Lab : Configuring Continuous Integration Using Jenkins

In this episode, we will teach you how to integrate application with Jenkins, a Continuous Integration (CI) server. We will introduce CI concepts and how they can be implemented using Jenkins. We will configure a sample pipeline so that you can see how changes in application code are propagated to the deployed application.

Let's start with the builds.

Pre-reqs:

- https://www.katacoda.com/athertahir/courses/cloud-development-with-wildfly

Lab Environment:

Click Openshift Environment to access lab environment and then follow instructions provided in this guide.

You can access the `OpenShift Web Console` by clicking `Dashboard` tab located right to the terminal window. You will be welcomed by the user login screen. Let's enter our
`Username` and **`Password`**.

Use the `developer` user, with `developer` password, to log in on the welcome page. We will be directed to the welcome screen, as follows:

Click `New Project` and add following data to create new project:

Name: `petstore`

Display Name: `petstore`

Enter **petstore** as the name of the project. In order to deploy
catalog-service to OpenShift, we will use the source-to-image build
using the CLI.

To start with, ensure that you have logged in to the
cluster, as follows:

`oc login -u developer -p developer`

Output

```
Login successful.
```

Then, you need to execute the following command:

`oc project petstore`

`oc create -f https://raw.githubusercontent.com/wildfly-swarm/sti-wildflyswarm/master/1.0/wildflyswarm-sti-all.json`

The preceding command creates a bunch of OpenShift objects that are necessary to start an OpenShift build.

Important: Please wait for build to comeplete before starting application. You can get build status by running `oc get build --watch`

Pipeline build

In the first chapter, when we were explaining why you may be considering implementing the microservice architecture in your applications, we mentioned the challenges that are being currently faced by application developers and architects.

One of the key tools that may enable us to deal with providing software in a way that enables us to meet those challenges is automation. As we covered in the preceding chapter, OpenShift enables us to automate infrastructure provisioning. However, we need more than that.

We will also like to automate the process of deploying software into production. Ideally, we will like to have tools that will enable us to release software immediately. OpenShift provides such a tool in the form of the build `pipeline`. Let's introduce the rationale behind this concept.

Let's start with CI.

Continuous integration

As a developer, you know too well what the development of projects looks like. There are many developers working on different functionalities, which they contribute to the same repository. Contributions from all the developers have to be integrated into the code repository so that stable code is created. After that, the code can be published into the production environment.

This sounds simple, but if you don't create an organized order according to which this process is executed, you will quickly end up with a huge mess. If the developers will integrate rarely, they are asking for problems. Their repositories will be highly diverged, and the application's functionality will be scattered between their repositories. As a result, during the development, there will be no *current state* source repository, and we will have no information about the state of an application. The new version of an application will emerge during the time people decide to push their contribution to the main code (which will presumably happen the day before the release). The process of integration at this point will be painful, where incompatible contributions are being discovered, and errors will emerge. Such a situation was described in the past as *integration hell*.

Owing to the preceding problems, it became clear that it will be a good idea to integrate code frequently. The methodology that advocates such a behavior and, more importantly, gives hints on how to do it, is called CI.

Obviously, pushing the code frequently to the repository is not helping us much. At each commit, we need to make sure that the current version of the code at least compiles, and passes unit and integration tests. This is by no means a comprehensive list: to declare your code correctly, you may also need automatic code inspections or code reviews to name a few.

In order for this process to be executed consistently, it has to be automated and executed each time the user wants to make the change to the code. Also, developers are supposed to integrate their code frequently, with each logical functionality developed, and are supposed to fix any errors that appear as soon as possible.

If this procedure is observed, this will lead to a number of benefits:

- Problems are detected quickly. As the result, their source can be debugged and fixed quickly.
- The current version of the application is always present—it is the result of the last successful build. At each point, we can tell the status of the application, how it works, and what functionalities have been currently implemented.
- The automated process works as a trigger for quality control. The build is guaranteed to be run and be reproducible.

Continuous deployment

Continuous Integration ensures continuous builds of source code. It demands that fixes are pushed often and provides instant feedback to the developers. What if we extend this notion and configure our build infrastructure so that it will ensure that our services will be built and deployed automatically?

Such an approach, which is an extension of CI, is called Continuous Deployment. To implement it, we will need to automate the release process also. This means that we will have to keep all the resources that are needed to release the software to the given environment, such as environment properties or configuration scripts.

As a reward, we will be able to obtain reliable and repeatable releases. First of all, as the release process is no longer manual, all the magic is taken away from the release process. The release is executed by the release script using environment properties, which are both parts of the versioned build configuration. Those files are the one source-of-truth regarding the build process. As a result, if an error occurs during the build, those scripts have to be fixed. There is no place for manual patches or ad hoc fixes. Also, builds happen often, so configuration bugs will have an opportunity to occur and be fixed. On the other hand, after builds and releases start to work correctly, each next correct build adds more confidence in the release process. As a result, the release becomes a well-tested and an automated event.

Note

Such an approach changes the way the team works by changing the speed at which features are developed. With CD, you are not releasing the software in large chunks to the client. Instead, small functionalities are released often and are immediately visible to the client.

This is the expected behavior for a number of reasons. First, customers will like to respond to client demand as quickly as possible. Having the tool that enables them to do that will be a big market advantage for the customer. However, there is more to it: because new functionalities are released often, they are visible to the customer immediately. As a result, a customer can immediately assess the actually implemented functionality. This creates an efficient feedback loop between the developers and the customers, which allow for faster convergence to the functionality actually expected by the client.

Deployment pipeline

The process of automatic delivery is implemented using a `pipeline`. A `pipeline` is a chain of steps that takes the source code as its input and provides a working application on it's output.

The goal of the `pipeline` is to make sure that the source code is ready to be deployed in production. As a result, a `pipeline` should be able to catch errors as soon as possible and provide feedback to the developers immediately.

Also, because the final product is the released application, a `pipeline` should automate the release process so that it is run the same in all environments.

Although a `pipeline` is a configurable script and its direct operation depends on your concrete environment, there are a number of common steps that are executed in the deployment `pipeline`: commit, build, automatic tests, manual tests, release, and so on.

Configuring Continuous Deployment in OpenShift environments

After this quick theory recap, now let's return to our cluster and configure CD for our application.

At the beginning of this chapter, we described the source-to-image build, which we have used in previous chapters. We also hinted that there is a `pipeline` build available. As you probably have guessed by now, this is the kind of build that we will use to implement CD of our services.

The `pipeline` build uses the Jenkins server to configure the `pipeline` configuration. Before moving further, let's introduce it quickly.

Introducing Jenkins

Jenkins is an open source software automation server. It allows for `pipeline` creation and provides the relevant syntax. So, how are we able to use Jenkins in OpenShift cluster and configure `pipeline` execution? Let's find out.

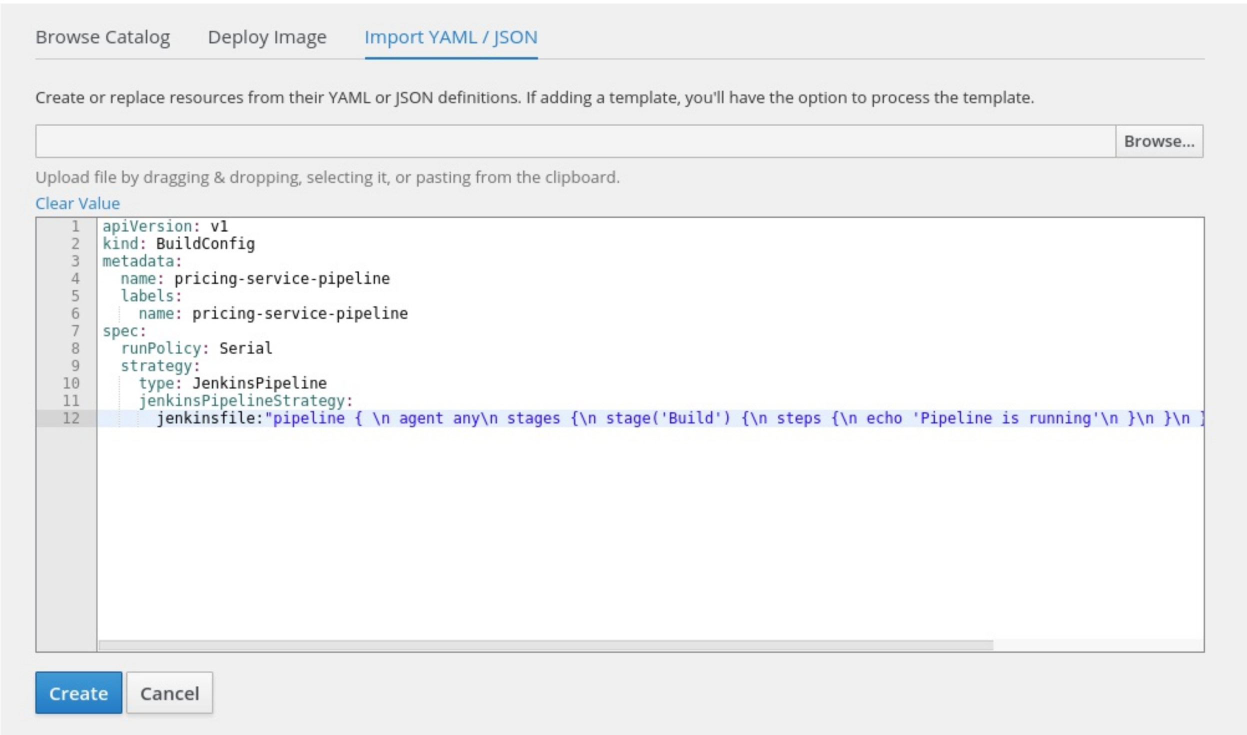
Our first pipeline

Let's start by creating our first `pipeline`. We have to log in to our w eb console and navigate to `Add` to project | `Import YAML`.

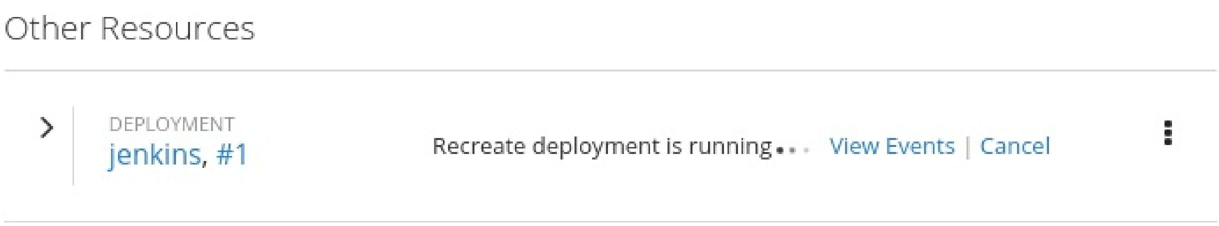
In order to do that, w e have to go the w eb console's main w eb page and navigate to `Add to Project` | `Import YAML/Json` and enter the follow ing script there:

```
apiVersion: v1
kind: BuildConfig
metadata:
  name: pricing-service-pipeline
  labels:
    name: pricing-service-pipeline
spec:
  runPolicy: Serial
  strategy:
    type: JenkinsPipeline
    jenkinsPipelineStrategy:
      jenkinsfile: "pipeline { \n agent any\n stages {\n stage('Build') {\n steps {\n echo 'Pipeline is running'\n }\n }\n
```

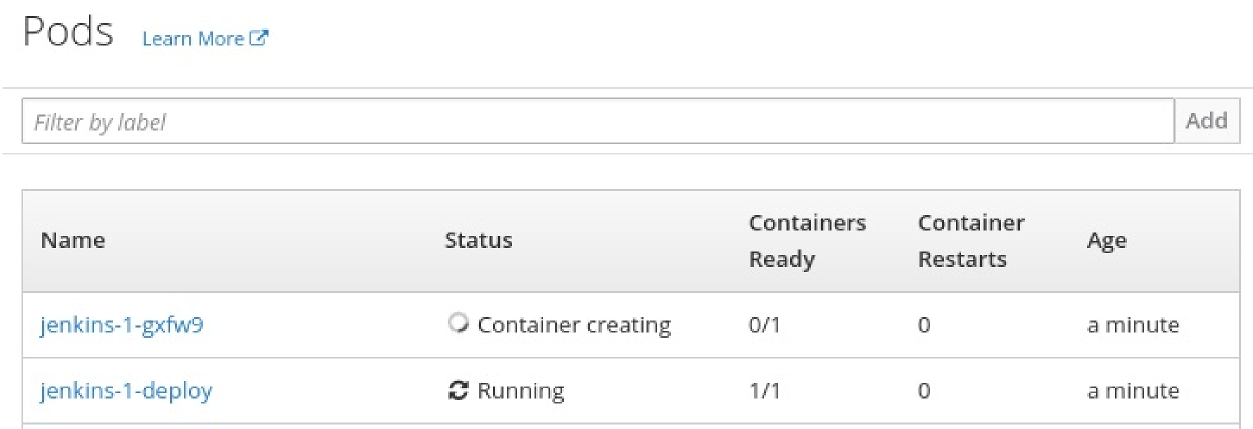
After the script is created, w e can click on the `Create` button:



Before w e look further at the `pipeline` code, let's note the other things that are happening. If w e get to the main view of the w eb console, w e w ill note that there is a new resource:



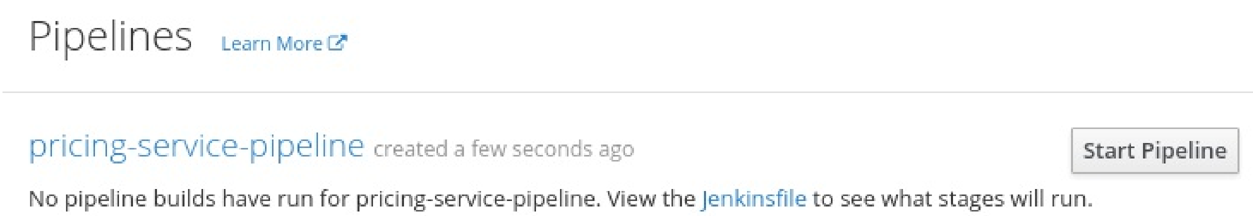
Let's take a look at the currently available `Pods` too:



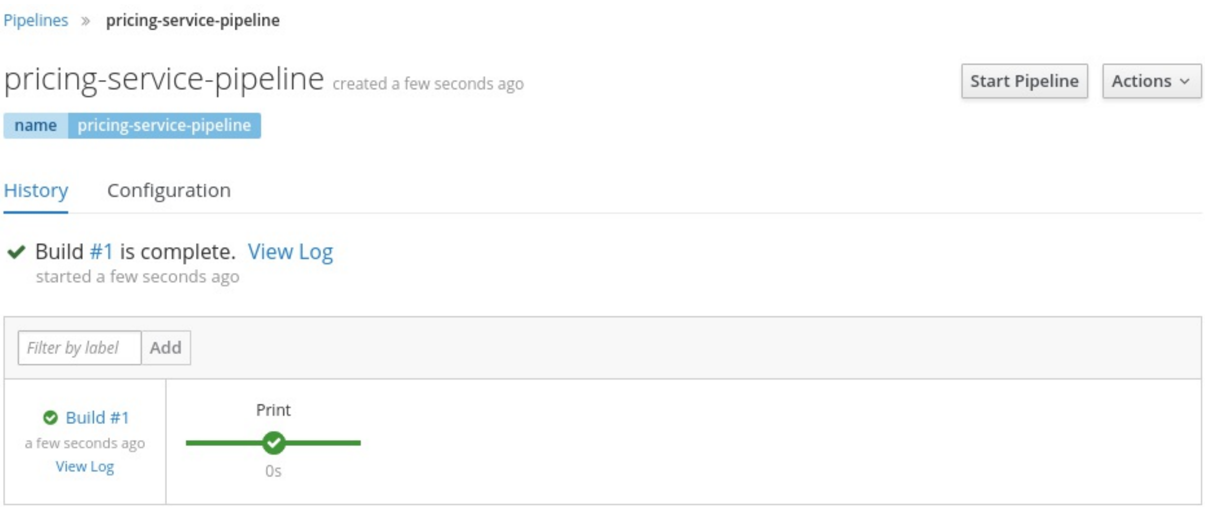
Indeed, there is a new deployment of Jenkins server running, and the container for the Jenkins server is being created. OpenShift runs a `pipeline` build using the Jenkins server. Therefore, w henever you create a `pipeline`, OpenShift must check w hether there is a Jenkins server present in the cluster. If not, OpenShift w ill start one automatically.

The creation of the Jenkins server takes some time, so w e have to w ait till it has been deployed. After w e are able to see that the application is running in the `Pods` view, w e are ready to start the build of our first `pipeline`.

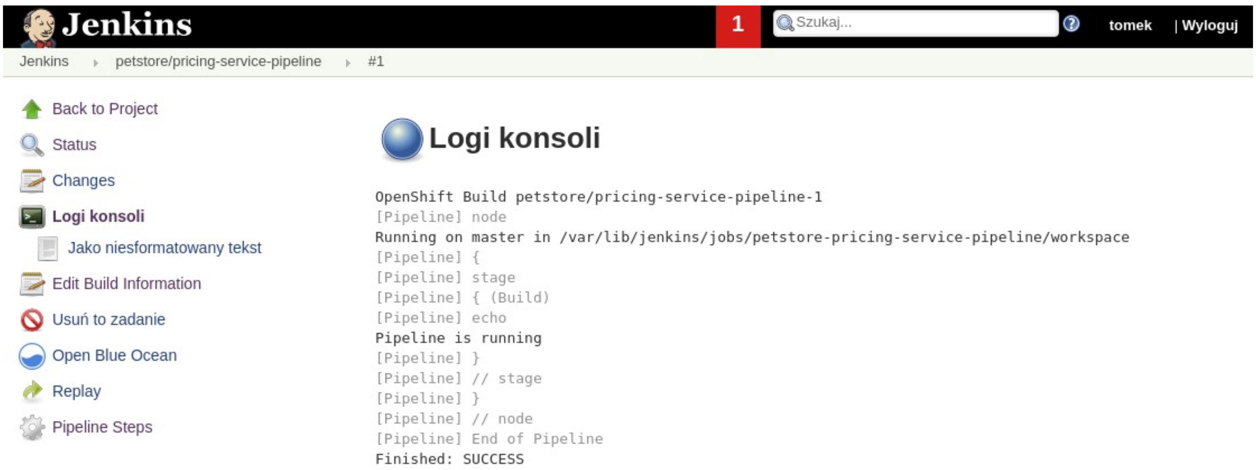
In order to do that, let's navigate to ** `Build | **` Pipelines `**. You will be able to see that there is a new` pipeline` present:



Let's click on the `Start Pipeline` button and see w hat happens:

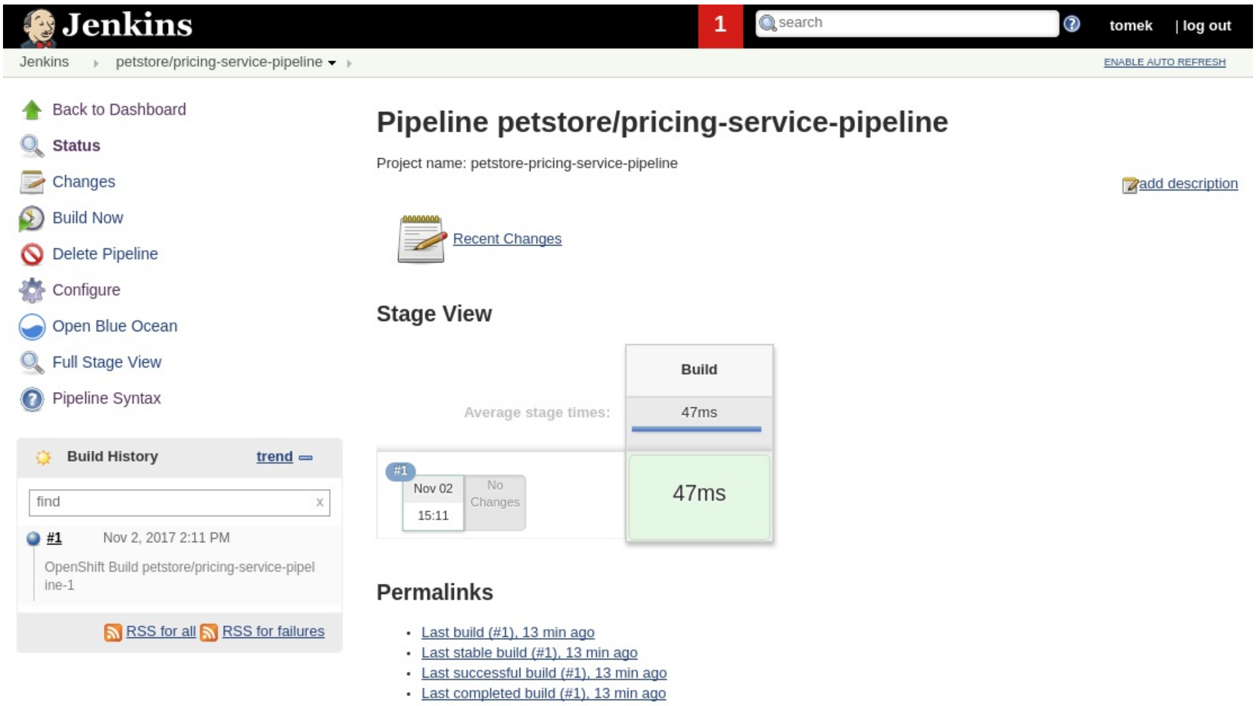


Note in the preceding screenshot that the build has run. The dot with the tick described as Print means that one stage has been run and that it has been successful. We will be talking about the Jenkins `pipeline` structure in just a moment. Now, let's take a look at more information about our current build by clicking on the `View Log` button:



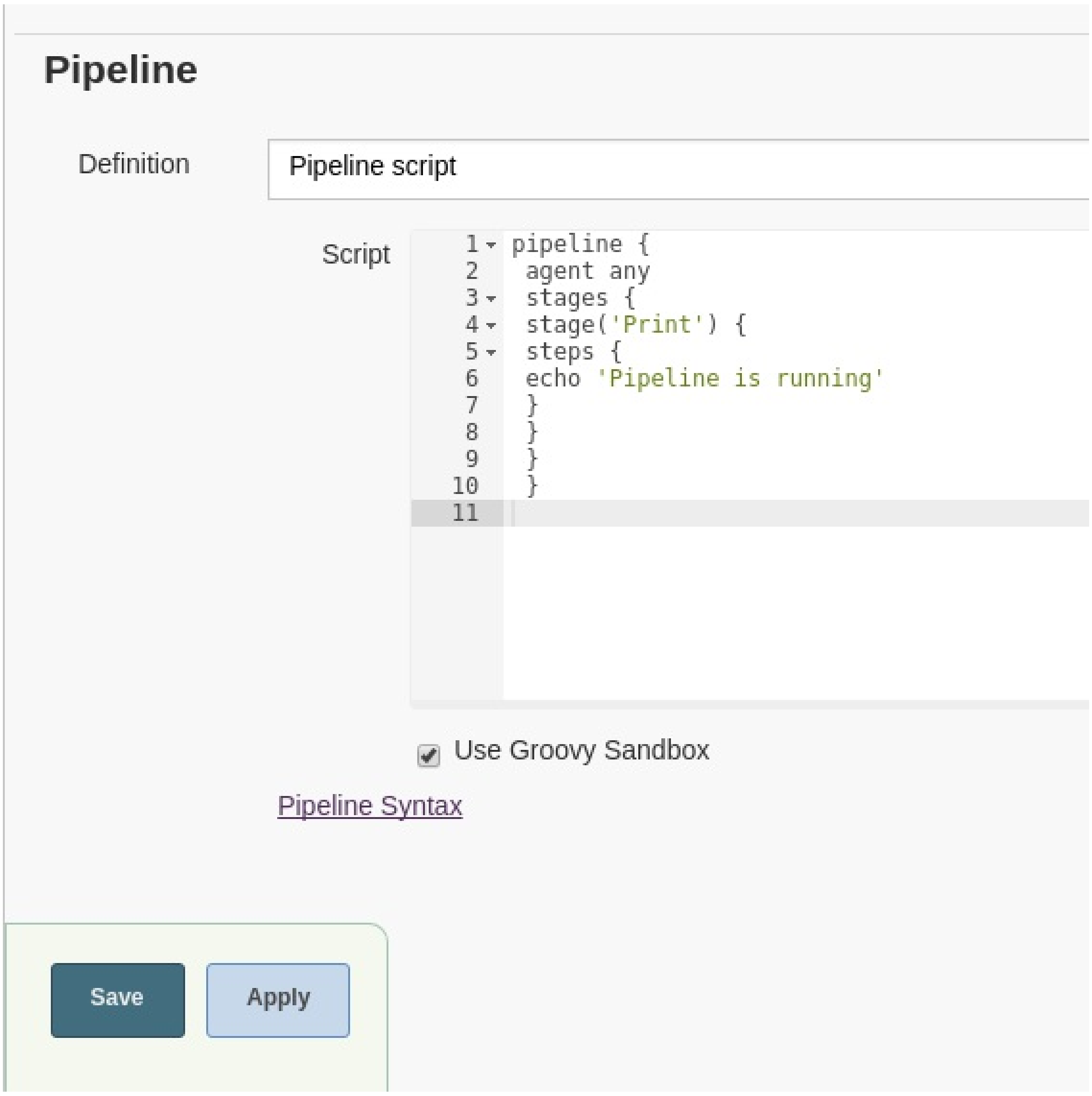
As you will have noticed in the preceding screenshot, we have been redirected to the Jenkins console. The build has been created, the `Print` stage has been executed, and the print message that we have echoed has indeed been written to a log.

As you can see, the `pipeline` build configuration has been automatically turned into the Jenkins build and run in the Jenkins console. We will get more information about the build when we click on `petstore/pricing-service-pipeline` in the top-left corner of the screen:

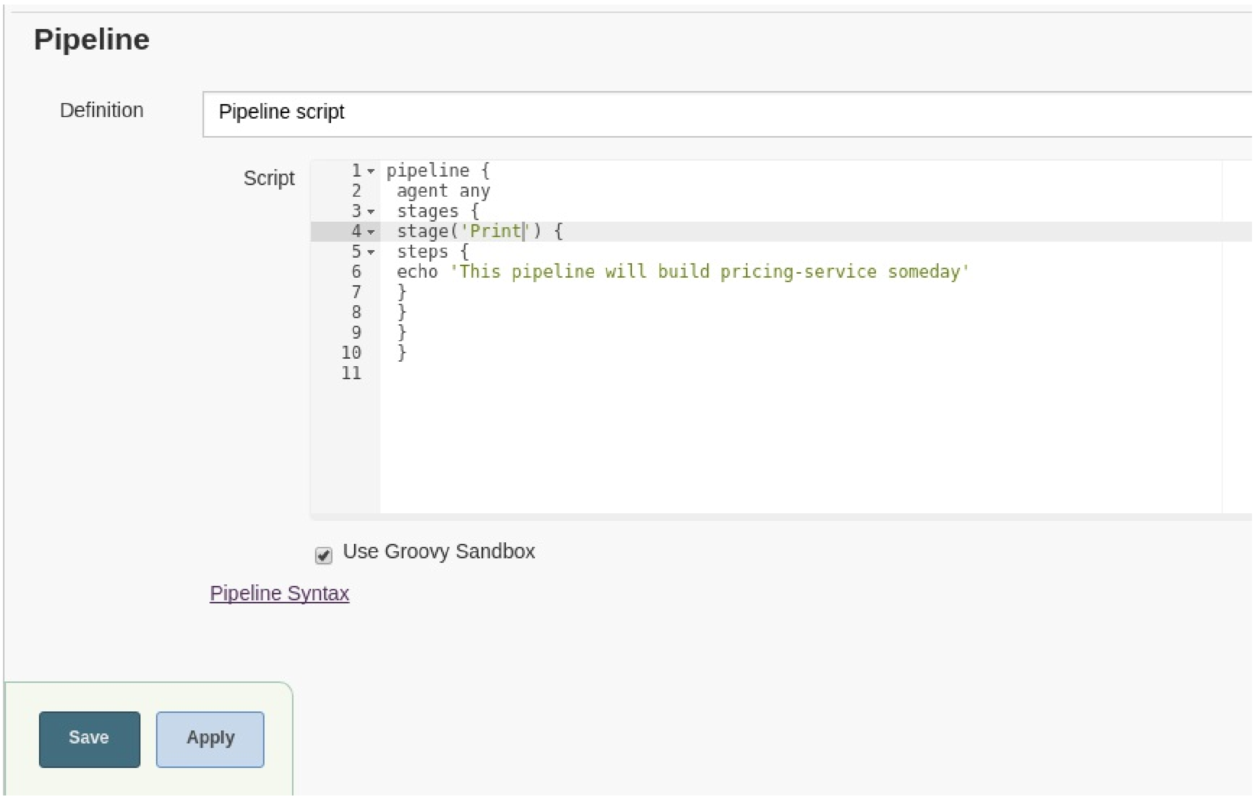


From this window, we can trace the build history, view the logs and time of the latest execution, or edit the `pipeline`, among others.
At this point, it is good to look again at the script that we have written in order to create the `pipeline`. You probably have noted immediately that the Jenkins `pipeline` was squashed into one line, making it hard to read and edit. Before we take any other steps, let's find a human way to edit our `pipeline`.

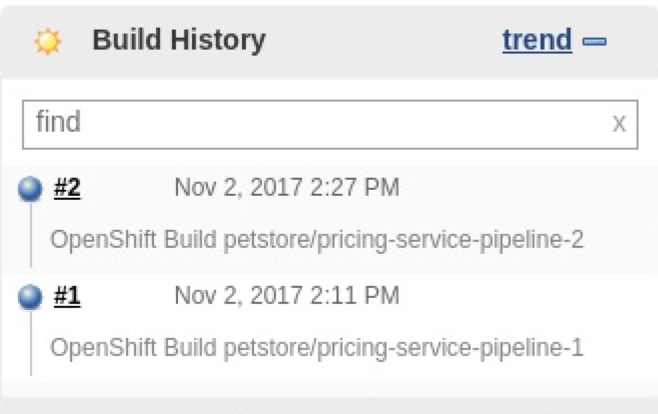
In order to do that, let's click on the **`Configure`** button on the left-hand side menu and scroll down:



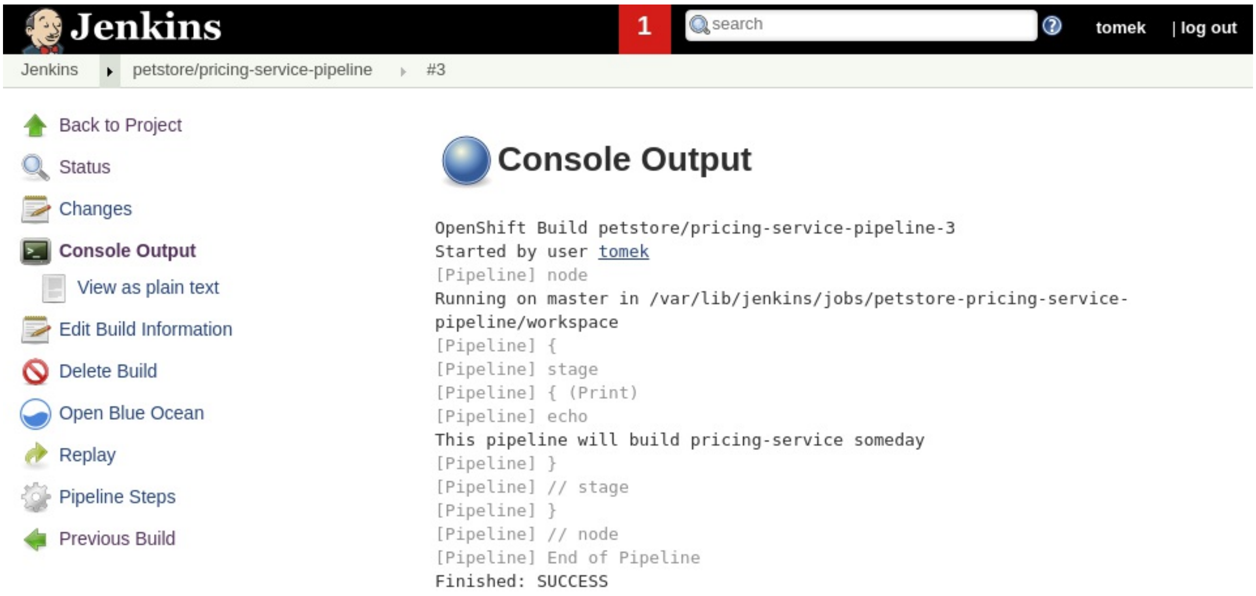
We have a good editor for our `pipeline` here. Let's make our first edit of the file:



We will then test it to check whether it works. In order to do that, we have to save the `pipeline` and click on the `Build Now` button in the build view. After that, we are ready to examine the log by clicking on the second build that has just been executed:



We will see the new log as follows:



Also, let's log in again to the web console and examine that `pipeline` there:

``

``

As you will have noticed, the `pipeline` build config was modified accordingly to the changes that we have made in Jenkins. We will perform our future changes using the Jenkins server.

The new message that we are printing in the build promises that our build will do something useful at some point. After all, we want to create a CD `pipeline` for our services and not print messages. Before we can do it though, we will need to learn a few more things. In the beginning, we will need to say a few more words about the language that we are using to define the `pipeline`.

Pipeline syntax language

When we wrote our first `pipeline`, we used the Jenkins declarative pipeline language. We will describe the essentials of the **Declarative Pipeline Language** (**DPL**) in the next section.

Core pipeline elements

In order to do that, let's return to the `pipeline` that we executed in the preceding section:

```
//1
pipeline {
    //2
    agent any
    //3
    stages {
        //4
        stage('Print') {
```

```
            steps {
                echo 'This pipeline will build pricing-service one day'
            }
        }
    }
}
```

Each `pipeline` in DPL must be enclosed with the `pipeline` block (1).

The `pipeline` must begin with the `agent` directive (2). This directive specifies the Jenkins builder machines in which the build stages (more about them in a moment) can be executed. This setting can be overridden in each of the stages. In our examples, we will use any agent for all the stages.

The core `pipeline` build blocks are the stages. The stages are meant to map to the stages in the CD `pipeline`. They are defined in a serial order, and each stage can execute only if the stage before has succeeded.

The stages have to be enclosed with the `stages` (3) block. Each stage (there need to be at least one of them) has its own `stage` block with the name specified as a parameter.

Each stage block can contain a bunch of directives followed by the steps block, which encloses one or more steps that will be executed in the `pipeline`.

Now, we are getting to the key point. What are the available steps that we can execute? Jenkins provides a very large number of different steps provided by different plugins. We will concentrate on one specific plugin that makes it easy to develop and execute operations on OpenShift clusters—let's discuss OpenShift, the `pipeline` Jenkins plugin (Further reading, link 1).

Standard Maven operation

The first stage that we will implement is the unit testing stage. In the beginning, we will add a simple unit test. We have to extend `pom.xml`:

```
(...)


    <dependencies>
        (...)
        <dependency>
            <groupId>org.postgresql</groupId>
            <artifactId>postgresql</artifactId>
            <version>${version.postgresql}</version>
        </dependency>

        //1
        <dependency>
            <groupId>junit</groupId>
            <artifactId>junit</artifactId>
            <version>${version.junit}</version>
            <scope>test</scope>
        </dependency>

        //2
```

```
        <dependency>
            <groupId>org.jboss.arquillian.junit</groupId>
            <artifactId>arquillian-junit-container</artifactId>
            <scope>test</scope>
        </dependency>

        //3
        <dependency>
            <groupId>org.wildfly.swarm</groupId>
            <artifactId>arquillian</artifactId>
            <version>${version.wildfly.swarm}</version>
            <scope>test</scope>
        </dependency>

        //4
        <dependency>
            <groupId>com.h2database</groupId>
            <artifactId>h2</artifactId>
            <version>${version.h2}</version>
            <scope>test</scope>
        </dependency>

    </dependencies>

    (...)



</project>
```

Recall that w e had to add dependencies for JUnit (1), Arquillian (2), Sw arm's Arquillian adapter (3), and the in-memory database that w e w ill use (4).

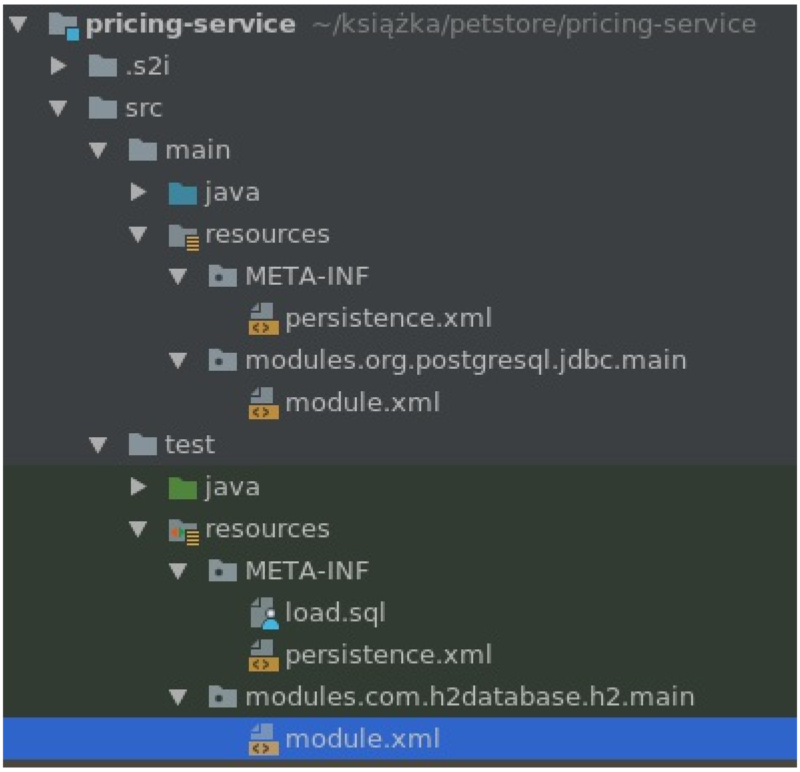
Secondly, w e have to provide test resources, namely `persistence.xml`:

```
<?xml version="1.0" encoding="UTF-8"?>
<persistence
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
version="2.1"
xmlns="http://xmlns.jcp.org/xml/ns/persistence"
xsi:schemaLocation="http://xmlns.jcp.org/xml/ns/persistence http://xmlns.jcp.org/xml/ns/persistence/persistence_2_1.xsd">
<!-- 1 -->
<persistence-unit name="PricingPU" transaction-type="JTA">
<!-- 2 -->
<jta-data-source>java:jboss/datasources/PricingDS</jta-data-source>
        <properties>
<!-- 3 -->
<property name="javax.persistence.schema-generation.database.action" value="drop-and-create"/>
            <property name="javax.persistence.schema-generation.create-source" value="metadata"/>
            <property name="javax.persistence.schema-generation.drop-source" value="metadata"/>

            <property name="javax.persistence.sql-load-script-source" value="META-INF/load.sql"/>
        </properties>
    </persistence-unit>
</persistence>
```

And the load script that w e are going to use to test the database:

```
DROP TABLE IF EXISTS PRICE;

CREATE TABLE PRICE (id serial PRIMARY KEY, name varchar, price smallint);

INSERT INTO PRICE(name, price) VALUES ('test-pet', 5);
```

Ensure that w e also add the `h2` driver module:



We are now ready to w rite a test:

```
package org.packt.swarm.petstore.pricing;

import org.jboss.arquillian.container.test.api.Deployment;
import org.jboss.arquillian.junit.Arquillian;
import org.jboss.shrinkwrap.api.ShrinkWrap;
import org.jboss.shrinkwrap.api.asset.EmptyAsset;
import org.jboss.shrinkwrap.api.spec.JavaArchive;
import org.junit.Assert;
import org.junit.Test;
import org.junit.runner.RunWith;
import org.wildfly.swarm.Swarm;
import org.wildfly.swarm.arquillian.CreateSwarm;
import org.wildfly.swarm.datasources.DatasourcesFraction;
import org.wildfly.swarm.jaxrs.JAXRSArchive;
import org.wildfly.swarm.spi.api.Module;

import javax.inject.Inject;

//1
@RunWith(Arquillian.class)
public class PricingServiceTest {

//2
@Deployment
public static JavaArchive createDeployment() {
return ShrinkWrap.create(JavaArchive.class)
                .addClasses(Price.class, PricingService.class)
                .addAsResource("META-INF/persistence.xml")
                .addAsResource("META-INF/load.sql")
                .addAsManifestResource(EmptyAsset.INSTANCE, "beans.xml");
}

//2
@CreateSwarm
public static Swarm createSwarm() throws Exception {
```

```
        DatasourcesFraction datasourcesFraction = new DatasourcesFraction()
//3
.jdbcDriver("h2", (d) -> {
                    d.driverClassName("org.h2.Driver");
d.xaDatasourceClass("org.h2.jdbcx.JdbcDataSource");
d.driverModuleName("com.h2database.h2");
})
                .dataSource("PricingDS", (ds) -> {
                    ds.driverName("h2");
ds.connectionUrl("jdbc:h2:mem:test;DB_CLOSE_DELAY=-1;DB_CLOSE_ON_EXIT=FALSE");
ds.userName("sa");
ds.password("sa");
});

Swarm swarm = new Swarm();
swarm.fraction(datasourcesFraction);

        return swarm;
}

//3
@Inject
PricingService pricingService;

//4
@Test
public void testSearchById() {
       Assert.assertEquals(pricingService.findByName("test-pet").getPrice(),5);
}
}
```

Now, w e are finally ready to w rite the testing stage. We w ill like to make this stage run fast and fail immediately if there are some problems, w ithout creating an image or changing anything in our OpenShift model. For this, w e w ill use standard Maven and git from the command line.

In order to do this, w e need to configure those tools. To do this, w e w ill have to go to Jenkins configuration in the main menu, click on `Manage Jenkins` and select the tool configuration for `JDK`:

And `Maven`:

We are finally ready to update our `pipeline`. Let's take a look:

```
pipeline {
//1
 agent any
//2
tools {
    maven 'maven3.5.2'
    jdk 'jdk8u152'
    git 'Default'
 }
 stages {
//3
 stage('Unit tests') {
     steps {
      //4
      git url: 'https://github.com/PacktPublishing/Hands-On-Cloud-Development-with-WildFly.git'
 //5
 sh 'mvn clean test -Dswarm.build.modules=target/test-classes/modules'
 }
 }
}
```

We have provided the mandatory agent any (1) and configured Maven, JDK, and git tools, providing the versions for all of them. We have replaced our print stage with the unit test stage (3), which consists of the following two steps:

1. The first step clones the **`pricing-service`**'s git repository (4)
2. The second step runs the Maven tests (5)

Note

We have to provide the modules directory in order for the tests to work.

OK. So, we have our first stage. Now, what next? If the unit tests pass, we will like to build and deploy an image with our application. In order to do that, we will have to interact with our cluster object from within the `pipeline`. The tool that will help us do that with ease is the OpenShift Pipeline Plugin. Let's learn more about it.

OpenShift Pipeline Plugin

Jenkins has a pluggable architecture, which allows for plugin development. OpenShift provides its own plugin, which allows for straightforward operations on OpenShift cluster objects in a declarative manner. The plugin provides a number of commands. We will introduce them one by one during the `pipeline` development.

In the beginning, we will write a build stage, which will assemble the image and ensure that the application works correctly.

The first command that we will use is the `openShiftBuild` command. It allows running one of the builds defined in the OpenShift cluster. This command takes one mandatory parameter, `buildCfg`, which is the name of the build that will be executed.

The second command that we will use is verified as `Build`. This command also takes `buildCfg` and checks whether the last build of this type has finished successfully within a reasonable time period. To set the period, we will use the `waitTime` parameter.

Let's take a look at our new `pipeline`:

```
pipeline {
 agent any
 tools {
    maven 'maven3.5.2'
    jdk 'jdk8u152'
    git 'Default'
 }
 stages {
 stage('Test') {
     steps {
      git url: 'https://github.com/PacktPublishing/Hands-On-Cloud-Development-with-WildFly.git'
      sh 'mvn clean install -Dswarm.build.modules=target/test-classes/modules'
     }
    }
 //1
 stage('Build') {
     steps {
        //2
        openshiftBuild(bldCfg: 'pricing-service', showBuildLogs: 'true')
        //3
        openshiftVerifyBuild(bldCfg: 'pricing-service', waitTime: '300000')
    }
 }
 }
}
```

We have introduced the `Build` stage (1) and added two steps to it, as mentioned in the preceding paragraph. The `Build` command runs the `pricing-service``s2i` build that we configured at the beginning of this chapter (2). The verify command checks whether the build was executed successfully within 5 minutes.

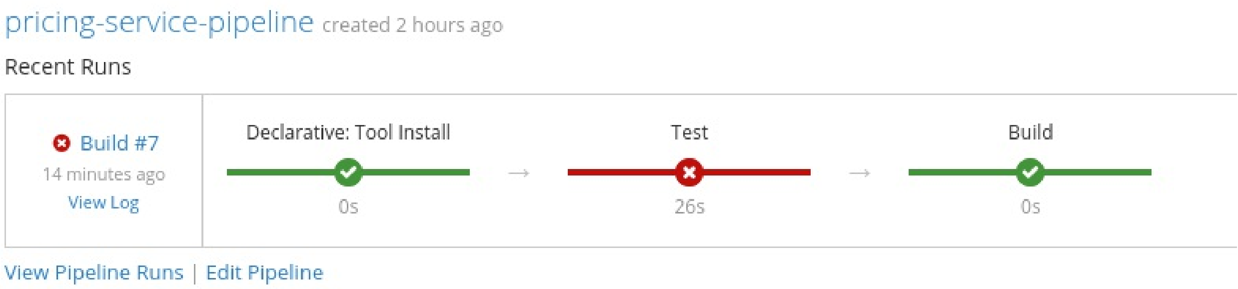
Note

We w ill like to only build the image here and not deploy it yet. So, w e w ill need to modify our build and remove the image change as the trigger for the deployment.

After that, w e are ready to start our `Build` in Jenkins. If you do it and click on console output, you w ill be able to see the execution log. Let's take a look at it:

```
        at org.apache.maven.surefire.booter.ProviderFactory.invokeProvider(ProviderFactory.java:85)
        at org.apache.maven.surefire.booter.ForkedBooter.runSuitesInProcess(ForkedBooter.java:115)
        at org.apache.maven.surefire.booter.ForkedBooter.main(ForkedBooter.java:75)


Results :

Failed tests:   testSearchById(org.packt.swarm.petstore.pricing.PricingServiceTest)

Tests run: 1, Failures: 1, Errors: 0, Skipped: 0

[INFO] ------------------------------------------------------------------------
[INFO] BUILD FAILURE
```

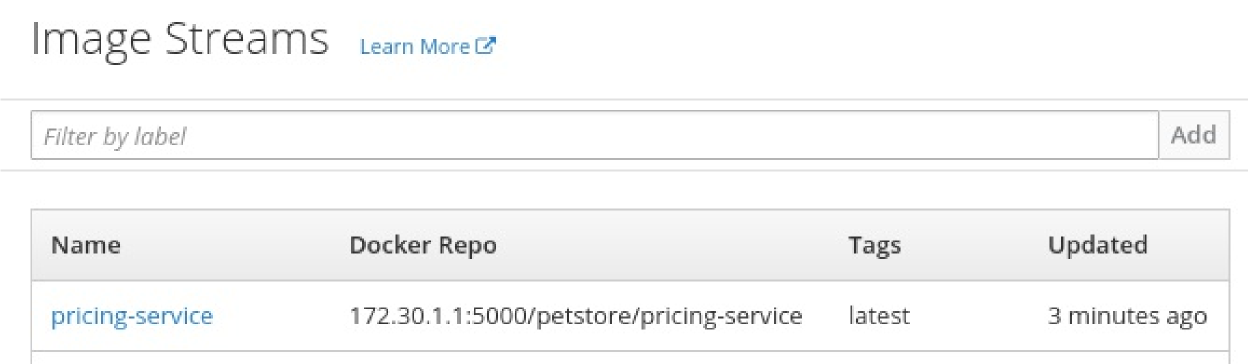
Oops! If you look again at the test, you w ill note that there is an error, as the price of the test-pet is 5 none 7. Before w e fix it, let's note how the `pipeline` w orks. Our first unit test stage failed immediately. As a result, no further stages w ere started. No images w ere built and no applications w ere deployed. Let's also look at the `pipeline` view on the w eb console:



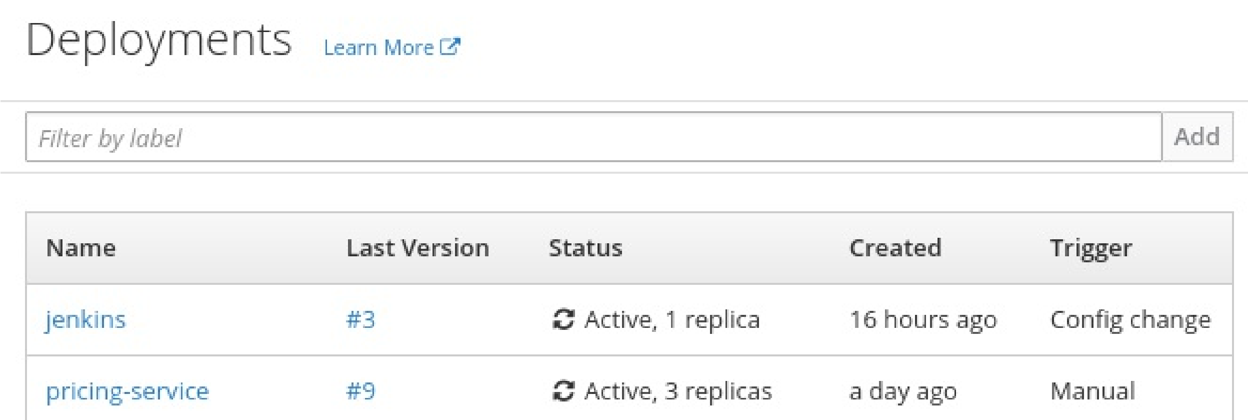
The console presents the `pipeline` execution in a graphic w ay, show ing that the test stage failed. Let's fix our tests and run the application again. If you do it and look at the console log, you w ill be able to see that the test has passed and the `Build` stage has been executed:

```
[WARNING] The requested profile "openshift" could not be activated because it does not exist.
...done
Pushing image 172.30.1.1:5000/petstore/pricing-service:latest ...
Pushed 7/8 layers, 88% complete
Pushed 7/8 layers, 95% complete
Pushed 8/8 layers, 100% complete
Push successful

Exiting "Trigger OpenShift Build" successfully; build "pricing-service-19" has completed with status:  [Complete].
[Pipeline] openshiftVerifyBuild


Starting the "Verify OpenShift Build" step with build config "pricing-service" from the project "petstore".
  Waiting on build "pricing-service-19" to complete ...
Operation will timeout after 5000 milliseconds


Exiting "Verify OpenShift Build" successfully; build "pricing-service-19" has completed with status:  [Complete].
[Pipeline] }
[Pipeline] // stage
[Pipeline] }
[Pipeline] // withEnv
[Pipeline] }
[Pipeline] // node
[Pipeline] End of Pipeline
Finished: SUCCESS
```

When you take a look at the w eb console, you w ill be able to see that the `Build` has been finished and that the image has been created:



Let's look at the currently available deployments:



Now, w e only have the build image and have not triggered the deployment yet. Let's add another stage to our build. We w ill use `openshiftDeploy` , `openshiftScale` , `openShiftVerifyDeployment` , and `openShiftVerifyService`. Before doing that, let's introduce each of these commands.

The `openshiftDeploy` command takes a mandatory parameter—`dplCfg`—which is the name of the deployment. It runs the deployment of an application.

`openshiftScale`, irrespective of a mandatory `dplCfg` parameter, takes the `replicaCount` parameter, which specifies the number of replicas of the application. Since we are using this command to scale the application, we will change the number of instance deployments in the `deploymentConfig` to zero. As a result, the pods will be started only after the `openshiftScale` operation has been executed without an unnecessary rescale.

`openShiftVerifyDeployment` has the same mandatory parameter as the two previous commands—`dplCfg`. This command has three optional parameters, and we will use all of them:

- `replicaCount`: This parameter specifies the expected number of replicas
- `verifyReplicaCount`: This is a Boolean parameter, which specifies whether the replica count should be checked
- `waitTime`: This indicates the time in milliseconds in which we should wait for the verification
- `openshiftVerifyService`: This command checks whether the service is available

`openshiftVerifyService` has one mandatory parameter:

- `svcName`
- One optional parameter `retryCount` specifies how many times the connection is attempted before declaring the verification invalid

Before showing you the new script, we will introduce one more concept. As we mentioned in the theoretical section of this chapter, the build should give immediate feedback to its authors regarding its status. In order to react to the `Build` status, the DPL provides the ability to perform an action after the `pipeline` is finished based on the status of the build. The construct that allows doing that is post directive.

A post directive enables us to perform an action after the build has been finished. It can be placed at the end of the `pipeline` or at the end of each stage. The post directive provides a bunch of subdirectories: always, success, failure, unstable, (runs if the build is unstable—the result changes during the build) aborted, and changed.

In our script, for the sake of simplicity, we will echo the build status to the console, but we can use the available Jenkins plugins0; to configure email, HipChat, or slack notification.

Let's take a look at the build:

```
pipeline {
```

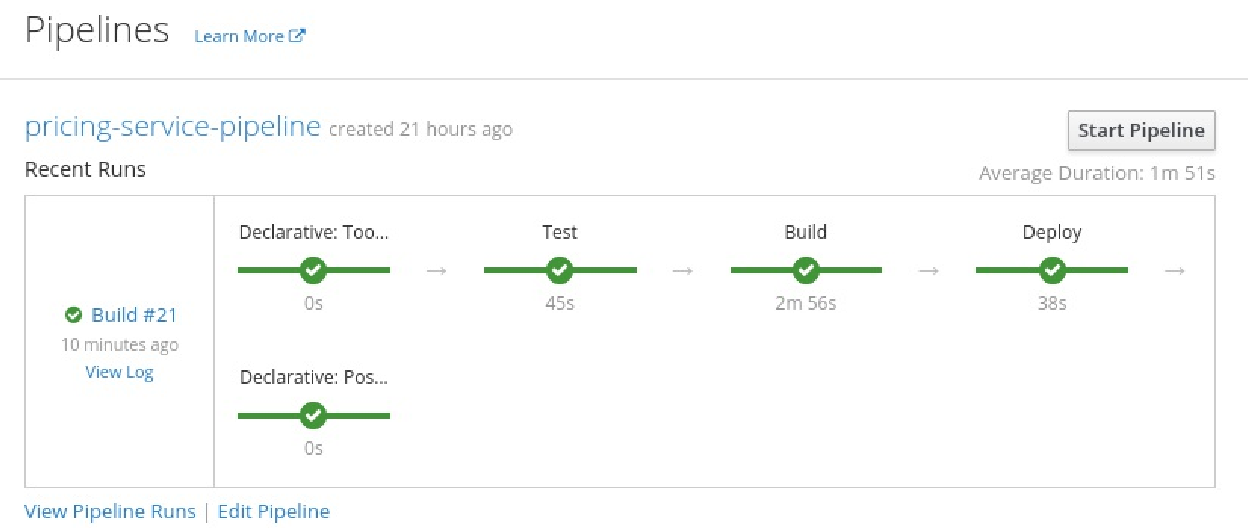
```
  agent any
  tools {
     maven 'maven3.5.2'
     jdk 'jdk8u152'
     git 'Default'
  }
  stages {
  stage('Test') {
      steps {
       git url: 'https://github.com/PacktPublishing/Hands-On-Cloud-Development-with-WildFly.git'
       sh 'mvn clean install -Dswarm.build.modules=target/test-classes/modules'
      }
     }
  stage('Build') {
      steps {
         openshiftBuild(bldCfg: 'pricing-service', showBuildLogs: 'true')
         openshiftVerifyBuild(bldCfg: 'pricing-service', waitTime: '300000')
     }
     }
 //1
  stage('Deploy'){
      steps {
          //2
          openshiftDeploy(depCfg: 'pricing-service')
          //3
          openshiftScale(depCfg: 'pricing-service',replicaCount:'3')
          //4
          openshiftVerifyDeployment(depCfg: 'pricing-service',verifyReplicaCount:'true',replicaCount:'3', waitTime: '300000
          //5
          openshiftVerifyService(svcName: 'pricing-service')
      }
  }
  }
  post {
     //6
     success {
         echo "Job '${env.JOB_NAME} [${env.BUILD_NUMBER}]' result: SUCCESS"
     }
     //7
     failure {
         echo "Job '${env.JOB_NAME} [${env.BUILD_NUMBER}]' result: FAILURE"
     }
  }
 }
```

We have extended our `pipeline` in a w ay described previously:

1. We have added the `Deploy` stage (1), w hich deploys the application (2)
2. Then, it scales the application (3)
3. It verifies that the deployment succeeded (4) and that the service is available (5)
4. After each build, the result of the test is echoed to the output, depending on w hether the test succeeded (6) or failed (7)

If you look at the console output, you w ill be able to see that all the steps that w e have implemented have been executed successfully.

You can also verify this in the w eb console `pipeline` view :



Finally, you can verify in the w eb console that the service has indeed been created and that the corresponding pods are running.