containerId**: mybusinessapp
7. **body**:

```
{"container-id" : "mybusinessapp",
    "release-id" : {
        "group-id" : "org.kie.businessapp",
        "artifact-id" : "mybusinessapp",
        "version" : "1.0"
    }
}
```

8. Click on the blue button "Execute". You should get a 201 result as follows:

36.2 Testing the Automated Approval Decision

Now, using the KIE server REST API, we'll consume the decision we've just deployed.

1. Under the section **DMN Models** locate:
2. `POST /server/containers/{containerId}/dmn Evaluates decisions for given input`
3. Click on try it out
4. Use the following data:
5. **ContainerID**: mybusinessapp
6. **Body:**

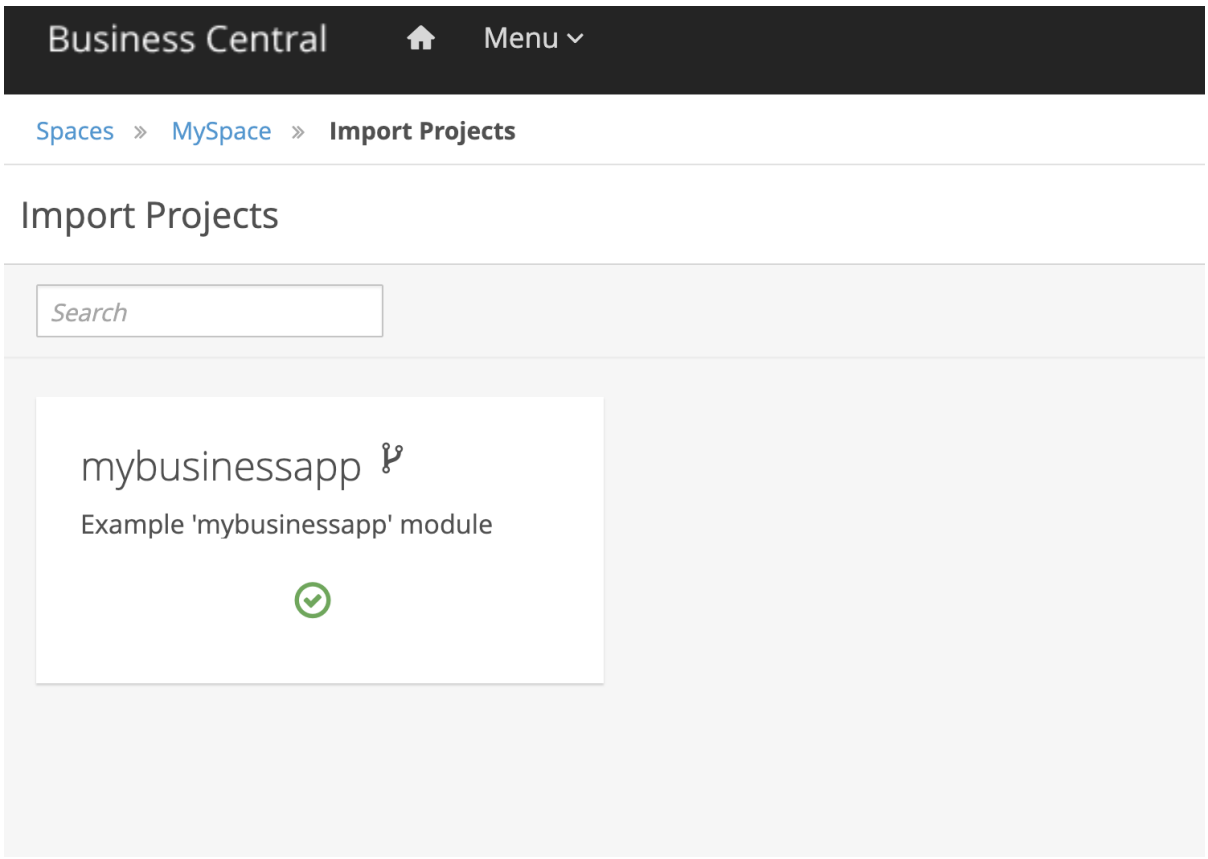
```
{
 "dmn-context": {
```

```
      "request type": "urgent",
      "request price": "250"
   }
  }
```

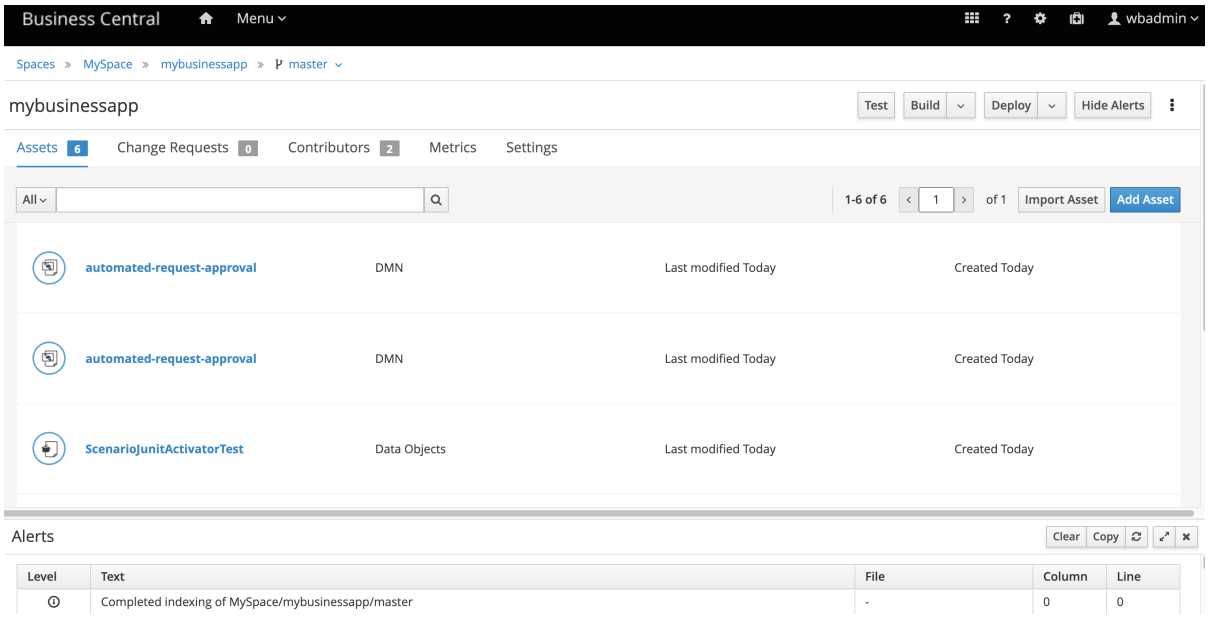
36.3 Extra Lab: Business Central

Finally, you can import this project in Business Central. In order to do so, this needs to be a git-based project and Business Central needs to have access to the git repository where the project is stored. The following steps consider a local environment scenario.

1. Access your application folder in the terminal.
2. Initialize the git repository and do the first commit
3. `git init`
4. `git add -A`
5. `git commit -m "first commit"`
6. With this you can already import the project in Business Central. Open Business Central and select the **import the project** option.
7. In the pop-up, in the **Repository URL** field, you should insert the git repository. If it is on your local machine you can inform something like: `/$PROJECT_DIR/tooling-labs/mybusinessapp`. Confirm the operation.
8. You should see the project. Select it and click the `Ok` button.



Feel free to explore the project and validate the test scenario and deployment through Business Central.



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