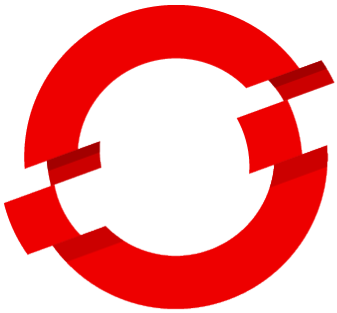

Red Hat OpenShift

Full DevEx Workshop

UKI DSA Team

Version 1.0.0, June 09, 2020

Table of Contents

Introduction

Attendee details

Name:	
User ID (userX):	

This workshop is designed to introduce Developers to **OpenShift 4** and explain the usage and technologies around it from a developer perspective.

What is Openshift

Red Hat® OpenShift® is a hybrid cloud, enterprise, secure Kubernetes application platform.

OpenShift is an Enterprise strength, secure implementation of the Kubernetes container orchestration project with additional tooling designed to make the lives of Developer and Administrators as easy as possible.

Links

- https://www.openshift.com/learn/what-is-openshift, window="_blank"
- https://en.wikipedia.org/wiki/OpenShift, window="_blank"
- https://www.openshift.com/products/container-platform, window="_blank"
- https://example.manifest.com, window="_blank" (the Web Console URL for the Workshop)

Contributors

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- Jonny Browning

Original asciidoc documentation for DevEx3.x by Phillip Kruger, Red Hat CEMEA

Workshop Pre-requisites

Setting up the UI and Terminal

The workshop was designed and tested on the Chrome browser and it is advised to avoid issues that this browser be used whenever possible

For a number of the labs you will be interacting with the OpenShift cluster using a number of different command line tools. In order to avoid you having to install them on your own machine we have taken advantage of the nature of OpenShift and produced a Container that does it all for you, and provides a terminal experience in the browser. In this section you will create that application; this terminal is used throughout the workshop.

If you leave the Terminal window open for a long time without using it it will disconnect. To reconnect simply refresh the page.

Open the browser and navigate to the console url https://example.manifest.com, window="_blank"

Logon using the user provided by the course administrator (user*x* where **x** is a unique number for your session)

When logged on you will be presented with a screen listing the projects, of which there are currently none

Hit *Create Project*

For *Name* enter terminal*x*, where **x** is the same unique number from your UserID (user*X*)

Display Name and *Description* are optional labels

Once the project has been created (you will be given a dashboard) change the mode of the UI from Administrator to Developer by clicking on the top left of the UI where it says *Administrator* and selecting *Developer*

On the Topology page it will state *No workloads found* - Click on *Container Image*

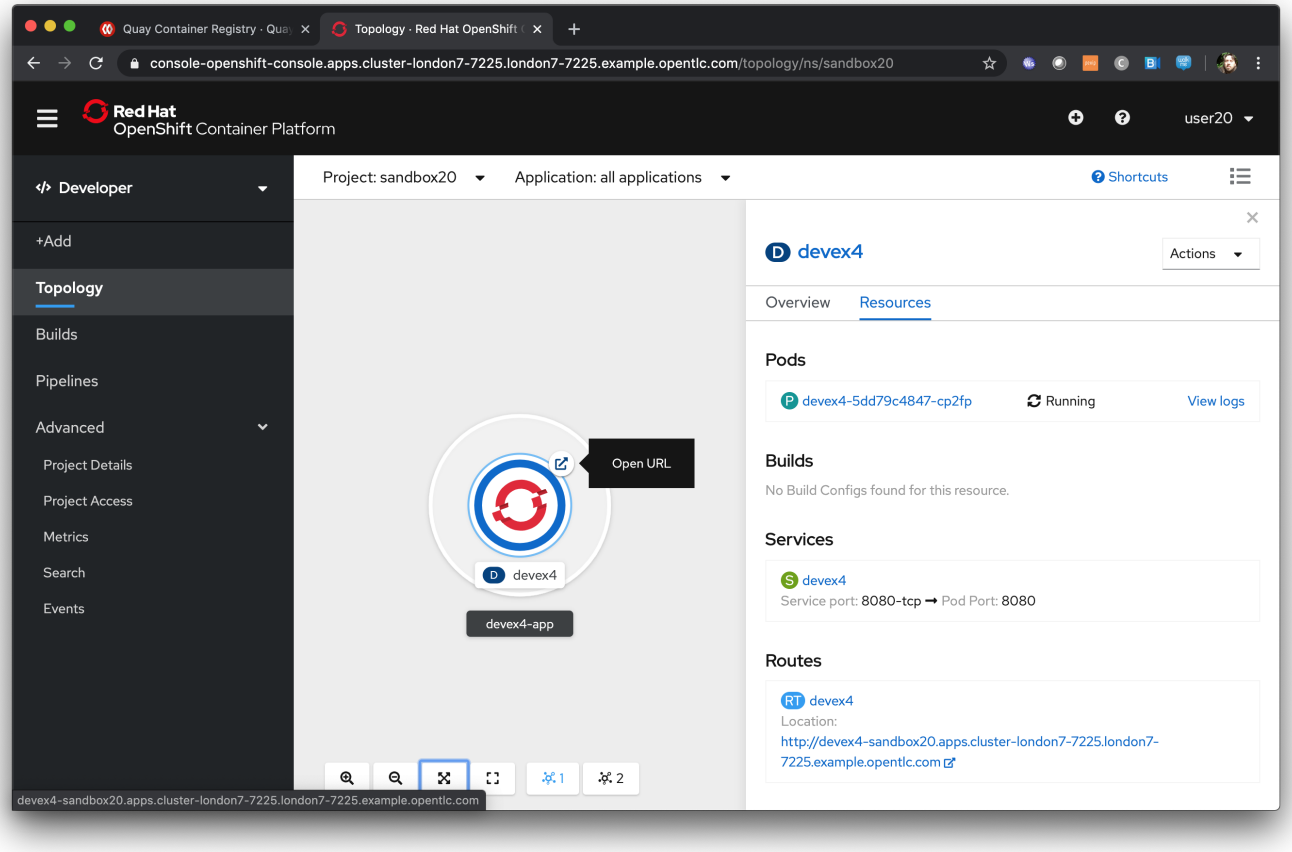
In *Image Name* enter *quay.io/ilawson/devex4*

Click on the search icon to the right of the text box

Leave everything else as default and scroll down to the bottom of the page. Hit *Create*

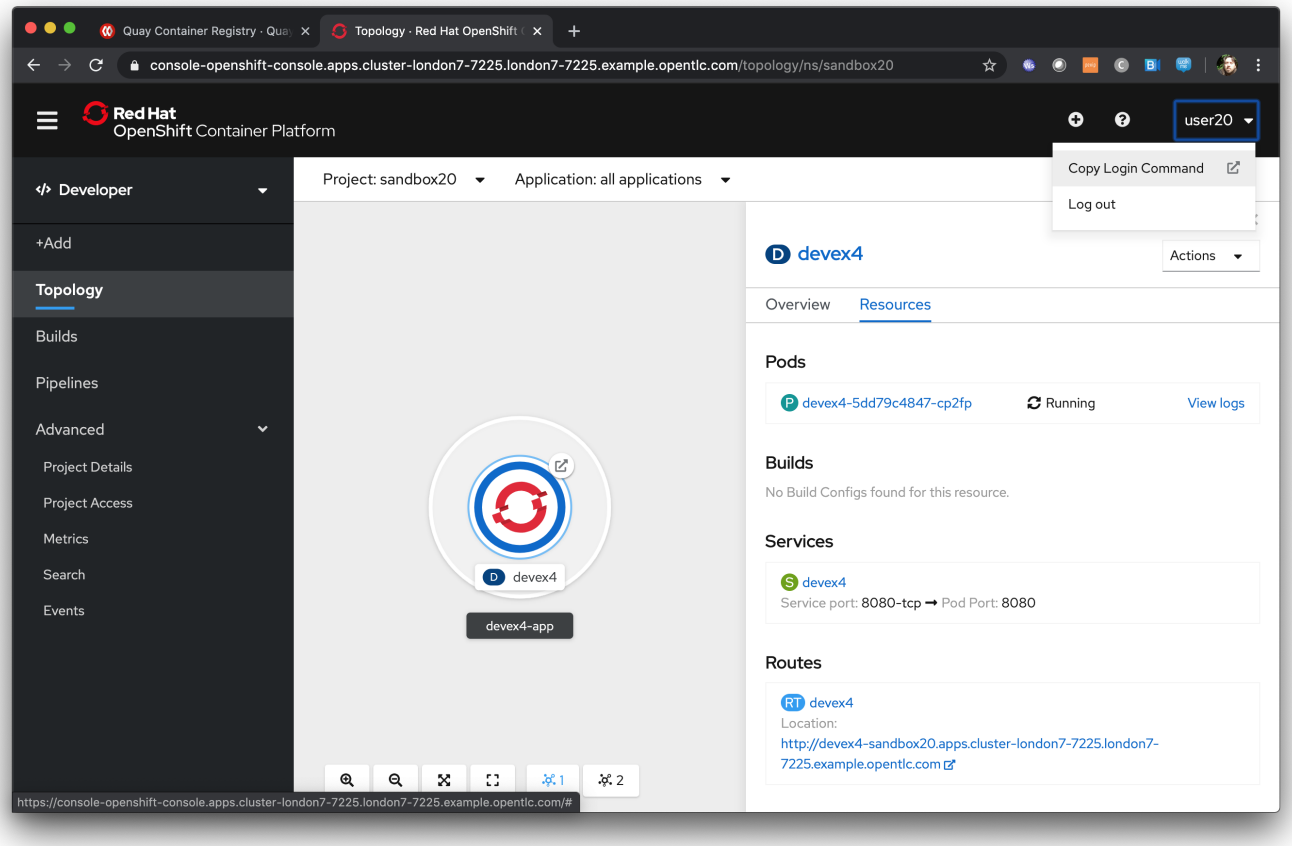
Wait for the ring around the application icon to change to dark blue - this indicates the application has been started

In the topology page click on the *Open URL* icon as shown below



This will open another tab with a command line in it - this is your terminal for the duration of the basic workshop

Switch back to the UI and click on the userx displayed at the top right and select *Copy Login Command* as shown below



In the new tab that appears login with your userx (unique number instead of x) and password *openshift*

Click on *Display Token*

Copy the command given for *Log in with this token* - this may require using the browser *copy* command after highlighting the command

Close this tab and switch to the terminal tab - if you have closed the terminal tab go back to the UI and select the *Show URL* from the topology view in the Developer UI

Paste and execute the command

Press *y* to use insecure connections

The terminal should now be logged on - to check it try

```
oc whoami
oc version
```

The terminal should display your user for the first command and the client and Kubernetes versions for the second command

Introduction to *oc* [INTRODUCTION]

Author: Ian Lawson (feedback to ian.lawson@redhat.com)

Introduction

This lab introduces the command line interface to OpenShift, *oc*, and the concepts of the interactions you can have with the OpenShift system through it.

The attendee will be using the terminal application created in the pre-requisites step (for command line exercises). It is strongly suggested the attendee uses Chrome or Firefox. All of this lab is done with the terminal.

A quick overview of *oc*

OpenShift is built around Kubernetes, which is a fantastically complex and elegant orchestration system for containers. It works by maintaining a state vision of the entire system, which is a set of what are called *objects*.

An *object* has a type - i.e. Service, Pod, User, Namesapce and the like. This type tells Kubernetes how and what it can do with the object; in fact Kubernetes has a number of processes called *controllers* whose only job is to create, monitor and maintain these *objects*.

In order for a user to interact with the system, be it OpenShift or Kubernetes, an API is provided that allows you to create, manipulate and remove these objects. But it's very complicated, because of the nature of the systems.

So, for Kubernetes, there was a command line utility created called *kubectl*. OpenShift's own command line, *oc*, derives from this utility but adds the extra features, and access to the additional objects that OpenShift offers above and beyond Kubernetes.

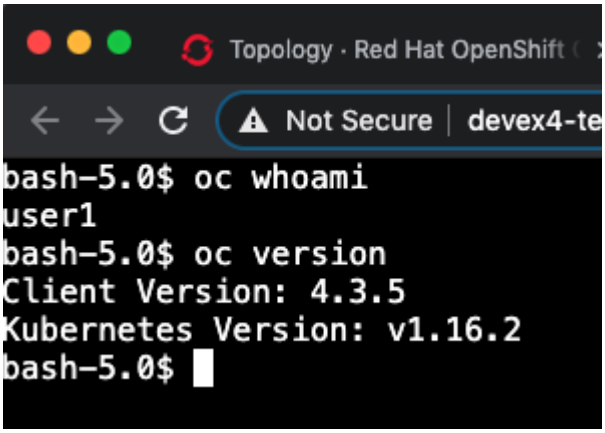
What we will be doing in this lab is using the oc client to work with OpenShift from a developers perspective. OpenShift provides a number of ways that you can interact with it; for example the Developer UI, the Administration UI, odo. But oc is the most powerful because it exposes the entire set of objects through the RESTful API provided.

You will find that, once you understand the nature of the underlying objects and the way you can interact with them, that *oc* is a fantastic tool for developers wanting to use OpenShift to orchestrate their applications.

Creating a Project/Namespace

Let's start by going to the terminal window as defined in the pre-requisites. To make sure we are working in the correct context type the following:

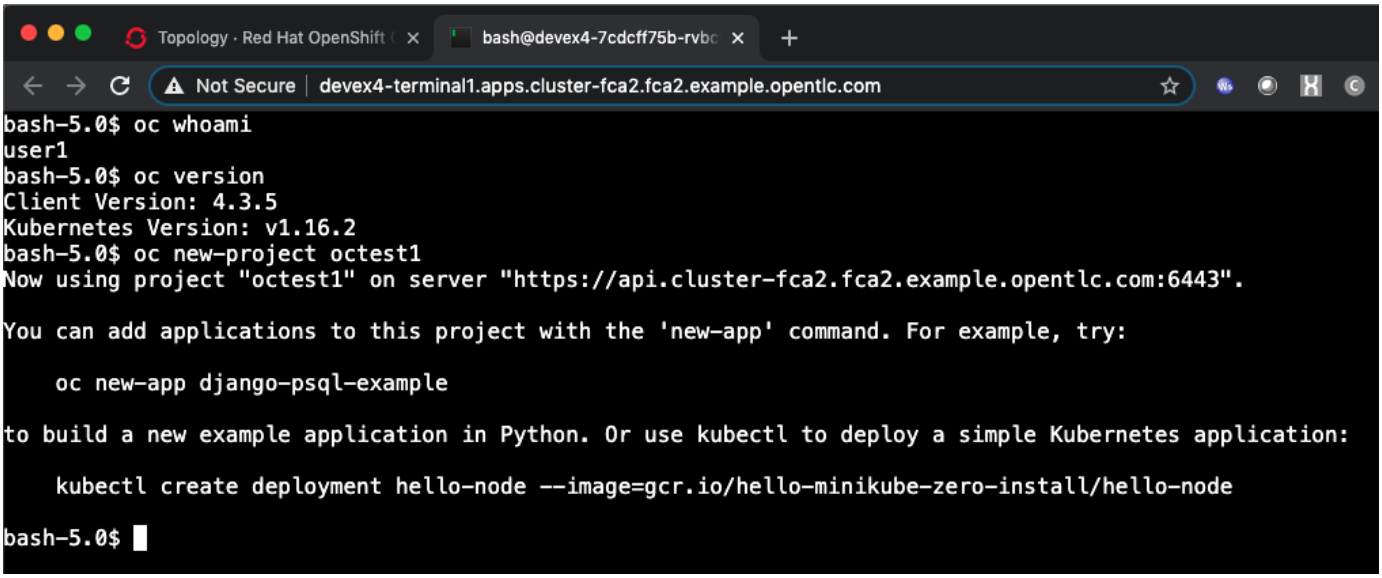
```
oc whoami
oc version
```



The oc client works using something called a *context*. This is a valid login to a target OpenShift system. If the commands do not return the successful output (see above for a similar output) then please repeat the login steps listed in the pre-requisites.

What we are going to do is create a Project to work in. This is equivalent, but not the same as, the Kubernetes *namespace*. Type the following (remembering to replace the *x* in the name with your user number):

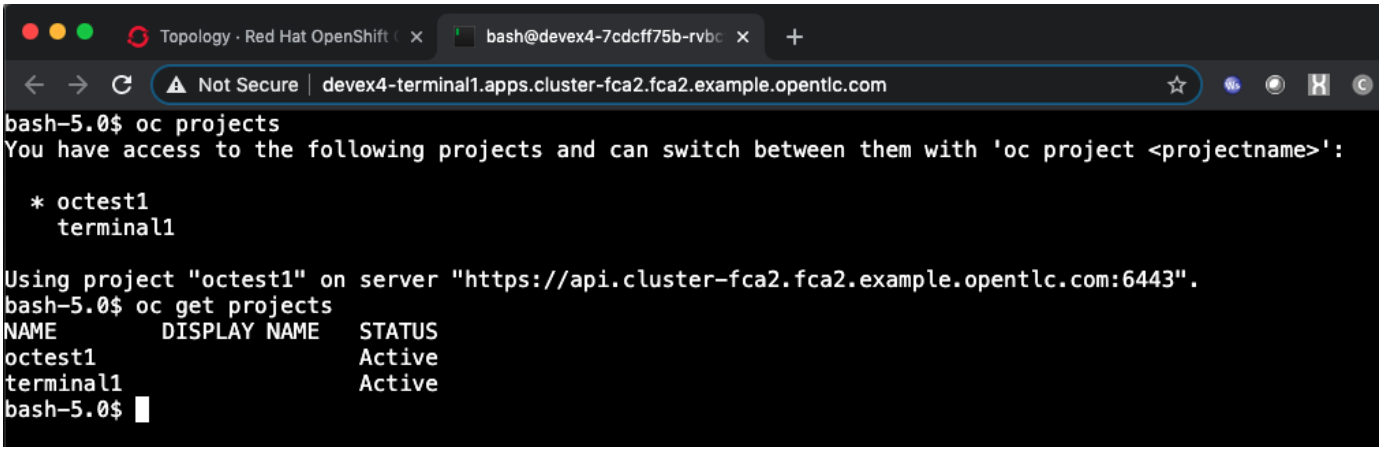
```
oc new-project octestx
```



What we have done is create a context within our user's object space on the OpenShift Cluster. As creators we have admin access and rights to this space - we can create and delete objects, that we have the rights to create, as much as we like here.

Now type:

```
oc projects
oc get projects
```



The *oc projects* is an opinionated command - because we work with Projects so much there is a shortcut for them. The second command is the standard way of getting any object that you have the rights to via the oc command.

Now type:

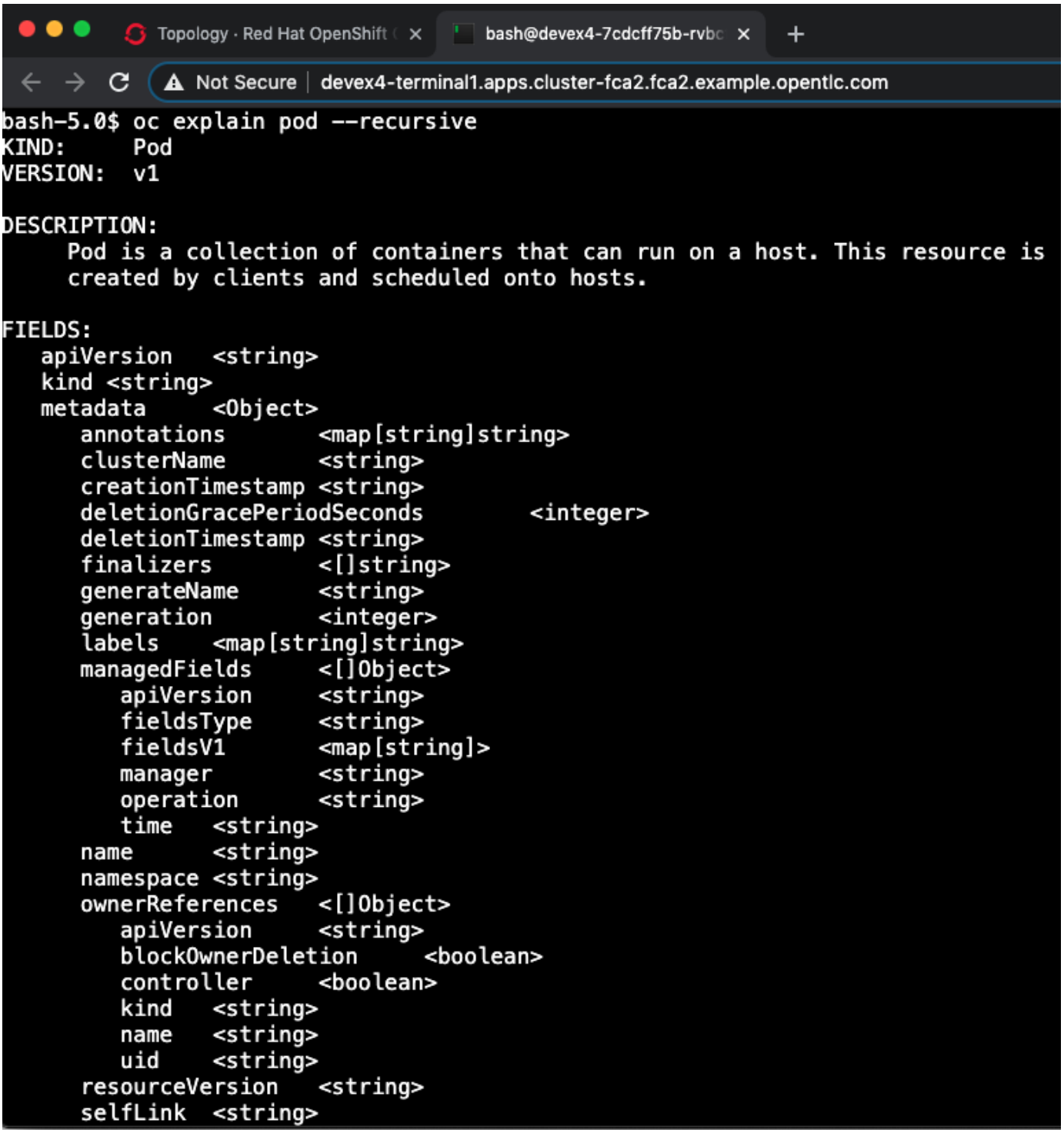
```
oc api-resources
```

This command goes to the OpenShift Cluster and gets a list of the all the object types/resources you can see. There are a lot of them. Try this command:

```
oc explain pods
```

This command will show an explanation of that API object type, namely *Pods*. Now the cool bit - type the following:

```
oc explain pods --recursive
```



Every object can be described using JSON or YAML - this command returns, from the Server, the exact definition of that object. This is incredibly useful when we get to editing the objects via oc.

Adding some Applications

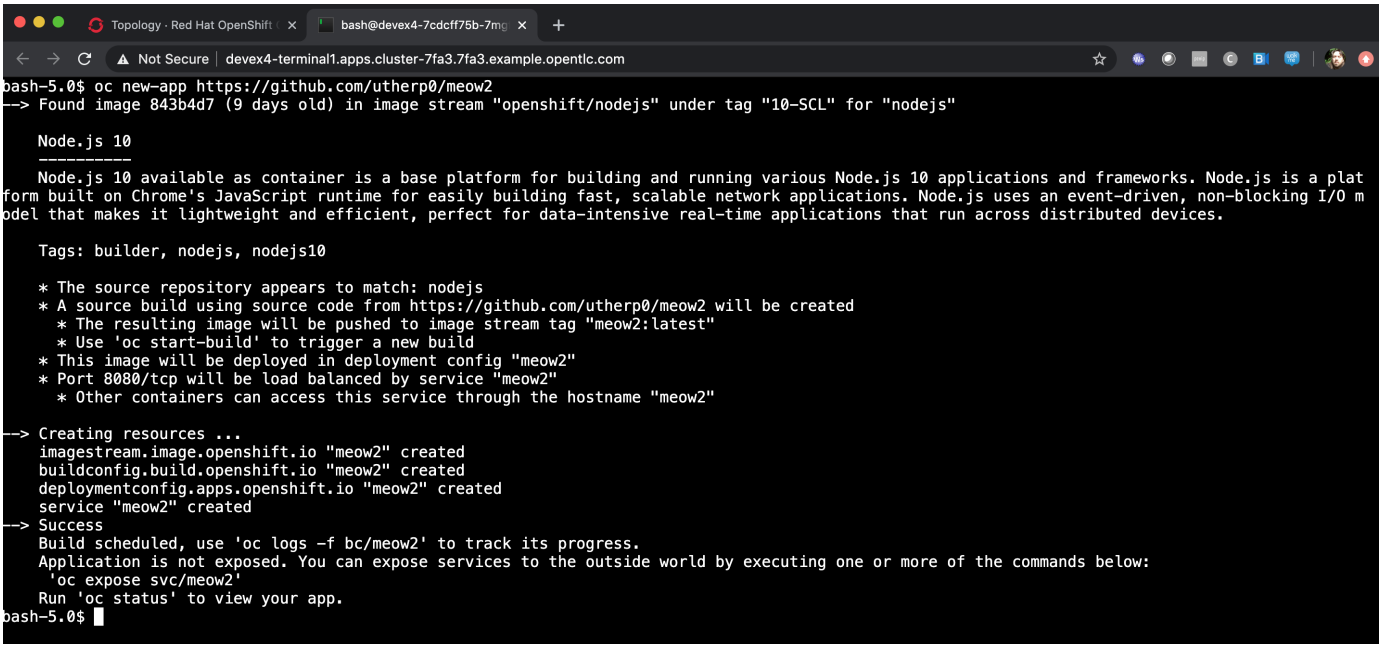
We are going to take advantage of some of the OpenShift's opinionated developer features with the next part. Rather than manually create all the objects we would need for an Application from scratch on OpenShift, which would include a BuildConfig, which describes how to build the Image that will contain our Application, a Build, which is the actual task that executes the BuildConfig, in a Pod, to

generate out Application Image, a Service, which is the IP endpoint for the Application within the OpenShift Cluster and an ImageStream, which is a wrapper around the created Image.

We can shortcut this as developers, if we have, for example, a GitHub repo with existing code. Type the following:

```
oc new-app https://github.com/utherp0/meow2
```

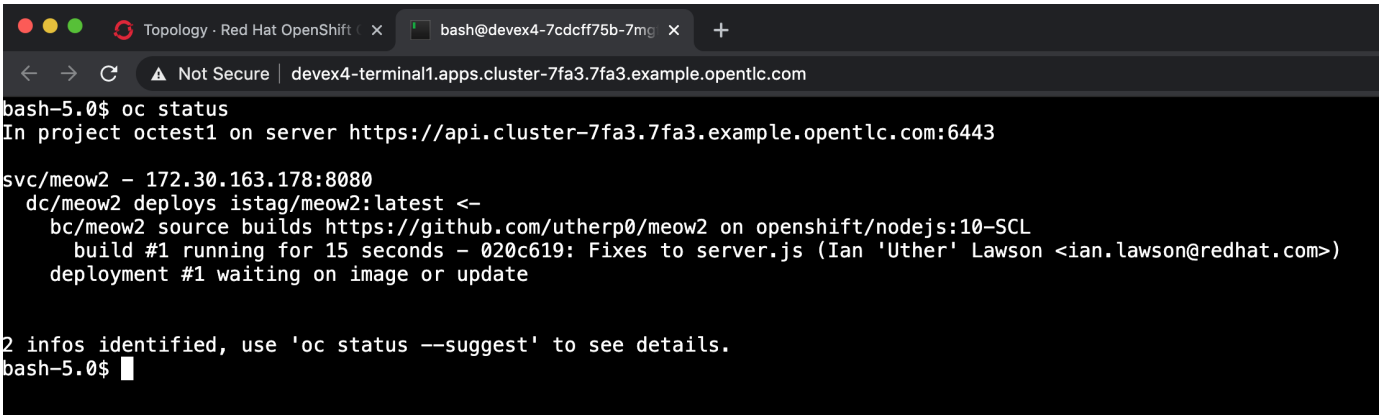
The oc command will cause OpenShift to create all the contents it needs for an Application based on the source code it finds at the GitHub repo. In this case the source code contains the building blocks for a node.js application. The image belows shows the output you should receive:



Note the Resources Created part of the output - from a single command to create an App it has created the core required components.

Now type the follow, as suggested by the output:

```
oc status
```

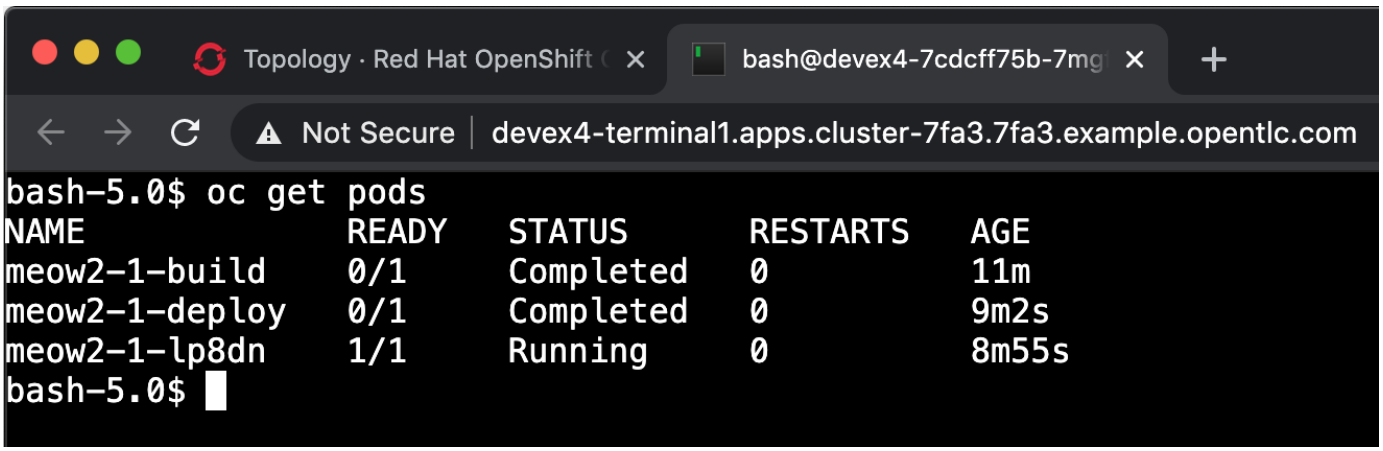


The system is performing a build, defined by the buildconfig that has been created using the chosen technology deduced by OpenShift from the repo. When the build finishes it will deploy the application - the deployment is shown as the *dc*, which is the deployment config object. This is waiting on the image to be created by the build. It also creates a Service, which is the internal endpoint for the application.

If you wait a little (feel free to repeat the *oc status* command) the build will complete and the application will be deployed. You can check for when it deploys by typing:

```
oc get pods
```

Once deployed the output should look like this:



You will notice there are three Pods - two have completed and one is running. This is because those actions of building an Application into an Image and then deploying the Application are executed as Pods themselves.

Now, for the sake of the lab, we will create a second application. Type:

```
oc new-app https://github.com/utherp0/nodenews
```

Again use the *oc get pods* and *oc status* to watch the build of the second application. When it completes it will look like this:

```
[Ians-MacBook-Pro-2:workshop4 uther$ oc get pods
NAME                 READY   STATUS      RESTARTS   AGE
meow2-1-build        0/1     Completed   0          4m17s
meow2-1-deploy       0/1     Completed   0          3m1s
meow2-1-f5xvz        1/1     Running     0          2m58s
nodenews-1-build     0/1     Completed   0          88s
nodenews-1-deploy    0/1     Completed   0          21s
nodenews-1-qqnfx     1/1     Running     0          18s
```

Using oc for manipulating existing objects

Now we will show the power of the oc command. First, type the following:

```
oc get pods | grep Running
```

This will list the Pods running, i.e. the applications. We will now scale the *meow2* application to three Pods and the *nodenews* application to two Pods. Type the following:

```
oc scale dc/meow2 --replicas=3
oc scale dc/nodenews --replicas=2
```

Once the commands come back successfully type:

```
oc get pods | grep Running
```

```
[Ians-MacBook-Pro-2:workshop4 uther$ oc get pods | grep Running
meow2-1-85v7m        1/1     Running     0          56s
meow2-1-f5xvz        1/1     Running     0          10m
meow2-1-pjlqh        1/1     Running     0          56s
nodenews-1-fs9n7     1/1     Running     0          45s
nodenews-1-qqnfx     1/1     Running     0          8m17s
```

We are now going to look at the composition of a single *object*, in this case a pod. Using the output of the command above, pick one of the three Running meow2 Pods. You will need the name, which will be meow2-1-xxxxx, where xxxxx are random characters. Using the five characters from your chosen Pod type the following:

```
oc get pod meow2-1-[PUT YOUR CHOSEN POD'S CHARACTERS HERE]
```

That will give you a simple overview of the object, in this case the Pod. Now type this:

```
oc get pod meow2-1-[PUT YOUR CHOSEN POD'S CHARACTERS HERE] -o json
```

You will get a huge amount of information. What this command has done is returned the entire object in JSON. Now type this:

```
oc get pod meow2-1-[PUT YOUR CHOSEN POD'S CHARACTERS HERE] -o yaml
```

Now you will see the entire object listed in YAML. This is the complete object from OpenShift/Kubernetes, so as well as seeing the definition, which is all the components under *spec:*, you will also see the metadata for the object, listed under *metadata:* and the current status of the object, listed under *status:*.

Using jsonpath to extract specific object values

And this is where the oc command becomes incredibly powerful. Type the following:

```
oc get dc -o jsonpath='{.items[*].metadata.name}'
```

We can use the output of an object in json through a jsonpath filter and access **any** component of the object. Here's a more useful example - type the following:

```
for pod in $(oc get pods -o jsonpath='{.items[*].metadata.name}'); \
do echo $pod; \
echo "  "$(oc get pod $pod -o jsonpath='{.status.phase}'); \
done
```

```
Ians-MacBook-Pro-2:~ uther$ for pod in $(oc get pods -o jsonpath='{.items[*].metadata.name}'); \
> do echo $pod; \
> echo "  "$(oc get pod $pod -o jsonpath='{.status.phase}'); \
> done
meow2-1-85v7m
  Running
meow2-1-build
  Succeeded
meow2-1-deploy
  Succeeded
meow2-1-f5xvz
  Running
meow2-1-pjlqh
  Running
nodenews-1-build
  Succeeded
nodenews-1-deploy
  Succeeded
nodenews-1-fs9n7
  Running
nodenews-1-qqnfx
  Running
Ians-MacBook-Pro-2:~ uther$
```

What we will do now is to scale down **all** of the applications to a single Pod using the oc command - this may seem a little pithy but imagine if you had operations to run over hundreds or thousands of objects. This approach makes it very easy to automate tasks. Type the following:

```
for dc in $(oc get dc -o jsonpath='{.items[*].metadata.name}'); \
do oc scale dc/$dc --replicas=1; \
done

oc get pods | grep Running
```

This command will scale **all** of the deployment configs to one copy.

The oc command gives access to **all** the objects available for the logged on User. In the case of a standard user, such as the one we are using for this lab, this will be the objects created in the namespace. In the case of what is called a *Cluster Admin* user this is effectively all the objects in the entire system.

Cleanup the lab

We will finally use the oc command to clean the project. Type the following, replacing the x with your user number (i.e. octest84):

```
oc delete project octestx
```

Application Basics [INTRODUCTION]

Author: Ian Lawson (feedback to ian.lawson@redhat.com)

Introduction

This chapter will introduce the attendee to the mechanics of creating and manipulating Applications using OpenShift Container Platform. It will introduce the two distinct contexts of the User Interface, the Administrator and Developer views, and guide the attendee through creating some Applications.

The attendee will be using a browser for interacting with both the OpenShift Container Platform UI and the terminal application created in the pre-requisites step (for command line exercises). It is strongly suggested the attendee uses Chrome or Firefox.

Starting up - logging on and creating a project

Log on to cluster at https://example.manifest.com, window="_blank" as *userx*, where x is the number assigned to you by the course administrator, password *openshift*

Ensure you are on the Administrator View - at the top left of the UI is a selection box which describes the current view selected.

The Administrator view provides you with an extended functionality interface that allows you to deep dive into the objects available to your user. The Developer view is an opinionated interface designed to ease the use of the system for developers. This workshop will have you swapping between the contexts for different tasks.

Click on *Create Project*

Name - ‘sandboxX’ where x is user number

Display Name, Description are labels

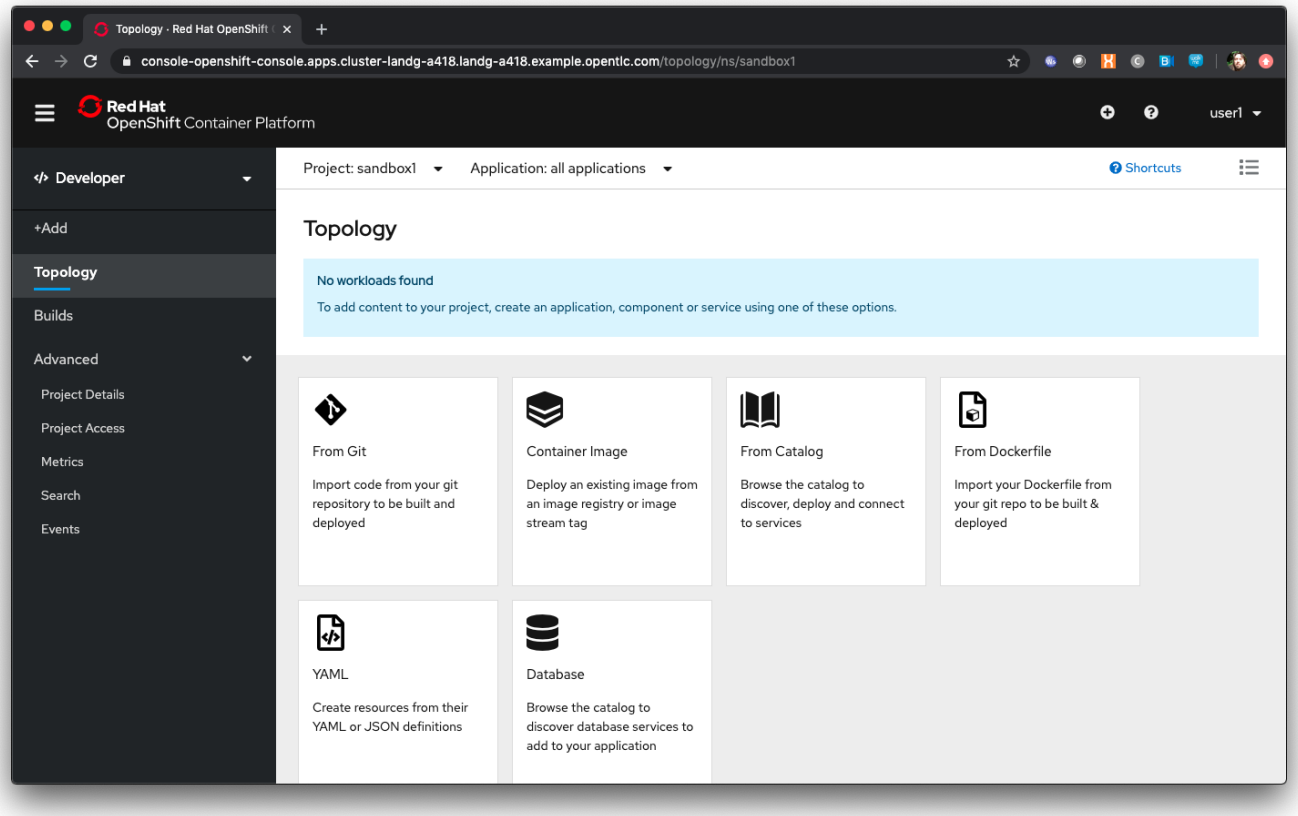
When created click on *Role Bindings*

By default when you create a Project within OpenShift your user is given administration rights. This allows the user to create any objects that they have rights to create and to change the security and access settings for the project itself, i.e. add users as Administrators, Edit Access, Read access or disable other user’s abilities to even see the project and the objects within.

Creating your first Application

In the top left of the UI, where the label indicates the view mode, change the mode from Administrator

to Developer



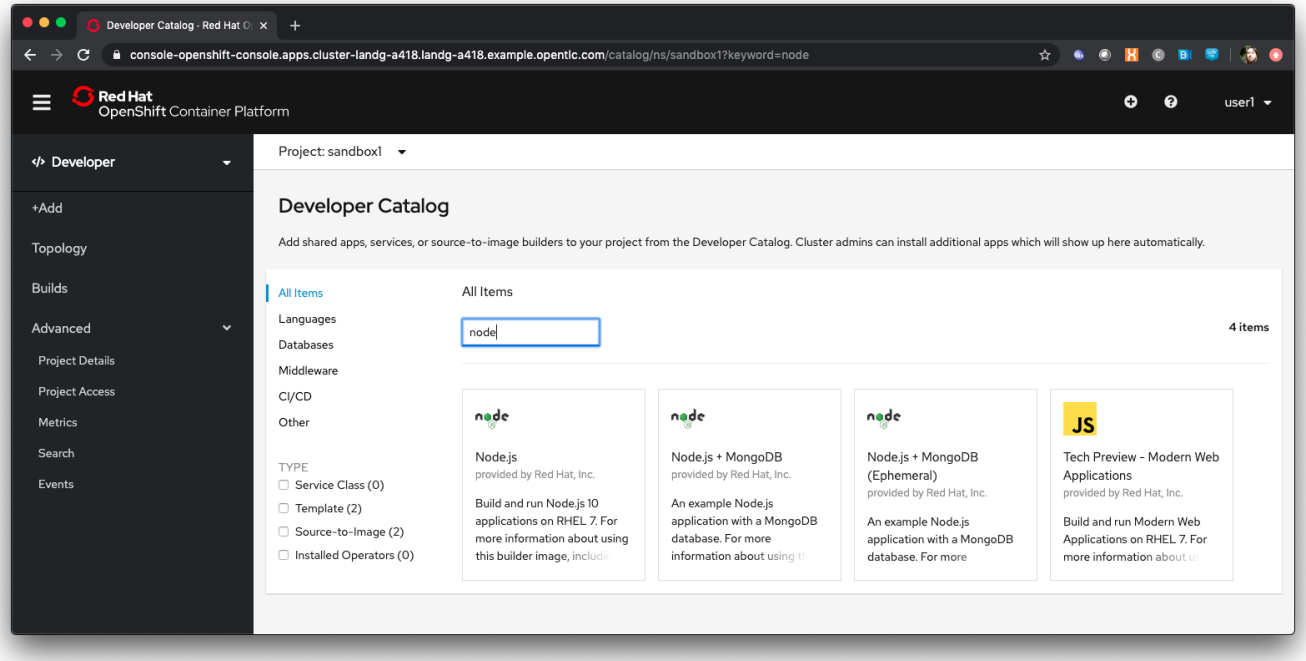
Click *Add*

The Catalog screen for the developer combines all the ways components can be added into the Project. These are:

- **From Git - this provides another way to do a Source-2-Image build by first choosing the Git repo and then the builder image to use**
- **Container Image - this provides a way to directly deploy an Image from a repository**
- **From Catalog - this allows the Developer to browse all available templates, which are predefined sets of Objects to create an application**
- **From Dockerfile - this allows the Developer to do a controlled build of an Image from a Dockerfile**
- **YAML - this allows the Developer to provide a set of populated YAML to define the objects to be added to the Project**
- **Database - this allows the Developer to browse pre-created Database services to add to the Project**

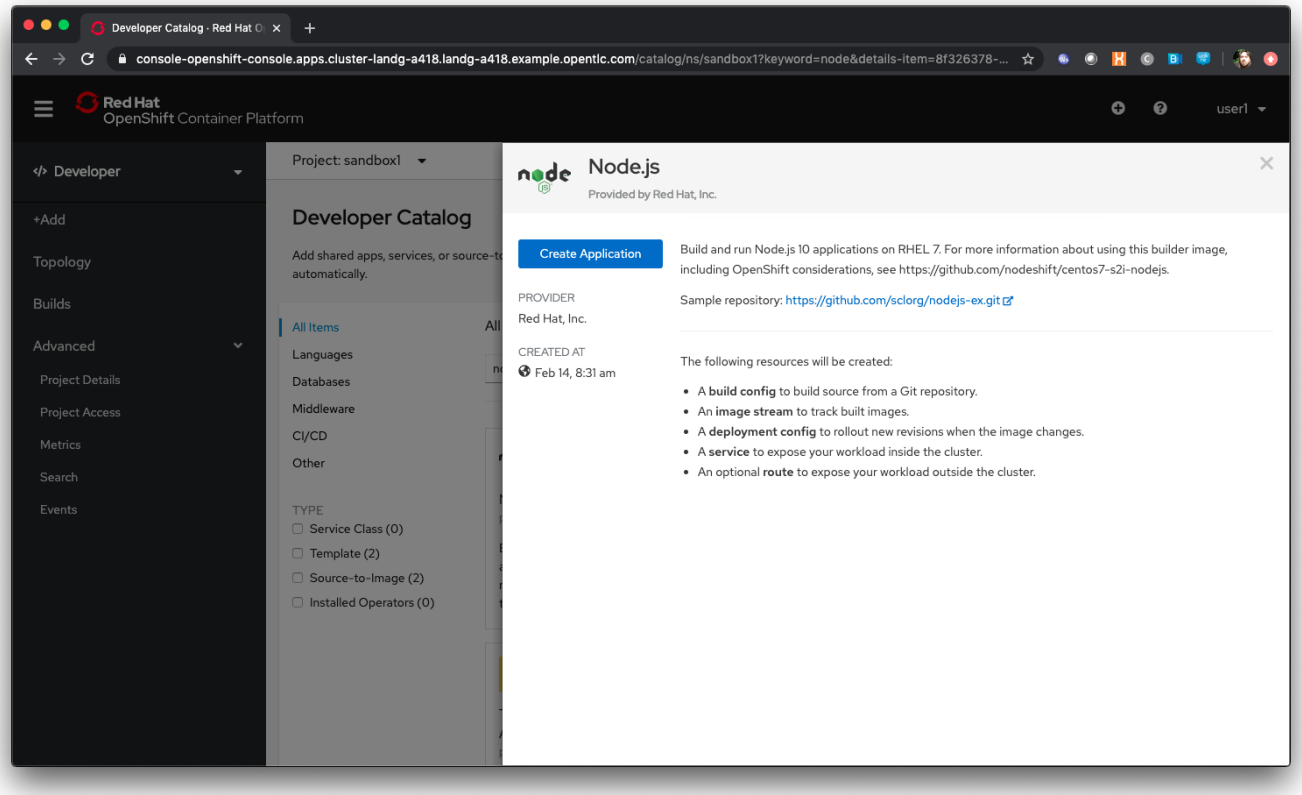
Select ‘From Catalog’

Enter ‘node’ in the search box



OpenShift allows for multiple base images to be built upon - the selection of node searches for any images or templates registered into the system with the label *node*. In the screenshot above, and in the catalog you will be presented with, there will be a selection of base images.

Select ‘Node.js’



When you select an option, in this case the Node.js builder one, you are presented with a wizard that shows you exactly what components will be created as part of your Project. In this case, with Node.js, the template will create a build config, that will build the Image that will contain your Application, an ImageStream which is the OpenShift representation of an Image, a deployment config, which defines exactly how the image will be deployed as a running Container within the Project, a service which is the internal endpoint for the application within the Project and a route, optionally, which will provide access to the Application for external consumers.

Click on *Create Application*

This approach uses the OpenShift *'source-2-image'* concept, which is a controlled mechanism provided by OpenShift that automates the creation of application images using a base image and a source repository.

Change the Builder Image Version to 8

The *'source-2-image'* approach allows you to use differing versions of a base image - in this case you can execute the Node build against a number of supported Node versions.

Enter the following for the Git repo for the application - https://github.com/utherp0/nodenews, window="_blank"

In a separate browser tab go to https://github.com/utherp0/nodenews, window="_blank"

If you visit the URL you will see there is no OpenShift specific code in the repository at all.

Close the github tab

Back at the OCP4.3 UI click on the *Application Name* entry box. It will auto-fill with the Application Name and the Name will auto-fill as well.

OpenShift 4 introduces the concept of Application Grouping. This allows a visualisation of multiple Applications in the same *group*, making visibility of the Application much simpler.

Ensure the application name is 'nodenews-app'

Ensure the Name is 'nodenews'

Scroll down to *Resources*. Click the selection box for *Deployment Config* rather than the default of *Deployment*

OpenShift supports the Kubernetes mechanism of *Deployment* but DeploymentConfigs are more advanced and offer more features for deploying an application, including strategies.

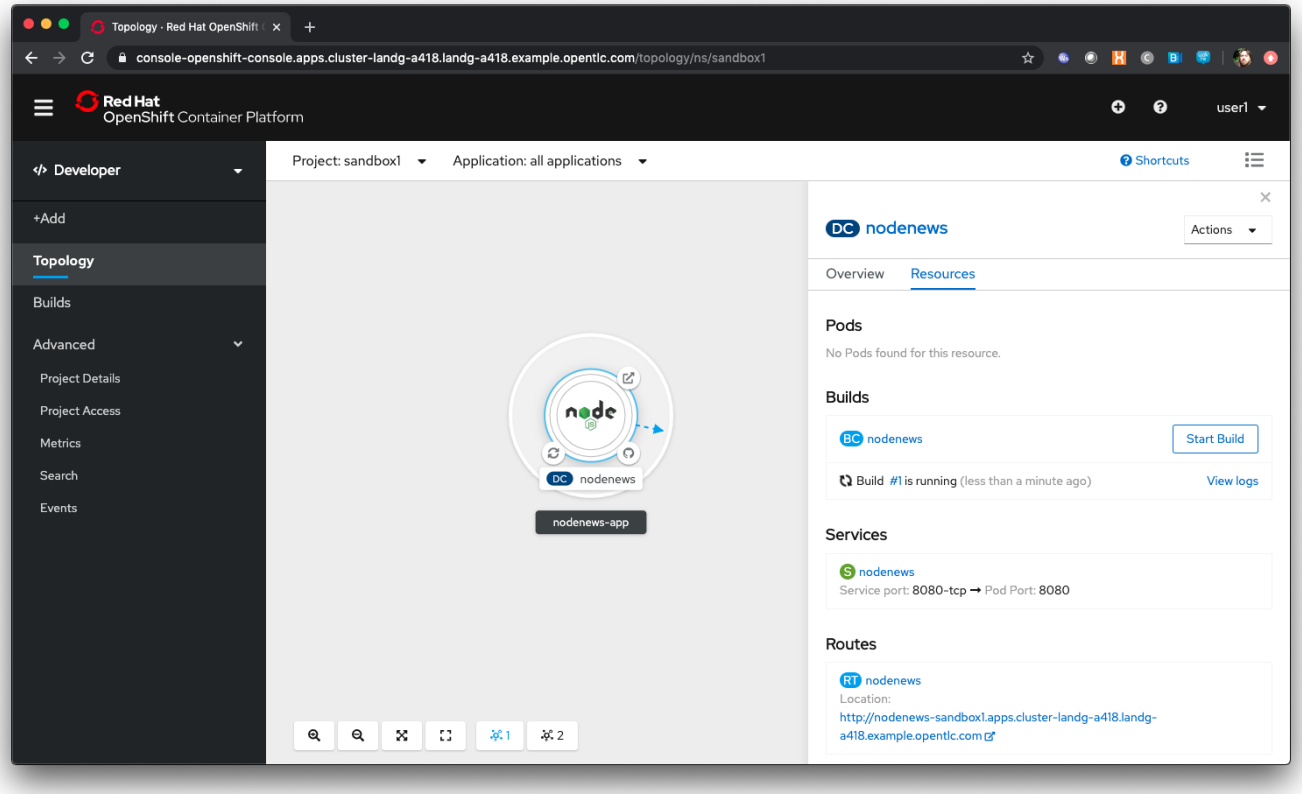
Ensure the 'Create Route is checked'

Click *Create*

The Topology view is a new feature of OpenShift 4 that provides a dynamic and useful

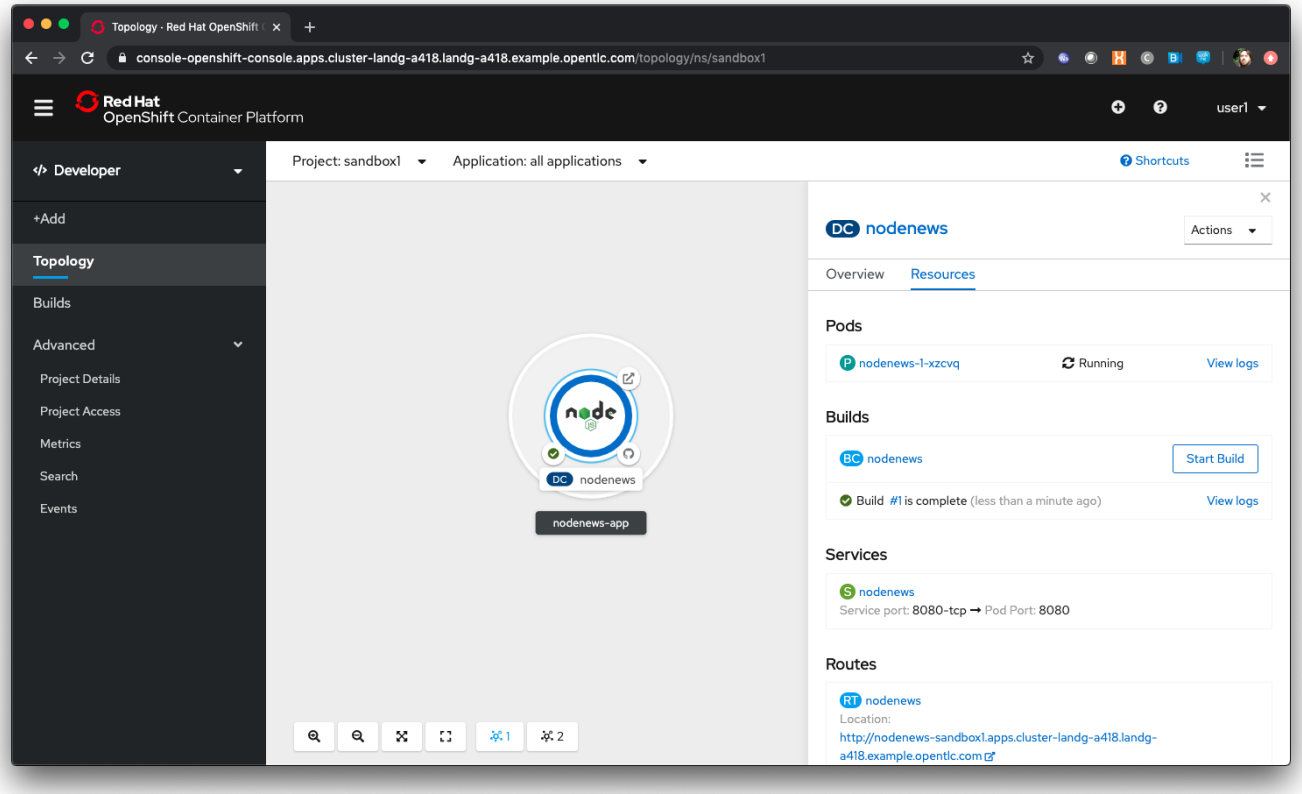
visualisation of all of your Applications in a given Project.

Click on the Icon marked *Node*



The side-panel contains an overview of the Application you chose. In this case it will cover the build. Once a build has completed this side panel shows the Pods that are running, the builds that have completed, the services exported for the Application and the routes, if the Application has any.

Wait for the Build to finish, the Pod to change from Container Creating to Running



When an Application is created the Pod ring will be empty, indicating that an Application will appear once the build has completed. When the build completes the Pod ring will switch to light blue, indicating the Pod is being pulled (the image is being pulled from the registry to the Node where the Pod will land) and is starting (the Pod is physically in place but the Containers within it are not reporting as ready). Once the Pod is placed and running the colour of the Pod ring will change to dark blue.

Click on the Tick at the bottom left of the Pod

If you scroll the log of the Build output you will see the steps that the build takes. This includes laying the foundational file layers for the base image, performing the code specific build operations (in this case an *'npm install'*) and then pushing the file layers for the image into the OpenShift integrated registry.

Adding additional Applications

Click *Add+*

Click *From Catalog*

Search for 'httpd'

Select the Apache HTTP Server (httpd) template - Note that there are two options, you want to choose the one that is labelled (httpd) and starts with the text *Build and serve static content*

Click on *Create Application*

Leave Image Version as 2.4

Enter the following for the Git repo for the application - https://github.com/utherp0/forumstaticassets, window="_blank"

Make sure the Application is ‘nodenews-app’

Click on the entry point for *Name* - it should autofill

Make sure the Name is forumstaticassets

In the Resources section leave the Deployment as *Deployment*

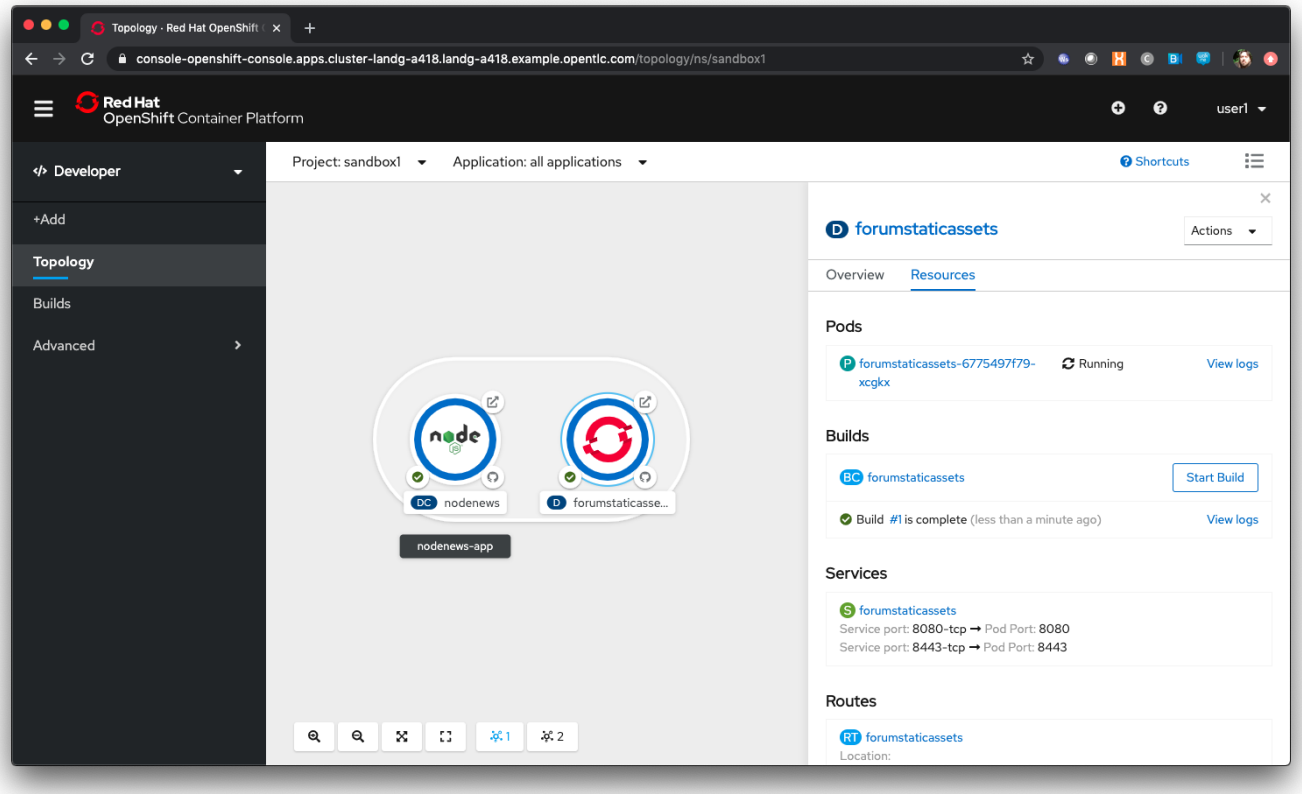
Make sure the ‘Create a Route’ checkbox is clicked

Click *Create*

Note that the new Application icon appears within a bounded area on the Topology page labelled with the *Application* chosen above. If you click on the area between the Pods you can move the group as a single action.

Click on the forumstaticassets Pod

Watch the build complete, the Container Creating and the Running event.



Click *Add*

Click *From Catalog*

Search for ‘node’

Select ‘Node.js’

Click *Create Application*

Leave at Builder Image Version 10

Enter the following for the Git repo for the application - https://github.com/utherp0/ocpnode, window="_blank"

In the ‘Application’ pulldown select ‘Create Application‘

In the ‘Application Name’ enter ‘ocpnode-app’

Ensure the Name is ‘ocpnode’

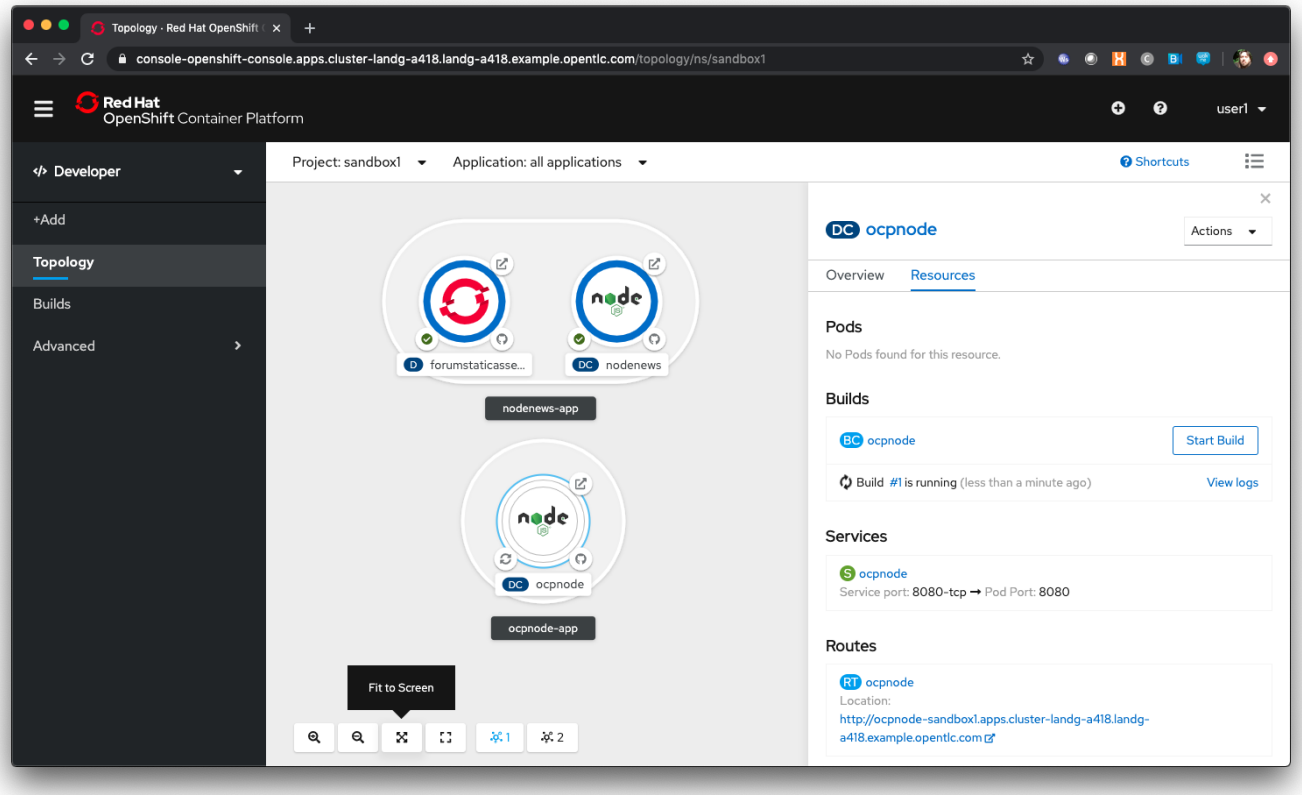
In *Resources* set the deployment type to DeploymentConfig

Ensure the ‘Create Route’ is checked

Click *Create*

Click on the ‘ocpnode’ Application in the topology - click on the  icon (if you hang over it it will say *Fit To Screen*) situated at the bottom left of the Topology panel to centralise the topology

Now we have created a new Application grouping you will see two *'cloud*' groupings, labelled with the appropriate Application name you entered.



Interacting with OpenShift through the Command Line

With the OpenShift Enterprise command line interface (CLI), you can create applications and manage OpenShift projects from a terminal. The CLI is ideal in situations where you are:

- Working directly with project source code.
- Scripting OpenShift Enterprise operations.
- Restricted by bandwidth resources and cannot use the web console.

As part of the pre-requisites for the workshop we created and started a terminal app. Go to that tab now (if you have closed it go back to the pre-reqs and follow the instructions for opening it).

Make sure `oc` is working, type:

```
oc whoami
oc version
```

Also see the **Command-Line Reference**: https://docs.openshift.com/container-platform/4.2/cli_reference/openshift_cli/getting-started-cli.html, window="_blank"

To explore the command line further execute the following commands and observe the results.

Change the X at the end of sandbox to your user number

```
oc projects
oc project sandboxX
```

User should now be using the sandboxX project created and configured earlier

Next we will try a command that will fail because of OpenShift's security controls

```
oc get users
```

There is a level of permission within the OpenShift system called *'Cluster Admin'*. This permission allows a User to access any of the objects on the system regardless of Project. It is effectively a super-user and as such normal users do not normally have this level of access.

```
oc get pods
```

If you look carefully at the Pods shown you will notice there are additional Pods above and beyond the ones expected for your Applications. If you look at the state of these Pods they will be marked as Completed. Everything in OpenShift is executed as a Pod, including Builds. These completed Pods are the Builds we have run so far.

```
oc get pods | grep Completed
```

```
oc get pods | grep Running
```

```
oc get dc
```

DC is an abbreviation for Deployment Config. These are Objects that directly define how an Application is deployed within OpenShift. This is the *'ops'* side of the OpenShift system. Deployment Configs are different to Kubernetes Deployments in that they are an extension and contain things such as Config Maps, Secrets, Volume Mounts, labelled targetting of Nodes and the like.

Enter the command below to tell OpenShift to scale the number of instances of the Deployment Config *nodenews* to two rather than the default one.

```
oc scale dc/nodenews --replicas=2
```

A Summary of Application Interactions

Go back to the UI and make sure you are on Developer mode. Click on Topology.

Click on the ‘nodenews’ application

Note the ‘DC’ reference to the application under the icon

In the pop-up panel on the right click on *Resources*

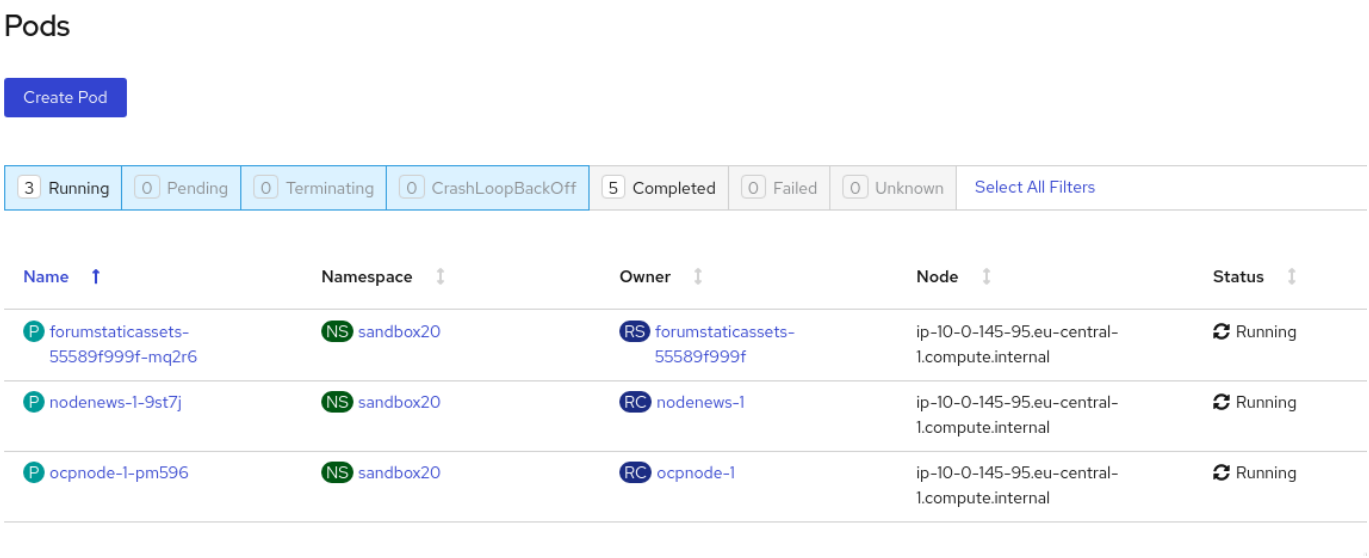
Note that there are two pods running with the application now

Change the mode from Developer to Administrator

Select the *sandboxx* project in the project list

Note the metrics for the project

Click on *Workloads* on the left menu (not the project overview) and then select Pods to see the list of pods for the project as shown in the image below.



It is possible to filter groups of pods that are displayed based on the headings of Running, Pending, Terminating etc. The classifications in dark blue are currently being displayed and those in grey are not being displayed. Click on the *Completed* heading to switch on the display of completed pods (there should be five). Click on *Running* to toggle the display of running pods off. Click on the appropriate headings again to switch off the display of completed pods and to switch back on the display of running pods.

Note that all the builds and deployments you have done, for the deployments that have a DeploymentConfig, have completed Pods. All of the actions are executed in separate Pods which is one of the key features that makes OpenShift so scalable

Change to Developer mode and then select Topology if the Topology page isn’t already shown

Hold down the shift button, click and hold on the forumstaticassets icon, and pull it out of the application grouping graphic. Release the hold on the forumstaticassets icon.

The UI will now prompt you if you wish to remove the application component. Select Remove. This component is now separated from the application group

Now hold down the shift button again, click and hold on the free floating forumstaticassets icon, and drag back over the boundary displayed for the nodenews-app application group. Release the hold and the application should be re-grouped.

Continue on with the Deployments chapter, which uses the applications created here to show the capabilities of the deployment configuration and how to alter the behaviour and file system of a Container without changing the image.

Understanding Deployments and Configuration [INTRODUCTION]

Author: Ian Lawson (feedback to ian.lawson@redhat.com)

Introduction

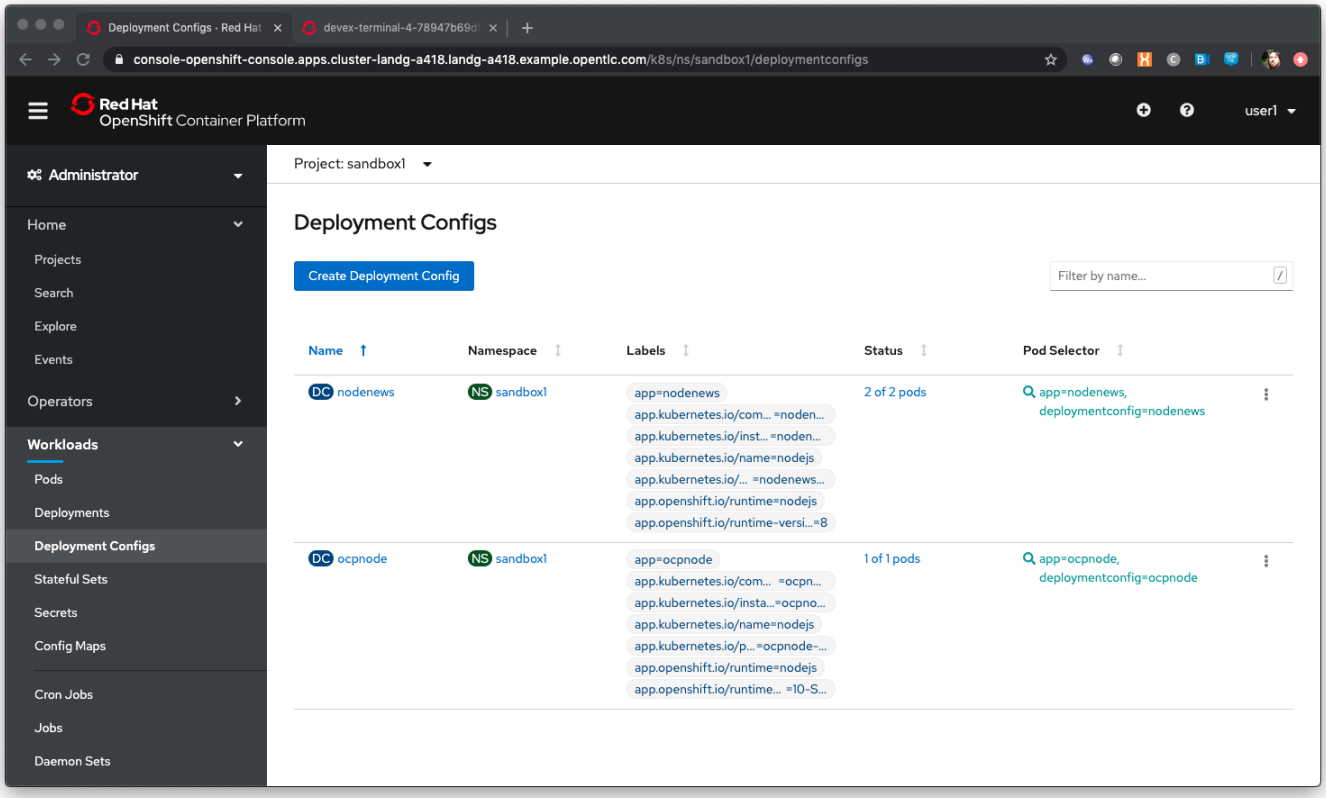
This chapter will introduce the attendee to concepts of deployments and configuration injection using OpenShift Container Platform.

The attendee will be using a browser for interacting with both the OpenShift Container Platform UI and the provided terminal (for command line exercises). It is suggested the attendee uses Chrome or Firefox.

This chapter follows directly on from the Application Basics one so it is assumed the attendee is logged on to the system and has the applications pre-created. If you are starting at this chapter please repeat the commands from the Application Basics chapter. You should start this chapter with two application running in the project, nodenews and ocpnode

Introducing Deployment Configurations

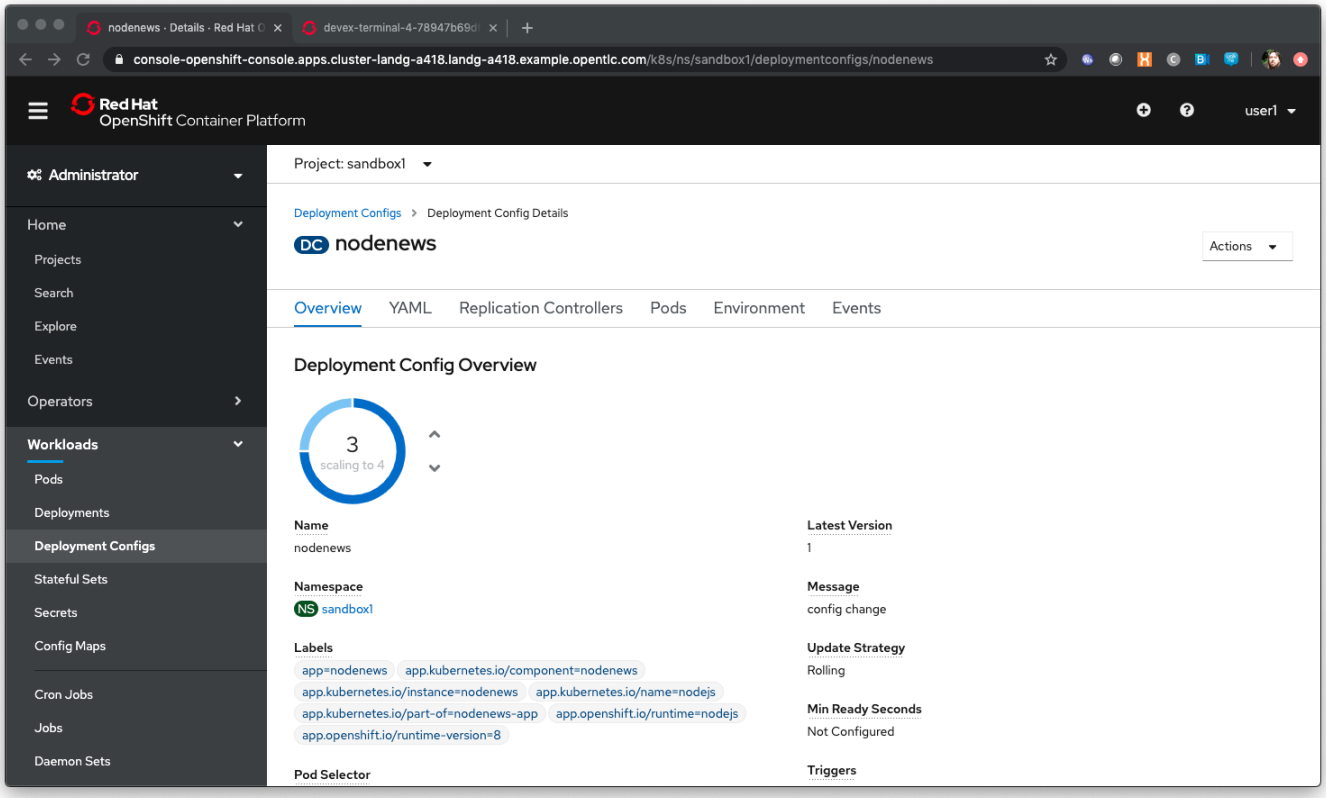
Ensure you are on the Administrator View (top level, select *Administrator*) Select *Workloads/Deployment Configs*



Observe the information provided on the Deployment Configs screen. DC indicates the Deployment Config by name, NS is the project/namespace, Labels are the OpenShift labels applied to the DC for collating and visualisation, status indicates the active Pod count for the Deployment and pod selector indicates the labels used for the Pods attributed to the Deployment Config.

Click on the *nodenews* deployment-config

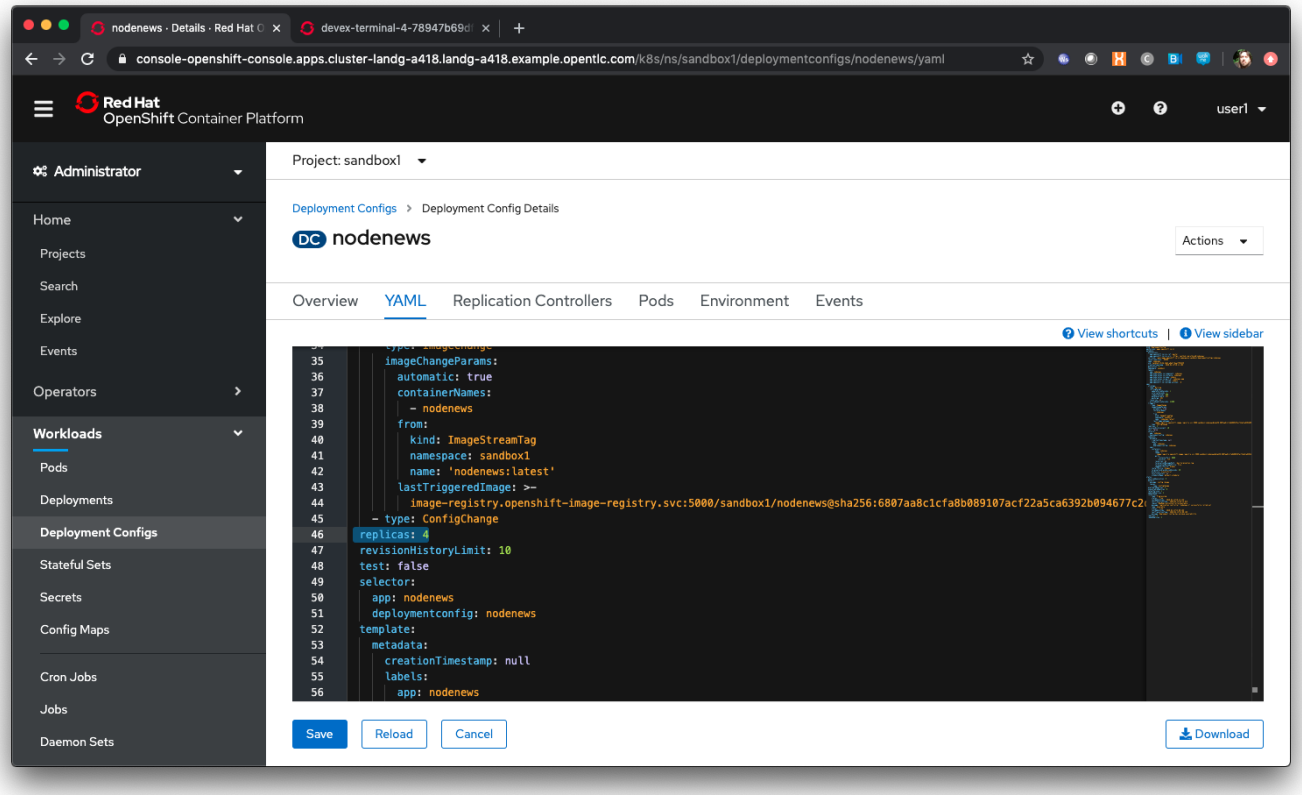
Next to the Pod icon, with the count in it which should be set to two, click on the up arrow twice



We have told the deployment config to run four replicas. The system now updated the replication controller, whose job is to make sure that x replicas are running healthily, and once the replication controller is updated the system will ensure that number of replicas is running

Click on ‘YAML’

In the YAML find an entry for replicas. It should say 4. Set it to 2, then save.



Click on ‘Deployment Configs’ near the top of the panel.

Select the nodenews deployment config by clicking on the nodenews DC link

Ensure the Pod count is now two

Dependency Injection using Config Maps

Click on *Workloads/Config Maps*

Config Maps allow you to create groups of name/value pairs in objects that can be expressed into the Applications via the Deployment Configs and can change the file system, environment and behaviour of the Application without having to change the *image* from whence the Application was created. This is extremely useful for dependency injection without having to rebuild the Application image

Click on ‘Create Config Map’

In the editor change the name: from example to ‘nodenewsconfig’

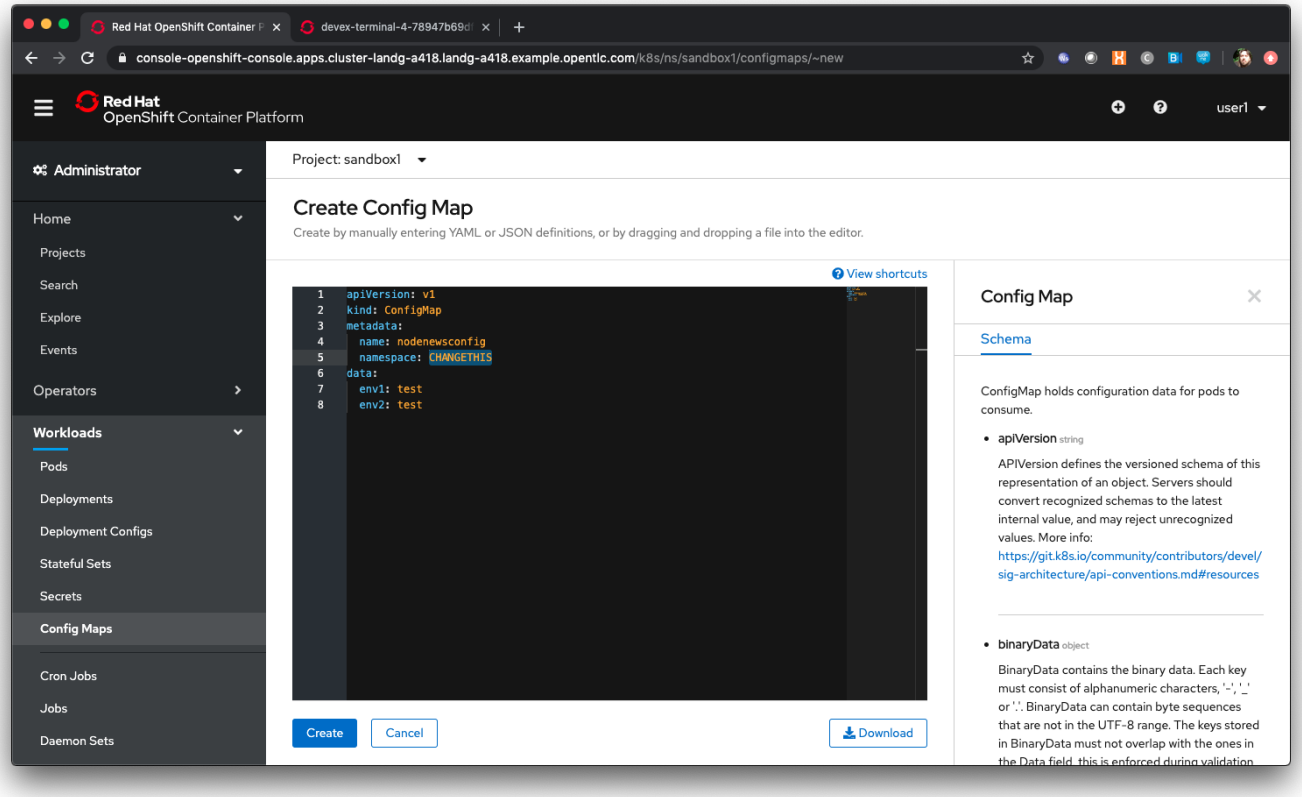
Delete all of the lines below **data:**

Add “ env1: test”

Add “ env2: test”

Make sure there is a space between the *:* and the data itself, otherwise it is invalid YAML and the editor will not allow you to save it.

The YAML should look similar to the screenshot below, with your project name instead of sandbox99 and the name you have entered rather than CHANGETHIS.



Press *Create*

Go back to the command line tab

Type ‘oc get configmaps’

Type ‘oc describe configmap nodenewsconfig’

Go back to UI, select *Workloads/Deployment Configs*

Click on the *nodenews* dc

Click on *Environment*

In ‘All Values from existing config maps’ select nodenewsconfig from the pulldown on the left and add nodenewsconfig as the prefix in the righthand textbox (labelled PREFIX (OPTIONAL))

Click *Save*

Click on *Workloads/Pods* - if you are quick enough you will see the nodenews Pods being redeployed

By default when you create a Deployment Config in OpenShift, as part of an Application or as a standalone object via YAML, the Deployment Config will have two distinct triggers for automation. These make the Deployment redeploy when a: the image that the Deployment Config is based on changes in the registry or b: the defined configuration of the Deployment changes via a change to the DC object itself

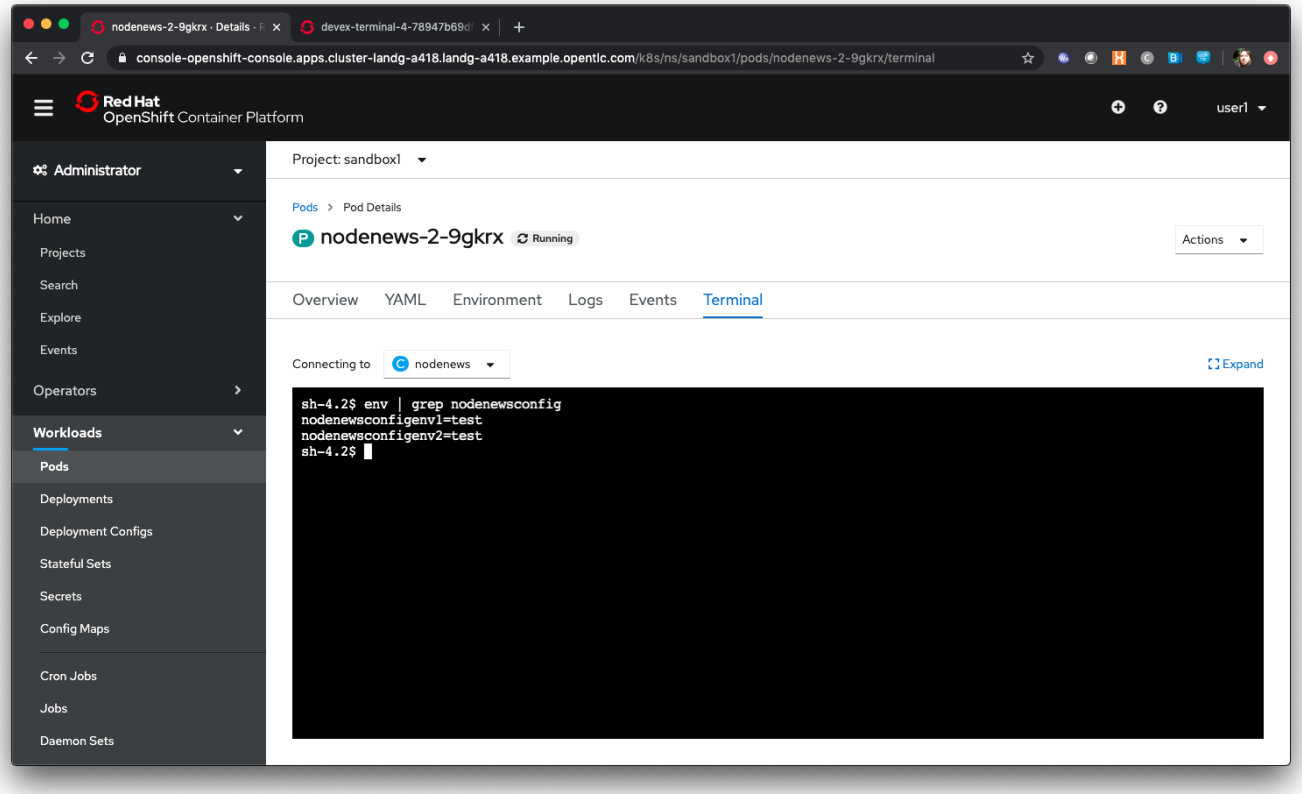
These are default behaviours but can be overridden. They are designed to make sure that the current deployment exactly matches the Images and the definition of the deployment by default.

Click on one of the Pods for *nodenews*

In the Pod Details page click on *Terminal*

In the terminal type 'env | grep nodenewsconfig'

Note that the env variables from the config map have been expressed within the Pod as env variables (with the nodenewsconfig prefixed)



Go back to the Terminal tab you created in the pre-requisites. We are going to use some material pre-loaded into the terminal image. Type the following commands in the Terminal tab.:

```
cd /workspace/workshop4/attendee
cat testfile.yaml
```

This file is the one to be used. If it, or any of the directories, don't exist, please follow the pre-requisite instructions and recreate the Terminal application.

All objects in Kubernetes/Openshift can be expressed as yaml and this is a basic configmap for a file. What is very nice about the API and it's object oriented nature is that you can export any object that you have the RBAC rights to view and import them directly back into OpenShift, which is what we will do now with the following commands in the terminal

```
oc create -f testfile.yaml
oc get configmaps
```

Go back to the UI, select *Workloads/Deployment Configs*

Select *nodenews* dc

Click on *YAML*

In order to add the config-map as a volume we need to change the container specification within the deployment config.

Find the setting for 'imagePullPolicy'. Put the cursor to the end of the line. Hit return. Underneath enter:

```
        volumeMounts:
          - name: workshop-testfile
            mountPath: /workshop/config
```

Make sure the indentation is the same as for the 'imagePullPolicy'.

Now in the 'spec:' portion we need to add our config-map as a volume.

Find 'restartPolicy'. Put the cursor to the end of the line and press return. Underneath enter:

```
      volumes:
        - name: workshop-testfile
          configMap:
            name: testfile
            defaultMode: 420
```

Save the deployment config.

Click on *Workloads/Pods*. Watch the new versions of the nodenews application deploy.

When they finish deploying click on one of the nodenews Pods. Click on *Terminal*.

In the terminal type:

```
cd /workshop
ls
cd config
```

Note that we have a new file called 'app.conf' in this directory. This file is NOT part of the image that generated the container.

In the terminal type:

```
cat app.conf
```

This is the value from the configmap object expressed as a file into the running container.

In the terminal type:

```
vi app.conf
```

Press 'i' to insert, then type anything. Then press ESC. Then type ':wq'

You will not be able to save it. The file expressed into the Container from the configmap is ALWAYS readonly which ensures any information provided via the config map is controlled and immutable.

Type ':q!' to quit out of the editor

Dependency Injection of sensitive information using Secrets

The config map to be written as a file is actually written to the Container Hosts as a file, and then expressed into the running Container as a symbolic link. This is good but can be seen as somewhat insecure because the file is stored *as-is* on the Container Hosts, where the Containers are executed

For secure information, such as passwords, connection strings and the like, OpenShift has the

concept of *Secrets*. These act like config maps *but* importantly the contents of the secrets are encrypted at creation, encrypted at storage when written to the Container Hosts and then unencrypted only when expressed into the Container, meaning only the running Container can see the value of the secret.

In the UI select *Workloads/Secrets*

Click on *Create*

Choose ‘Key/Value Secret'

For ‘Secret Name’ give ‘nodenewssecret’

Set ‘Key’ to ‘password’

Set ‘Value’ textbox to ‘mypassword’

Click ‘Create’

When created click on the ‘YAML’ box in the Secrets/Secret Details overview

Note that the type is ‘Opaque’ and the data is encrypted

Click on ‘Add Secret To Workload’

In the ‘Select a workload’ pulldown select the nodenews DC

Ensure the ‘Add Secret As’ is set to Environment Variables

Add the Prefix ‘secret’

Click ‘Save’

Watch the Pods update on the subsequent ‘DC Nodenews’ overview

When they have completed click on ‘Pods’

Choose one of the nodenews running pods, click on it, choose Terminal

In the terminal type ‘env | grep secret’

Understanding the Deployment Strategies

Click on *Workloads/Deployment Configs*

Click on the DC for *nodenews*

Scale the Application up to four copies using the up arrow next to the Pod count indicator

Once the count has gone to 4 and all the Pods are indicated as healthy (the colour of the Pod ring is blue for all Pods) select Action/Start Rollout.

The DC panel will now render the results of the deployment.

Deployments can have one of two strategies. This example uses the *Rolling* strategy which is designed for zero downtime deployments. It works but spinning up a single copy of the new Pod, and when that Pod reports as being healthy only then is one of the old Pods removed. This ensures that at all times the required number of replicas are running healthy with no downtime for the Application itself.

Click on *Actions/Edit Deployment Config*

Scroll the editor down to the 'spec:' tag as shown below

```
spec:
 strategy:
   type: Rolling
   rollingParams:
```

Change the type: tag of the strategy to Recreate as shown below

```
spec:
 strategy:
   type: Recreate
```

Click on *Save*

Click on *Workloads/Deployment Configs*, select nodenews dc

Click on 'Action/Start Rollout'

Watch the colour of the Pod rings as the system carries out the deployment

In the case of a Recreate strategy the system ensures that NO copies of the old deployment are running simultaneously with the new ones. It deletes all the running Pods, regardless of the required number of replicas, and when all Pods report as being fully deleted it will start spinning up the new copies. This is for a scenario when you must NOT have any users interacting with the old Application once the new one is deployed, such as a security flaw in the old Application

Cleaning up

From the OpenShift browser window, click on *Home* and then *Projects* on the left hand side menu.

In the triple dot menu next to your own project (sandboxX) select ‘Delete Project’ Type ‘sandboxX’ (where X is your user number) such that the Delete button turns red and is active.

Press Delete to remove the project.

Application Deployment Configurations and DevOps Approaches [ESSENTIALS]

Author: Mark Roberts (feedback to mroberts@redhat.com)

Introduction

DevOps is a much overloaded term that is used to describe a variety of concepts in the creation of modern applications. In a simple definition DevOps is concerned with the interface between development practices used for the creative elements of software engineering and the procedural rigour of operationally running applications in production. Clearly these concepts have different objectives so it is important for teams (whether tasked with development or operations) to have a good understanding of the concepts, objectives and concerns of their counterparts on the other side of the fence.

In terms of this workshop it is important to highlight the capabilities of containerised platforms with respect to the roll out of new versions of applications and how they get introduced to production and to end users. Terms such as blue/green deployments, black and white deployments, A/B deployments and canary deployments are used in various text books on *DevOps* principles and some of these areas will be used in this chapter of the workshop.

The activities in this workshop will introduce a new version of a simple application to use in two different manners.

Workshop Content

The application to be used in this workshop is a simple NodeJS REST interface. Version 1 exists on the master branch of the GIT Repository and version 2 exists on the experimental branch.

To begin the creation of the application use the following commands in an command line window. :

Creation of version 1

```
oc new-project master-slaveX
```

(Where X is your user number)

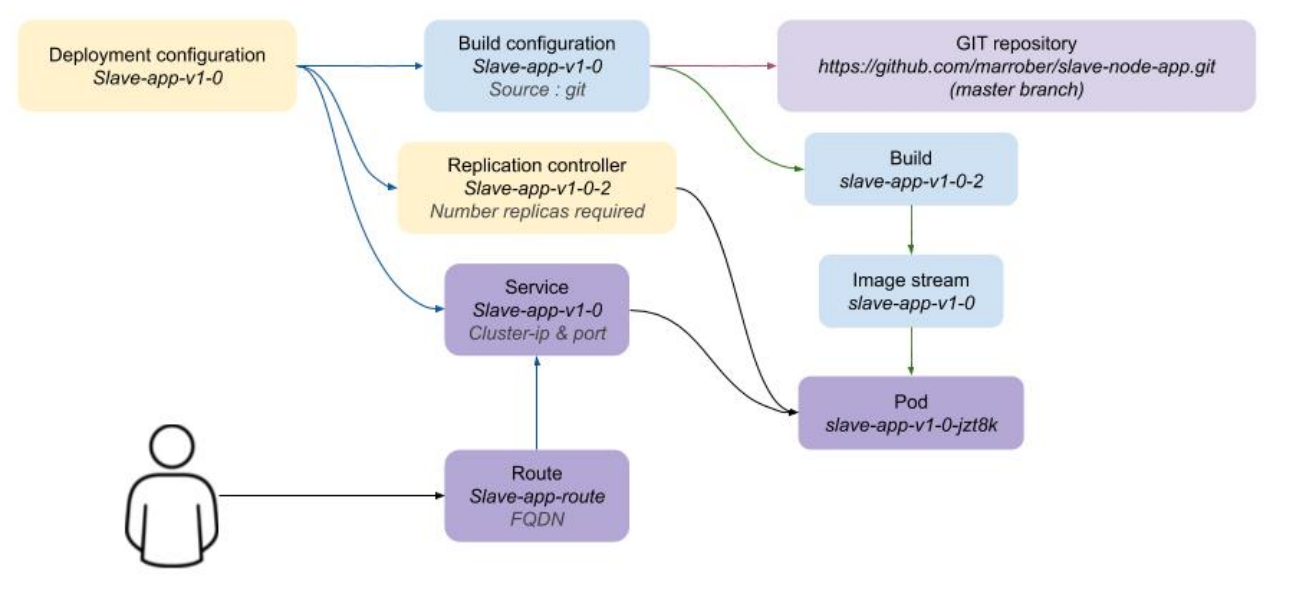
```
oc new-app --name slave-app-v1-0  https://github.com/marrober/slave-node-app.git

oc expose service slave-app-v1-0 --name="slave-app-route"
```

What got created ?

It is important to understand the artefacts and content that are created by the above commands within OpenShift:

- A new project is created called master-slaveX.
- A deployment configuration is created called slave-app-v1-0.
- A replication controller is created associated with the application and the built objects. This defines the scaling of the application in terms of the number of pods and the deployment strategy (rolling or recreate).
- A build configuration is created to compile the application source code which is extracted from the associated GIT repository.
- The build configuration will create a build instance which includes logs of the build process and a reference to the built image.
- The newly created image is deployed as a running pod (or pods depending on the number of pods defined in the deployment configuration).
- A service is created as part of the application creation process. The service endpoints will point to the pod(s) created by the build process. In the case of a rebuild and redeploy operation the service endpoints are updated to point to the new pods in accordance with the deployment strategy of the deployment configuration.
- The service is then exposed external to the cluster by the creation of a route. The route has a fully qualified domain name for access from machines outside the cluster.

The diagram below shows the above and how they relate together.



To identify the URL of the route execute the command shown below:

```
oc get route slave-app-route -o jsonpath='{"http://"}{.spec.host}{"/ip\n"}'
```

This will display a formatted URL with the *http://* part at the beginning which will be similar to :

http://slave-app-route-master-slave.apps.cluster-xxxx-yyyy.xxxx-yyyy.example.opentlc.com/ip

To test the application use the command line window to issue a curl command to:

```
curl -k <url from the above command>
```

The response should be as shown below (example ip address) :

"10.131.0.114 v1.0"

Creation of version 2

The development team now wants to introduce an experimental version 2 of the application and introduce it to the users in a number of different ways. The first action is to create the new build process for the experimental version using the command below.

```
oc new-app --name slave-app-v2-0 https://github.com/marrober/slave-node-
app.git#experimental
```

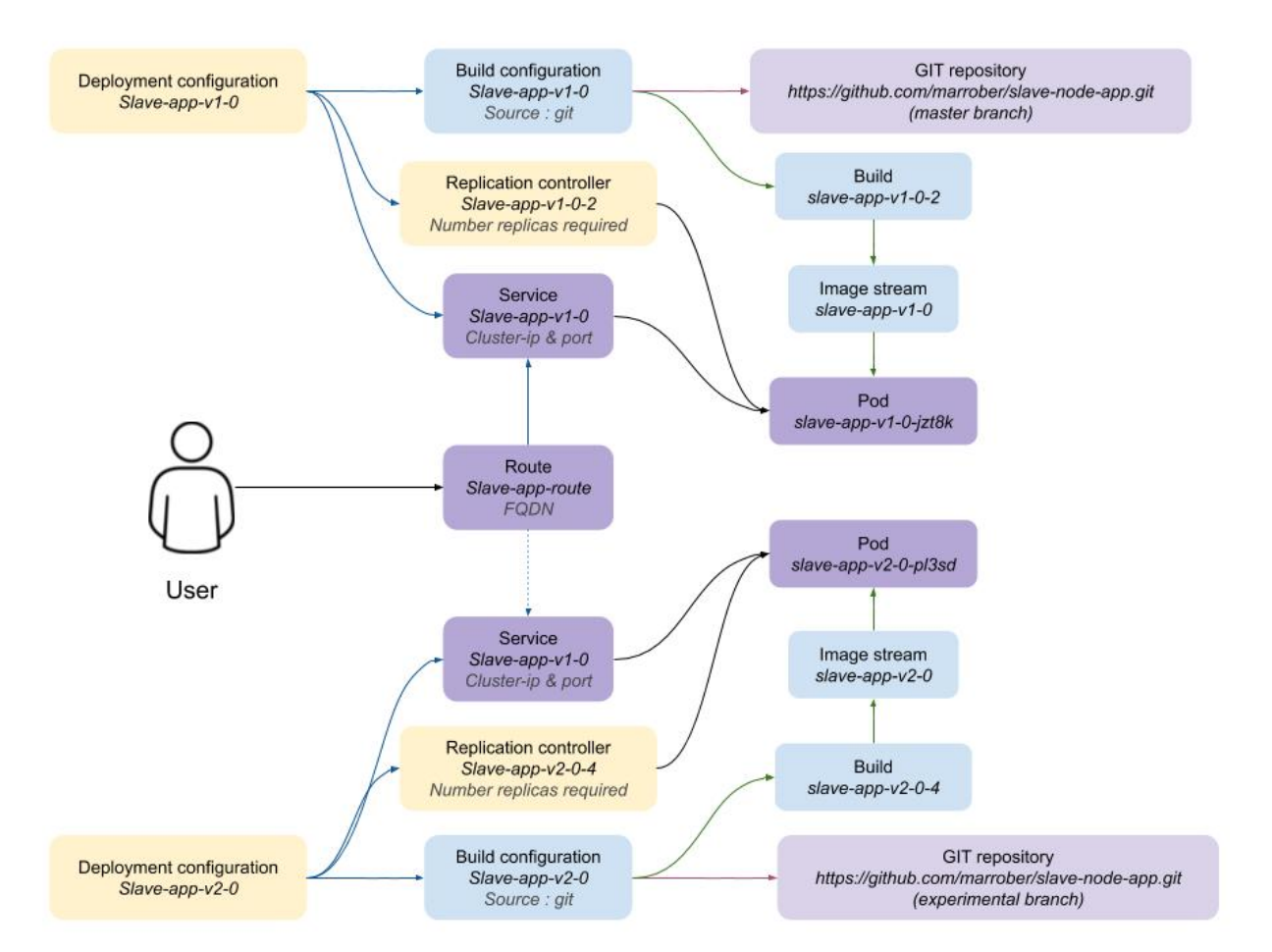
Note the use of the #experimental branch identifier in the end of the GIT repository. This syntax cannot be used through the web interface to openshift so any requirements for non-standard GIT connectivity must be done through the command line interface. It is also possible to configure the source-2-image capability to reference a specific sub directory of the repository using the --context option.

What got added to the project ?

New content was added to the project as a result of the above command specific to the experimental (v2) version of the application.

- A deployment configuration
- A replication controller
- A build configuration
- A running container in a pod
- A service

The diagram below shows the above and how the relate together.



At this point the version 2 application is operational but not accessible externally to the cluster.

Blue / Green Deployment

The benefit of creating the new version of the application alongside the old is that it is quick and easy to migrate users to a new version of the application. It also allows teams to validate that the pods are running correctly.

Switching the route from v1 to v2 involves patching the route to change configuration. Before executing this operation open a new command window and execute the command below to send requests to the route every second. The responses received should all include the ip address of the pod and the version (v1) of the application.

Get the URI of the route using the command :

```
oc get route slave-app-route -o jsonpath='{"http://"}{.spec.host}{"/ip\n"}'
```

Copy the result of the above command and paste it into the shell script below:

```
for i in {1..1000}; do curl -k <URI> ; echo ""; sleep 1; done
```

A series of reports of ip address and version 1 of the application will then start to scroll up the screen. Leave this running.

Switch back to the original command window and execute the command below to patch the route to version 2 of the application.

```
oc patch route/slave-app-route -p '{"spec":{"to":{"name":"slave-app-v2-0"}}}'
```

Switch back to the command window with the shell script running and you should see the responses have a new ip address and now report v2 of the application. This has completed a migration from the old version of the application to the new.

The details of the route patched by the above command are displayed by the command:

```
oc get route/slave-app-route -o yaml
```

The output of the above command is shown below, and the nested information from spec → to → name is easy to see.

```
apiVersion: route.openshift.io/v1
kind: Route
metadata:
  annotations:
    openshift.io/host.generated: "true"
  creationTimestamp: 2019-12-04T17:16:37Z
  labels:
    app: slave-app-v1-0
  name: slave-app-route
  namespace: master-slave
  resourceVersion: "884652"
  selfLink: /apis/route.openshift.io/v1/namespaces/master-slave/routes/slave-app-route
  uid: d4910fef-16b9-11ea-a6c5-0a580a800048
spec:
  host: slave-app-route-master-slave.apps.cluster-telf-c8e6.telf-c8e6.example.opentlc.com
  port:
    targetPort: 8080-tcp
  subdomain: ""
  to:
    kind: Service
    name: slave-app-v2-0
    weight: 100
  wildcardPolicy: None
status:
  ingress:
  - conditions:
    - lastTransitionTime: 2019-12-04T17:16:38Z
      status: "True"
      type: Admitted
    host: slave-app-route-master-slave.apps.cluster-telf-c8e6.telf-
c8e6.example.opentlc.com
    routerCanonicalHostname: apps.cluster-telf-c8e6.telf-c8e6.example.opentlc.com
    routerName: default
    wildcardPolicy: None
```

Before moving to the A/B deployment strategy switch back to version v1 with the command:

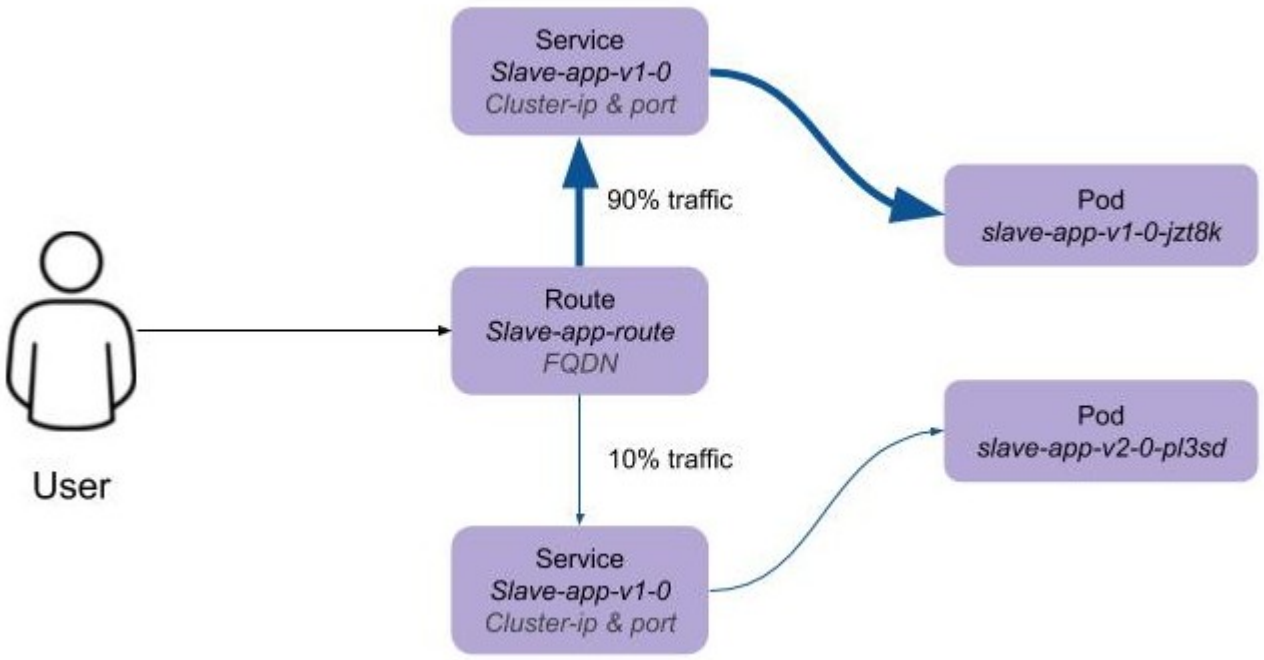
```
oc patch route/slave-app-route -p '{"spec":{"to":{"name":"slave-app-v1-0"}}}'
```

Confirm this has worked in the command window executing the shell script.

A/B Deployment

The benefit of an A/B deployment strategy is that it is possible to gradually migrate workload to the new version. This example presents a simple process of gradually migrating a higher and higher percentage of traffic to the new version, however more advanced options are available for migrating traffic based on headers or source ip address to name just two. Red Hat OpenShift Service Mesh is another topic that is worth investigation if advanced traffic routing operations are required.

Gradually migrating traffic from v1 to v2 involves patching the route to change configuration as shown below.



To migrate 10% of traffic to version 2 execute the following command:

```
oc set route-backends slave-app-route slave-app-v1-0=90 slave-app-v2-0=10
```

Switch back to the command window running the shell script and after a short wait you will see the occasional report from version 2.

To balance the workload between the two versions execute the following command:

```
oc set route-backends slave-app-route slave-app-v1-0=50 slave-app-v2-0=50
```

Switch back to the command window running the shell script and after a short wait you will see a more even distribution of calls between versions 1 and 2.

The details of the route patched by the above command are displayed by the command:

```
oc get route/slave-app-route -o yaml
```

A section of the output of the above command is included below, showing the split of traffic between versions 1 and 2.

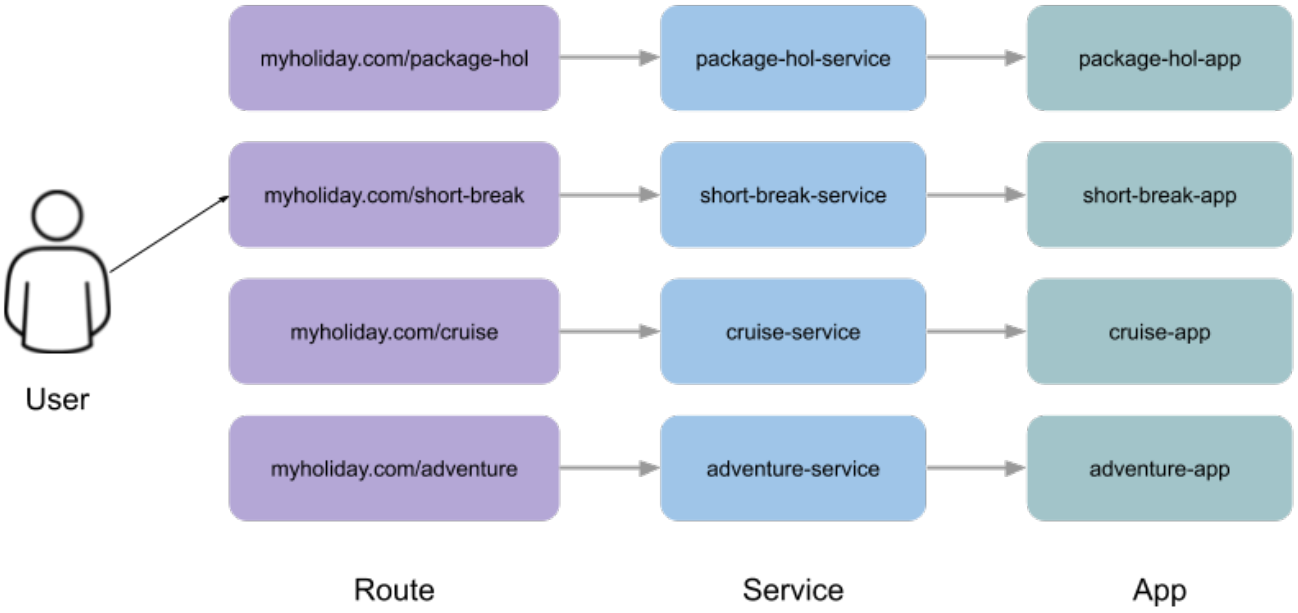
```
spec:
  alternateBackends:
  - kind: Service
    name: slave-app-v2-0
    weight: 50
  host: slave-app-route-master-slave.apps.cluster-telf-c8e6.telf-c8e6.example.opentlc.com
  port:
    targetPort: 8080-tcp
  subdomain: ""
  to:
    kind: Service
    name: slave-app-v1-0
    weight: 50
```

When satisfied that version 2 is working as required the following command will switch all traffic to that version and will remove the references to version 1 from the route.

```
oc set route-backends slave-app-route slave-app-v1-0=0 slave-app-v2-0=100
```

URL based routing

Many organisations want to use a common URL for their web sites so that it is easy for users. This is often achieved by pointing a specific URL at an OpenShift cluster route within a global load balancer function, however this is not essential and it is possible to use routes to achieve the same result. Take as an example a holiday company called myholiday.com. The company wishes to sell package holidays, short breaks, cruises and adventure holidays and they create different applications for these purposes. By using a common host name in a series of route it is possible to ensure that traffic flows to the right location, based on the path of the url used. The diagram below shows the descried sceanrio and how the routes, services and applications work together



In this example you will create an application that mirrors that shown above and you will use a single URL for access to the four different elements of the application.

Creating the applications

This example uses a common code base to create the specific applications for the above four holiday types. To create the four applications in a single project use the steps below substituting your student number for *X* so that you get a separate project to other users in the workshop.

```
oc new-project myholidayX
oc new-app https://github.com/marrober/workshop4.git --context-dir=attendee/myholiday \
--name=short-holiday -l app.kubernetes.io/part-of=holidays HOLIDAY_TYPE=short-break
oc new-app https://github.com/marrober/workshop4.git --context-dir=attendee/myholiday \
--name=package-holiday -l app.kubernetes.io/part-of=holidays HOLIDAY_TYPE=package
oc new-app https://github.com/marrober/workshop4.git --context-dir=attendee/myholiday \
--name=cruise-holiday -l app.kubernetes.io/part-of=holidays HOLIDAY_TYPE=cruise
oc new-app https://github.com/marrober/workshop4.git --context-dir=attendee/myholiday \
--name=adventure-holiday -l app.kubernetes.io/part-of=holidays HOLIDAY_TYPE=adventure
```

Switch to the web user interface and select the project that you have just created. Then select the topology view from the left hand side developer menu and watch the applications build and deploy. Progress of the build phase can also be tracked using the command :

```
oc get build
```

When all of the builds are complete the applications will take a few seconds to deploy and then will be ready.

At this stage the applications have services but they do not have any routes exposing them outside the cluster. Ordinarily users would create a route for each application which would result in a different URL for each. In this activity a common URL is required for all four.

To identify the cluster specific element of the hostname to use for the route, create a temporary route using the command below. The second command is used to get the hostname for the route.

```
oc expose service/adventure-holiday
oc get route adventure-holiday -o jsonpath='{.spec.host}'
```

This will result in a new route being created and the hostname will be displayed similar to :

```
adventure-holiday-myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com
```

The element of the path that we need for the new common hostname is from the .apps part forward, and a new part will be created to replace *adventure-holiday-myholiday2* based on the project name. A shell script is used to configure the four route creation yaml files which are downloaded from the workshop git repository. If you have not already done so clone the git repository using the command below and then switch directory and examine one of the yaml files.

```
git clone https://github.com/utherp0/workshop4.git
cd workshop4/attendee/myholiday
cat adventure-route.yaml
```

The YAML file is shown below :

```
apiVersion: route.openshift.io/v1
kind: Route
metadata:
  labels:
    app: adventure-holiday
  name: adventure-route
spec:
  host: URL
  path: "/adventure"
  to:
    kind: Service
    name: adventure-holiday
    weight: 100
```

The host *URL* will be replaced by the configure-routes.sh shell script. The path shows /adventure, and a similar path exists in the cruise, package and short-break files to point to their specific paths.

Execute the shell script *configure-routes.sh* with this command:

```
./configure-routes.sh
```

Now take another look at adventure-route.yaml, which will be similar to that which is shown below.

```
apiVersion: route.openshift.io/v1
kind: Route
metadata:
  labels:
    app: adventure-holiday
  name: adventure-route
spec:
  host: myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com
  path: "/adventure"
  to:
    kind: Service
    name: adventure-holiday
    weight: 100
```

The host path is now made up of the common element from the project name and the common cluster specific path.

Delete the temporary route used to generate the hostname with the command below.

```
oc delete route/adventure-holiday
```

Execute the following commands to create the four routes.

```
oc create -f adventure-route.yaml
oc create -f cruise-route.yaml
oc create -f package-route.yaml
oc create -f short-break-route.yaml
```

Examine the new routes using the command :

```
oc get routes
```

An example of the important information from the above command is shown below.

```
NAME                  HOST/PORT                                                  PATH
SERVICES
adventure-route       myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com   /adventure
adventure-holiday
cruise-route          myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com   /cruise
cruise-holiday
package-route         myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com   /package
package-holiday
short-holiday-route   myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com   /short-
break   short-holiday
```

Test the routes (copy and paste from your result of the *oc get routes* command) by accessing the four different holiday types from the common url with the curl commands below. The text responses will show that the correct application is responding to each request.

```
curl myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com/adventure
curl myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com/cruise
curl myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com/package
curl myholiday2.apps.cluster-c2d5.c2d5.example.opentlc.com/short-break
```

Cleaning up

From the OpenShift browser window click on *Advanced* and then *Projects* on the left hand side menu.

In the triple dot menu next to your own project (master-slaveX) select ‘Delete Project’ Type ‘master-slaveX’ (where X is your user number) such that the Delete button turns red and is active. Press Delete to remove the project.

Repeat the above process for the myholidayX project too.

Understanding the Software Defined Network [ESSENTIALS]

Introduction

This chapter provides a developer-centric view of the fundamentals and capabilities of the SDN (Software Defined Network) that is used within OpenShift for Application connectivity.

If you are not already logged on go to the UI URL at https://example.manifest.com, window="_blank" and logon as *userx* (x is the number provided to you) and password openshift.

The basics of Service Addressing

In this section we will create a couple of simple applications and show how they are represented via the Service and load-balancing of Pods within the SDN itself.

If you do not already have a terminal tab running as defined in the pre-requisites please open one following the instructions in the pre-requisites

Ensure you are on the Administrator View (top level, select Administrator)

Select Home/Projects

Click on ‘Create Project’

For the project name give it networktestx where x is your user number

Display Name and Description are optional

Click on *Create*

Using the top left selection switch the UI from Administrator to Developer

In the Topology Tab click on ‘From Catalog’

In the search box enter ‘node’. Select the Node.js option

Click ‘Create Application’

Default the image to version 10

For the git repo enter ‘https://github.com/utherp0/nodenews’

Set the *Application Name* to ‘application1-app’

Set the *Name* to *application1*

In Resources set the deployment type to DeploymentConfig

Click *Create*

Click on '+Add'

Click on 'From Catalog'

In the search box enter 'node'. Again select the Node.js option

Click 'Create Application'

For the git repo enter 'https://github.com/utherp0/nodenews'

Choose *Create Application* from the Application pulldown

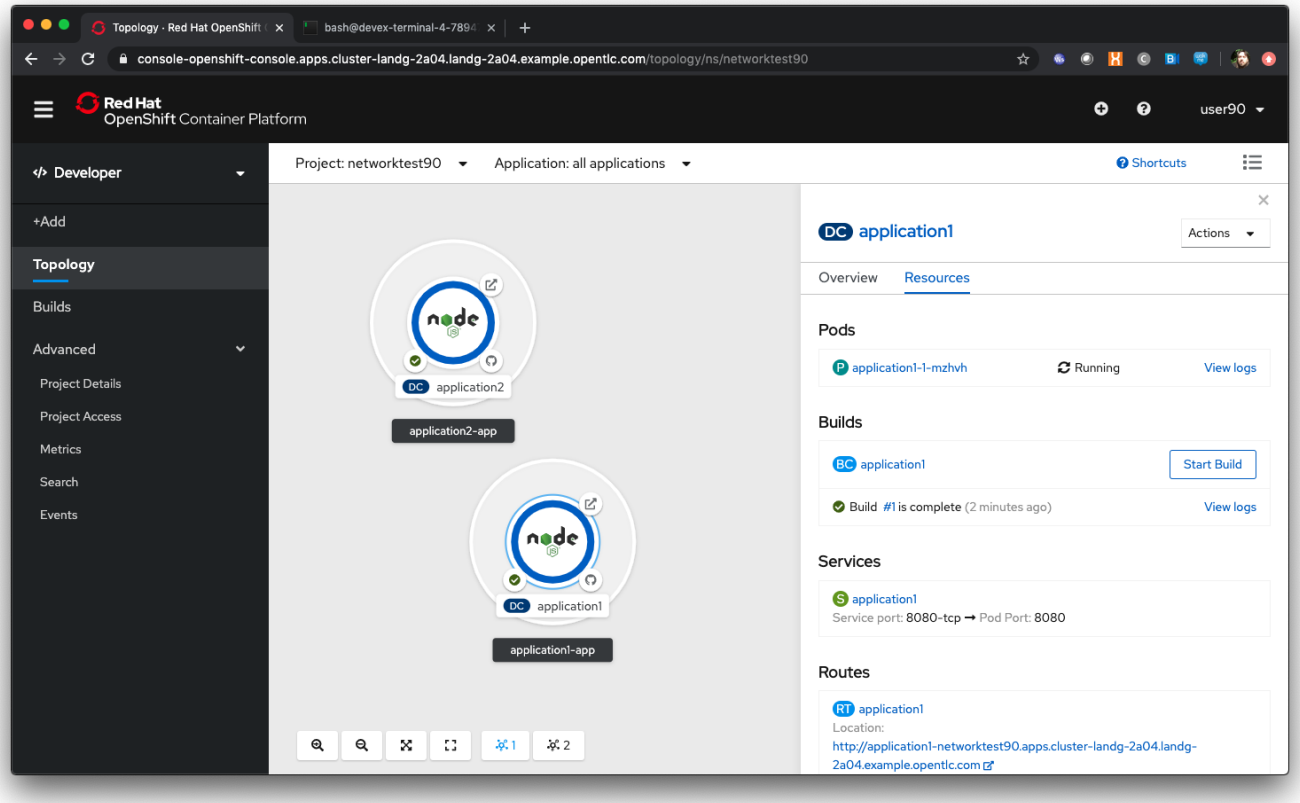
Set the *Application Name* to *application2-app*

Set the Name to 'application2'

In Resources set the deployment type to DeploymentConfig

Click *Create*

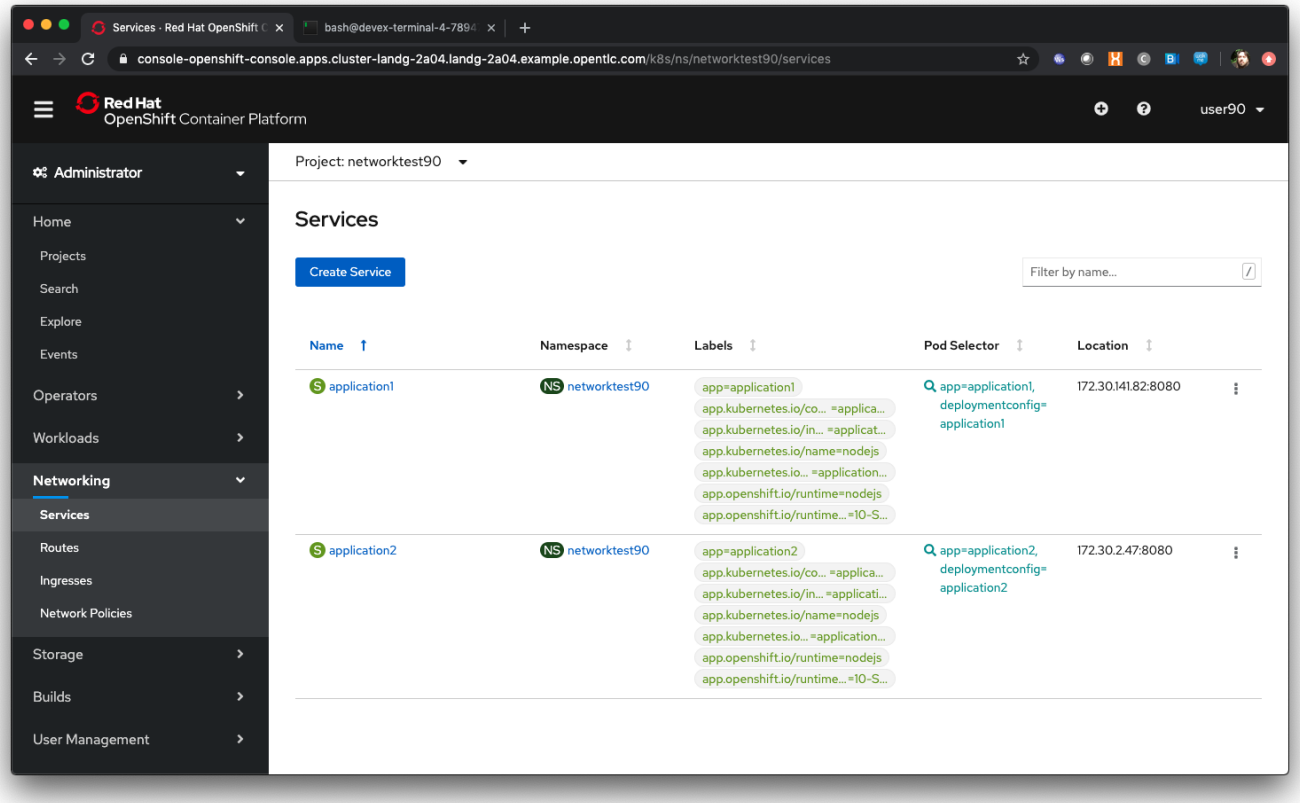
Wait until both applications have built and deployed. The Topology view will look similar to the image below:



Once the applications have created change the mode from Developer to Administrator using the top left selection point

Click on *Projects*. Select the networktestx project

Click on *Networking/Services*



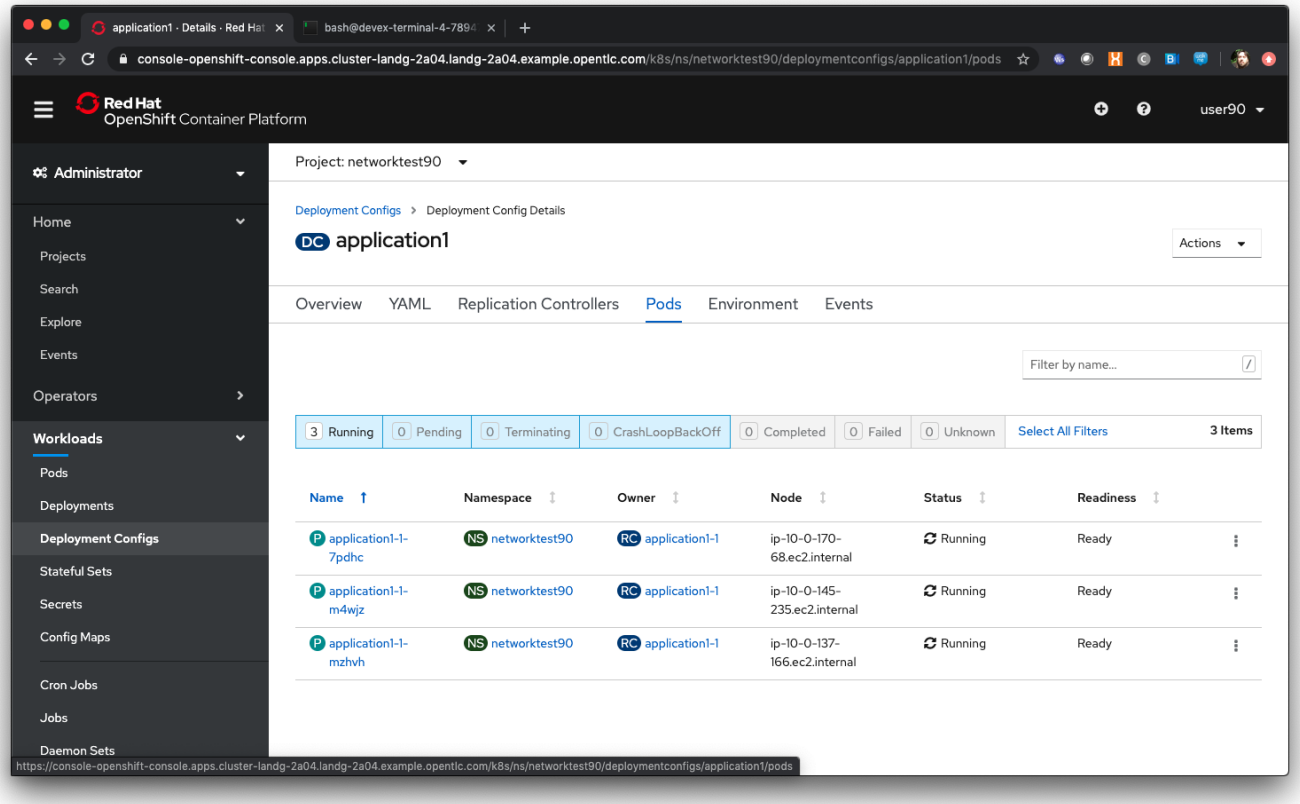
The Services UI shows the services currently available in the Project. Note that there is a Service per application, so in this case there are two Services, application1 and application2. The Location is a singular IP address for each Service within the SDN - more on this later.

Click on *Workloads/Deployment Configs*

Click on the application1 dc

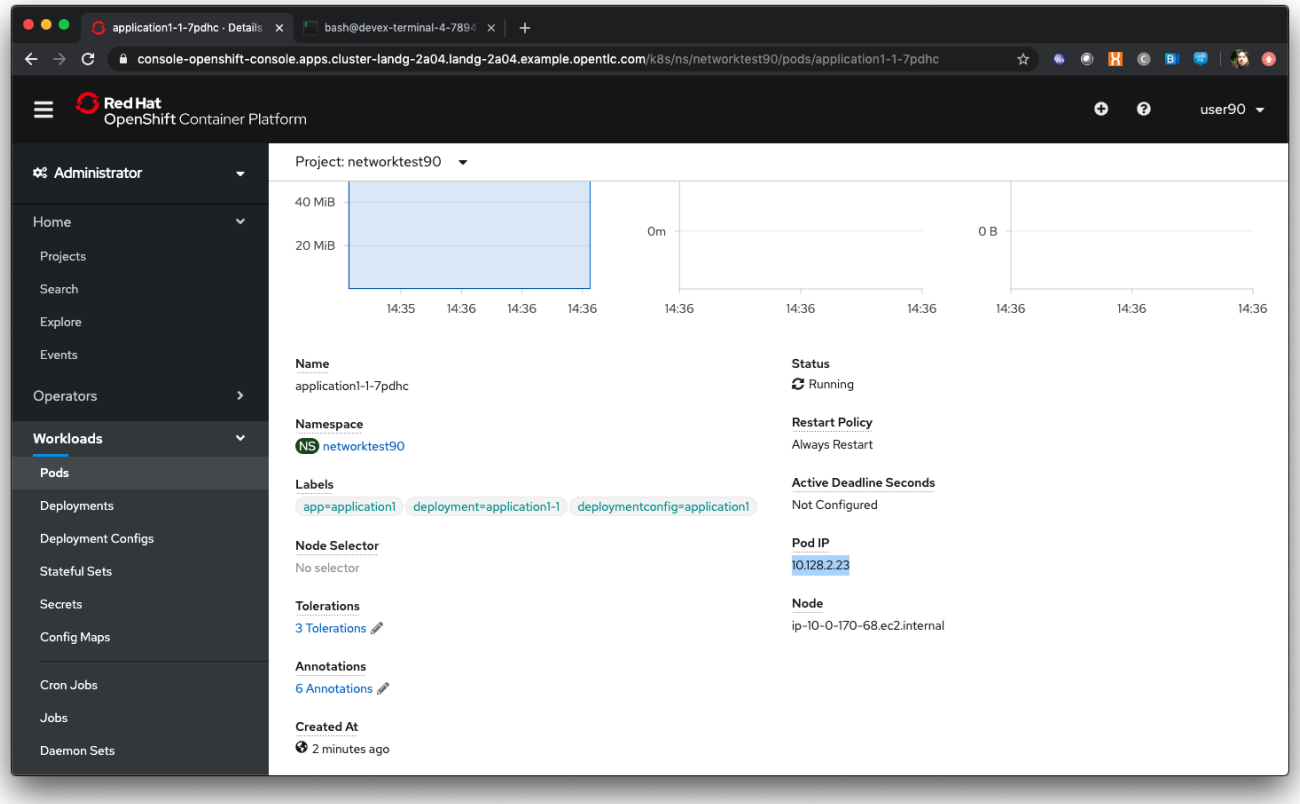
Using the arrows next to the Pod indicator scale the application to three replicas

Click on ‘Pods’ in the DC view (not Workloads/Pods)



Click on the first active Pod for application1 listed

Scroll down and take a note of the IP address for the Pod



Click on *Networking/Services*

Click on the application1 service

Note that the IP address for the Service has NOT changed. Scaling the Application has no impact on the singular IP address for the Service, which in actuality acts as a load-balancer across ALL of the IP addresses for the Pods of that Application.

Using the shorthand Service name directly

Click on *Workloads/Pods*

Click on the first running Pod for application1 (the name will be application1-1-(something)

Click on Terminal

In the Terminal window type:

```
curl http://localhost:8080
```

You will see the webpage for the Application as a return from the curl statement. The Container sees itself as localhost. Also note that because we are calling from within the Container we use the port address - if you were using the Routes their would be a Route for every Service, with no port address.

In the Terminal window type:

```
curl http://application1:8080
```

This is where it starts to get interesting. The Service *name* itself is exported into the network namespace of the Container so it can refer to it as a short name. The SDN translates the service name into the service IP - in reality this Container could be getting a webpage back from any of the Application Pods that satisfy this Service.

Using the Fully Qualified Domain Name for accessing Services

In the Terminal window type (and replace x with your number):

```
curl http://application1.networktestx.svc.cluster.local:8080
```

And this is the fully qualified version of the Service. by including the namespace/project name we can reach, effectively, any service on the SDN assuming the SDN has been configured to allow that. In this case we are just targeting our own Service from the application Container, now we will try the other application in the namespace.*

In the Terminal window hit the up arrow to get the last command, edit the name and change application1 to application2, hit return at the end of the statement

You should get the contents of a webpage. This is the output of the other application. This long format makes it easy to refer to other applications without having to leave and come back into the SDN (via a Route).

In the terminal type:

```
curl http://application2:8080
```

We can also connect to any of the Services hosted within the namespace/project by default

Ask the person sat next to you what their project name is and make a note of it

In the terminal type:

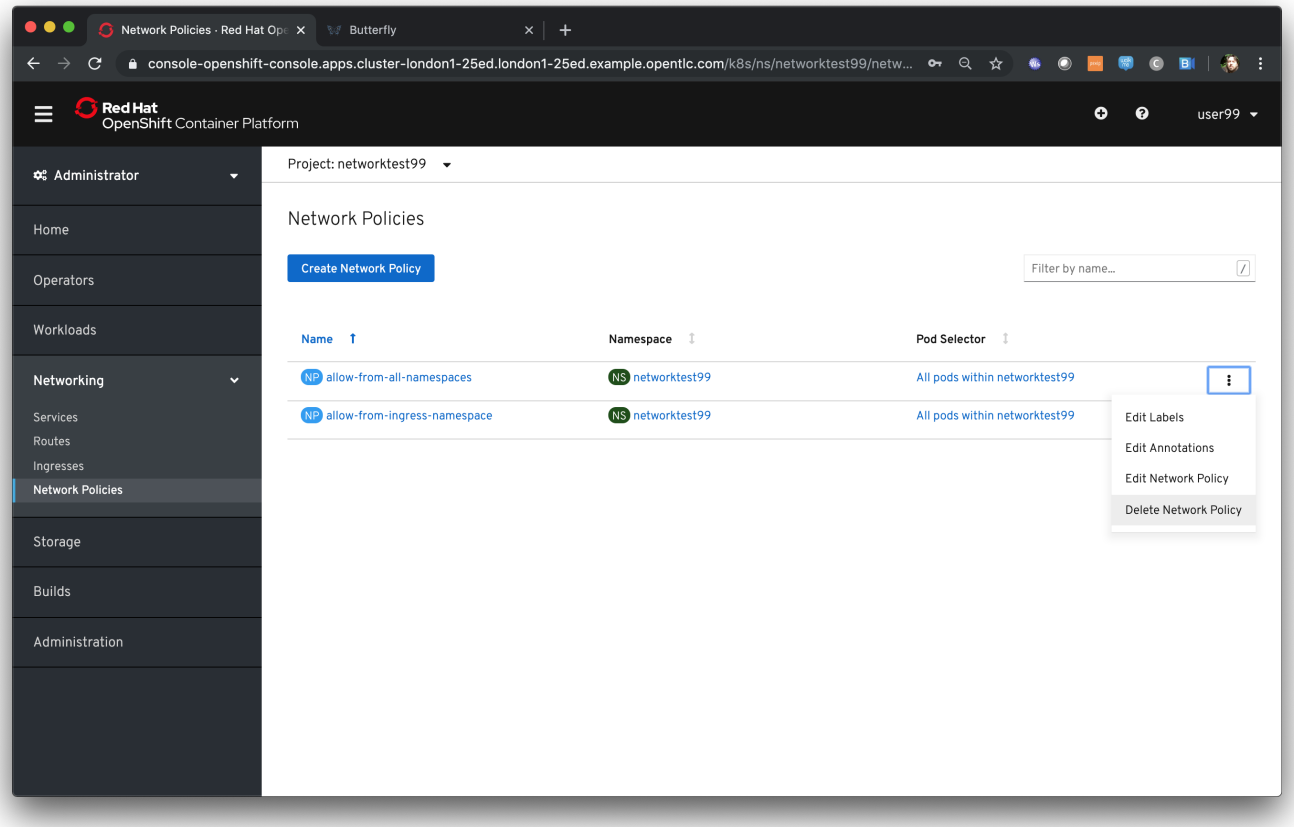
```
curl http://application1.(the project name from the person next to
you).svc.cluster.local:8080
```

OpenShift Container Platform can be installed with two different modes of SDN. The first is subnet, which exposes all Services in all Namespace/Projects to each other. This instance has a subnet SDN which is why you should be able to call other peoples Services directly from your own via the internal FQDN address.

Controlling Access through Network Policies

Click on *Network/Network Policies*

For each of the policies listed click on the triple dot icon on the far right and choose ‘Delete Network Policy’.



The Network Policy tab should display ‘No Network Policies Found’.

Go to Workloads/Pods, click on one of the application1 Pods, choose Terminal

Repeat the ‘curl’ command listed above for the person sat next to you, i.e. curl their application1

Ensure you get a webpage

Go to Network/Network Policies

Click on ‘Create Network Policy’

Enter the following - remember to change YOURNUMBERHERE to your user number

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
 name: example
 namespace: networktestYOURNUMBERHERE
spec:
 podSelector:
   matchLabels:
     app: application1
 ingress: []
```

Click ‘Create’

Wait until the person next to you has done the same

Click on *Workloads/Pods*, click on one of the application1 Pods, choose Terminal

Repeat the ‘curl’ command listed above for the person sat next to you, i.e. curl their application1

The call will eventually fail - feel free to hit Ctrl-C to interrupt

The creation of a Network Policy that prohibits ingress to the Application Service has stopped access to the Service from external namespaces AND internal Services.

Click on *Workloads/Pods*

Click on the active pod for application2

Click on Terminal

Type:

```
curl http://application1:8080
```

The call will eventually fail

This shows that the Service is prohibited even from Services in its own namespace/project. This application of Network Policy allows for fine-grain control of traffic egress/ingress at the Service level. The other installation mode for SDN for OpenShift 4 is with Network Policies enabled, with default Network Policies providing a fully multitenanted environment.

Click on *Projects*

On the triple dot icon on the far right for networktestxx select ‘Delete Project’

In the pop-up enter the name of the project (‘networktestxx’ with your number) and hit Delete

The RBAC model for Developers [ESSENTIALS]

Introduction

This chapter will introduce the attendee to the concepts around the Role Based Access Control model integrated into OpenShift. This will cover the use of Users, Service Accounts and Permissions.

For the majority of this chapter the attendee will need to pair up with another. If the numbers are odd the presenter should fill the gap of the missing attendee - pair the attendees up before the chapter starts and get them to exchange numbers - remember the numbers as MYUSER and PARTNERUSER

If you are not already logged on go to the UI URL https://example.manifest.com, window="_blank" and logon as *userx* (x is the number provided to you) and password openshift.

If you do not already have a terminal tab running as defined in the pre-requisites please open one following the instructions in the pre-requisites

Ensure you are on the Administrator View (top level, select Administrator)

In the UI click on *Home/Projects*

Click on *Create Project*

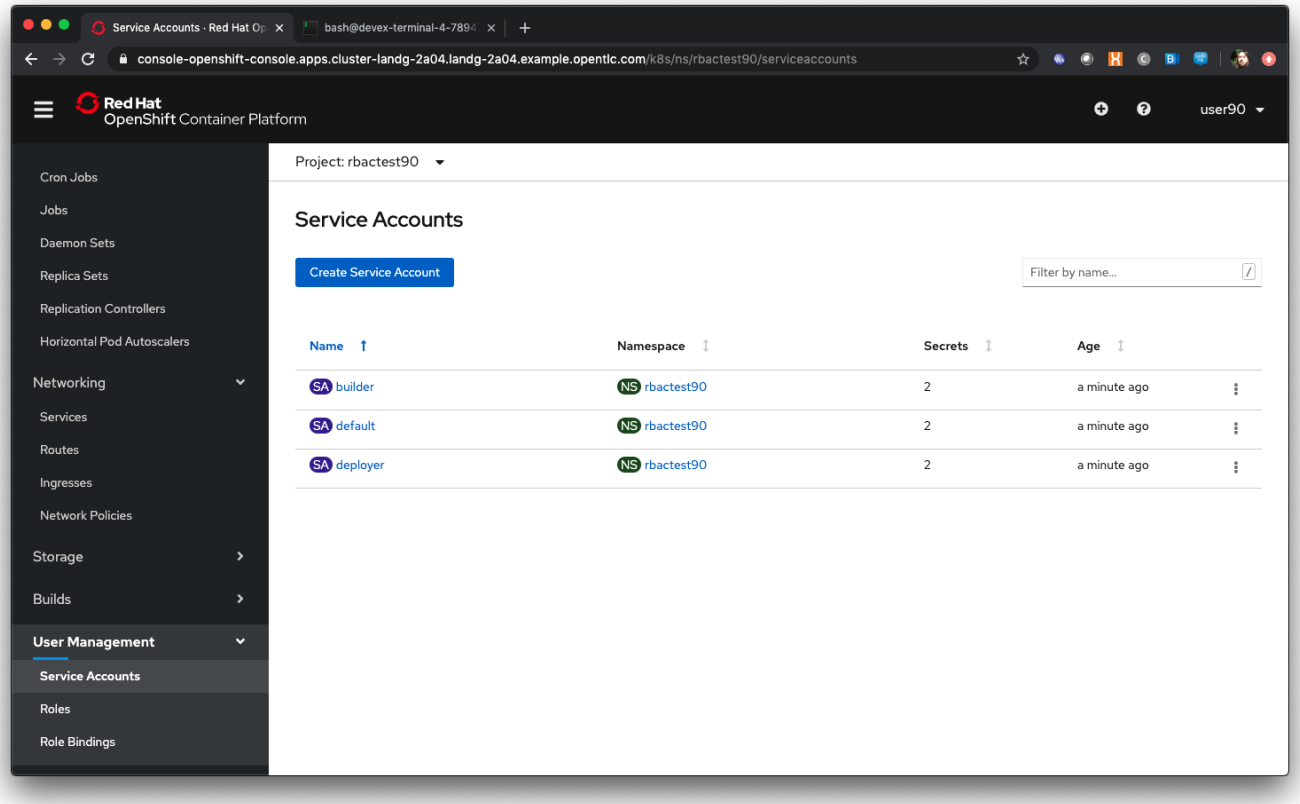
For the project name give it rbactestx where x is your user number

Display Name and Description are optional

Click on *Create*

Examining Service Accounts

Once the project has been created, click on *User Management/Service Accounts*



Service Accounts are effectively virtual users - even though you have logged on when you do anything within the namespace, such as a build or a deployment, the namespace uses a virtual user, with appropriate permissions, to do the actual tasks internally, like pushing a built image to the registry, or pulling an image to start a Container.

Each project gets a Service Account by default, named default or to give it its full name system:serviceaccount:rbactestx:default (where x is your number). There are also Service Accounts for doing the appropriate actions, such as Builder and Deployer

In addition further Service Accounts can be created by the project owner and given additional security details and roles, such as being able to execute Containers as root, or giving Containers specific controlled sec-comp profiles (like changing the Group ID for the process)

Switch to the Developer view using the top left pulldown

In the Topology Tab click on ‘From Catalog’

In the search box enter ‘node’. Select the Node.js option

Click ‘Create Application’

Default the image to version 10

For the git repo enter ‘https://github.com/utherp0/nodenews’

Set the Application Name to ‘rbac’

Set the Name to ‘rbactest’

In Resources set the deployment to DeploymentConfig

Click *Create*

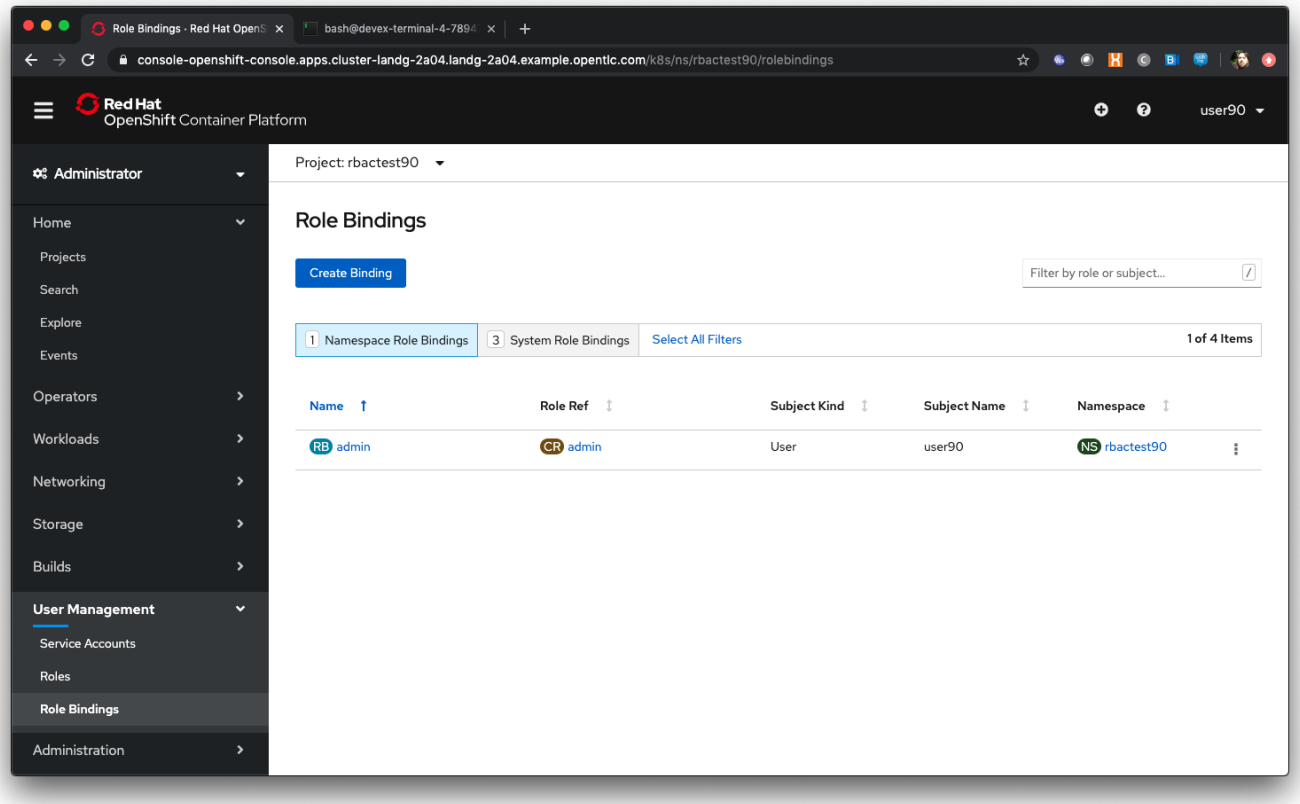
Click on the Node pod indicator so the informational panel appears

Watch the build and ensure it completes

Once the build is complete ensure the deployment occurs. The Pod ring will turn dark blue

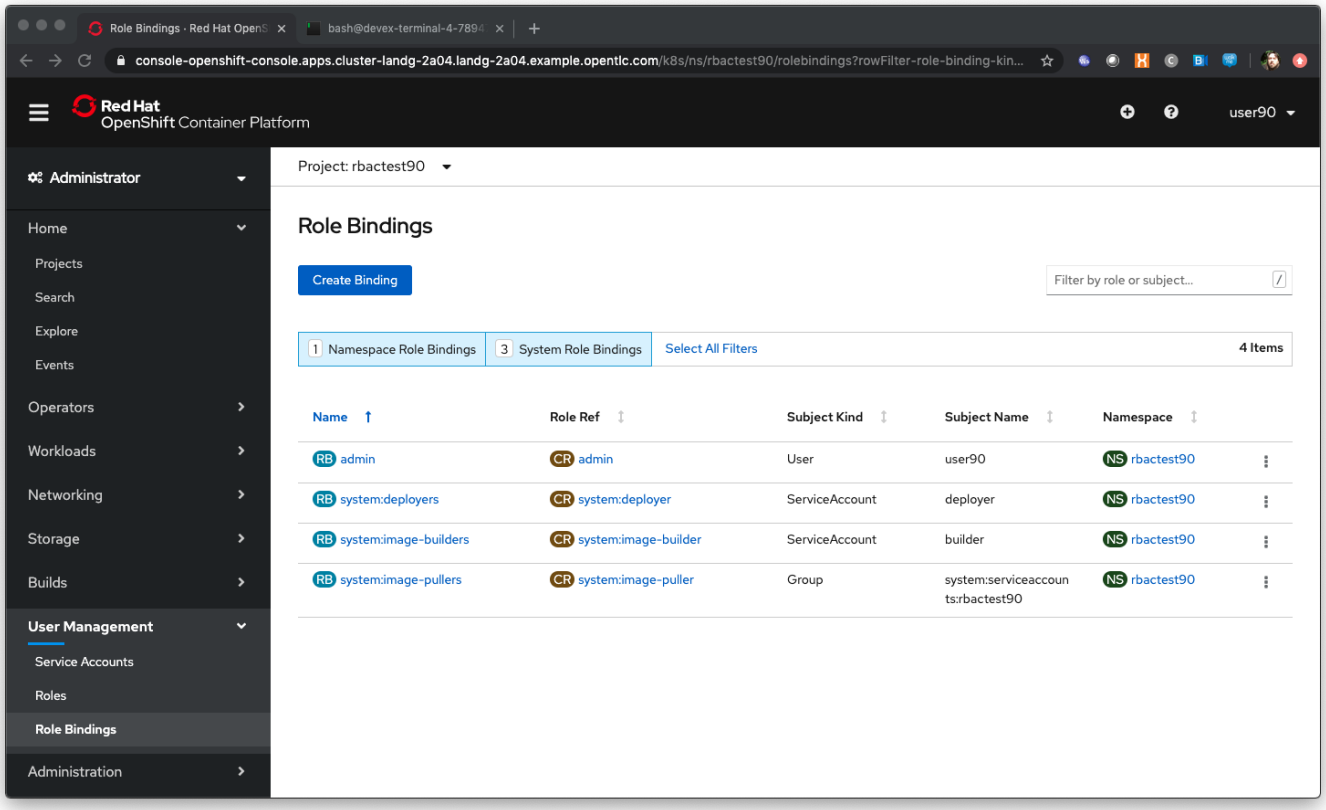
Switch back to Administrator view using the top left selection point

Click on User Management/Role Bindings



Note that we have one Role Binding shown at the moment, which is for Admin and applies to a kind of *user* and a subject name of *userx*. This is the binding of your user to the administration role within the project.

Click on the *System Role Bindings*



Note that with the addition of System Role Bindings to the screen we can now see the three Service Accounts also created. Deployer is part of the system:deployers binding, builder is part of the system:image-builders binding and the group of users under system:serviceaccounts:rbactestx (where x is your number) have the system:image-pullers binding.

Click on the (CR) admin Role Ref

This screen displays ALL the actions, via API, that this role has access to grouped by the API groups. This mapping is what controls what the user can do via the bindings they have.

Adding Role Bindings to your namespace/project

Click on *User Management/Role Bindings*

Click on *Create Binding*

Set Name to ‘partneraccess’

Select ‘rbactestx’ from the Namespace pulldown; it should be the only one.

As a user with the admin role within the namespace/project you can add other users with role bindings within your project.

Select ‘Admin’ in the Role Name pulldown

Ensure ‘User’ is selected in the radiobox for Subject

Enter ‘userPARTNERUSER’ for the Subject Name

What we are doing is adding the user you have chosen to pair with as an admin role binding within your project.

Click *Create*

Ensure the partner has done the same with your userx

Click on Home/Projects

If the partner user has set the role binding appropriately you will now see two projects - your own and the other person’s

Click on the partner’s project (rbactestPARTNERUSER)

Change to the Developer view using the top left selection point

Ensure you can see the Topology page

Change back to the Administrator view using the top left selection point

Select *Workloads/Deployment Configs*

Ensure that the ‘rbactest’ DC shown has a Namespace that is the Partner’s project

Click on the DC rbactest

Using the arrows scale the deployment to 4 pods

Click on *Home/Projects* and select your project (rbactestMYUSER)

Click on ‘Role Bindings’ in the project overview pane

On the triple dot for ‘partneraccess’ choose ‘Delete’

Confirm deletion in the pop-up message box

Giving Users lower levels of permission

Click on *User Management/Role Bindings*

Click on *Create Binding*

Set Name to ‘partneraccess’

Choose the ‘rbactestMYUSER’ in the Namespace pulldown

Select ‘view’ in the Role Name pull down

Ensure the Subject radiobox is set to ‘User’

In the Subject Name enter the user name for the partner (userPARTNERUSER)

Click Create

Ensure the partner has done the same with your userx

Click on *Home/Projects*

Select the partner project (rbactestPARTNERUSER)

In the Project overview pane click on Role Bindings

You now do not have the appropriate access rights to interact with the role bindings as you only have View access to the target project

Click on *Workloads/Deployment Config*

Click on the rbactest (DC)

Try and scale down the Pod to one pod

View access allows you to see the state of objects but NOT to change them.

Click on *Home/Projects*

In the triple dot menu next to the rbactestPARTNERUSER select ‘Delete Project’

Type ‘rbactestPARTNERUSER’ in the message box and press ‘Delete’

Note that you cannot delete the other persons project.

Hit Cancel

In the triple dot menu next to your own project (rbactestMYUSER) select ‘Delete Project’

Type ‘rbactestMYUSER’ in the message box and press ‘Delete’

Understanding Persistent Volumes [ESSENTIALS]

Author: Ian Lawson (feedback to ian.lawson@redhat.com)

Introduction

If you are not already logged on go to the UI URL https://example.manifest.com, window="_blank" and logon as userx (x is the number provided to you) and password openshift.

If you do not already have a terminal tab running as defined in the pre-requisites please open one following the instructions in the pre-requisites

Ensure you are on the Administrator View (top level, select Administrator)

Click on ‘Create Project’

Enter ‘pvtestx’ for the name, where x is your user number

Enter ‘PV Test’ for the Display Name and Description

Hit ‘Create’

Switch to the Developer UI (click on Developer in the top left pulldown)

Select ‘From Catalog’

Search for ‘node’

Click on the ‘node.js’ option

Click ‘Create Application’

Leave the Builder Image Version as ‘10’

Enter the following for the Git Repo URL - ‘https://github.com/utherp0/workshop4’

Click on ‘Show Advanced Git Options’

In Context Dir put ‘/apps/nodeatomic’

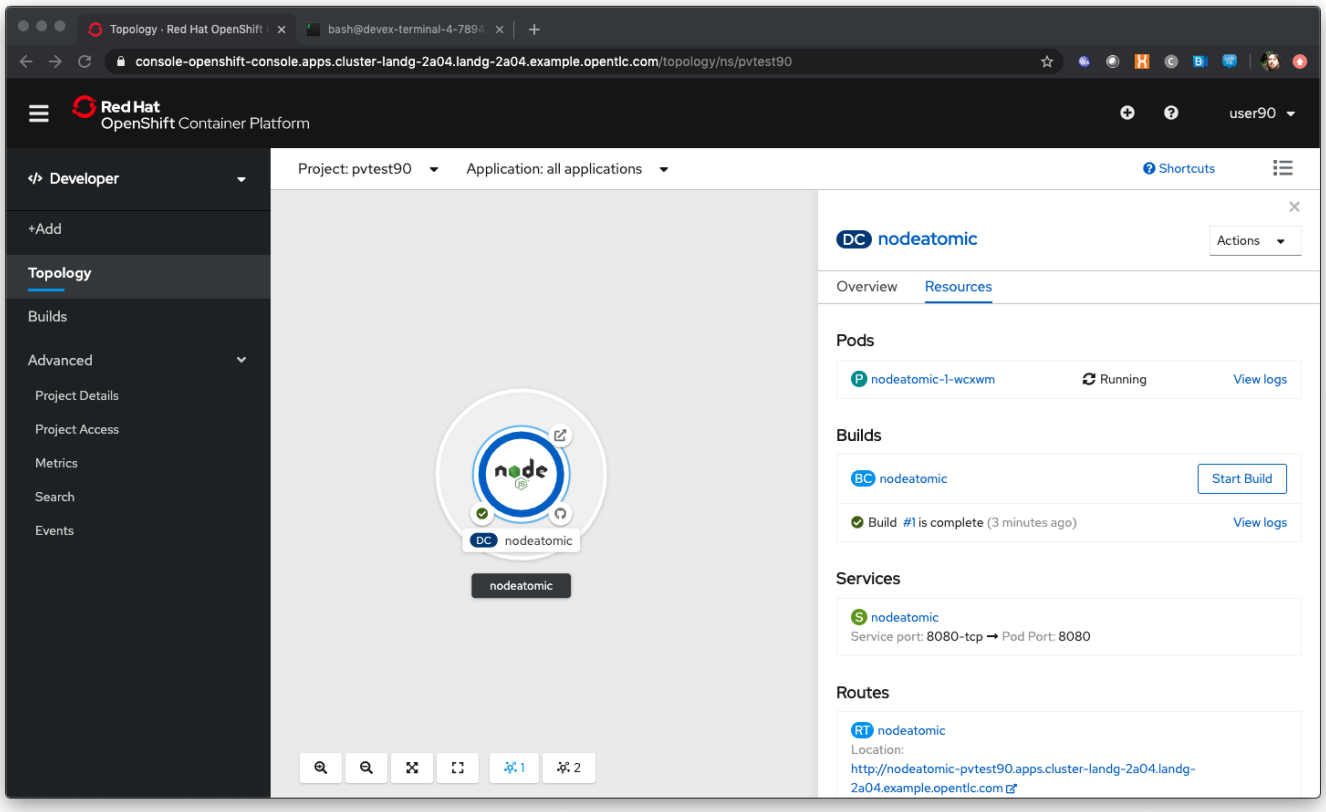
In Application Name put ‘nodeatomic’

In Name put ‘nodeatomic’

In Resources set the deployment to DeploymentConfig

Click on ‘Create’

When the Topology page appears click on the node Pod to see the information window



Ensure the build completes correctly

In the informational panel choose ‘Action/Edit Count’

Up the count to 4 and hit ‘Save’

Watch the Topology and ensure four copies of the Pod appear and are healthy

Adding a Persistent Volume to an Application

Switch to the Administrator view (top left pulldown)

Click on *Storage/Persistent Volume Claims*

Click on ‘Create Persistent Volume Claim’

Leave the Storage Class as ‘gp2’

Storage Classes are objects configured by the Administrator of the Cluster which allow you to request externalised persistent storage for your Applications. In this case we are using the default storage class for the Cluster which happens to be AWS storage

Set the Persistent Volume Claim Name to ‘testpvx’ where x is your user number

Ensure the Access Mode is set to ‘RWO’

The Access Mode for a Persistent Volume defines how the storage is offered to the Applications. If you choose RWO, Read/Write/Once, a single piece of storage is allocated which is shared across ALL instances of the Application. If you choose RWM, Read/Write/Many, the volume will be created independently on all Nodes where the Application runs, meaning the storage will only be shared by co-resident Pods on Nodes.

Set the size to 1Gi

Ensure the Use Label Selectors checkbox is not set

Click on ‘Create’

Click on Storage/Persistent Volume Claims

The status of the claim will sit at *Pending*. This is because the Persistent Volume itself is not created until it is assigned to a Deployment Config.

Click on *Workloads/Deployment Configs*

Click on the nodeatomic DC

Click on *Actions/Add Storage*

In the Add Storage page ensure ‘Use existing claim’ is checked

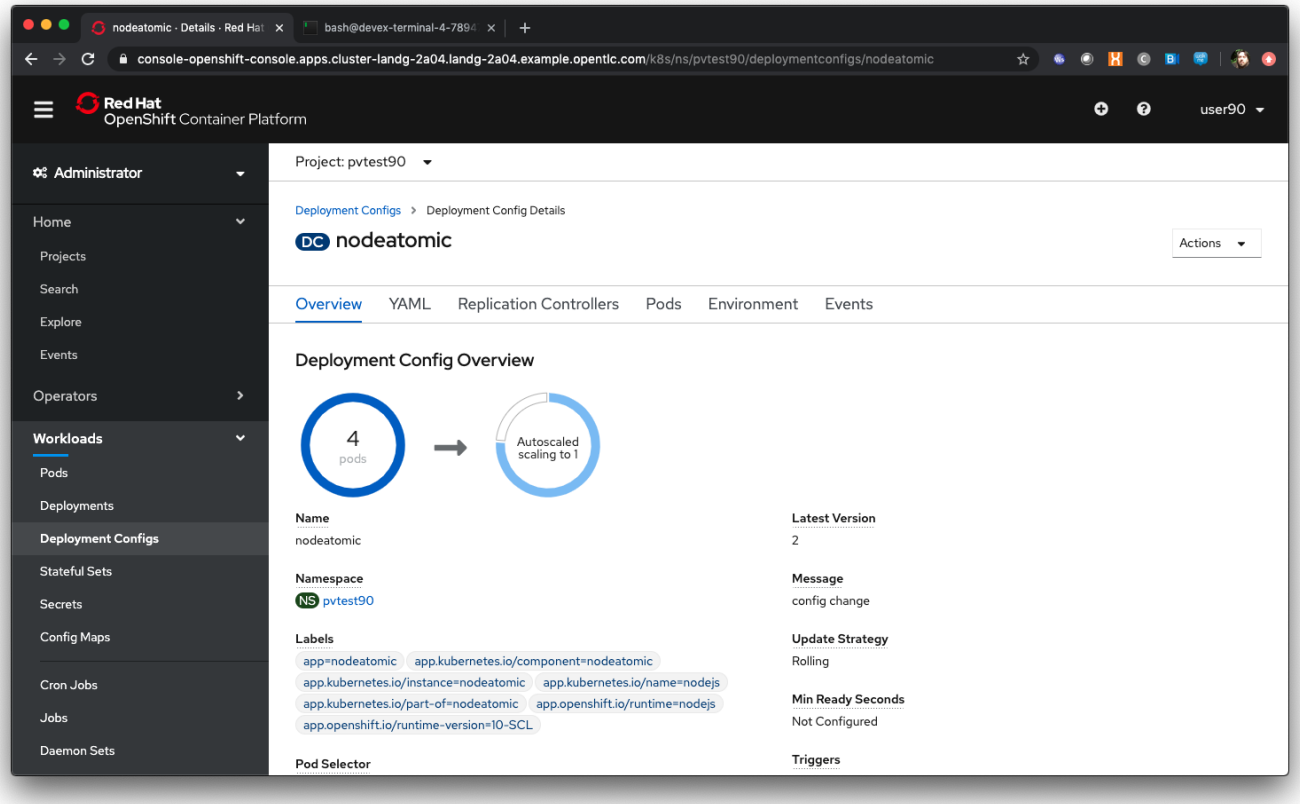
In the ‘Select Claim’ pulldown select the created claim (testpvx based on your user number)

Set the Mount Path to ‘/pvtest/files’

What this will do is to export the Persistent Volume into the file space of the Containers at the mount point stated.

Click on ‘Save’

As we have changed the configuration of the Deployment, and the default triggers are set to redeploy if the Image changes OR the configuration of the Deployment changes, a redeployment will now occur.



When the deployment has completed, click on ‘Pods’ in the DeploymentConfig display (not Workloads/Pods)

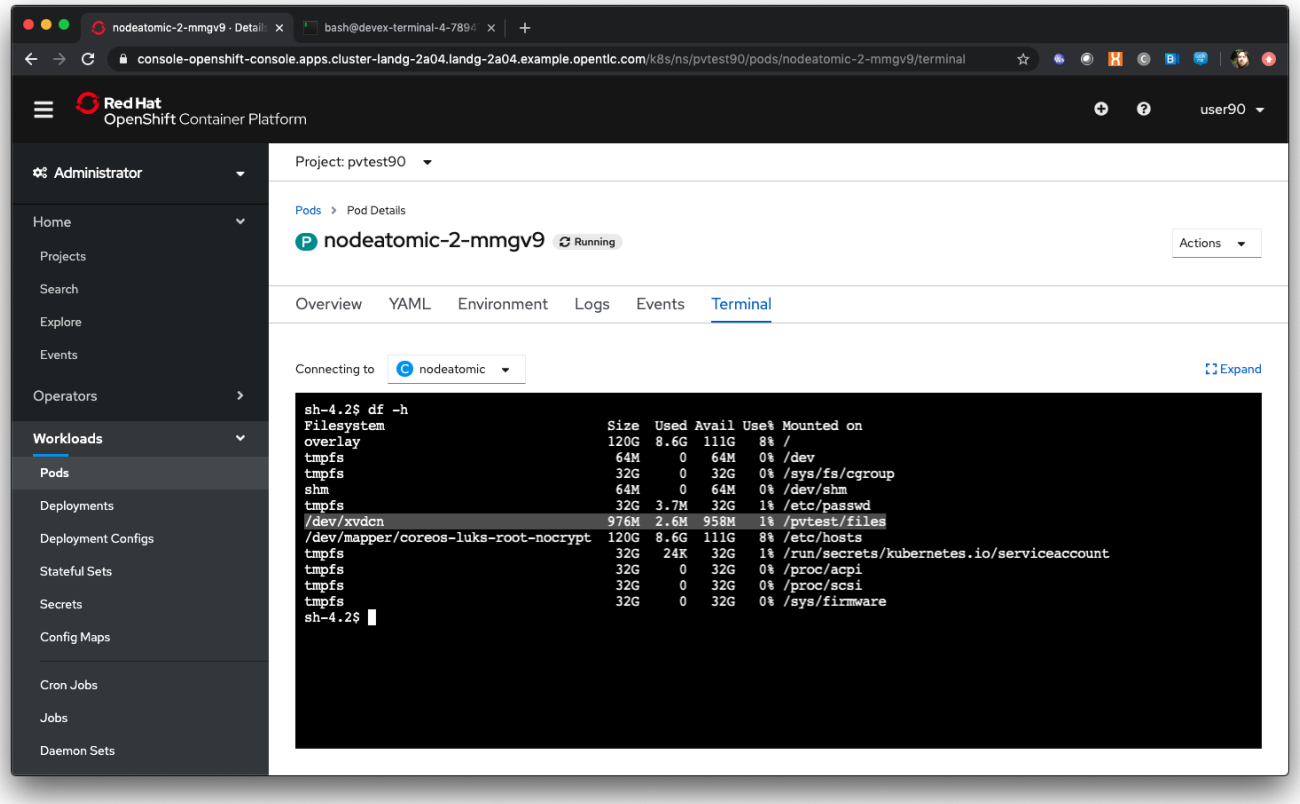
Select the first running Pod - take a note of its name (nodeatomic-2-xxxxx) - click on the Pod

Click on Terminal

In the terminal window type:

```
df -h’
```

Note the additional file system mount as shown below



In the terminal window type:

```
ls -alZ /pvtest/files
```

Click on *Networking/Routes*

Click on the Route address for the nodeatomic route - it should open in a separate tab

Ensure the OpenShift NodeAtomic Example webpage is displayed

Add ‘/containerip’ to the end of the URL in the browser window and hit return

Take a note of the address returned

Switch back to the OCP UI and choose Workloads/Pods

Click on **each** of the Pods until you find the one that has the IP returned by the webpage, take a note of the Pod name (**1*)

Go back to the tab with the nodeatomic webpage in it

Remove ‘/containerip’ from the end of the URL and replace it with ‘/fileappend?file=/pvtest/files/webfile1.txt&text=Hello%20World’ and then press return

Ensure the webservice returns 'Updated */pvtest/files/webfile1.txt* with *Hello World*'

Switch back to the browser tab with the OCP UI in it. Select *Workloads/Pods* and click on the Pod with the name that matches the IP discovered in (**1*)

Click on *Terminal*

In the terminal type:

```
cat /pvtest/files/webfile1.txt
```

Ensure 'Hello World' is displayed

The Webservice endpoint provided appends the given text to the given file.

Click on *Workloads/Pods*

Select another Pod (**NOT** the one that matched the IP from the (*1) step)

Click on *Terminal*

In the terminal type:

```
cat /pvtest/files/webfile1.txt
```

Note that this separate Pod has the SAME file with the same contents

Switch back to the nodeatomic webservice browser tab

Alter the end of the URL to read 'Hello%20Again' and press return

Return to the OCP UI tab window (the terminal should still be active) and type:

```
cat /pvtest/files/webfile1.txt
```

Again note the file has been updated by another container but this container shares the same file system.

Close the web service browser tab

Demonstrating survivability of removal of all Pods

Click on *Workloads/Deployment Configs*

Click on the nodeatomic DC

Scale to ZERO pods by clicking the down arrow displayed next to the Pod icon until the count reaches 0

Ensure the Pod graphic displays zero running Pods.

Scale the deployment back up to ONE Pod using the arrows

When the Pod indicator goes to dark blue indicating the Pod has started, click on Pods

Select the one active Pod and click on it

Click on *Terminal*

In the terminal window type:

```
---
cat /pvtest/files/webfile1.txt
----
```

Note that the contents of the file have survived the destruction of ALL Pods

Click on *Home/Projects*

On the triple dot next to the ‘pvtestx’ project (where x is your user number) select Delete Project

In the pop-up type ‘pvtestx’ (where x is your user number) and hit Delete

Pod Health Probes [ESSENTIALS]

Author: Mark Roberts (feedback to mroberts@redhat.com)

Introduction

Liveness and Readiness probes are Kubernetes capabilities that enable teams to make their containerised applications more reliable and robust. However, if used inappropriately they can result in none of the intended benefits, and can actually make a microservice based application unstable.

The purpose of each probe is quite simple and is described well in the OpenShift documentation here. The use of each probe is best understood by examining the action that will take place if the probe is activated.

Liveness : Under what circumstances is it appropriate to restart the pod?

Readiness : under what circumstances should we take the pod out of the list of service endpoints so that it no longer responds to requests?

Coupled with the action of the probe is the type of test that can be performed within the pod :

Http GET request : For success, a request to a specific http endpoint must result in a response between 200 and 399.

Execute a command : For success, the execution of a command within the container must result in a return code of 0.

TCP socket check : For success, a specific TCP socket must be successfully opened on the container.

Creating the project and application

Log on to cluster as userx, password openshift

Ensure you are on the Administrator View (top level, select Administrator)

The Administrator view provides you with an extended functionality interface that allows you to deep dive into the objects available to your user. The Developer view is an opinionated interface designed to ease the use of the system for developers. This workshop will have you swapping between the contexts for different tasks.

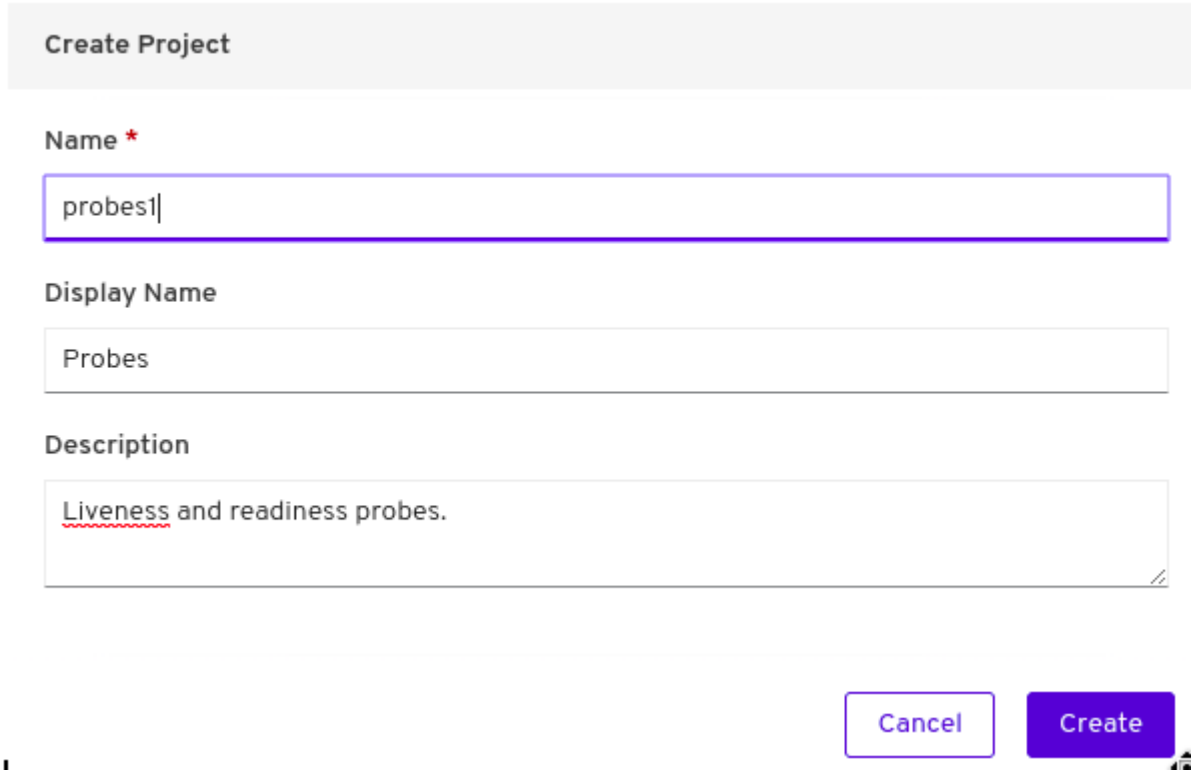
Click on *Create Project*

Name - ‘probesX’ where X is your assigned user number

Display Name - *Probes*

Description - *Liveness and readiness probes*

as shown in the image below:



By default when you create a Project within OpenShift your user is given administration rights. This allows the user to create any objects that they have rights to create and to change the security and access settings for the project itself, i.e. add users as Administrators, Edit Access, Read access or disable other user's abilities to even see the project and the objects within.

In the top left of the UI, where the label indicates the view mode, change the mode from Administrator to Developer and select the Topology view.

Select 'From Catalog'

Enter 'node' in the search box

The various catalogue items present different configurations of applications that can be created. For example the node selections include a simple node.js application or node.js with a database platform that is pre-integrated and ready to use within the application. For this workshop you will use a simple node.js application.

Select 'Node.js'

A wizard page will then pop up on the right hand side with details of exactly what will be created through the process.

Source-2-Image

One of the most exciting features of OpenShift from a developer's perspective is the concept of S2I, or **Source-2-Image** which provides a standardised way of taking a base image, containing, for example, the framework for running a node.js application, a source code repository, containing the code of the application that matches the framework provided in the base image, and constructing and delivering a composite Application image to the Registry. Simply put this enables a developer to create source code for an application and OpenShift will convert that to a running application within a container with minimal effort. The process that you will use below is the Source-2-Image capability.

Click on 'Create Application'

The wizard process has a number of options that the user may elect to use. These include:

- Selecting a specific version of Node to use
- Selecting a GIT repository and choosing to use code from a specific directory within the repository.

Select the default offering for the Builder Image Version

For the GIT repository use : https://github.com/marrober/slave-node-app.git, window="_blank"

In a separate browser tab go to https://github.com/marrober/slave-node-app.git, window="_blank"

You can see that the GIT repository at this location only has a small number of files specific to the application. There is no content specific to how the application should be built or deployed into a container.

Close the github tab

Back at the OCP4.2 user interface complete the following information in the section titled *General*.

For the Application drop down menu select *Create Application*.

For the Application name enter *Slave-application*.

For the Name field enter *node-app-slave*

The application name field is used to group together multiple items under a single grouping within the topology view. The name field is used to identify the specific containerised application.

In the Resources section ensure that you select *Deployment Config*

In the Advanced Options section ensure the 'Create a route to the application' checkbox is checked.

Click Create

The user interface will then change to display the Topology view. This is a pictorial representation of the various items (applications, databases etc.) that have been created from the catalogue and added to an application grouping.

Multiple application groupings can exist within a single project.

Viewing the running application

Click on the Icon marked ‘Node’

A side panel will appear with information on the Deployment Configuration that has just been created. The overview tab shows summary information and allows the user to scale the number of pods up and down. The resources tab shows information on the building process, the pods and the services and route to reach the application (if these have been created).

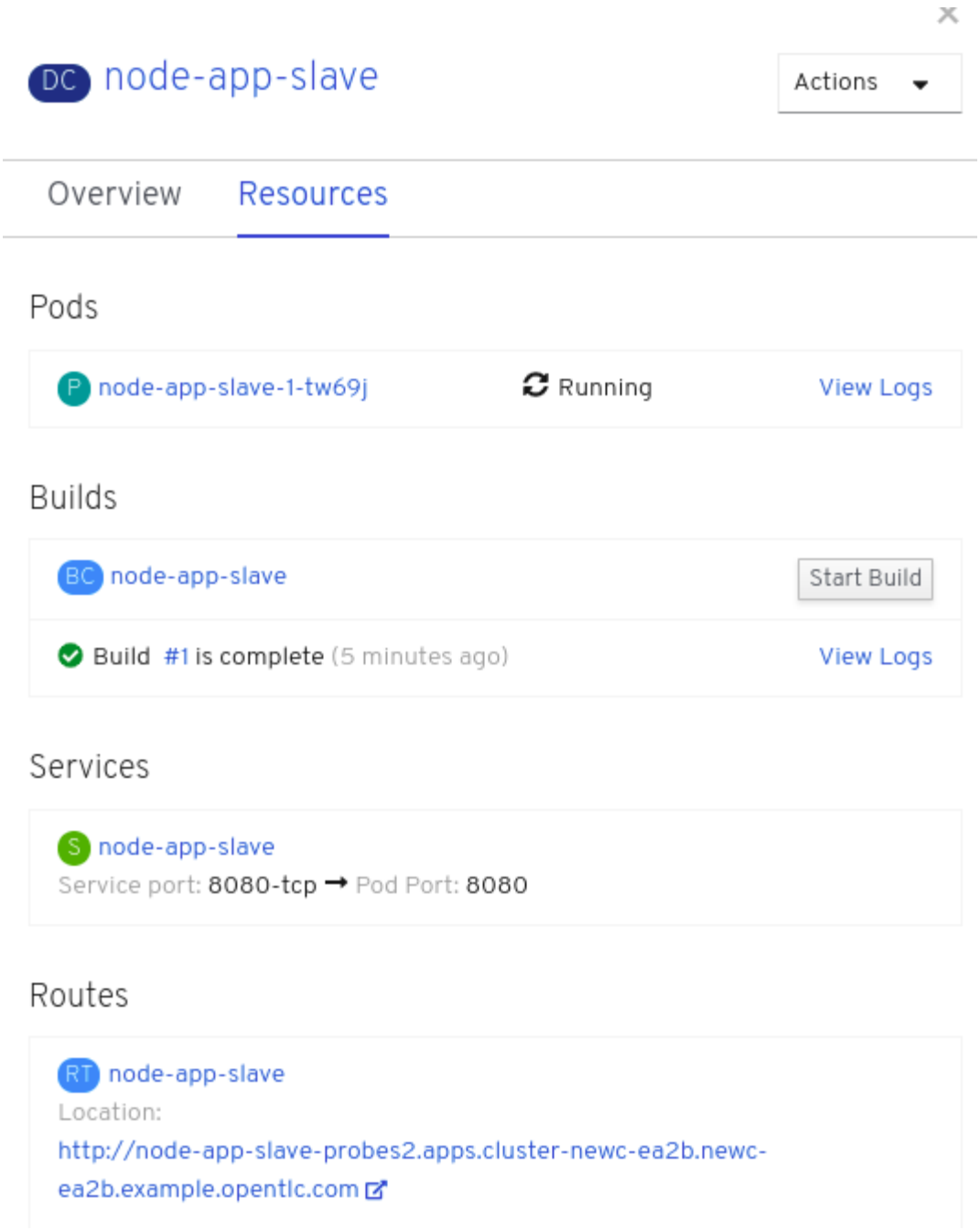
Wait for the Build to finish, the Pod to change from Container Creating to Running.

Pod Colour Scheme

The colour scheme of the pods is important and conveys information about the pod health and status. The following colours are used :

- Running - Dark blue
- Not Ready - Mid blue
- Warning - Orange
- Failed - Red
- Pending - light blue
- Succeeded - Green
- Terminating - Black
- Unknown - Purple

When the build has completed the right hand side panel will shown something similar to the image below. Note that the route will be different to that which is shown below.



Click on the Tick at the bottom left of the Pod. Note that this display can also be shown by clicking on the 'View Logs' section on the right hand side panel.

The build log will show information on the execution of the source-2-image process.

Click on the arrow on the top right corner of the Pod, or click on the route URL shown in the right hand side resource details window. The application window will launch in a new browser window and should display text as shown below:

```
Hello - this is the simple slave REST interface v1.0
```

Liveness Probe

A number of probes will be created to show the different behaviours. The first probe will be a liveness probe that will result in the restart of the pod.

Since this work will be done using the oc command line you need to switch the current oc command line to work with the new project using the command:

```
oc project probesX
```

(Where X is the number that you used when you created the project)

To create the probe use the OC command line interface to execute the following command.

```
oc set probe dc/node-app-slave --liveness --initial-delay-seconds=30 --failure
-threshold=1 --period-seconds=10 --get-url=http://:8080/health
```

The above probe will create a new liveness probe with the characteristics:

- Become active after 30 seconds
- Initiated a reboot after 1 instance of a failure to respond
- Probe the application every 10 seconds *Note that ordinarily a gap of 10 seconds between probes would be considered very long, but we use this time delay within the workshop to allow time for observing the behaviour of the probe.*
- Use the URL /health on the application at port 8080. Note that there is no need to specify a URL for the application.

The command line response should be as shown below.

```
deploymentconfig.apps.openshift.io/node-app-slave probes updated
```

Review the liveness probe information by executing the command:

```
oc describe dc/node-app-slave
```

The output of this command will include the following section that highlights the new liveness probe

```
Pod Template:
  Labels:   app=node-app-slave
            deploymentconfig=node-app-slave
  Containers:
   node-app-slave:
    Image:      image-registry.openshift-image-registry.svc:5000/probes2/node-app-
slave@sha256:bf377...241
    Port:           8080/TCP
    Host Port:      0/TCP
    Liveness:       http-get http://:8080/health delay=30s timeout=1s period=10s
#success=1 #failure=1
    Environment:    <none>
    Mounts:         <none>
  Volumes:          <none>
```

Alternatively to view the probe in a different format use the command below:

```
oc get dc/node-app-slave -o yaml
```

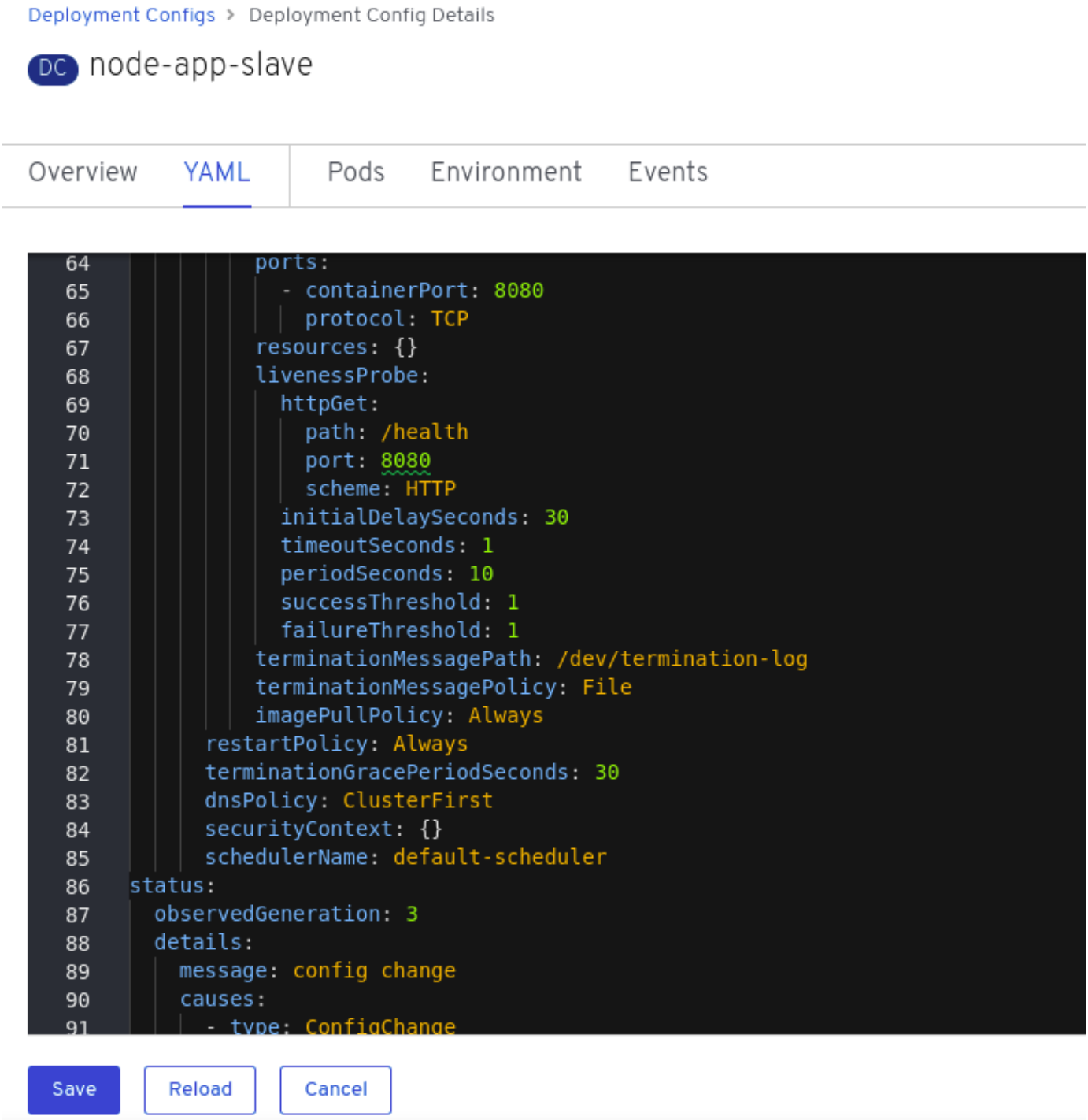
Part of the output will show:

```
livenessProbe:
    failureThreshold: 1
    httpGet:
        path: /health
        port: 8080
        scheme: HTTP
    initialDelaySeconds: 30
    periodSeconds: 10
    successThreshold: 1
    timeoutSeconds: 1
```

To view the above information graphically then use the following steps:

Select the Topology view of the application.

Click on the pod in the centre of the screen to display the information panel on the right hand side. From the action menu on the right hand side click **Edit Deployment Configuration** as shown in the image below.



On the Deployment Configuration page that is displayed ensure that the YAML tab is selected and scroll down to aroundline 68 to see the YAML definition for the liveness probe. It is also possible to edit the parameters of the probe from this screen if necessary.

In order to execute the probe it is necessary to simulate a pod failure that will stop the application from responding to the health check. A specific REST interface on the application has been created for this purpose called `/ignore`.

Activation of the Liveness Prove

To view the activity of the probe it is necessary to open two windows.

Select the Topology view of the application.

Click on the arrow on the top right hand corner of the node icon to open the application URL in a new browser tab.

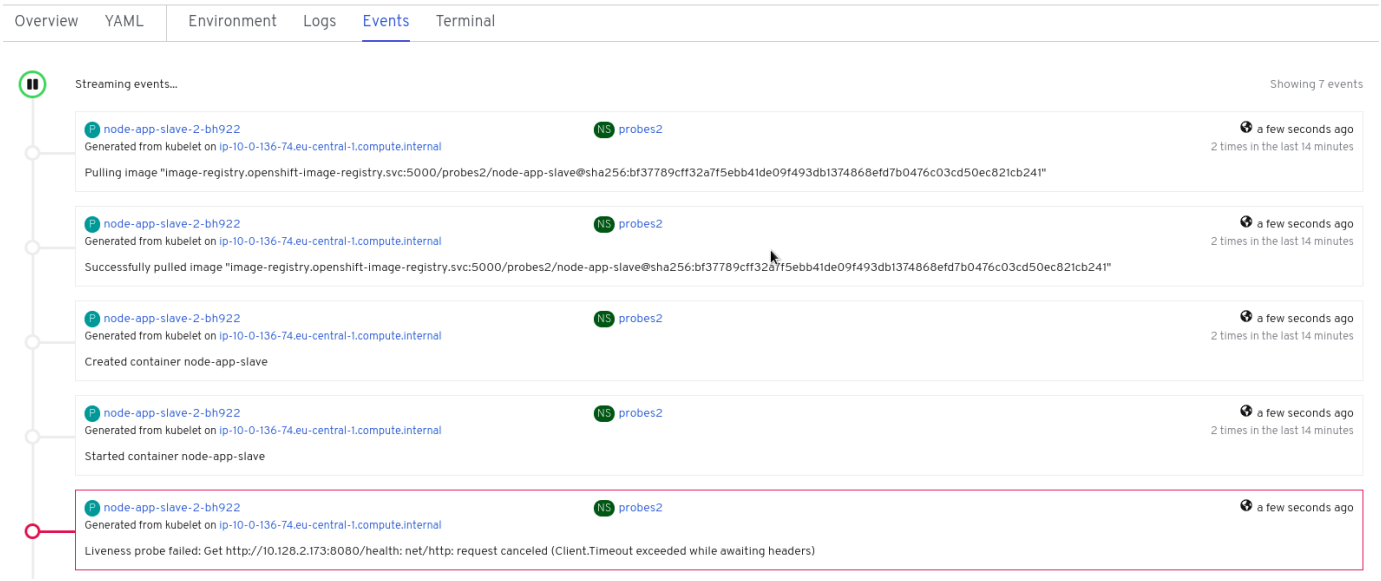
Back on the OpenShift browser tab, Click on the pod to open the details window on the right hand side and then click on the pod link on the resources tab. This will display a multi-tab window with details of the pod, select the events tab.

Switch to the application tab and put /ip on the end of the url and hit return. This will display the ip address of the pod.

Change the url to have /health on the end and hit return. This will display the amount of time that the pod has been running.

Change the url to have /ignore on the end and hit return. Quickly move to the browser tab showing the pod events and watch for the probe event.

The pod will restart after 1 failed probe event which takes up to 10 seconds depending on where the schedule is between the probe cycles. The events for the pod on the details screen will be similar to that shown below.



The events after the firing of the liveness probe are the re-pulling and starting of the container image in a new pod.

Switch to the application tab and put /health on the end of the url and hit return. This will display the amount of time that the new pod has been running, which will understandably be a small number.

In order to experiment with the readiness probe it is necessary to switch off the liveness probe. This can either be done by changing the deployment configuration YAML definition using the web interface or by executing the following command line:

```
oc set probe dc/node-app-slave --liveness --remove
```

Readiness Probe

To create the probe use the OC command line interface to execute the following command.

```
oc set probe dc/node-app-slave --readiness --initial-delay-seconds=30 --failure
-threshold=3 --success-threshold=1  --period-seconds=5 --get-url=http://:8080/health
```

The above command will create a new readiness probe with the characteristics:

- Become active after 30 seconds
- Remove the pod from the service endpoint after 3 instances of a failure to respond
- Cancel the removal of the pod and add it back to the service endpoint after 1 successful response
- Probe the application every 5 seconds
- Use the URL /health on the application at port 8080. Note that there is no need to specify a URL for the application.

The command line response should be as shown below

```
deploymentconfig.apps.openshift.io/node-app-slave probes updated
```

Review the probe created using the commands above:

```
oc describe dc/node-app-slave
```

and

```
oc get dc/node-app-slave -o yaml
```

View the state of the pod within the endpoints using the command below:

```
oc get ep/node-app-slave -o yaml
```

The output of the above command will list the details of the service endpoint which will include information on the pod to which the health probe is attached as shown below.

```
apiVersion: v1
kind: Endpoints
metadata:
  annotations:
    endpoints.kubernetes.io/last-change-trigger-time: 2019-11-26T16:04:50Z
  creationTimestamp: 2019-11-26T09:37:12Z
  labels:
    app: node-app-slave
    app.kubernetes.io/component: node-app-slave
    app.kubernetes.io/instance: node-app-slave
    app.kubernetes.io/name: nodejs
    app.kubernetes.io/part-of: master-slave
    app.openshift.io/runtime: nodejs
    app.openshift.io/runtime-version: "10"
  name: node-app-slave
  namespace: probes1
  resourceVersion: "1172051"
  selfLink: /api/v1/namespaces/probes1/endpoints/node-app-slave
  uid: 534139aa-1030-11ea-af1c-024039909e8a
subsets:
- addresses:
  - ip: 10.128.2.145
    nodeName: ip-10-0-136-74.eu-central-1.compute.internal
    targetRef:
      kind: Pod
      name: node-app-slave-5-hwj89
      namespace: probes1
      resourceVersion: "1172049"
      uid: ad6cc0e5-1043-11ea-af1c-024039909e8a
  ports:
  - name: 8080-tcp
    port: 8080
    protocol: TCP
```

The lines of interest above are:

```
subsets:
- addresses:
  - ip: 10.128.2.145
```

This shows that the address is currently part of the endpoint (it will participate in servicing requests) prior to the readiness probe activation.

Activation of the Readiness Probe

Select the Topology view of the application.

Click on the arrow on the top right hand corner of the node icon to open the application URL in a new browser tab (unless you already have one open).

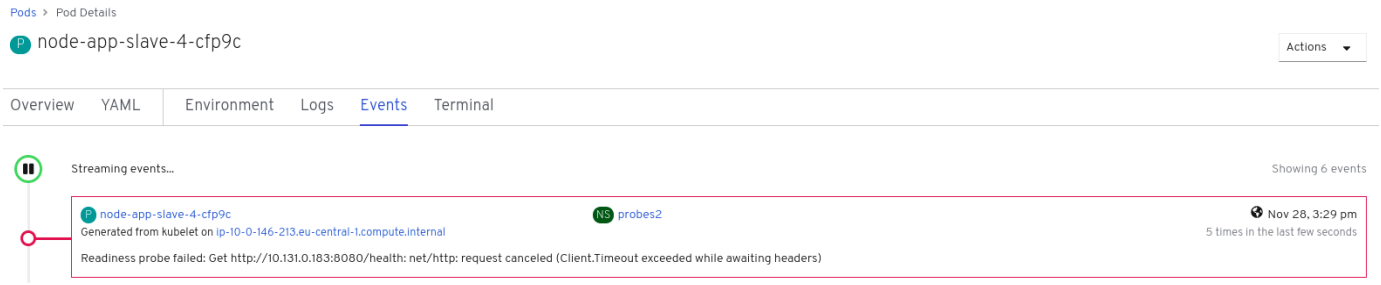
On the OpenShift browser tab, click on the pod to open the details window on the right hand side and then click on the pod link on the resources tab. This will display a multi-tab window with details of the pod, select the events tab.

Switch to the application tab and put /ip on the end of the url and hit return. This will display the ip address of the pod.

Change the url to have /health on the end and hit return. This will display the amount of time that the pod has been running.

Change the url to have /ignore on the end and hit return. Quickly move to the browser tab showing the pod events and watch for the probe event.

The pod events will show a screen similar to that which is shown below.



Note that you will see the count of the readiness *events* incrementing every 5 seconds.

You will also see that the events continue counting up since readiness probes do not stop firing just because the pod has been removed from the endpoint list. It is important that they continue to probe since the conditions may change and it may be appropriate to add the pod back into the endpoint list.

View the state of the pod within the endpoints using the command below:

```
oc get ep/node-app-slave -o yaml
```

The output of the above command will list the details of the service endpoint which will include information on the pod to which the health probe is attached as shown below.

```
subsets:
- notReadyAddresses:
  - ip: 10.128.2.145
```

The subset of the command output shown above indicates that the address is now listed as ‘not ready’ and is not currently part of the endpoint.

Under production use conditions for the application may change and the pod may recover from the inability to respond to the readiness probe. If this happens then it will be added back to the endpoint list.

To simulate this the Node application has a REST endpoint at /restore. Since the pod is currently not receiving communications from outside the cluster the call to the restore endpoint is done from within the pod command window.

Switch to the OpenShift browser window that was showing the pod events.

Note that you will see a large number of pod readiness probe failures while you were reading the notes.

In the OpenShift Console choose Adminstrator View, then Workloads/Pods. Click on the Pod that is active and in the Pod information page click on the Terminal option.

Within the Pod Terminal enter the command :

```
curl -k localhost:8080/restore
```

You should see a response similar to that shown below (with a different IP address):

```
"10.128.2.146 restore switch activated"sh-4.2$
```

Now go back to the Terminal tab where you enter *oc* commands

View the state of the pod within the endpoints using the command below:

```
oc get ep/node-app-slave -o yaml
```

You should see that the line of interest, previously shown above, has changed back to that shown below:

```
subsets:
- addresses:
  - ip: <ip address of the pod>
```

On the OpenShift browser page switch back to the events tab and you should see that the readiness probe failure count is no longer increasing.

Finally, switch to the application browser page and change the URL to end in /health. You should see that the application has been running for some time (compared to the liveness probe that showed a restart had taken place) and it should be responding successfully to the health probe.

Cleaning up

From the OpenShift browser window click on *Advanced* and then *Projects* on the left hand side menu.

In the triple dot menu next to your own project (ProbesX) select ‘Delete Project’ Type ‘ProbesX’ (where X is your user number) such that the Delete button turns red and is active.

Press Delete to remove the project.

Camel K on Openshift [INNOVATION]

Author: Phil Prosser (feedback to pprosser@redhat.com)

Introduction

Apache Camel is based on a book called Enterprise Integration Patterns, window="_blank" that was written by Gregor Hohpe and Bobby Woolf. The purpose of the book was to describe all of the patterns required to successfully implement enterprise integrations. Apache Camel is an implementation of the Enterprise Integration Patterns. These patterns are expressed in Camel Routes using a Domain Specific Language, window="_blank" (DSL)

Apache Camel K is a lightweight integration framework built from Apache Camel that runs natively on Kubernetes and is specifically designed for serverless and microservice architectures.

Users of Camel K can instantly run integration code written in Camel DSL on their preferred cloud (Kubernetes or OpenShift).

The purpose of this lab is to show you how easy it is to build, deploy, and delete Camel K integations using very simple examples. It is not the goal of this lab to demonstrate the integration capabilities of Camel K.

This workshop requires you to be logged on to both the OpenShift console and the terminal as described in the pre-requisites. If you do not have both tabs logged in please follow the instructions before continuing

Check the project is ready to use

In the browser based terminal window, check you are still logged on and using the correct project by typing:

```
oc whoami
oc project
```

If the response from the commands indicates that you are not userX (where X is your assigned user number) and not using the project sandboxX please repeat the commands in the pre-requisites.

Camel K and the Operator Lifecycle Manager

Camel K and the Operator Lifecycle Manager

Camel K uses the Operator Lifecycle manager, this means that new Custom Resource Definitions (CRDs) will be added to Openshift. These CRDs will extend the Openshift data model and allow Camel K to be managed using the standard 'oc' command. Installing operators requires a higher cluster privilage. All the required operators for the workshop should have been pre-installed for you

The examples required for this workshop have been pre-created as part of the terminal. In the terminal type:

```
cd /workspace/examples
ls
```

These are the example files we will be using.

To allow a developer to easily interact with an Openshift cluster, Camel K has it's own command line interface. The cli is called *kamel* and is preinstalled in the terminal app

Before we can create an integration, we need to add a Camel K *IntegrationPlatform*.

In the terminal window, type

```
cd /workspace/workshop4/attendee/camelfiles/camelkplatform/
oc apply -f integrationplatform.yaml
```

now type

```
oc get integrationplatform
```

The output should look similar to below

```
NAME      PHASE
camel-k   Ready
```

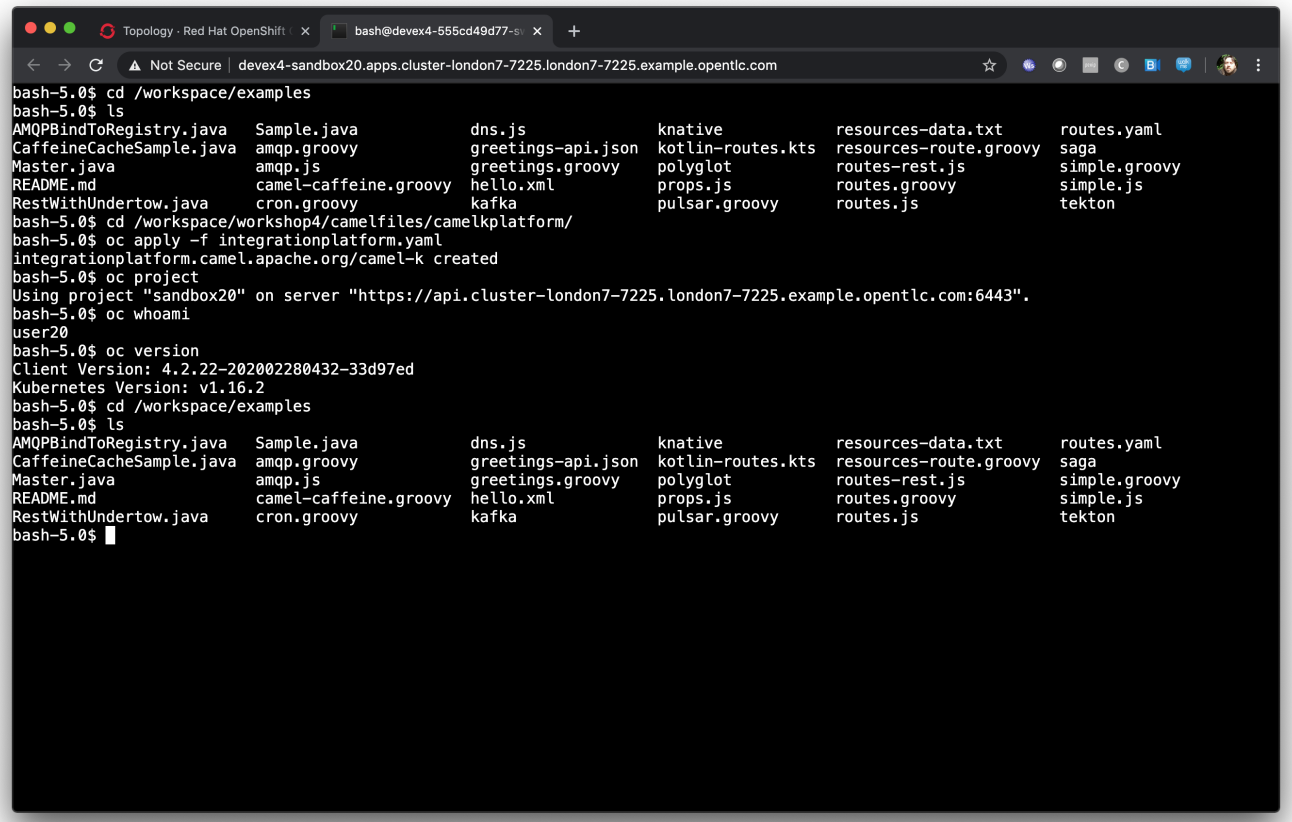
Once the "Phase" says "Ready", you can continue

You should now have all the pieces you need to start creating and deploying lightweight Camel Integrations to Openshift.

Now enter the following commands:

```
oc project
oc whoami
oc version
cd /workspace/examples
ls
```

You should see an output similar to the one shown below:



Deploy a Camel K Integration

Firstly, let's start by deploying a simple integration, type

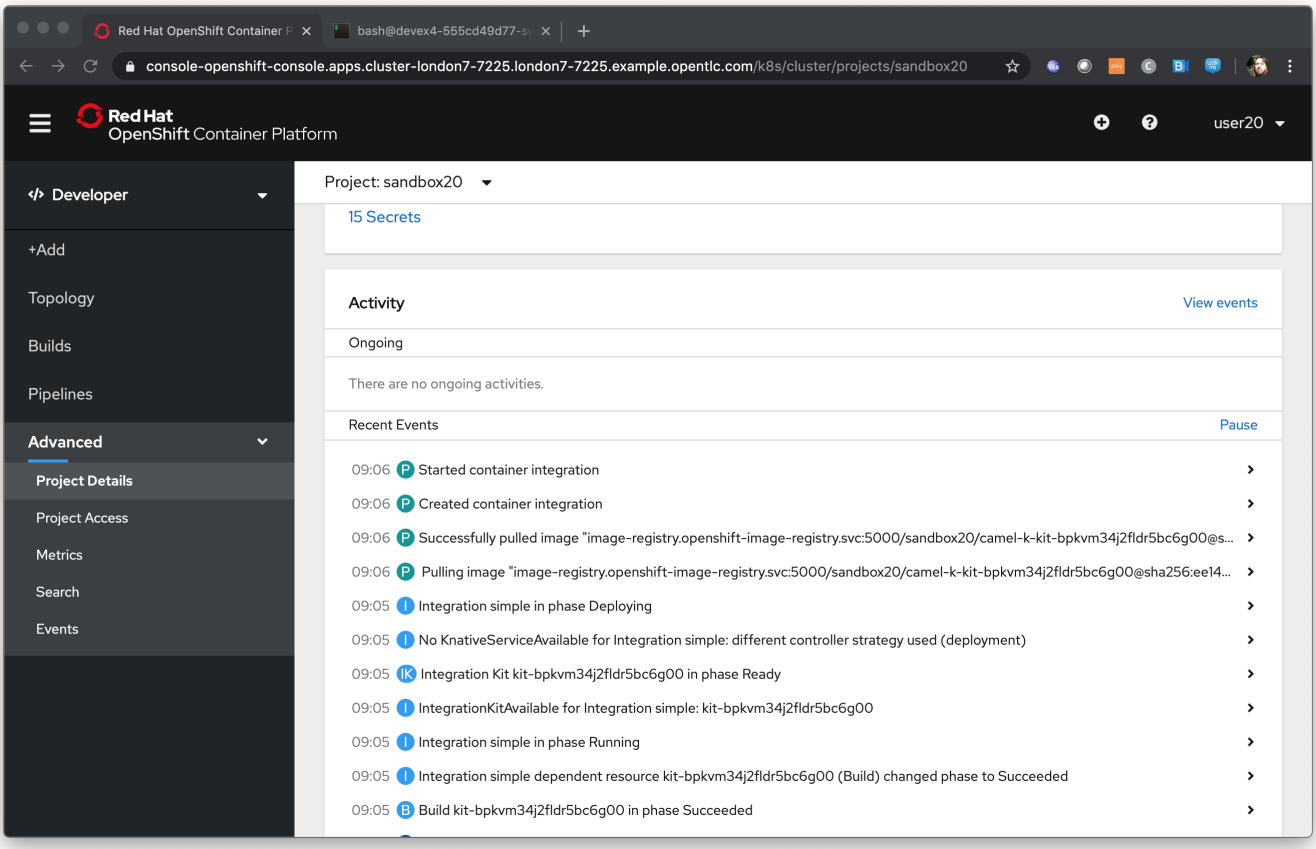
```
kamel run simple.groovy
```

The first time you deploy an Integration, it will take a few minutes. The operator manages all dependencies required by the Integration and downloads these from the Red Hat repository on demand. Once downloaded, the operator caches dependancies therefore subsequent deployments are significantly quicker. If you want to see what's happen, in the terminal window type *oc get pods*, you will see that there are builds running

To see what is going on go to the console UI in the Browser, make sure you are switched to *Developer view*

Click on *Advanced/Project Details*

If your screen is wide enough the Activity pane will appear on the right hand side. If not, scroll down to the *Activity* pane - this shows the events and actions currently occuring within the project. It will look similar to this:



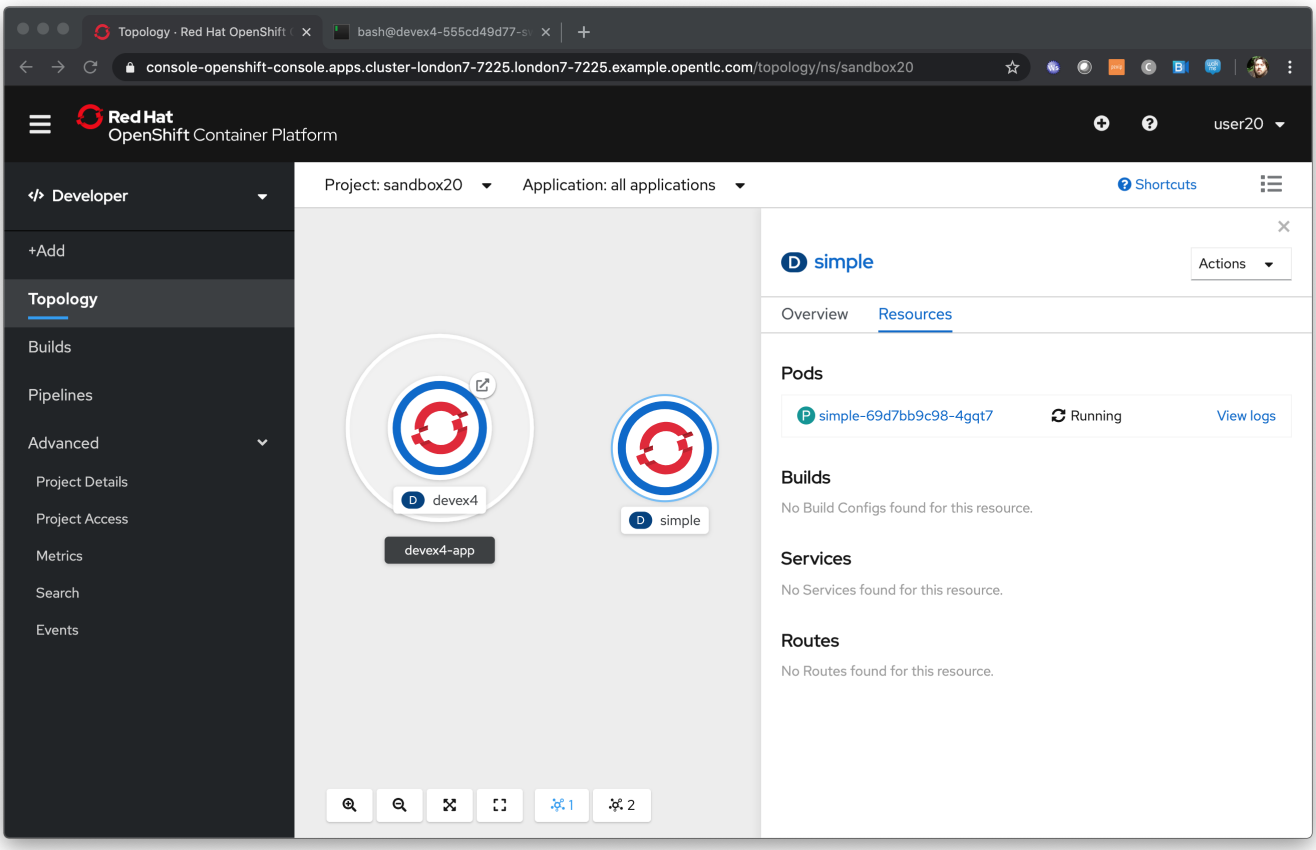
Switch back to the project Topology view by clicking on *Topology*

Once the deployment is complete, you will see *Simple* deployed on the topology view

Click on *Simple* (this is your integration), and you can see what's going on.

Once the pod has a dark blue ring around it, it is running, as per the screenshot below. The devex4

application is your terminal application and can be ignored for the duration of this chapter

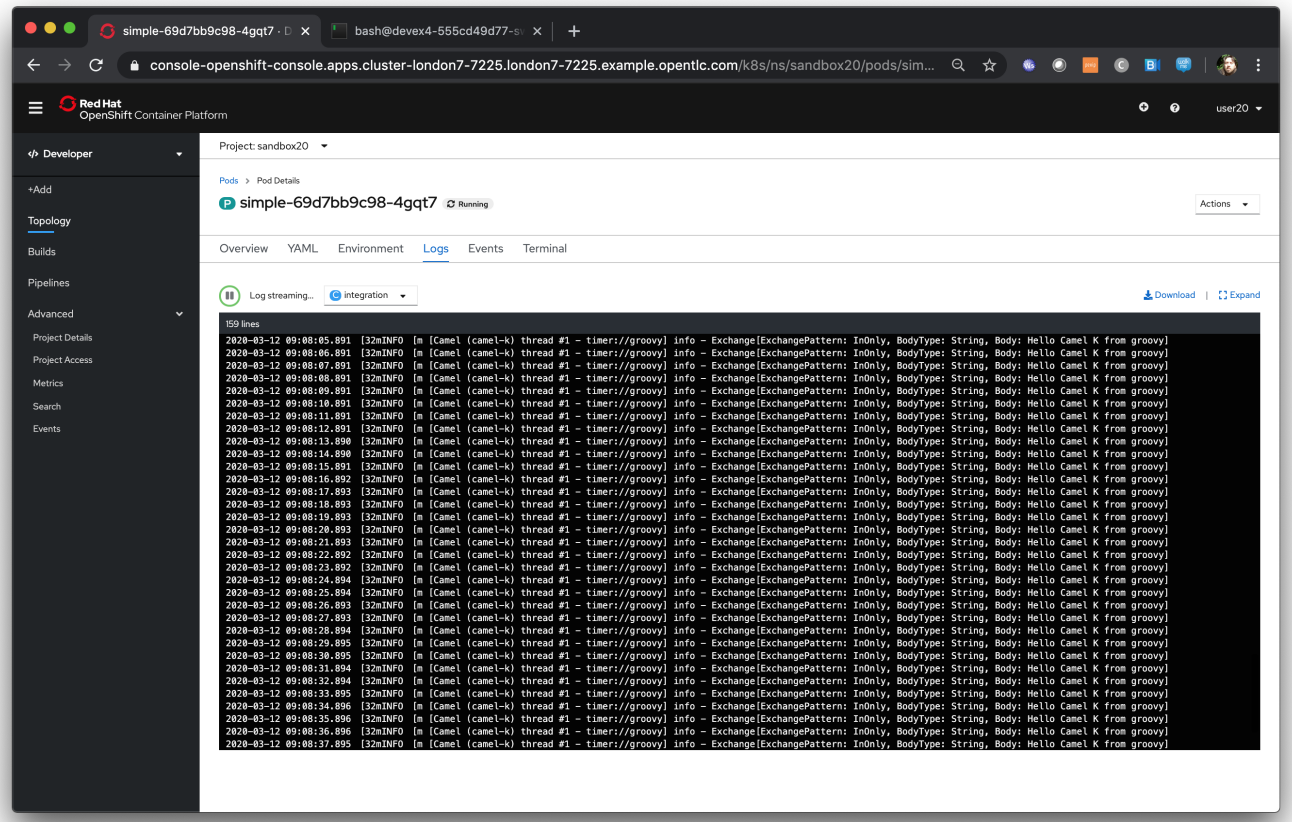


If you haven't already, click *inside the circle* to open the overview window

Click on *Resources*

There will be one Pod running with a name similar to simple-xxxxxxx-yyyyy (randomly generated). Next to it will be an indicator that it is running. Next to that is a clickable point labelled *View Logs*. Click on this.

The output of the log should look as shown below:



The integration is a simple timer that triggers every 1 second and writes to the log file.

In the Terminal Browser window type

```
oc get integrations
```

You should now see an integration called *simple* in the list similar to this:

```
NAME     PHASE     KIT                          REPLICAS
simple   Running   kit-bpj4ns3tvn0va7c7gs9g   1
```

In the Terminal browser window type

```
oc describe integration simple
```

If you scan to the top of the output you will see some code in the *from* component that represents the integration's behaviour

We will now make a change to the integration

In the browser terminal window

```
cd /workspace/examples/
vi simple.groovy
```

You will see the text - *Hello Camel K from ${routeId}* in the code definition of the integration

Change the text to the following by pressing [ESC] then I to insert:

```
'Hello Camel K from ${routeId}. Added some more text'
```

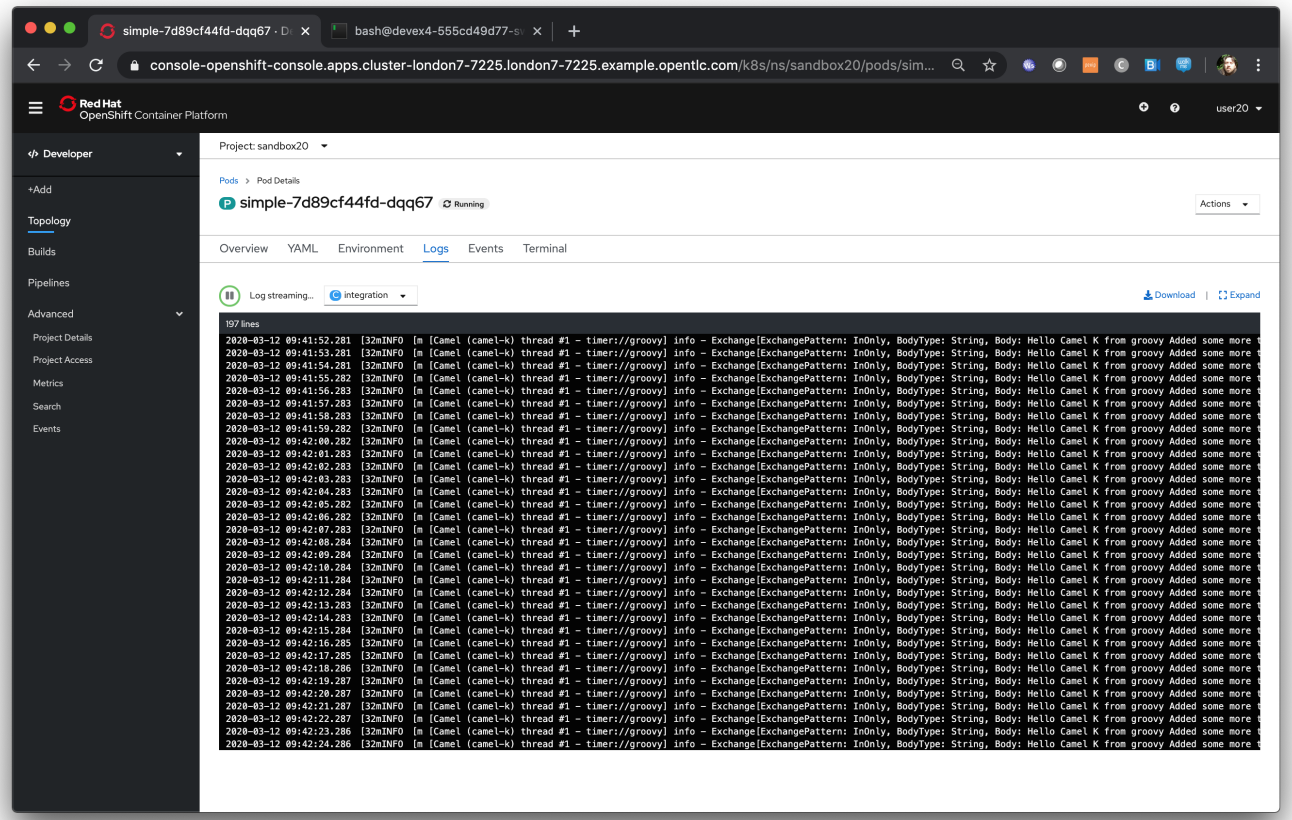
To save the change now hit [ESC]:wq[RETURN]

Now, you need to deploy this integration to Openshift again to test by typing:

```
kamel run simple.groovy
```

If you are quick enough (you need to be really quick) switch back to the OpenShift console and hit *Topology*, you'll see the integration doing a re-deployment

Look at the log file again (as above) to make sure the change has been deployed



Deploy Camel K in Developer mode

While the process of redeploying is simple, it isn't very developer friendly. The *kamel* cli has a developer friendly "hot deploy" mode that makes this experience much better

First delete the integration.

There are 2 ways you can do this in the Terminal Browser window (your choice). Either use the "kamel" cli:

```
kamel delete simple
```

Or use the Openshift cli:

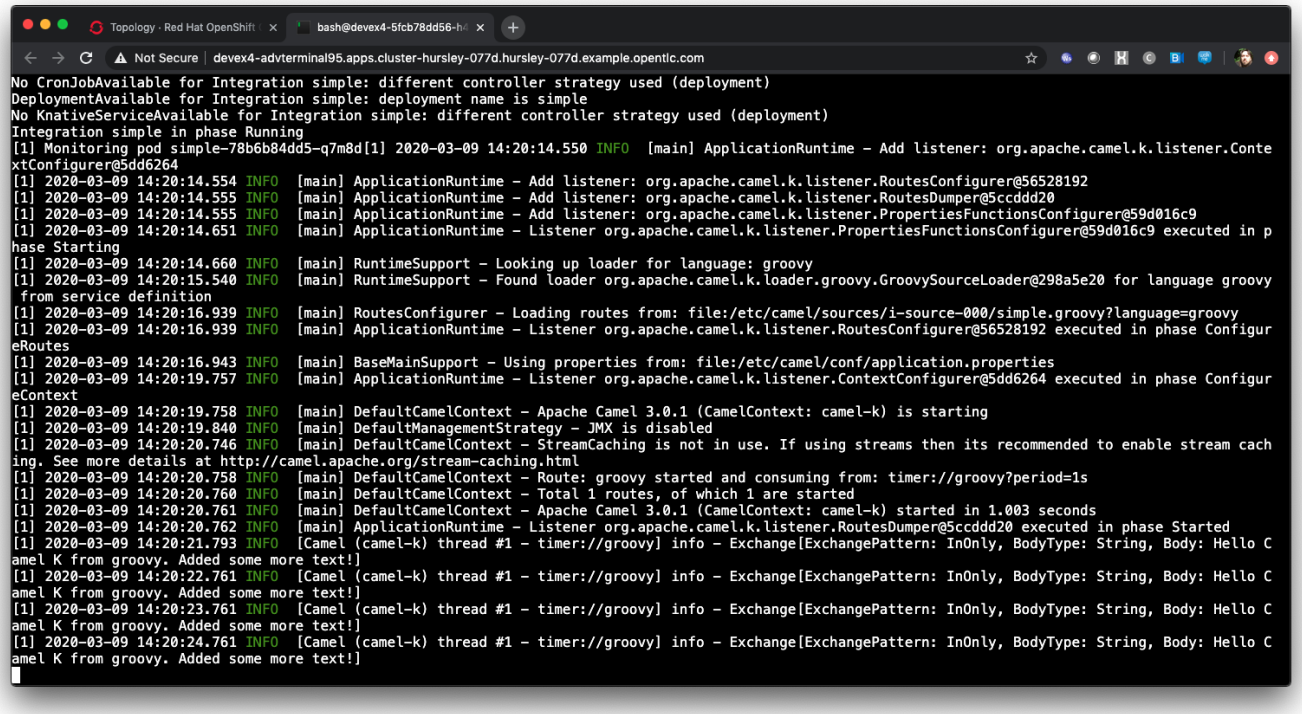
```
oc delete integration simple
```

This is the great thing about CRDs, you can use the normal Openshift cli to managed the custom data model (integrations in this case)

To deploy the integration in developer mode, type:

```
kamel run simple.groovy --dev
```

You will see the deployment phases logged on the screen, followed by the log outputting automatically from the integration pod, useful for a developer to see what's going on. The output should look similar to the screenshot below



For the next exercise, you will need 2 terminal windows. Go to the OpenShift Console, which should be on the Developer view. Click on Topology if the Topology window is not currently in focus. Click on the URL icon at the top right of the *Devex4* application as you did to originally open the terminal. This will open another Terminal for you to use.

In the first terminal tab, which will be the one furthest to the right, you will notice that the terminal window is outputting the log of the active and running integration

In the **new** terminal now type:

```
cd /workspace/examples/
```

Make another change to the text in "simple.groovy" by following the same instructions above - make sure the text outputted is different and that you save it as described above

Once you have saved the changes, go back to the browser terminal tab outputting the log

Switch to the original output tab. The integration will shutdown and restart with the new code and new text

You should see that the changes have been automatically applied to the running integration, without the need to redeploy

Go back to the browser terminal that's outputting the log, press 'ctrl c'

Look at the Topology view in the Openshift console(or *oc get integrations* in the terminal)

The integration should have been deleted and no Pods should now be running (other than the Terminal pod), just like a developer would see by pressing *ctrl c* on a Java application running on their laptop

Close down one of the terminal window tabs so you only have one terminal and the OpenShift console

If you followed the lab, the Integration should be gone, however, lets make sure we clean up the project.

In the terminal window, type

```
kamel get
```

If there is no Integration running then proceed to the next lab of your choice

If an Integration is running, then please delete it by typing

```
kamel delete simple
```

Camel K and OpenShift Serverless Eventing [INNOVATION]

Author: Phil Prosser (feedback to pprosser@redhat.com)

Introduction

OpenShift Serverless

OpenShift Serverless, based on Knative is the serverless technology that was introduced in OpenShift 4.2. OpenShift Serverless enables Pods running on OpenShift to be scaled to 0 therefore taking zero processing power. Only when called, OpenShift Serverless will scale the Pod up on demand before processing the request. OpenShift Serverless also has the ability to autoscale based on load before eventually scaling back to zero when no requests are being received.

OpenShift Serverless supports "Serving" and "Eventing"

At the time of writing, Serving is in Technology Preview, and Eventing is in Developer Preview

"Serving" enables request/response workloads, and Eventing enables asynchronous event based workloads using cloudevents.

Eventing has become an important part of a Microservice architecture. It enables services to notify other services of change (typically, change in state) in a loosely coupled manner. To enable this, Knative Eventing uses a publish and subscribe architecture. This enables the source service to publish events without having the knowledge of who maybe wanting to consume the events. It allows any number of sink services to subscribe to the event and act upon it.

In this lab, we are going to look at eventing, and how easy it is to integration with Camel K.

Check the project is ready to use

In the browser based terminal window, check you are still logged on and using the correct project by typing:

```
oc whoami
oc project
```

If the response from the commands indicates that you are not userX (where X is your assigned user number) and not using the project sandboxX please repeat the commands in the pre-requisites.

Whilst OpenShift Serverless has it's own cli (kn), the purpose of this lab is to show the integration of Camel K into OpenShift Serverless and how easy this is to use.

OpenShift Serverless and the Operator Lifecycle Manager

OpenShift Serverless and the Operator Lifecycle Manager

OpenShift Serverless uses the Operator Lifecycle manager, this means that its operator and Custom Resource Definitions (CRDs) will be added to OpenShift via "OLM". Once created, the new CRDs will extend the OpenShift data model allowing OpenShift Serverless to be managed using the standard 'oc' command. Installing operators requires a higher cluster privilege so the presenter will have already set these up for you.

Creating the pre-requisites for the chapter

Before we can create an integration, we need to check that the camel-k integration added in a previous chapter is still active

In the terminal window, type

```
cd /workspace/workshop4/attendee/camelfiles/camelkplatform
oc apply -f integrationplatform.yaml
```

This will either create the integration platform or, if it is still active, indicate it is unchanged

now type

```
oc get integrationplatform
```

The output should look similar to below

```
NAME      PHASE
camel-k   Ready
```

Once the "Phase" says "Ready", you can continue

Create Knative Messaging Channel

OpenShift Serverless uses Knative eventing. Knative eventing is a loosely coupled asynchronous architecture allowing event producers to send an event to one or more event consumers. Event Consumers can be scaled to zero when no events are following through the system.

By default, Knative uses an in-memory messaging channel. In this lab we will configure two of these channels to use with Camel K

Options are also available to replace in-memory messaging with other event sources such as the Kafka Channel. By combining Camel K and Red Hat AMQ Streams (Red Hat's Kafka Implementation) on OpenShift you create a powerful and reliable cloud native eventing platform for your applications.

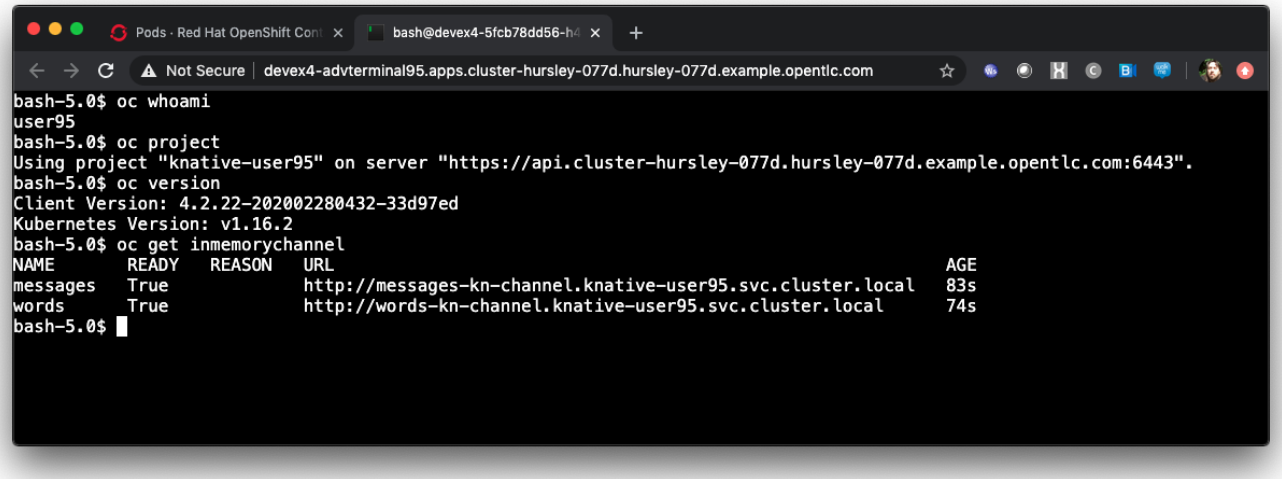
In the browser terminal window type the following:

```
cd /workspace/examples/knative
oc apply -f messages-channel.yaml
oc apply -f words-channel.yaml
```

To make sure the channels have been created correctly type:

```
oc get inmemorychannel
```

You should see a screenshot like the one below



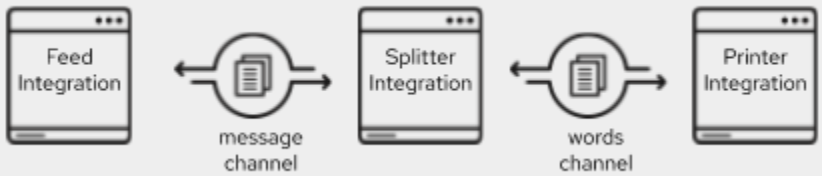
You are looking for *READY* to be *True*

Deploy the Integrations

Introduction to the integrations that we will use

Now that we have deployed 2 message channels, we will deploy 3 Camel K Integrations. *feed.groovy* will generate a simple sentence every 3 seconds, and send this to the *message channel*, *splitter.groovy* will subscribe to the *message channel*, take the message, split the message into individual words before sending the individual words to *words channel*. Finally, *printer.groovy* will subscribe to the *words.channel*, read the words from the channel and print them to the output log.

The flow looks like:



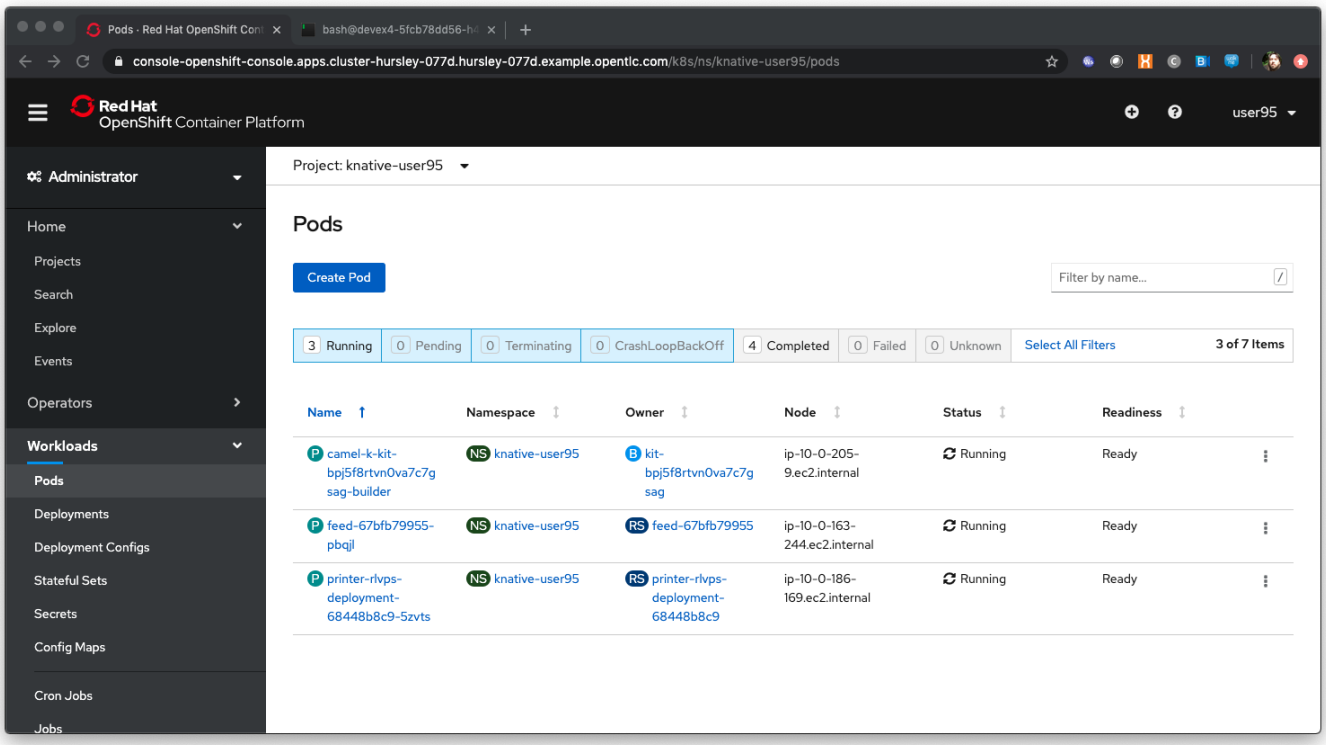
In the terminal window, deploy the 3 integrations

```
kamel run feed.groovy
kamel run splitter.groovy
kamel run printer.groovy
```

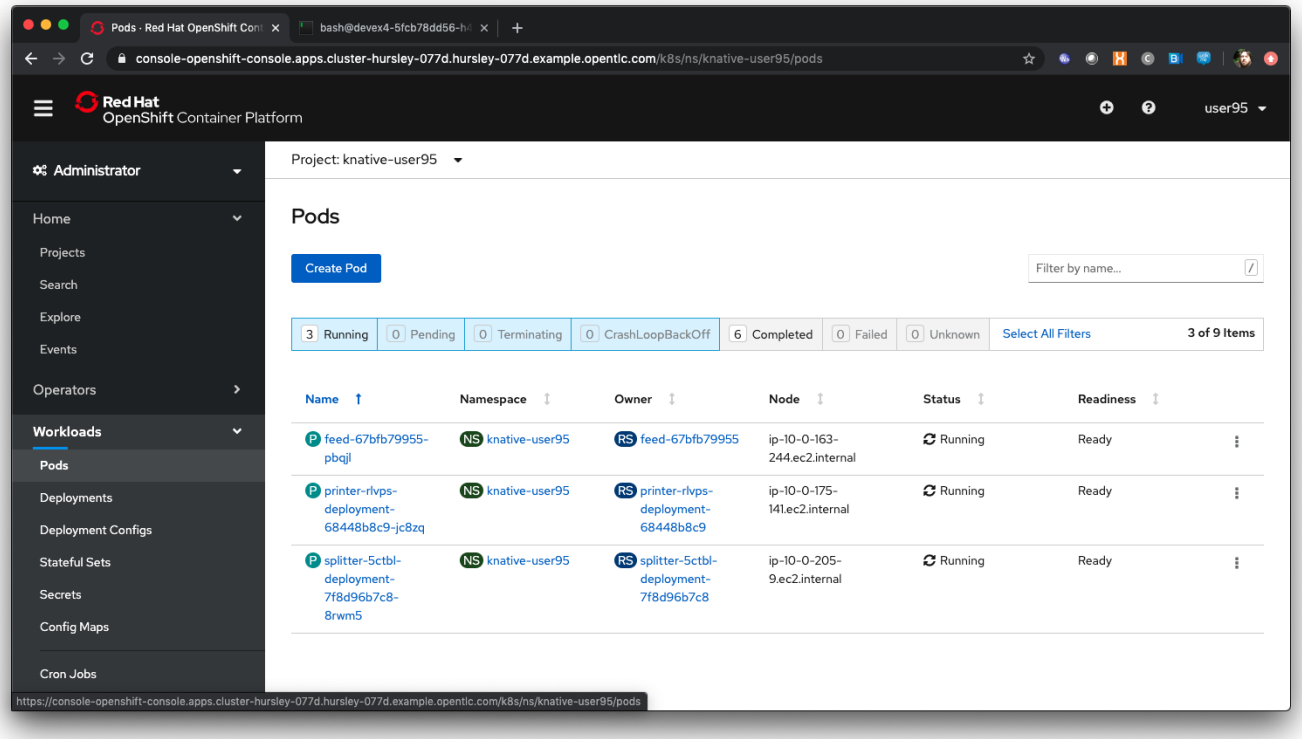
First go to the Administrator view in the OpenShift console - at the top left make sure the view is set to Administrator

Go to Workloads/Pods. As you are using a single namespace for the workshop this should display the active Pods in sandboxX, where X is your user number

Watch as the integrations are created using builder and deployment containers. This may take a little while.



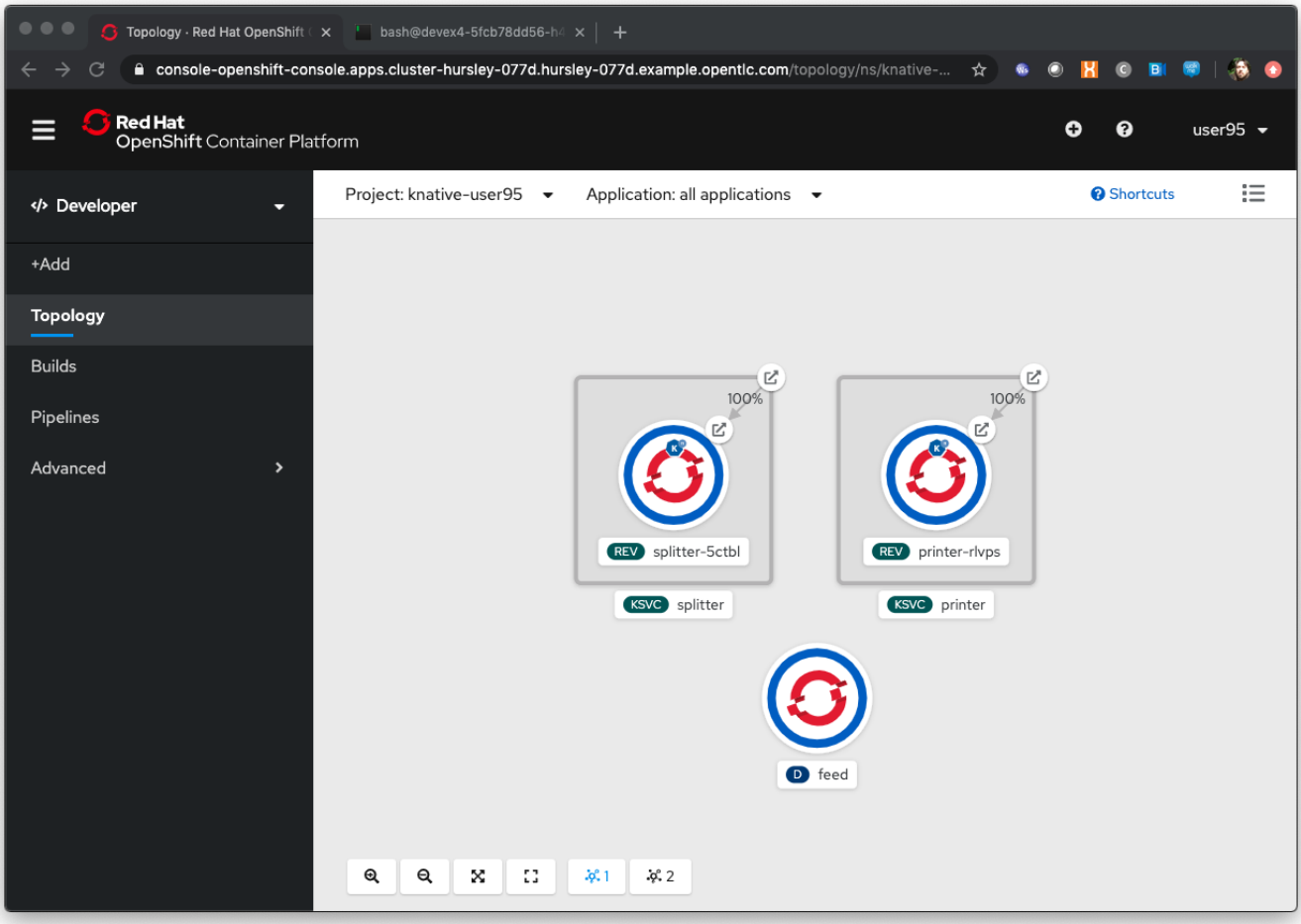
Once it has finished deploying the integrations you will have three Pods active as shown similar to the screenshot below (ignore the devex Pod, this is your terminal Pod)



Now go to the developer view in the OpenShift Console

Now that all 3 of the Integrations are deployed, the topology view should look like the screenshot

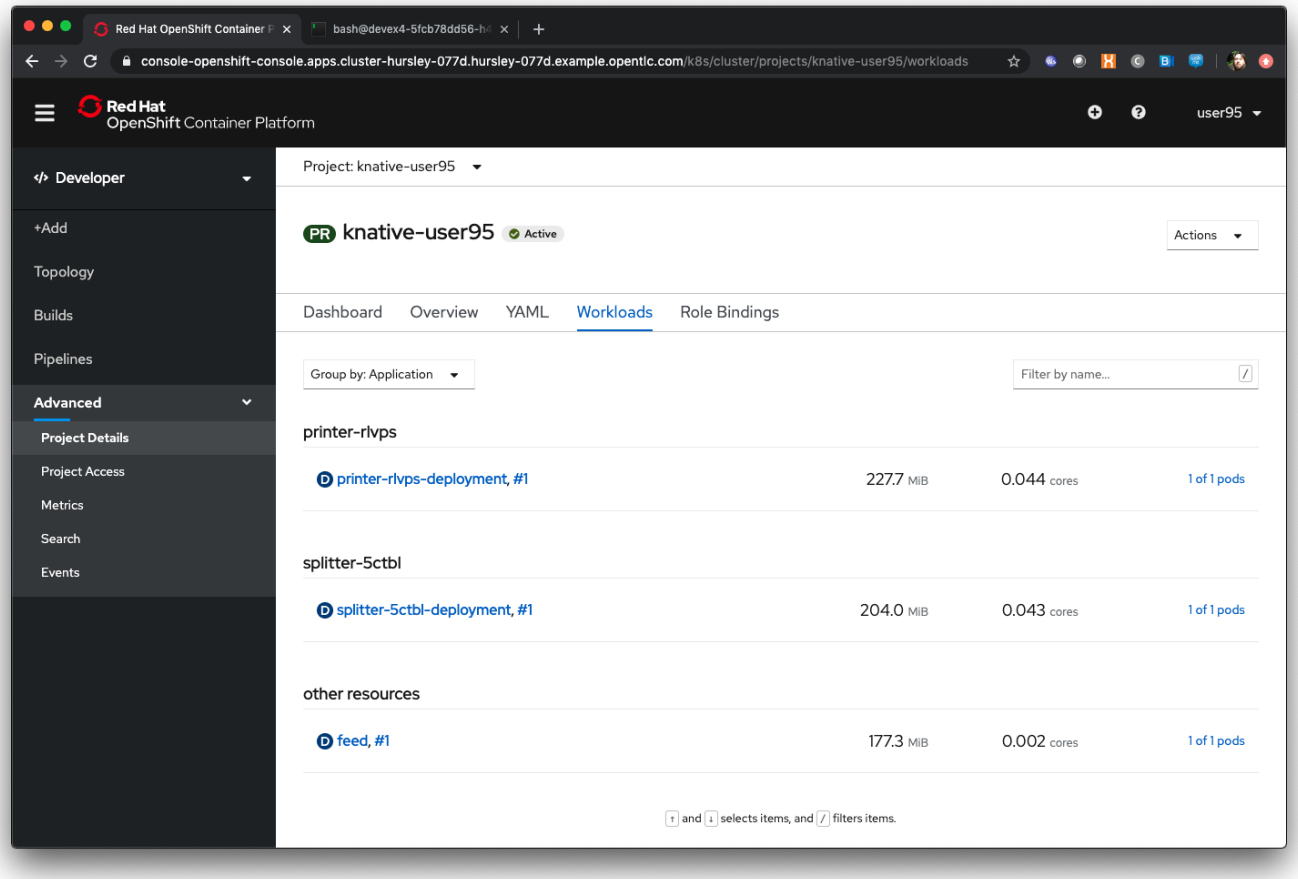
below



The Knative service is represented by the square box. You should see 2 of these in the topology view. On the OpenShift red logo in the middle of the service you will see the Knative "K" logo. You definitely know that you have a Knative service now. You will also notice an artefact called "KSVC", this is the Knative Service defined to OpenShift. There is also an artefact called "REV", this is the Knative revision that is current running. Revisions can be used to implement a Canary Release strategy. The diagram shows that 100% of the traffic is routed to the revision shown on the topology view. If you click on one of the "KSVC" on the topology view you will see an option to set the traffic distribution

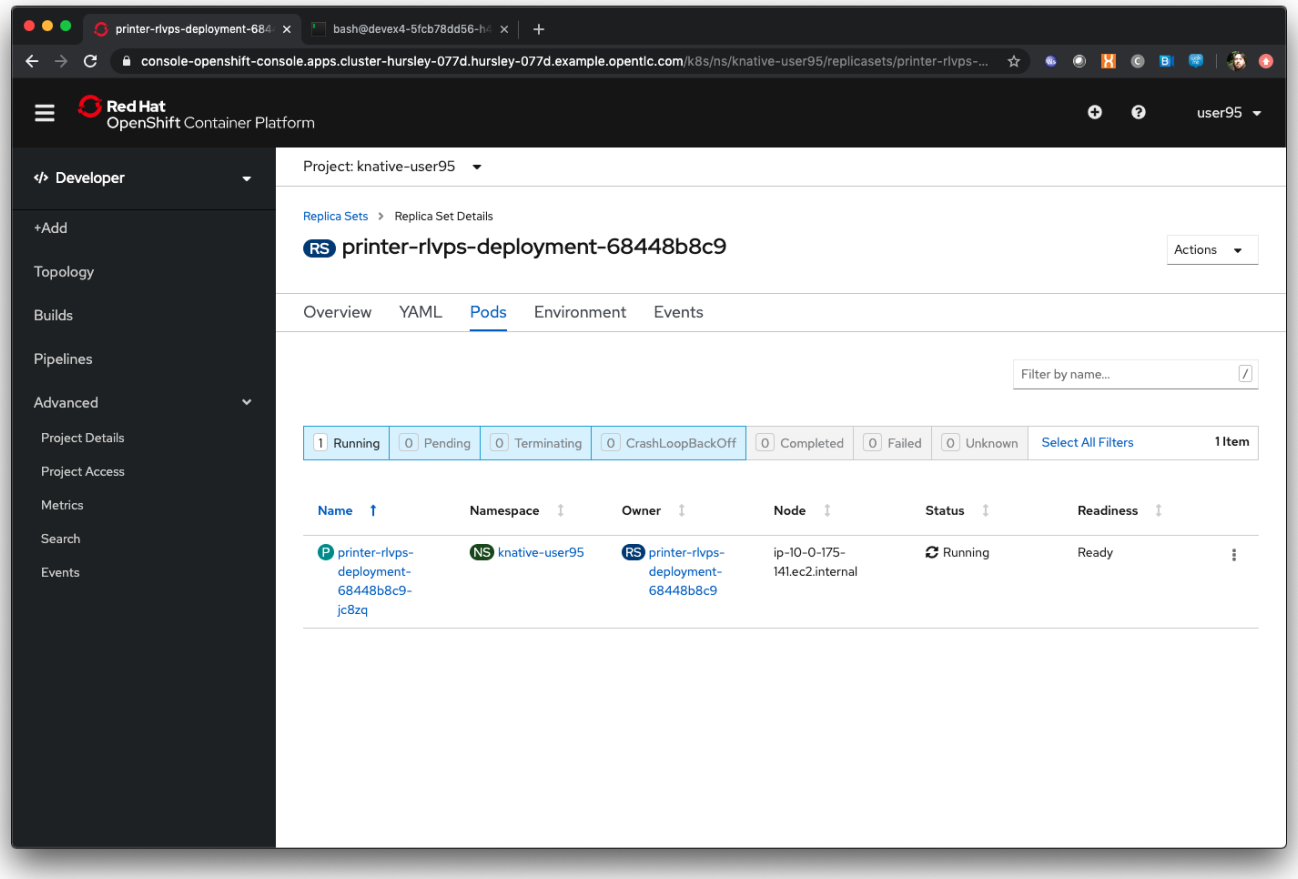
Each of the integrations is producing log information.

At the time of writing, there is no easy way to view the pod log files of a knative service in the console, so in the developer view click on Advanced/Project Details and choose Workloads



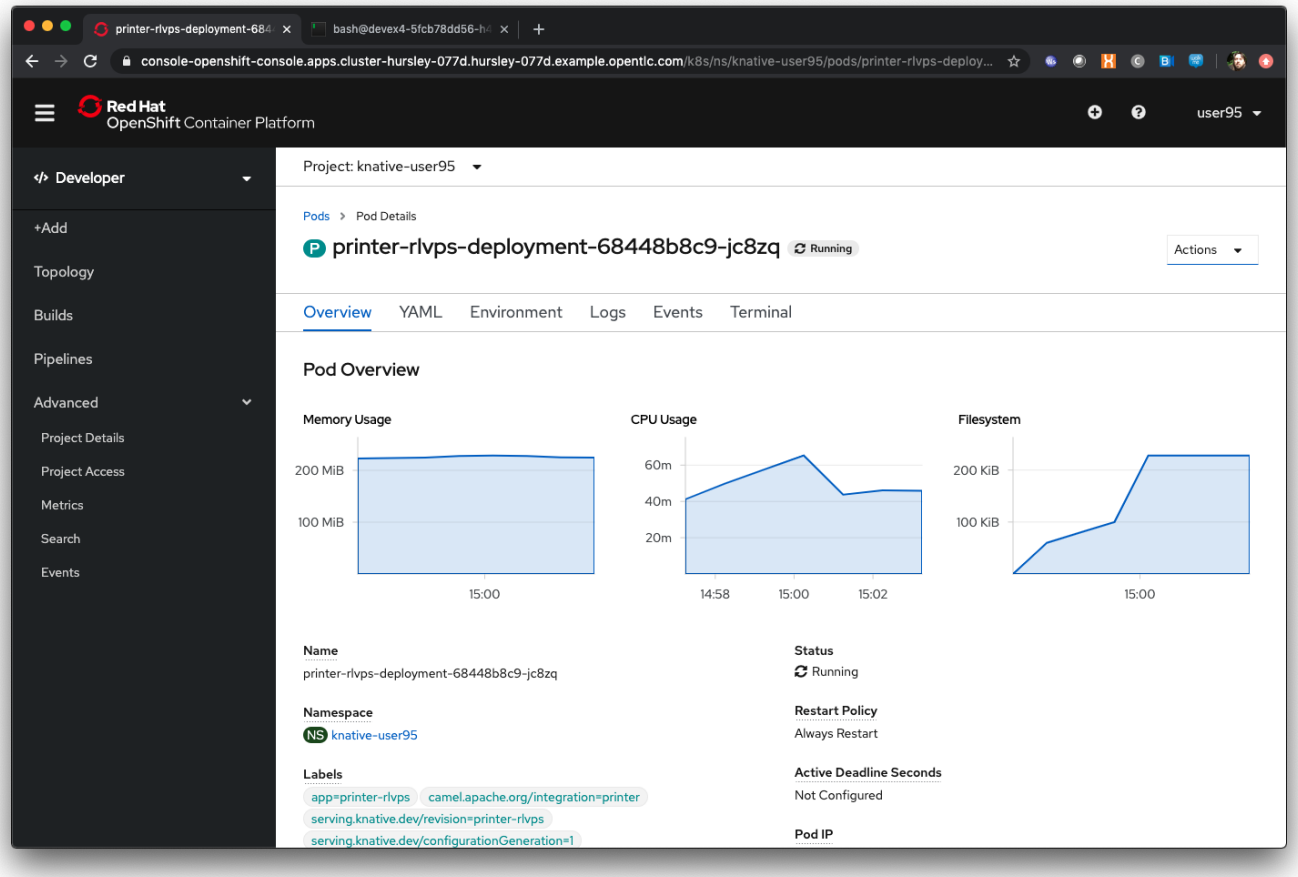
For each workload, you should see a *1 of 1 pods* on the right hand side. *Click* on the *1 of 1 pods*.

You should see a screen similar to the one below

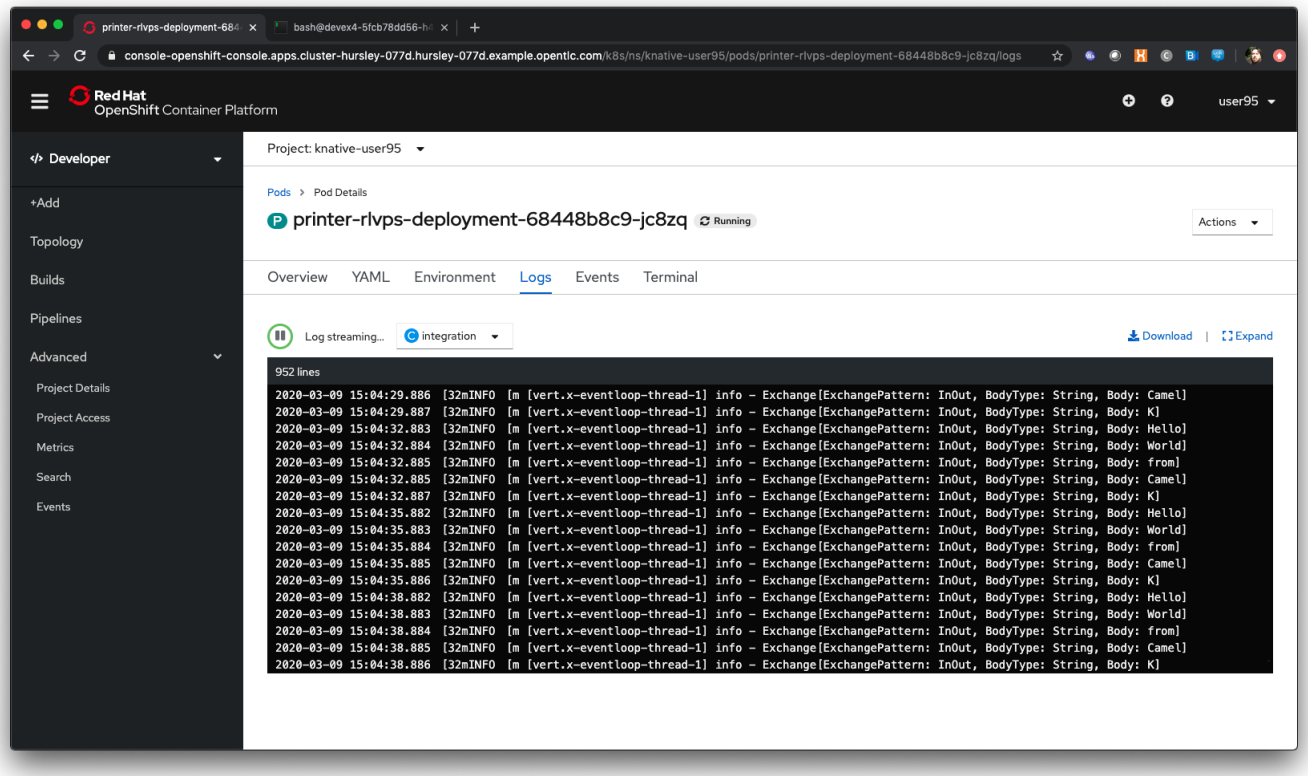


Click on the Pod name on the left e.g. printer-xxxxxxxxxxxx

This should show you a screen similar to the one below



Click on *Logs* to view the log for the pod. It should look something like the one below



Repeat the steps above for the other Integrations if you like.

Edit the Integration to use a Counter and Cache

NOTE

Because the output from the Feed Integation doesn't change, it's hard to see if all the messages are being processed, or indeed if some are being dropped. Lets make a small change to the Integration. The change will add a cache, and a counter to ensure that each message has a counter in it.

In the terminal window edit the Integration called feed.groovy

```
cd /workspace/examples/knative
vi feed.groovy
```

Between the line starting with **from** and the line starting with **.setBody** insert the follow code (copy the code by higlightling it and copying it)

```
        .setHeader("CamelCaffeineAction", constant("GET"))
        .setHeader("CamelCaffeineKey", constant("count"))
        .toF("caffeine-cache://%s", "messagecount")
        .choice()
                .when().simple('${body} == null') // When no counter stored, default to
zero
                        .setHeader('counter').constant(0)
                .otherwise() // retrieve the counter
                        .setHeader('counter').simple('${body}')
        .end()
        .setHeader('counter').ognl('request.headers.counter + 1')
        .setBody().simple('${header.counter}')
        .setHeader("CamelCaffeineAction", constant("PUT"))
        .setHeader("CamelCaffeineKey", constant("count"))
        .toF("caffeine-cache://%s", "messagecount")
        .setBody().simple('Hello${header.counter} World${header.counter}
from${header.counter} Camel${header.counter} K${header.counter}')
```

TIP

I'm no vi expert, but if you don't know vi, use the keyboard arrow keys to move to the line beginning with **from**, then to go to the end of the line press **$**, press **i**, press the **right arrow** once to move the cursor to the end of the line and press **enter** (this shoud insert a blank line and move the cursor to the beginning of that line. Paste in the code by pressing **ctrl v**. Don't worry about the indentation too much. Once pasted in press **esc**.

The final line pasted in is **.setBody**. There is an existing **.setBody** line that we need to delete, the line looks like :-

```
.setBody().constant("Hello World from Camel K")
```

TIP

To delete, move the cursor to the line and press **dd** Finally save your work by typing **:wq** and press **enter**

Once complete, the integration should look like :-

```
// camel-k: language=groovy
/*
 * Licensed to the Apache Software Foundation (ASF) under one or more
 * contributor license agreements.  See the NOTICE file distributed with
 * this work for additional information regarding copyright ownership.
 * The ASF licenses this file to You under the Apache License, Version 2.0
 * (the "License"); you may not use this file except in compliance with
 * the License.  You may obtain a copy of the License at
 *
 *      http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing, software
 * distributed under the License is distributed on an "AS IS" BASIS,
 * WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
 * See the License for the specific language governing permissions and
 * limitations under the License.
 */

from('timer:clock?period=3s')
        .setHeader("CamelCaffeineAction", constant("GET"))
        .setHeader("CamelCaffeineKey", constant("count"))
        .toF("caffeine-cache://%s", "messagecount")
        .choice()
                .when().simple('${body} == null') // When no counter stored, default to
zero
                        .setHeader('counter').constant(0)
                .otherwise() // retrieve the counter
                        .setHeader('counter').simple('${body}')
        .end()
        .setHeader('counter').ognl('request.headers.counter + 1')
        .setBody().simple('${header.counter}')
        .setHeader("CamelCaffeineAction", constant("PUT"))
        .setHeader("CamelCaffeineKey", constant("count"))
        .toF("caffeine-cache://%s", "messagecount")
        .setBody().simple('Hello${header.counter} World${header.counter}
from${header.counter} Camel${header.counter} K${header.counter}')
        .to('knative:channel/messages')
        .log('sent message to messages channel')
```

Each word should now have the counter appended to it

Test your work by typing :-

```
kamel run feed.groovy
```

Use the skills you've learned to view the output of the container logs to check that the messages now contain a counter.

Knative in action

Make sure you are in the developer view of the console, looking at the Topology view before continuing

The 2 Integrations "hooked" into Knative Eventing are the *splitter* and *printer* integrations (you can visually see this on the topology view).

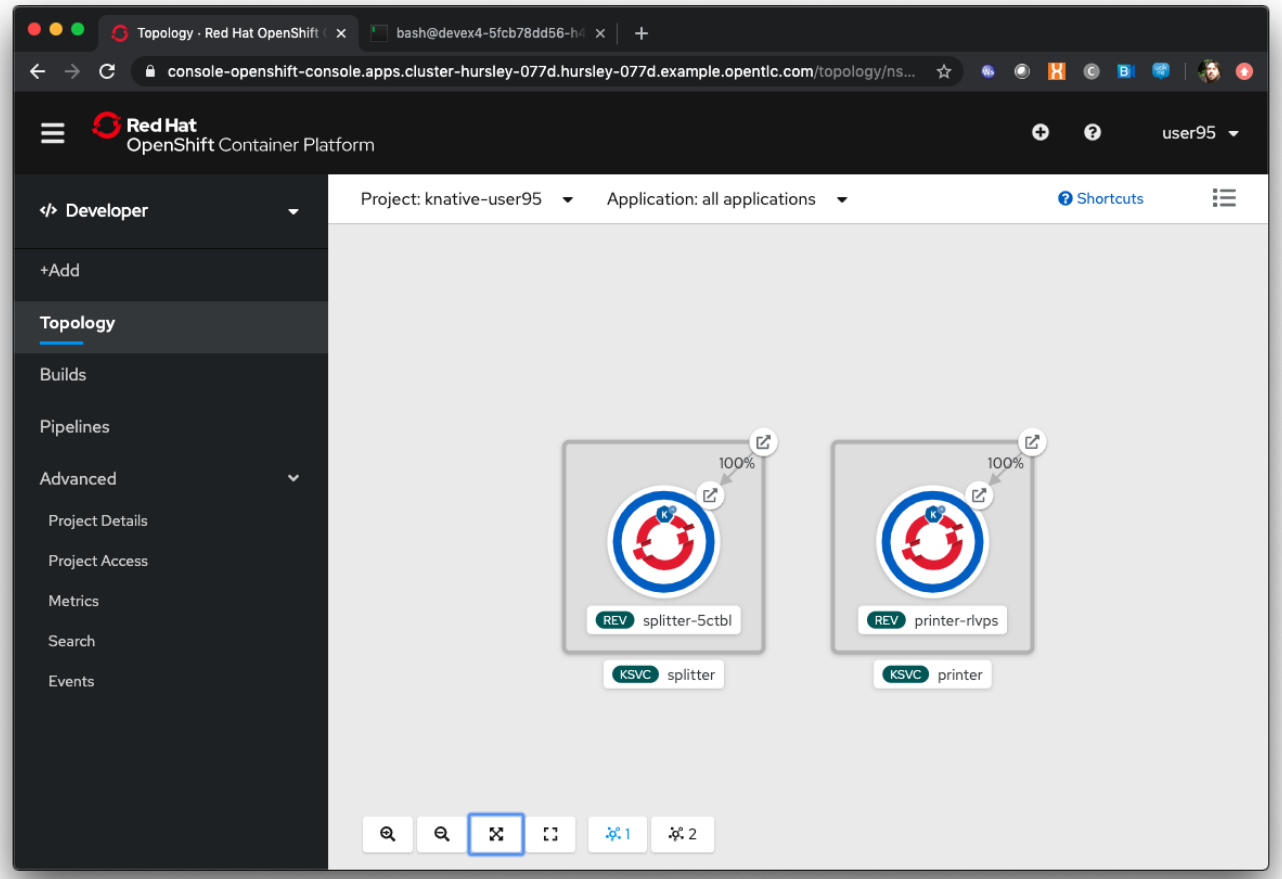
Let's see if the promise of scale to zero works.

To stop the integrations, we need to stop messages arriving at the "messages.channel". To do this, we need to stop the feed integration.

In the terminal browser window, type

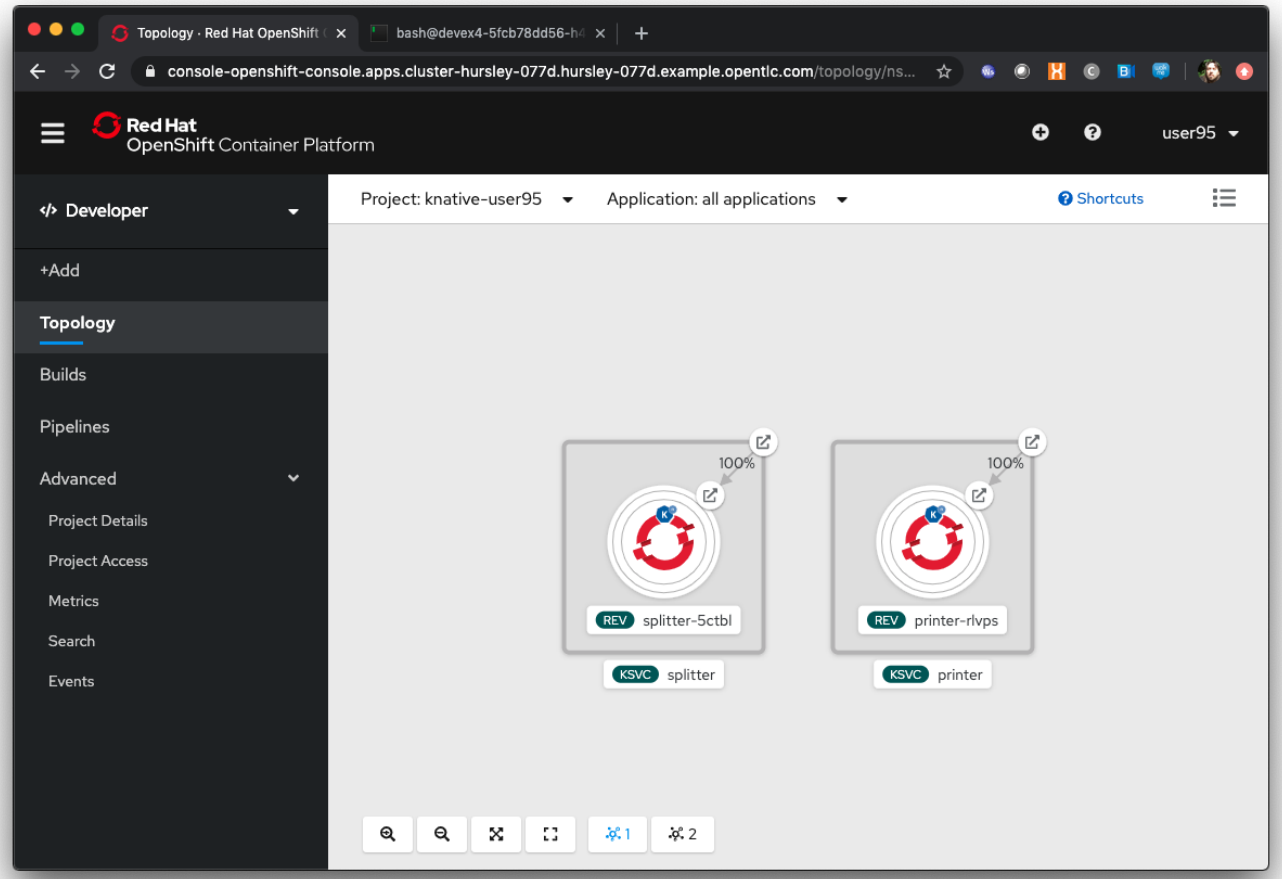
```
kamel delete feed
```

Go back to the topology view, you will notice that the feed integration has gone.



Show some patience now, keep looking at the topology view, we are waiting (and hoping!) that the integrations scale down to zero.

You will know when this starts as the rings around the circles will change from the normal blue to a very dark blue, before going white. Once they are white, the integrations are scaled to zero just like the screenshot below



To wake the Integrations up again, redeploy the *feed* integration.

```
kamel run feed.groovy
```

Go back to the topology view and you should see the *feed* integration redeploy, and the *splitter* and *printer* integrations awake from their slumber.

This shows the potential for effective serverless behaviour by the down-scaling of unused applications, combined with the ease of Camel-K integrations.

To clean up before the next chapter run the following commands in the terminal:

```
kamel delete feed
kamel delete splitter
kamel delete printer
```

Camel K and OpenShift Serverless Serving [INNOVATION]

Author: Phil Prosser (feedback to pprosser@redhat.com)

Introduction

OpenShift Serverless

OpenShift Serverless, based on Knative is the serverless technology that was introduced in OpenShift 4.2. OpenShift Serverless enables Pods running on OpenShift to be scaled to 0 therefore taking zero processing power. Only when called, OpenShift Serverless will scale the Pod up on demand before processing the request. OpenShift Serverless also has the ability to autoscale based on load before eventually scaling back to zero when no requests are being received.

OpenShift Serverless supports "Serving" and "Eventing"

At the time of writing, Eventing is in Tech Preview

"Serving" enables request/response workloads, and Eventing enables asynchronous event based workloads using cloudevents. In this lab, we are going to look at serving, and how easy it is to integrate with Camel K.

Check the project is ready to use

In the browser based terminal window, check you are still logged on and using the correct project by typing:

```
oc whoami
oc project
```

If the response from the commands indicates that you are not userX (where X is your assigned user number) and not using the project sandboxX please repeat the commands in the pre-requisites.

OpenShift Serverless and the Operator Lifecycle Manager

OpenShift Serverless and the Operator Lifecycle Manager

OpenShift Serverless uses the Operator Lifecycle manager, this means that its operator and Custom Resource Definitions (CRDs) will be added to OpenShift via "OLM". Once created, the new CRDs will extend the OpenShift data model allowing OpenShift Serverless to be managed using the standard ‘oc’ command. Installing operators requires a higher cluster privilege so the presenter will have already set these up for you.

Creating the pre-requisites for the chapter

Before we can create an integration, we need to check that the camel-k integration added in a previous chapter is still active

In the terminal window, type

```
cd /workspace/workshop4/attendee/camelfiles/camelkplatform
oc apply -f integrationplatform.yaml
```

This will either create the integration platform or, if it is still active, indicate it is unchanged

now type

```
oc get integrationplatform
```

The output should look similar to below

```
NAME      PHASE
camel-k   Ready
```

Once the "Phase" says "Ready", you can continue

Deploy a Restful Integration using Camel K and an OpenAPI definition

Introduction to the integrations that we will use

This integration is a simple hello world Restful integration. The Restful API interface is defined by the OpenAPI json document called greeting-api.json. This is demonstrating top down API design with Apache Camel. An Apache Camel Route can implement this interface without the need for code. Using a "from" action called "direct" the integration enables the Camel Route to listen/respond to the operation id defined in the OpenAPI document.

Feel free to have a look at both of the files to understand whats going on.

In the terminal window, the files are located in the directory /workspace/examples

OpenAPi definition: greetings-api.json Camel K integration: greetings.groovy

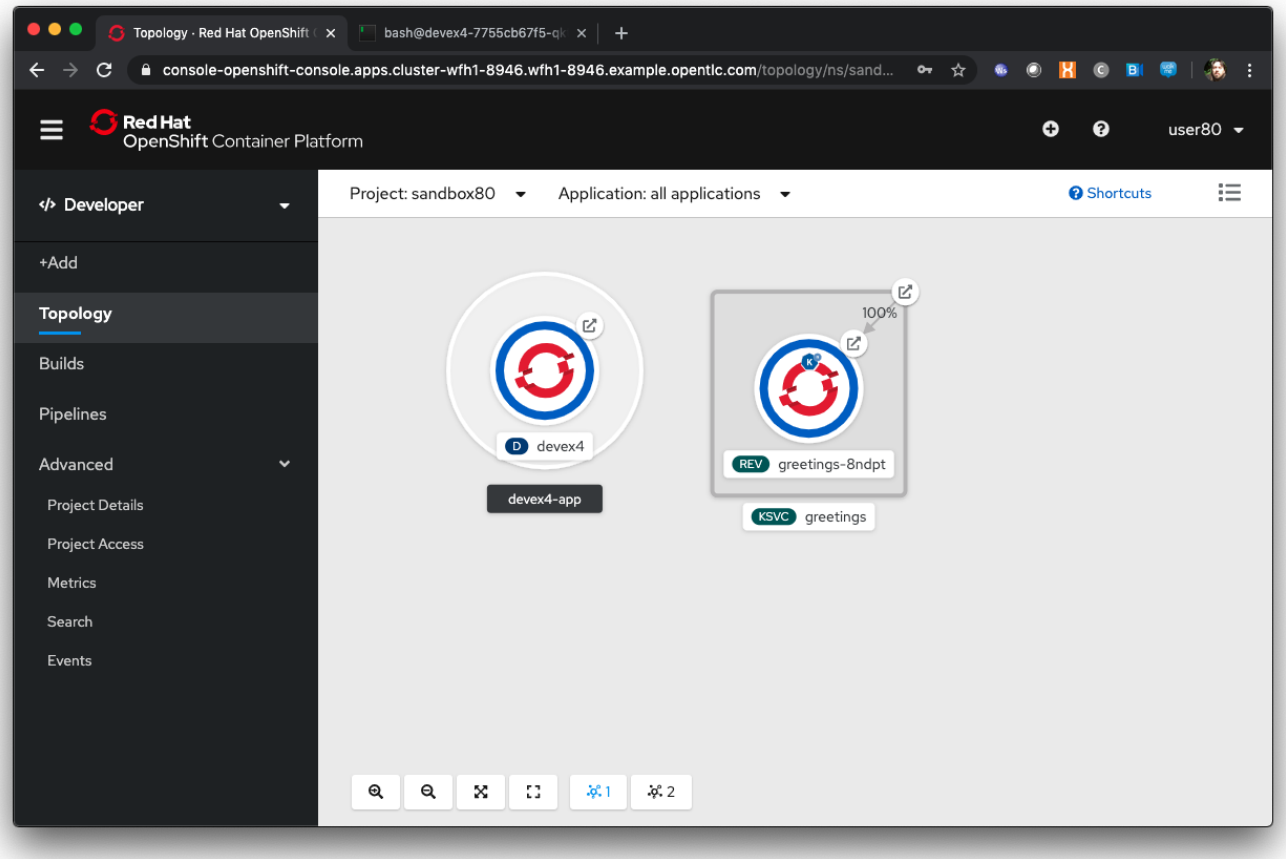
In the terminal window, deploy the integration

```
cd /workspace/examples
kamel run --name greetings --dependency=camel-rest --dependency camel-undertow --property
camel.rest.port=8080 --open-api greetings-api.json greetings.groovy
```

Go to the developer view in the OpenShift Console

If this is the first time you've deployed a Camel K integration, it will take a few minutes to download the dependencies

Once, the Integration is deployed, the topology view should look like the scrennshot below

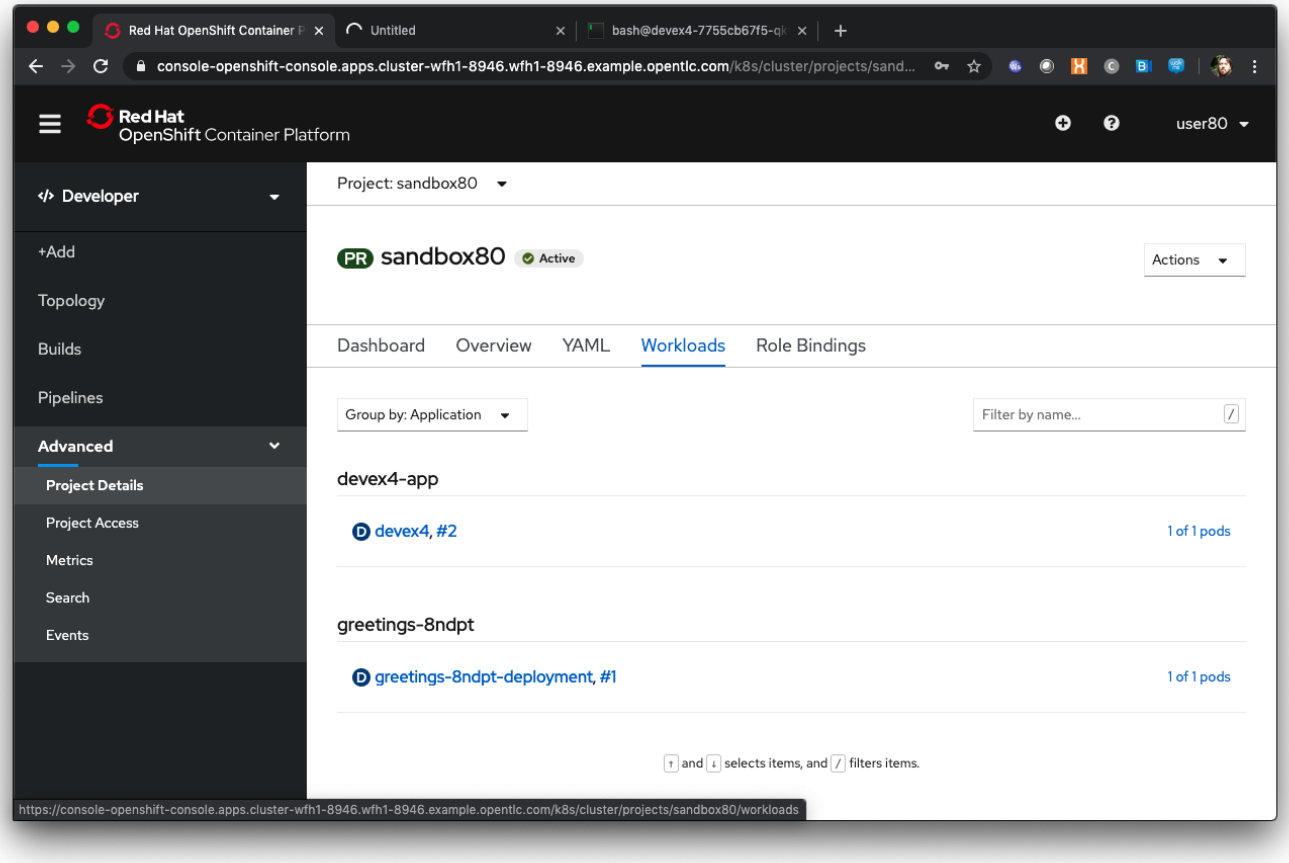


Camel K has detected that OpenShift Serverless is installed and automatically deployed the integration as a Knative serving (because it's API based) service.

TIP

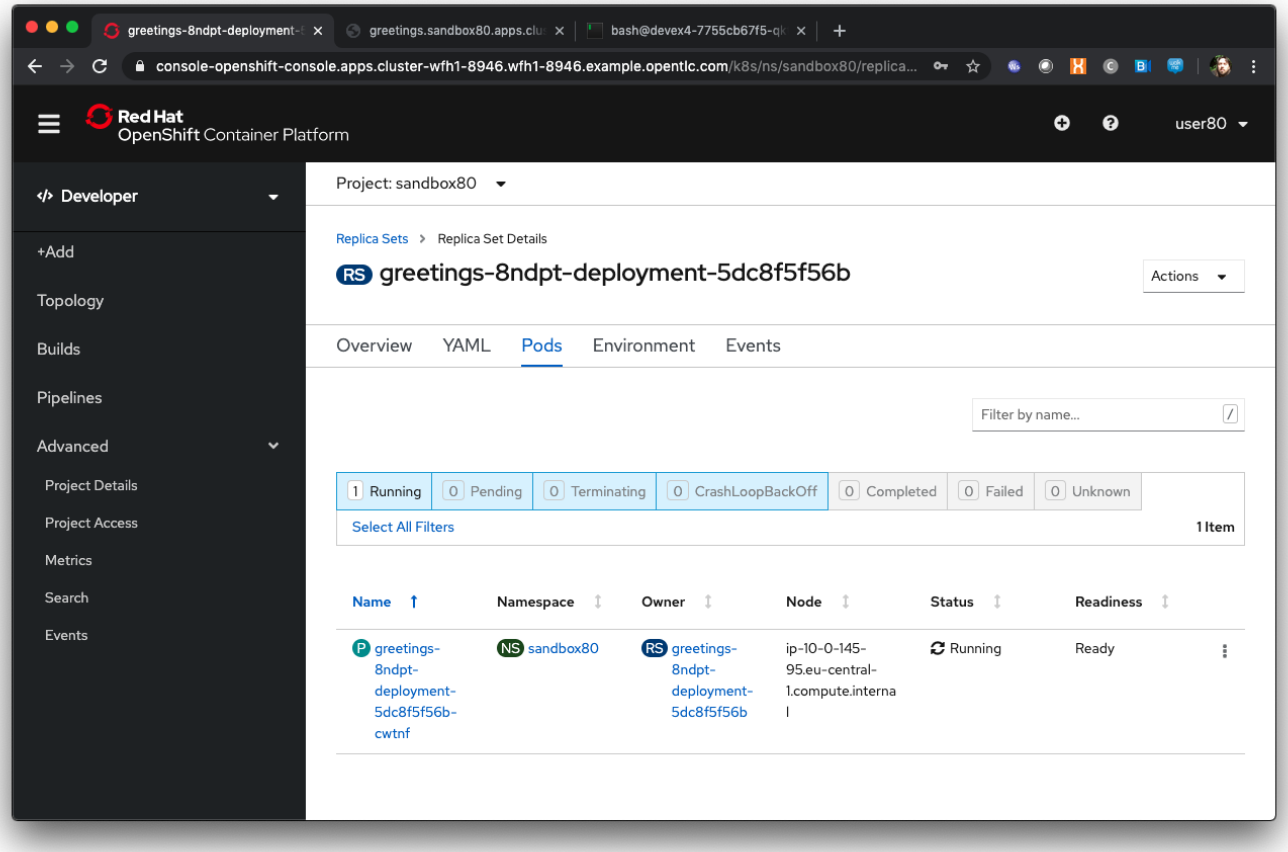
The next set of instructions will only be possible if Knative Serving hasn't already scaled the pod back to zero. If you do not see any running pods then please move on to the section title "Knative in action"

At the time of writing, there is no easy way to view the pod log files of a knative service in the console, so in the Developer view click on Advanced/Project Details and select Workloads. The interface should look like:



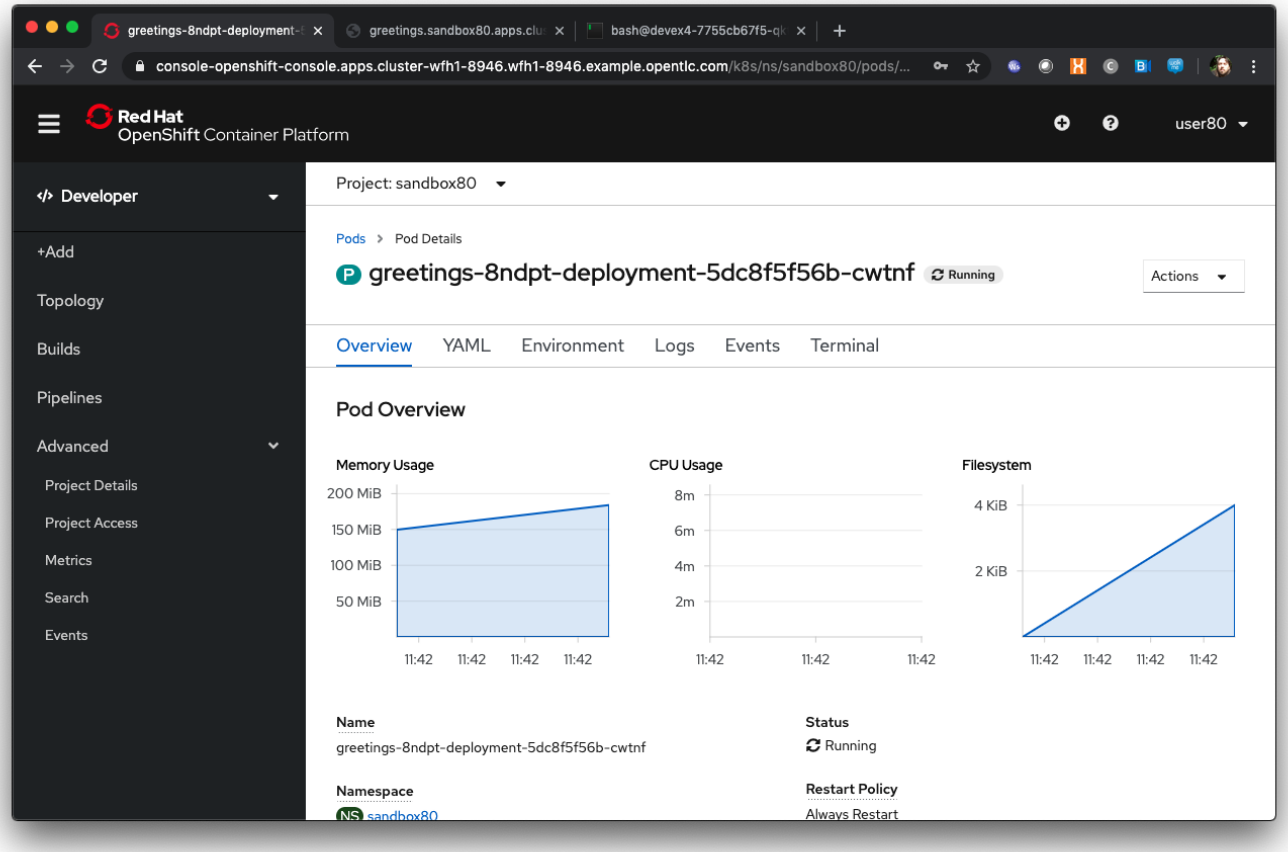
For the greetings integration, you should see a *1 or 1 pods* on the right hand side. Click on it.

You should see a screen similar to the one below

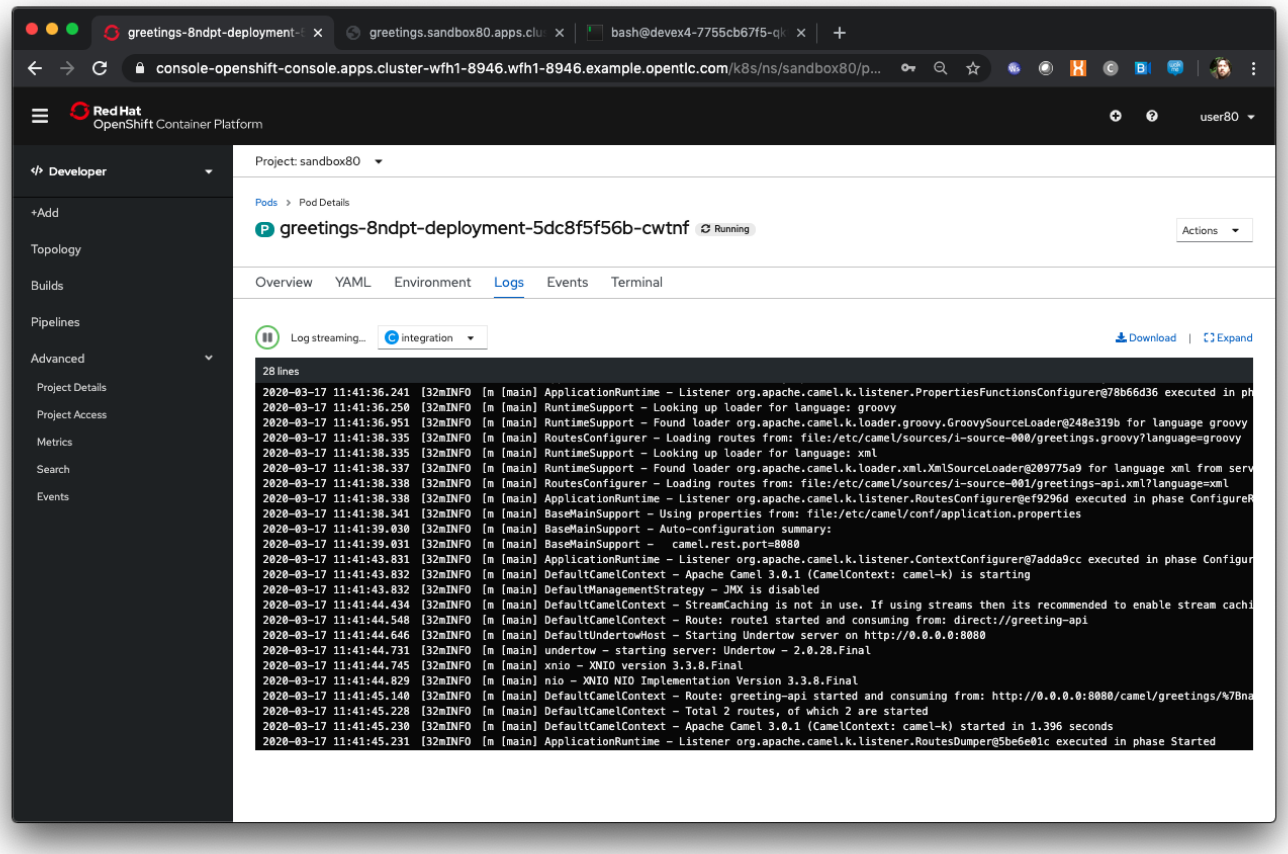


Click on the row name e.g. greetings-xxxxxxxxxxxx

This should show you a screen similar to the one below



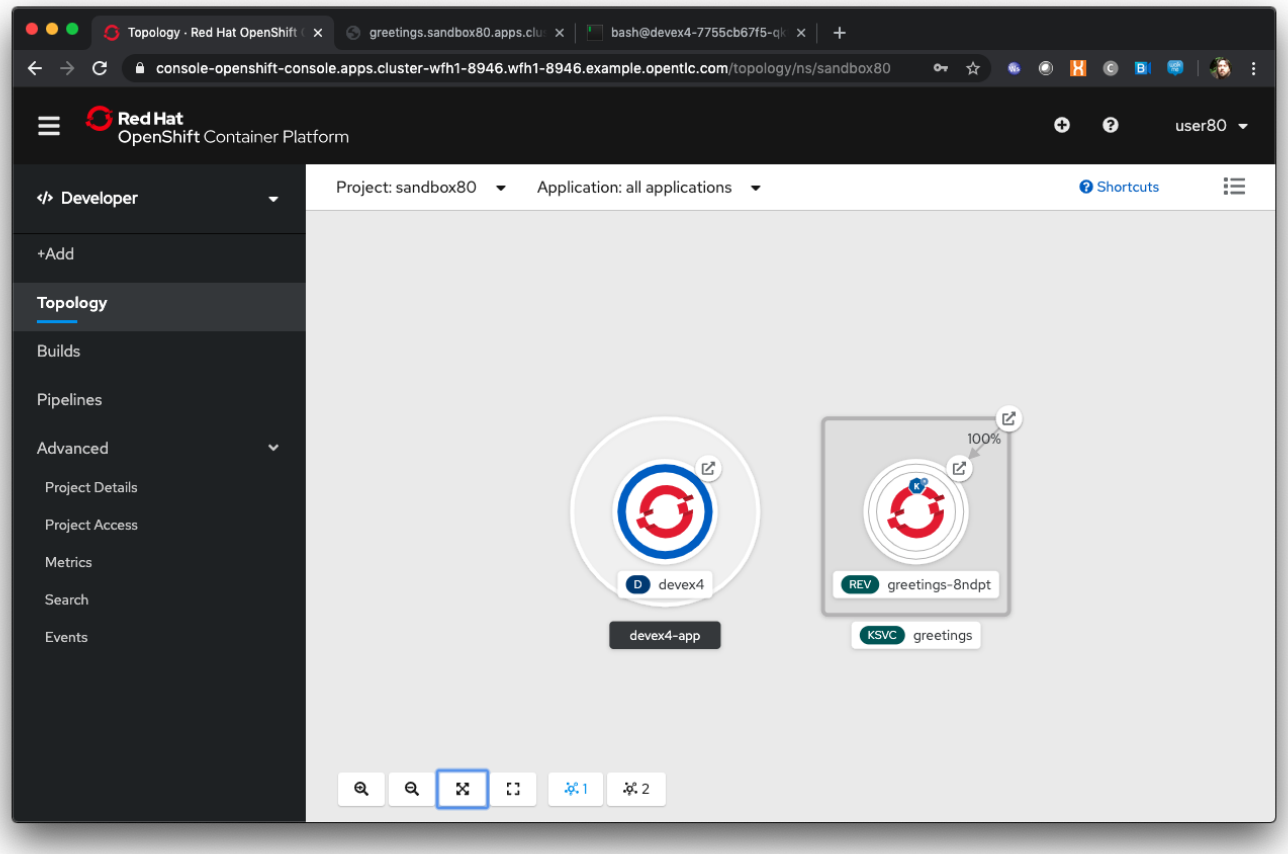
Click on *Logs* to view the log for the pod. It should look something like the one below



Knative in action

Following the steps above, you might find that the pod you are looking for is not there. That's because Knative Serving has scaled the pod back to zero.

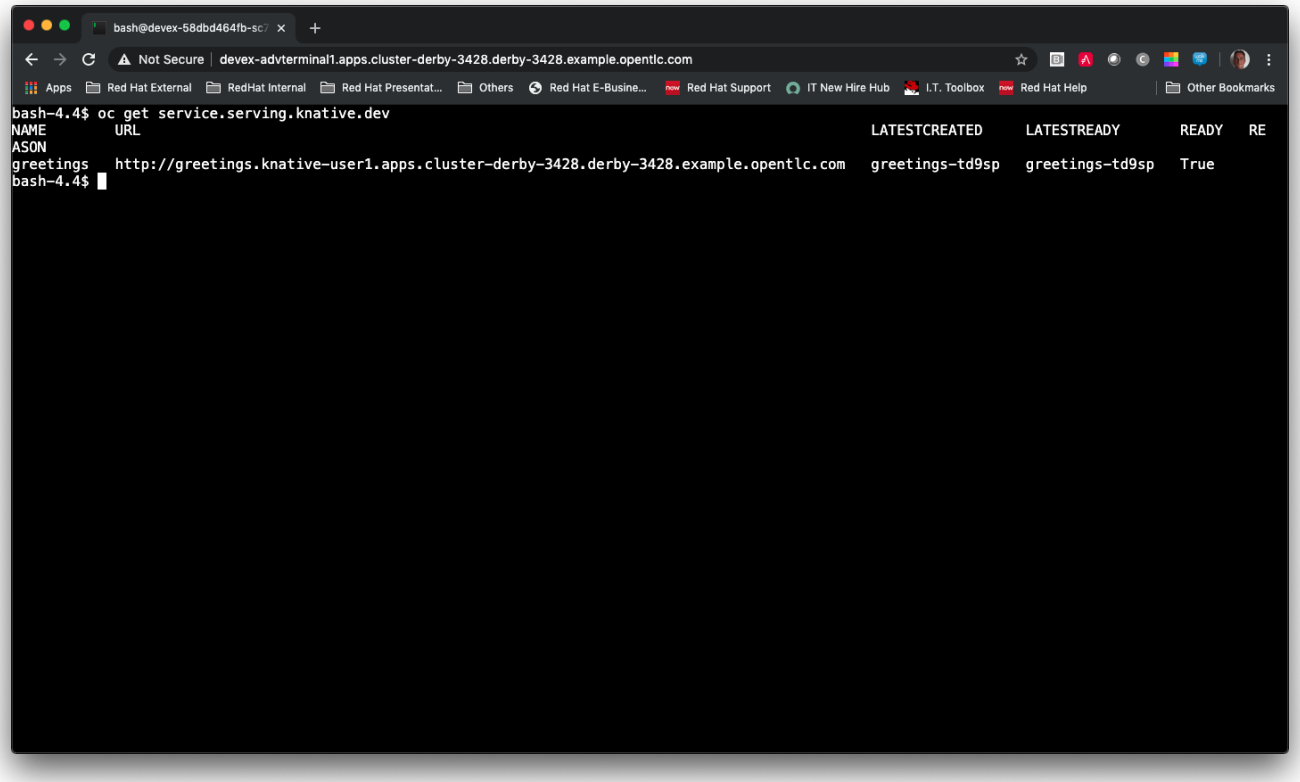
With the OpenShift console switch to developer view, viewing the toplogy. Your screen might look like the one below. If it doesn't, wait for up to 30 seconds and it scale down to zero. By default, Knative scales down an inactive pod after 30 seconds.



Next we are going to make a call to the greetings API. To do this, you need to find out the name of http route. To do this, in the terminal window, type in the following command

```
oc get service.serving.knative.dev
```

You should see something similar to the picture below

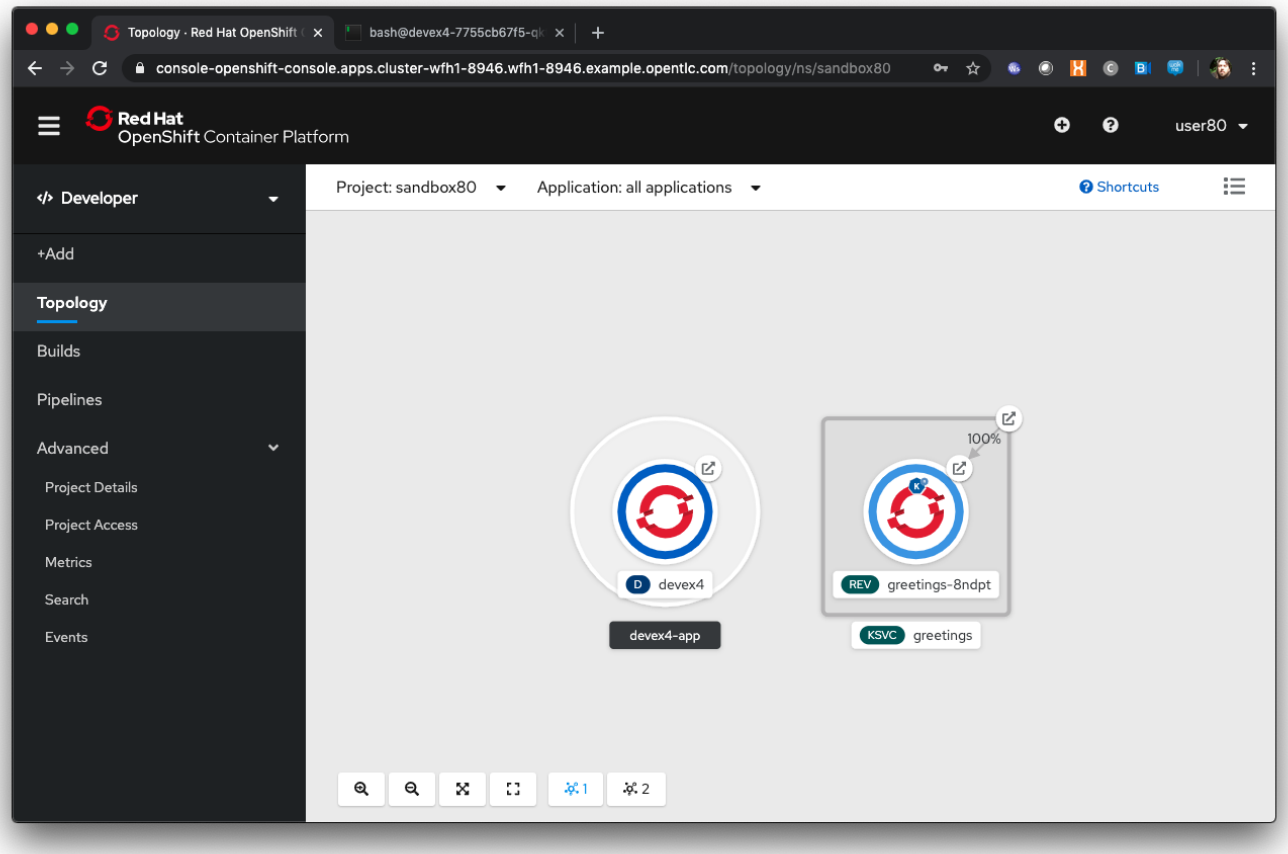


In the terminal window type (make sure you substitute the URL you see from running the command above). Note we are adding the /camel/greetings/YOURNAMEHERE bit to the URL

```
curl -m 60 URLFROMABOVE/camel/greetings/YOURNAMEHERE
```

After a few seconds you should get a response, and the topology view should now look similar to the picture below. The dark blue circle indicates that the service is now executing.

At the time of writing, the inital start up time issue is known to engineering and is documented in the Red Hat documentation. A fix for this will be coming in a future release. Please remember that Knative serving is still in Tech Preview



Knative has automatically scaled the service to one pod, and processed the curl request.

Options are available in Knative to determine how to scale based on concurrent calls or cpu useage. Options are also available to determine maximum number or pods, and also the inactivity time before a pod scales its self down - by default, all the way back down to zero.

Deploying Integration Services with Knative can't get easier than that!

To clean up before the next chapter run the following commands in the terminal:

```
kamel delete greetings
```

OpenShift DO [DEVTOOLS]

Author: Mark Roberts (feedback to mroberts@redhat.com)

Introduction

An overview of odo

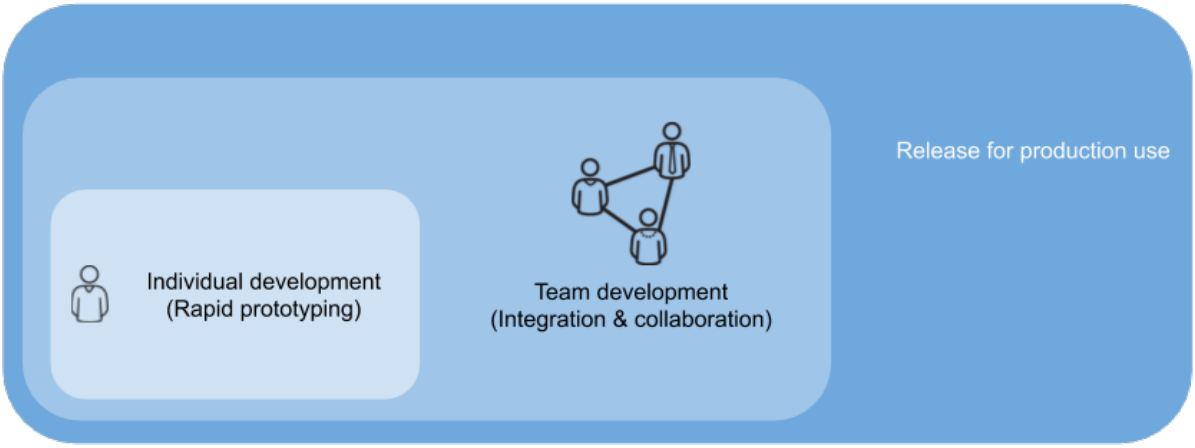
The OpenShift command line interface *oc* is a general purpose interface with a vast set of commands for both development and administrative purposes. The odo command is a more developer centric command line interface for users who simply want to build, deploy and run applications on OpenShift. There is definitely a place for both tools within the kitbag of an OpenShift user, and for fast iterations of edit - run - edit - run the odo interface is perfect.

The approach described in the application basics chapter used a GIT repository as the source of the content to be built and deployed. This is a excellent approach when multiple users are working together in a complex application performing frequent integration of source code in GIT and validating their combined efforts as the project progresses. Avoiding such frequent integration activity will make the code of each developer diverge storing up integration headaches in the future.

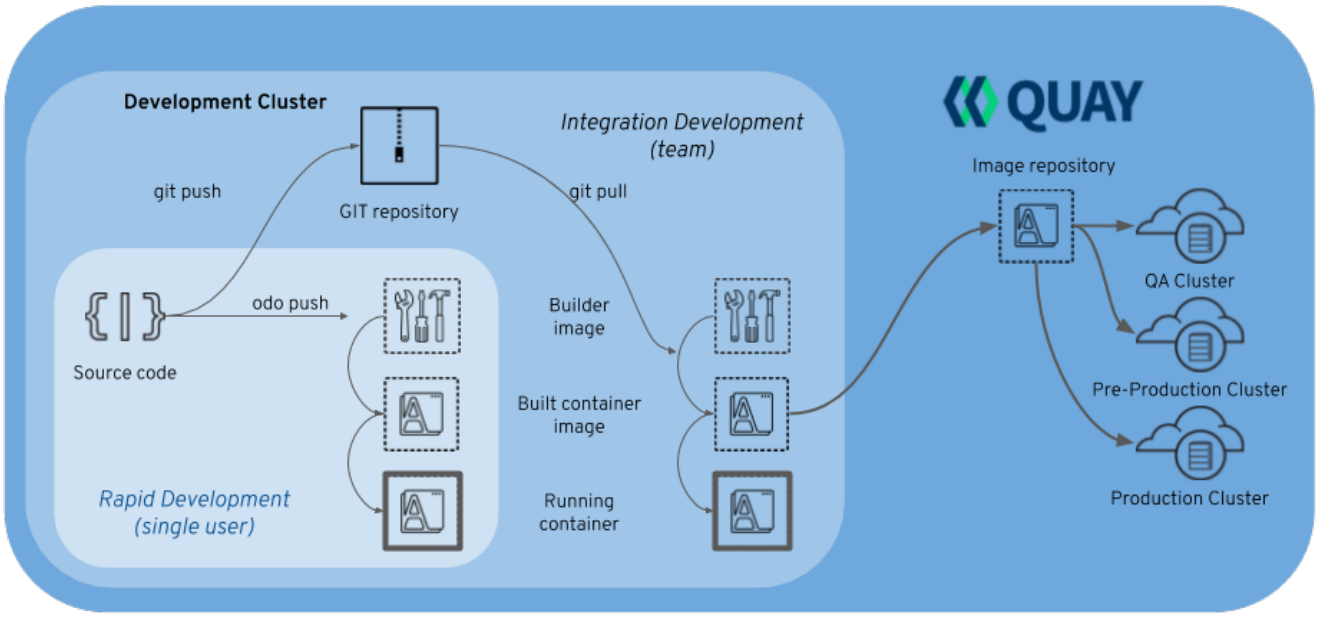
The ability of the OpenShift *Source-2-image* capability to identify the code within the GIT repository (from the options of Node.js, Java, Ruby, Perl, PHP, and Python), select a builder image, build the code and deliver a new container with the running application is a huge efficiency advantage for teams. However there are scenarios in which a single developer simply wants to get their code running as quickly as possible and which is where odo can be advantageous.

The principle of the odo command is that it can very quickly create a new project and use a *GIT like* syntax to enable a developer to push the code into OpenShift. The receiving OpenShift cluster will then decide how to build the code, perform the build and deliver a running container. When the developer wants to make changes they simply push their code and the build and deploy operations are repeated. The first push process may take around a minute, but after that each iteration will take only a few seconds.

The diagram below shows how the odo command can fit into a development cycle. The outline diagram shows that the odo command is appropriate for single developers working with a degree of isolation, the team development involves multiple developers integrating their code through a GIT repository and the final phase involves the use of multiple clusters for the deployment of applications through to production.



In more detail the diagram below shows how odo and oc / source-2-image work together to create a scaled development experience. In the single user phase the odo command is used to push the application code to a container in OpenShift. In the light blue box the source code is pushed to OpenShift in which the language specific builder image is used to create a new image containing the built code. This image is started to create a running container. When the developer needs to share the code with the work of others GIT is used as a vehicle for integration and to remove any code conflicts. This is the medium blue box in which the code is pushed to GIT and the OpenShift source-2-image capability is used to build a new running container. In the final phase shown in the darker blue box, the built container image can then be pushed to the Quay image repository to be stored securely ready for deployment to further environments such as pre-production and production.



Installing

The odo command line interface is built into the terminal that you create as a pre-requisite for this workshop so you don't have to install anything right now. However, if you want to install the interface on your own workstation then it is available for download from here : https://github.com/openshift/odo, window="_blank".

If you haven't already please follow the instructions in the pre-req chapter which explains the creation and setting up of the terminal application. For this chapter you will be using that application which has the odo command pre-installed for you

Switch to the terminal application tab of the browser as described in the pre-req chapter

To use the command simply type *odo* and you will see help regarding the objects and to get help on a specific object use *odo <object> --help*.

odo command set

The odo command has the following subcommands :

Commands:

```
app         Perform application operations (delete, describe, list)
catalog     Catalog related operations (describe, list, search)
component   Manage components (create, delete, describe, link, list, log, push, unlink,
update, watch)
config      Change or view configuration (set, unset, view)
debug       Debug commands (port-forward)
preference  Modifies preference settings (set, unset, view)
project     Perform project operations (create, delete, get, list, set)
service     Perform service catalog operations (create, delete, list)
storage     Perform storage operations (create, delete, list)
url         Expose component to the outside world (create, delete, list)
```

Utility Commands:

```
login       Login to cluster
logout      Log out of the current OpenShift session
utils       Utilities for terminal commands and modifying odo configurations (terminal)
version     Print the client version information
```

Component Shortcuts:

```
create      Create a new component
delete      Delete component
describe    Describe component
link        Link component to a service or component
list        List all components in the current application
log         Retrieve the log for the given component
push        Push source code to a component
unlink      Unlink component to a service or component
update      Update the source code path of a component
watch       Watch for changes, update component on change
```

The most common are used within this workshop but feel free to experiment with any of the above commands.

Logging in

At this point if you are using the terminal as explained in the pre-req chapter you will already be logged into the system. This can be checked by typing the following:

```
oc whoami
odo project list
```

This should result in your user name being displayed followed by the sandboxX project being shown by the result to the odo command

If you do need to login to odo outside of this workshop use the *odo login* command with appropriate parameters

The odo command will evolve over time and it performs a check to see if you have the latest version each time it is used. If there is an update available you will be given a prompt to update from a given URL

To see which version of odo you are using enter the command:

```
odo version
```

Examining source assets

The pipeline assets are located in a GIT repository that has been preinstalled in the terminal. Using your terminal window check the assets using the commands below

```
cd /workspace/workshop4/attendee/slave

ls -al
```

You will see that the directory only has the source file slave.js and the package file called package.json.

Create, push source & run cycle

Create a new project using the odo command replacing X with your user number below

```
odo create nodejs node-app-slave
```

TIP:The syntax of the above command is *odo create* <*component-type*> <*component-name*> *--project* <*project-for-the-component*>

The result of running this command is simply the creation of a .odo directory containing a config.yaml file. The file contains the desired state for the application in OpenShift and is only committed to OpenShift and acted upon by OpenShift when the user issues the command *odo push*. Examine the config.yaml file with the command below

```
---
cat .odo/config.yaml
---
```

Create a route for the application by using the command below

```
odo url create node-app-slave
```

Examine the contents of the .odo/config.yaml file again and you will see that new content has been added

```
cat .odo/config.yaml
```

Now push the configuration to OpenShift by using the command below

```
odo push
```

The output from the above command is shown below

```
Validation
 ✓  Checking component [113ms]

Configuration changes
 ✓  Initializing component
 ✓  Creating component [348ms]

Applying URL changes
 ✓  URL node-app-slave: http://node-app-slave-app-master-slave-odo.apps.cluster-london-a29c.london-a29
c.example.opentlc.com created

Pushing to component node-app-slave of type local
 ✓  Checking files for pushing [568214ns]
 ✓  Waiting for component to start [1m]
 ✓  Syncing files to the component [15s]
 ✓  Building component [22s]
 ✓  Changes successfully pushed to component
```

Wait for the response "Changes successfully pushed to component"

The application has started up and will be running at the URL indicated in the output above. Copy the URL from your command window and paste it into a new browser tab. You should see an output similar to that shown below.

Note - within the terminal window to copy text you should highlight the text, right click and select copy. To paste to the terminal window use ctrl-shift-v.

```
Hello - this is the simple slave REST interface v1.0
```

Now make a small change to the comment in the source code of the slave.js file to change the line shown below

```
response.send('Hello - this is the simple slave REST interface' + versionIdentifier);
```

Change the response to the following

```
response.send('Hello - MODIFIED and pushed with ODO' + versionIdentifier);
```

Now use odo to push the changed source to OpenShift

odo push

The code still needed to be pushed to the component, but the final stage of building the component is much faster. Refresh the browser window showing the application output and you will see your code change. The edit - push - test cycle is as simple as that

odo watch

The odo process also has a *watch* facility that allows you to force odo to constantly watch for source code changes and push them immediately. Open another instance of the terminal application by pointing a new tab in the browser to the route to the terminal application.

In the new terminal tab enter

```
cd /workspace/workshop4/attendee/slave
odo watch
```

The command window should report : *Waiting for something to change in <current-working-directory>*

Switch back to your other terminal window and make another change to the source code, similar to the change above. After saving the edit switch to the terminal window in which you typed *odo watch* and observe that a new push of the code to OpenShift has taken place

The window with the watch command running will report:

```
File <path-to-source>/slave.js changed
Pushing files...
 ✓  Waiting for component to start [73ms]
 ✓  Syncing files to the component [11s]
 ✓  Building component [4s]
```

Refresh the browser window showing the application output and you will see your code change

odo is clearly a very fast way to go from code to running your application without having to install tools and frameworks on your laptop

Finally, let's clean up the project by typing

```
odo delete node-app-slave
```

This will delete the application from the project

OpenShift Pipelines - Tekton [INNOVATION]

Author: Mark Roberts (feedback to mroberts@redhat.com)

Introduction

For many years teams have created automation pipelines to build, unit test, analyse and deploy applications in a variety of tool-chains. Some such tool-chains (Jenkins for one) pre-date the popularization of containers and are now being questioned for their fit for the delivery of cloud native applications. While we are at pains not to criticize Jenkins (we are big users and fans) there is scope to look at alternative approaches for cloud native applications.*

OpenShift Pipelines are based on the Tekton open source project and they provide a Kubernetes style, resource based approach to the construction of pipelines. Tasks are defined as small units of operations (typically 10 to 15 lines of YAML) and such tasks are grouped together into taskruns or pipelines for execution.

A new command line exists for the execution of Tekton commands and a graphical user interface can be added to the cluster to provide a simple way to run tasks and to observe running or completed tasks.

The Tekton project can be found here : https://tekton.dev/, window="_blank"

Further documentation on the specifics of Tekton can be found on the github site here : https://github.com/tektoncd/pipeline, window="_blank"

Tasks

Download pipeline assets

As part of the pre-requisites you should have cloned the required git repo and created the base project for all the chapters - if you haven't please go back to the pre-requisites and follow the instructions

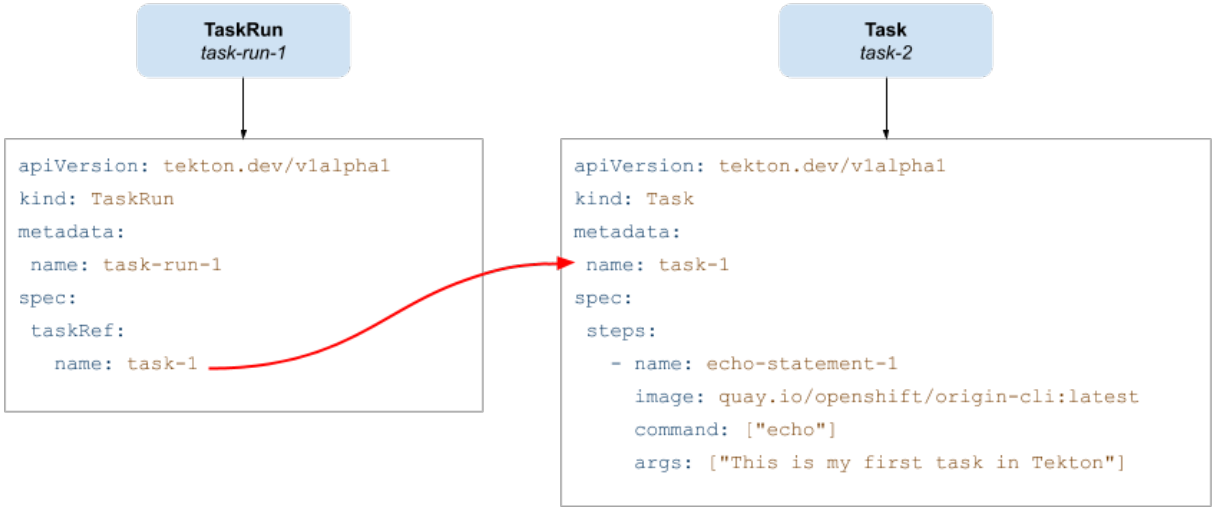
Check the required assets for the workshop are available in your terminal image using:

```
cd /workspace/workshop4/attendee/tekton/
ls -al
```

You should now see a list of yaml files that are used during the remainder of this chapter.

Simple task creation and execution

In the simplest format a task can be executed by a taskrun object. The diagram below shows a simple taskrun calling a single task



Tekton command line

A new command line utility is used to manage the Tekton command line. The commands cover the various different pipeline objects such as task, taskrun, pipeline, pipelinerun, resources, cluster tasks and conditions.

The Tekton command line interface is built into the terminal that you create as a pre-requisite for this workshop so you don't have to install anything right now. However, if you want to install the interface on your own workstation then it is available for download from here : https://github.com/tektoncd/cli, window="_blank"

To use the command simply type *tkn* and you will see help regarding the objects and to get help on a specific object use *tkn <object> --help*

To execute the above pipeline use the following commands to create the pipeline objects. Note that when creating the taskrun objects the associated task(s) will run immediately.

```
oc create -f task-1.yaml
oc create -f taskrun-1.yaml
tkn taskrun ls
```

The response from the last command will display a line similar to the following:

```
NAME          STARTED          DURATION      STATUS
task-run-1    9 seconds ago    ---           Running(Pending)
```

Repeat the final command a few times until you see it change to be similar to the following:

```
NAME          STARTED           DURATION      STATUS
task-run-1    3 minutes ago    21 seconds    Succeeded
```

The result of running the task can then be viewed by executing the following command:

```
tkn taskrun logs task-run-1
```

```
[echo-statement-1] This is my first task in Tekton

[echo-statement-2] ------------------------------------------------------------
[echo-statement-2]   - This is a multi-line comment
[echo-statement-2]   - This is useful as a separator but each line has
[echo-statement-2]   - the title repeated next to it using different colours
[echo-statement-2]   - which helps with the identification of different tasks.
[echo-statement-2]  ------------------------------------------------------------
[echo-statement-2]
```

Note that the command response above uses different colours for each block of command result titles in the [ ] brackets. This helps to differential between the response for each step.

Pipelines

Pipelines are used to manage the execution of a series of tasks within a pipeline. The example pipeline below is used to execute the Tekton tasks : task-1, task-2 and task-3. Remember that each Tekton task can have multiple steps within it.

```
apiVersion: tekton.dev/v1alpha1
kind: Pipeline
metadata:
  name: pipeline-1
spec:
  tasks:
  - name: task-1
    taskRef:
      name: task-1
  - name: task-2
    taskref:
      name: task-2
  - name: task-3
    taskref:
      name: task-3
```

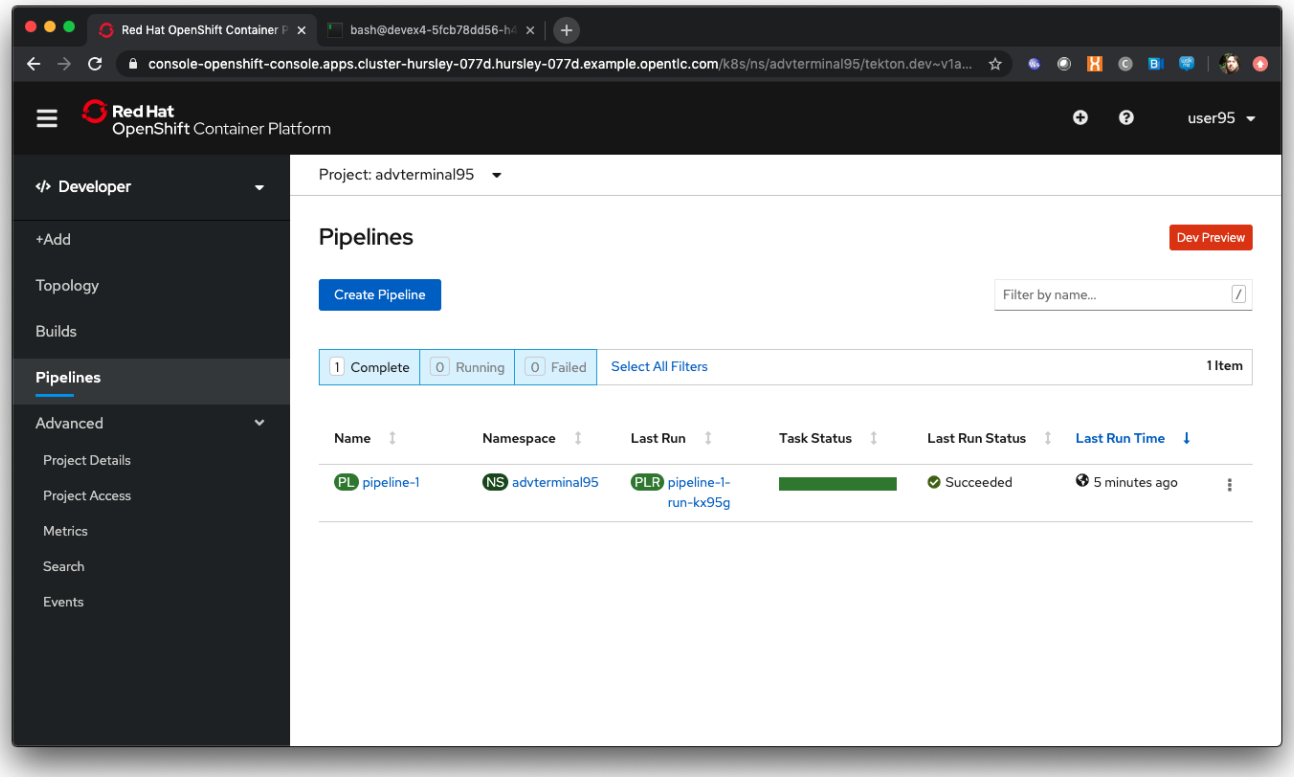
Before executing this pipeline create the required additional resources with the commands :

```
oc create -f task-2.yaml
oc create -f task-3.yaml
oc create -f pipeline-1.yaml
```

Execute the pipeline with the following Tekton task

```
tkn pipeline start pipeline-1
```

Once you have executed the command switch back to the OpenShift console. If you select the Developer view you will find there is a menu option on the left hand side labelled *Pipelines*. Select this option and the screen should look like this:



Once the pipeline is indicated to have finished, go back to the terminal and enter the command suggested by the response to the tkn command - it will look similar to this:

```
tkn pipelinerun logs pipeline-1-run-kx95g -f
```

Note that the -n parameter is optional, it states the namespace to look in for the pipelinerun and we are running in a single namespace

Enter the command as provided by the tkn command and the response should look something like this:

```
Pipelinerun started: pipeline-1-run-ffxsk
Showing logs...
[task-2 : what-directory] /workspace

[task-2 : describe-command] ------------------------------------------------------------
[task-2 : describe-command]   - Openshift oc command line example
[task-2 : describe-command]  ------------------------------------------------------------
[task-2 : describe-command]

[task-2 : oc-version] Client Version: unknown
[task-2 : oc-version] Kubernetes Version: v1.14.6+76aeb0c

[task-3 : echo-statement-3] echo - statement 3
[task-1 : echo-statement-1] This is my first task in Tekton


[task-3 : echo-statement-4] echo - statement 4

[task-1 : echo-statement-2] ------------------------------------------------------------
[task-1 : echo-statement-2]   - This is a multi-line comment
[task-1 : echo-statement-2]   - This is useful as a separator but each line has
[task-1 : echo-statement-2]   - the title repeated next to it using different colours
[task-1 : echo-statement-2]   - which helps with the identification of different tasks.
[task-1 : echo-statement-2]  ------------------------------------------------------------
```

There may be an issue in the order of the execution above. The order of the pipeline expected is different to the order observed:

```
   Expected              Actual
task 1 - step 1      task 2 - step 1
task 1 - step 2      task 2 - step 2
task 2 - step 1      task 2 - step 3
task 2 - step 2      task 3 - step 1
task 2 - step 3      task 1 - step 1
task 3 - step 1      task 3 - step 2
task 3 - step 2      task 1 - step 2
```

In some pipelines the order of execution may not matter but if it does the order can be managed by the addition of the *runAfter* directive to a specific task as shown in the update to the pipeline-1 pipeline shown below:

```
apiVersion: tekton.dev/v1alpha1
kind: Pipeline
metadata:
  name: pipeline-1
spec:
  tasks:
  - name: task-1
    taskRef:
      name: task-1
  - name: task-2
    taskref:
      name: task-2
    runAfter:
    - task-1
  - name: task-3
    taskref:
      name: task-3
    runAfter:
    - task-2
```

Make the above changes to the pipeline-1.yaml file by using vi:

```
vi pipeline-1.yaml
```

Press [ESC] then i to edit/insert, make the changes to the file, then press [ESC] and type :wq[RETURN] to save the changes

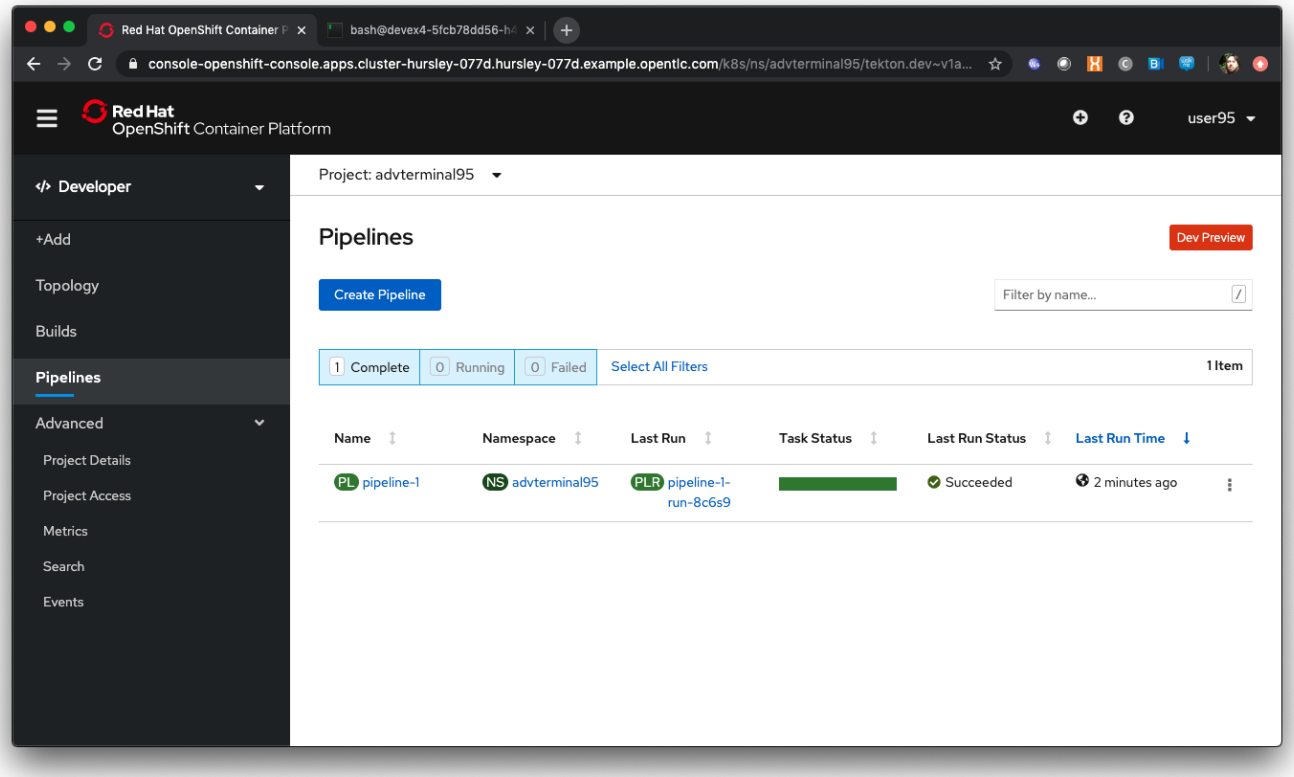
Now replace the existing pipeline using the following commands:

```
oc delete pipeline pipeline-1
oc create -f pipeline-1.yaml
tkn pipeline start pipeline-1
```

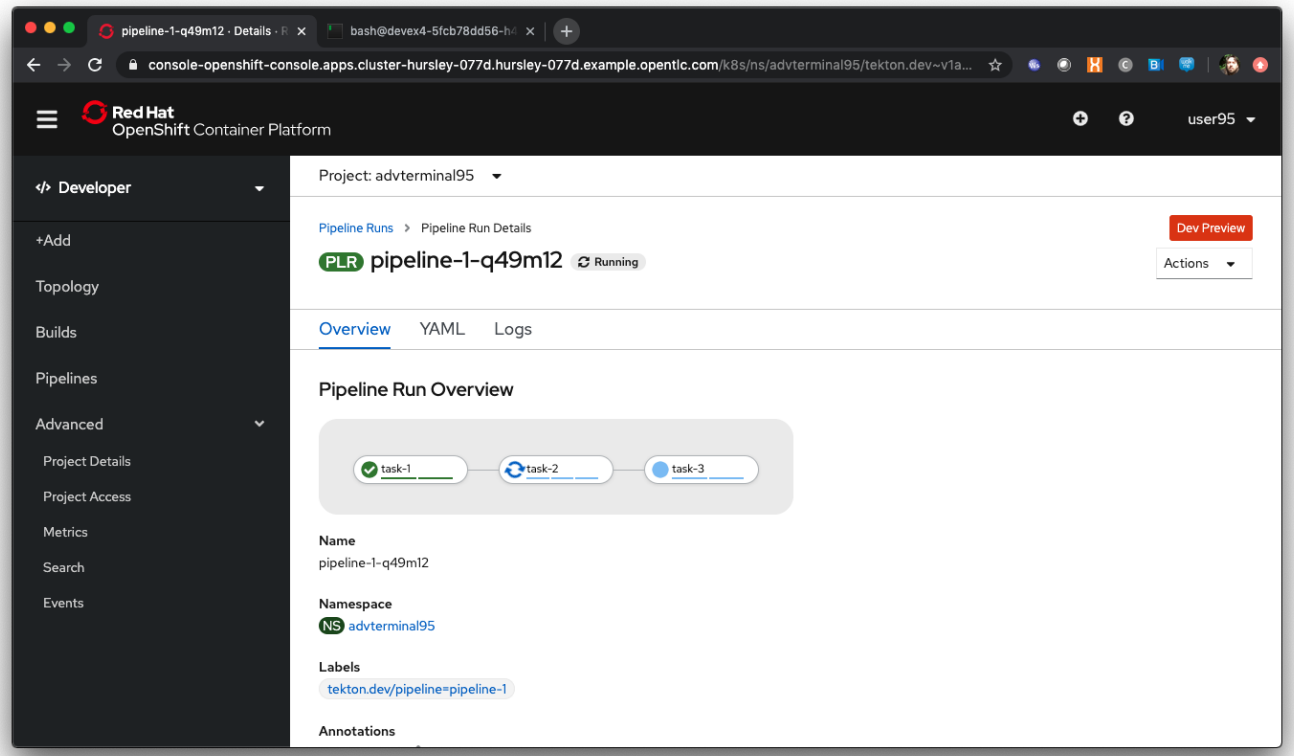
As soon as you enter the last command switch back to the console and watch the pipeline complete, note the synchronous order of the steps.

Viewing pipelines through the Web UI

In the OpenShift console you will see the pipeline recently created and it will show a green bar to the right indicating the previous successful execution of the pipeline, as shown below. Note that the green bar will display dark blue sections for running tasks, light blue sections for pending tasks, green for completed and red for failed.



From the three dot menu on the right hand side it is possible to start a run of the pipeline. Do this now and watch as the screen changes to show the details of the pipeline run as shown below:



Each block can be clicked on to show the details of the steps within the task. Experiment with the different screens to look at the details of the running or completed tasks.

Task inputs

There will be scenarios where it is necessary to provide specific parameters to a pipeline process and the underlying tasks that the pipeline call.

There are two mechanisms for getting specific values into tasks :

- parameters - used to provide specific values to tasks at runtime. If a parameter is declared it must either have a default value defined within the task or it must have a value supplied from a calling taskrun or pipeline run.
- pipeline resources - a reference to a defined resource object that can be accessed by a Tekton pipeline. If a resource is referenced by a task then the resource must exist unless it has been defined as an optional resource in the task definition.

Pipeline Resource Types

The following pipeline resource types exist :

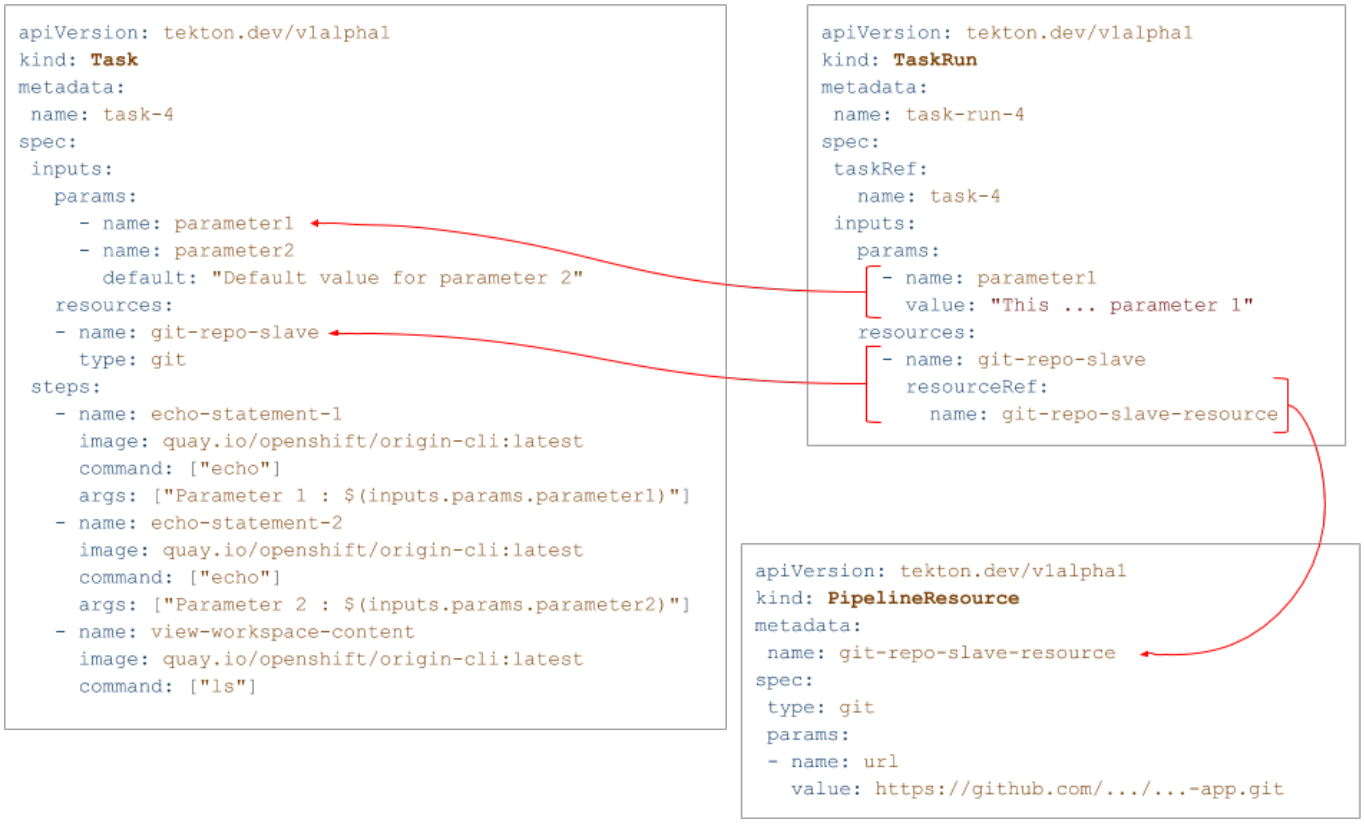
- Git Resource - The git resource identifies a git repository, that contains the source code to be built by the pipeline. The resource can point to a specific branch or commit and can extract content from a specific directory.
- Pull Request - Can be used as an input resource to identify specific meta data about a pull request. if used as an output a pull request can be updated with changes made during the pipeline process.
- Image - An image to be created as part of the pipeline process.
- Cluster Resource - A different cluster to the cluster on which the pipeline is running. This can be used to deploy content to an alternative cluster as part of a deployment pipeline process.
- Storage Resource - Blob storage that contains either an object or directory.
- Cloud Event Resource - A cloud event that is sent to a target URI upon completion of a TaskRun.

Further details on the options for all of the above resources is included here : https://github.com/tektoncd/pipeline/blob/master/docs/resources.md, window="_blank"

Task input example

The task defined in task-4.yaml uses both parameters and pipeline resources to get information into the task. This allows a generic task to be written with specific values supplied to it from the taskrun. The Taskrun object acts as a *value provider* giving specific values for parameters and referencing

specific pipeline resources. The following diagram shows the relationship between the three specific objects.



As shown above the task has place-holders for two parameters. The first parameter has a value defined within the taskrun. The second parameter has a default value so it is not essential to provide a value for it in the taskrun. Both parameters are referenced from the steps of the task using the notation $(inputs.params.<parameter-name>).

The task also defines a resource object called git-repo-slave of type git. Within the taskrun an input resource object is defined with the same name (git-repo-slave) referring to a pipeline resource object called git-repo-slave-resource. A pipeline resource object is created from the yaml file git-resources.yaml which makes a reference to the actual git repository.

To create the resource object go back to the terminal app and execute the following command :

```
oc create -f git-resources.yaml
```

To view the resources in the project use the command:

```
tkn resources list
```

The response will be :

```
NAME                      TYPE   DETAILS
git-repo-slave-resource   git    url: https://github.com/marrober/slave-node-app.git
```

The use of pipeline resource objects for git repositories and created images (as output resources) helps teams to create generic build, test and deploy pipelines that can be reused across multiple projects where the projects simply define the custom pipeline resource objects that are specific to their project or environment.

Workspaces and Volumes

Workspaces allow you to organize the content used by tasks and the assets that are produced by tasks. This can be useful to add structure to the content during large complex pipelines.

Workspaces are storage structures within the pod that runs the containers of the pipeline and workspaces are scoped at the task level. Separate steps within a task can see the same workspace.

Volumes are similar to workspaces except for the fact that they are backed by persistent volumes. This ensures that content written to the volume is accessible by steps from multiple tasks, allowing for a greater separation of steps into different tasks. For example a generic build task could be used to create an executable, writing the deliverable to a volume. A separate testing task could then be invoked by a pipeline to perform tests against the newly created deliverable. Accessing the file via a volume will work for the two separate tasks.

Task 5 has steps for creating files in the workspace and in a volume, followed by steps to display the files in the workspace and the volume which work fine. Task 6 only has tasks for attempting to display the content of the workspace and the volume. Since the workspace in task 6 is a different workspace to that used in task 5 there is no content to display. The volume however shows the file written in the step in task 5. Tasks 5 and 6 are orchestrated by the pipeline called pipeline-5.

Create the persistent volume claim to use in this exercise with the command:

```
oc create -f persistentvolumeclaim.yaml
```

Create tasks 5 and 6:

```
oc create -f task-5.yaml
oc create -f task-6.yaml
```

Create the pipeline task:

```
oc create -f pipeline-5.yaml
```

The persistent volume will show that it is in a pending state after creation as no resource has attempted to consume it. After the task has been executed look again at the persistent volume and it will show that it is bound.

To see the state of the pvc enter the following:

```
oc get pvc
```

Before executing the task the state of the pvc should be as follows

```
NAME                    STATUS        VOLUME                                     CAPACITY
ACCESS MODES   STORAGECLASS   AGE
tekton-task-cache-pvc   Pending
gp2            4s
```

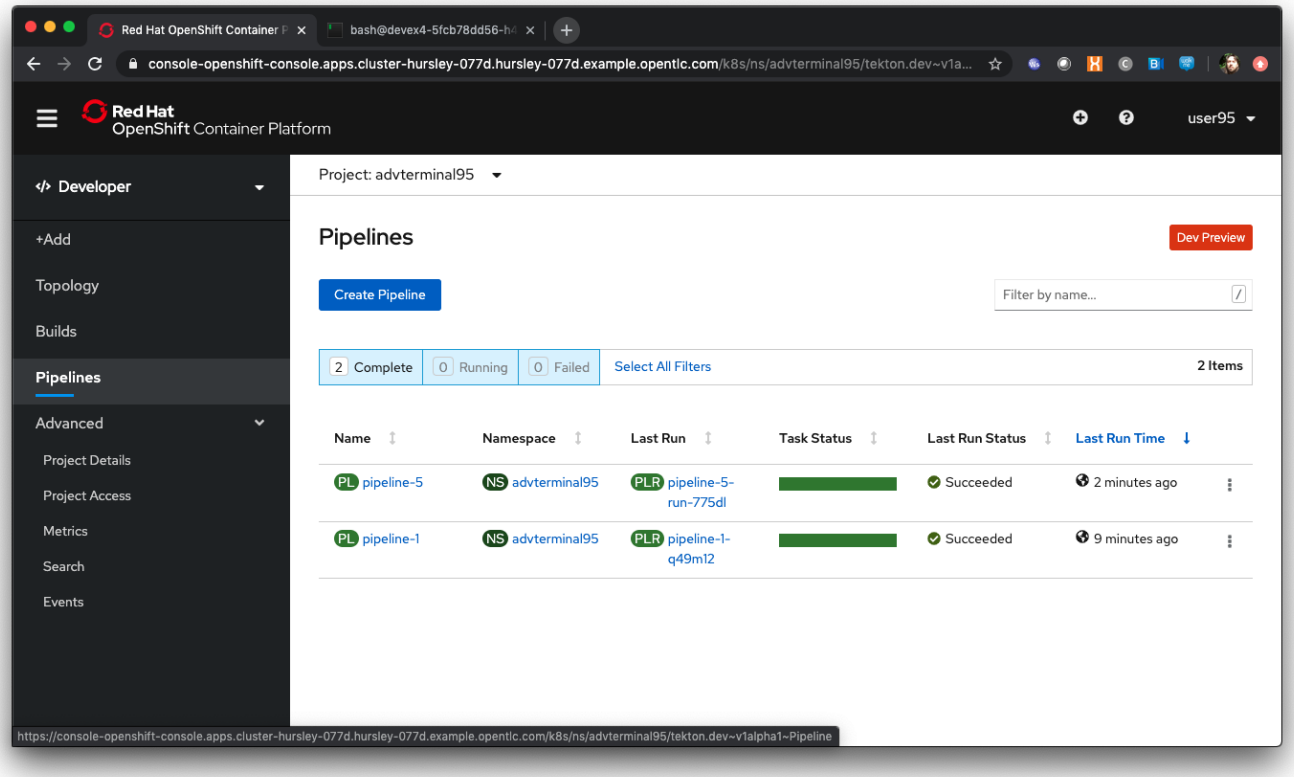
Once the pipeline has completed (you will run it after this) the pvc will indicate itself as bound - try it after the pipeline has completed

```
NAME                    STATUS        VOLUME                                     CAPACITY
ACCESS MODES   STORAGECLASS   AGE
tekton-task-cache-pvc   Bound         pvc-1d894a93-2646-11ea-9f45-0a9970779e5c   1Gi
RWO            gp2            2m2s
```

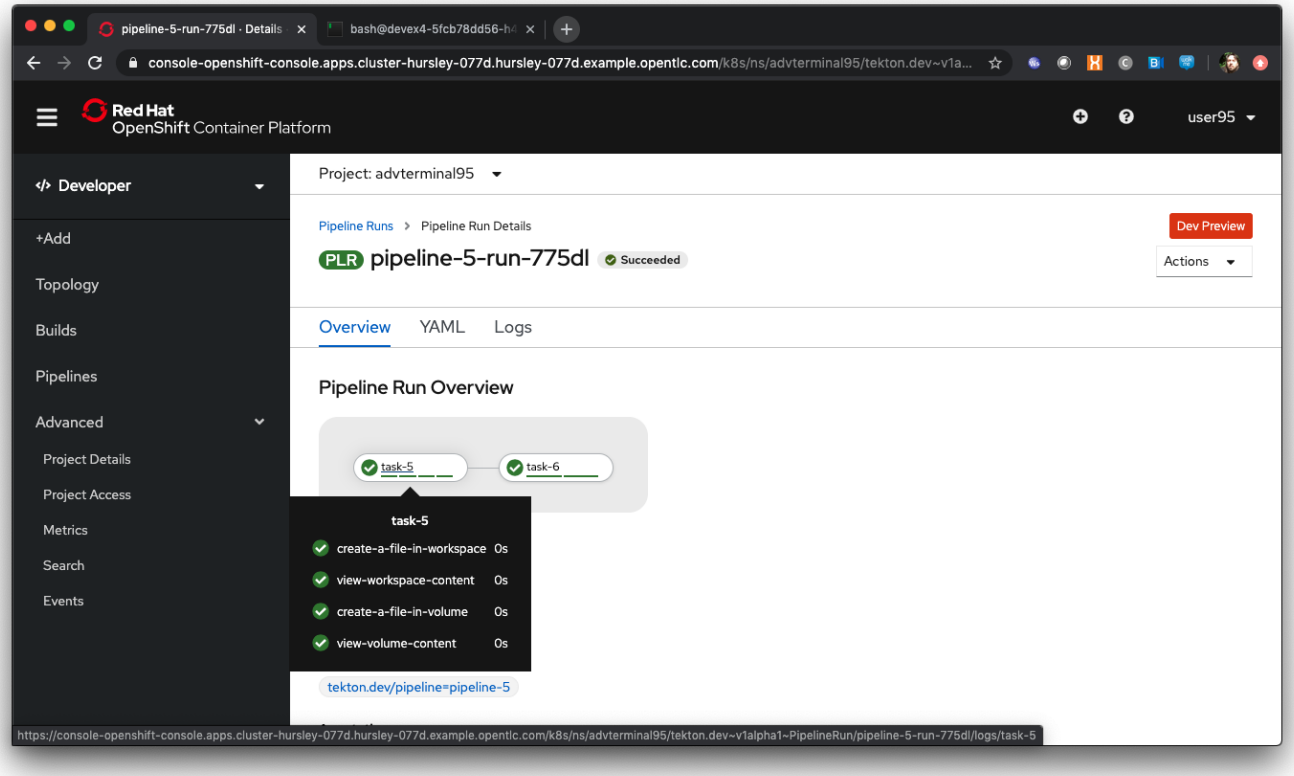
Execute the pipeline using the following command in the terminal

```
tkn pipeline start pipeline-5
```

Now switch to the OpenShift console. Select the Pipelines entry on the left side of the Developer panel.



You can click on the pipeline-run (labelled pipeline-5-run-XXXXX) and examine the logs for each of the tasks.



To examine the pipeline run in the terminal window use the command :

```
tkn pipelinerun logs pipeline-5-run-XXXXX
```

Replace the XXXX with the information reported on screen after the execution of the tkn pipeline start command.

The output will be similar to that that is shown below. Within task 5 the first step creates a file called /workspace/message. The second step displays the file name and the content of the file within the workspace. The third step creates a file in the persistent volume and the fourth step displays the file name and the content of the file within the volume.

Within task 6 the first step displays the contents of the workspace. Note that this is empty because the workspace is unique to the task. The second step of task 6 shows the content of the persistent volume which is the same a that which was reported for step 5. This shows that workspaces can be used for sharing data between steps in the same task and volumes should be used for sharing data between steps within different tasks.

[task-5 : create-a-file-in-workspace] /workspace/message

[task-5 : view-workspace-content] message [task-5 : view-workspace-content] This is a file in the workspace

[task-5 : create-a-file-in-volume] /var/run/message

[task-5 : view-volume-content] lost+found [task-5 : view-volume-content] message [task-5 : view-volume-content] secrets [task-5 : view-volume-content] This is a file in the volume

[task-6 : view-workspace-content] view workspace content [task-6 : view-workspace-content] total 0 [task-6 : view-workspace-content] drwxrwsrwx. 2 root 1000800000 6 May 1 14:17 . [task-6 : view-workspace-content] drwxr-xr-x. 1 root root 37 May 1 14:17 ..

[task-6 : view-volume-content] lost+found [task-6 : view-volume-content] message [task-6 : view-volume-content] secrets [task-6 : view-volume-content] This is a file in the volume

OpenShift Service Mesh [INNOVATION]

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Introduction

OpenShift is a platform that enables developers to deliver and manage extremely complex polyglot applications covering a variety of language runtimes and underlying technologies. However, OpenShift to date has not provided controls and monitoring regarding how each application component interacts with other components within an application or wider enterprise. This is where the Red Hat OpenShift Service Mesh adds value to the development and operations staff responsible for applications.

Red Hat OpenShift Service mesh is comprised of a number of separate open source projects that have been tested and integrated as a whole to deliver value to the OpenShift user. Each open source project breaks down further to specific named elements, some of which are encountered and described in the following workshop chapter.

Istio

Istio is an implementation of the service-mesh and this component is responsible for the overall management of communication traffic between the elements of the application. The service mesh provides the manageable and measurable interaction between different services and enables teams to introduce new functionality and services in a controlled manner. One of the major benefits of the service-mesh is the fact that functionality such as Load balancing, resilience, security and observation is delivered by the mesh and not by the application. Application developers can focus in the value of their application and not how to add the resilience etc. to the application. In the earlier chapter on *Application deployment strategies* users created a mechanism for blue/green deployments and A/B deployments to spread the load across different versions of services. These capabilities are extended further with Istio in terms of the basis for the rules that are used for traffic management. For a more detailed introduction to Istio please take a look at the free O'Reilly book *Introducing Istio Service Mesh for Microservices* which can be downloaded from here, window="_blank".

Kiali

Kiali provides the observability capability to the Red Hat Service Mesh. This enables users to build a picture of service interaction, observe traffic and look in detail at the resources that are added to the OpenShit platform to create the operational service mesh. Kiali is used to understand the structure of the mesh and to gather metrics. A link is available to from Kiali to Jaeger for distributed tracing.

Jaeger

Jaeger provides a detailed distributed traffic tracing capability. This shows accurately message interaction and enables teams to understand in detail the sequencing of traffic flow and to identify bottlenecks and weaknesses within the mesh.

Using Red Hat Service Mesh

The following workshop steps will show you how to create a service mesh using a simple application. The application communication will work perfectly fine with the use of OpenShift services and routes, and the introduction of the service mesh to provide more capable communication management will have no implications on the application code.

The application is called layers and it is a very simple Node JS REST interface that receives request either from an external curl command or from another version of itself. The application uses a number of environment variables that are set within the deployment yaml files. If the application instance has an environment variable called NEXT_LAYER_NAME then it will send a message to that layer. This continues down the layers of communication until an application instance is reached that does not have the environment variable. With each response the application returns its name, version identifier and IP address.

Create a new project for the service mesh activity

```
oc new-project service-mesh-X
```

(Where X is your user number)

Not all projects are required to be managed by service mesh. As a result you need to add the project that you just created to the service mesh control plane so that the sidecar containers will be injected into the pods. We will be using some preloaded assets in the Terminal window, so enter the following command to set the context:

```
cd /workspace/workshop4/attendee/service-mesh
```

To add the current project as a service mesh member within the control plane called *istio-system* execute the command :

```
oc create -f servicemeshmember.yaml
```

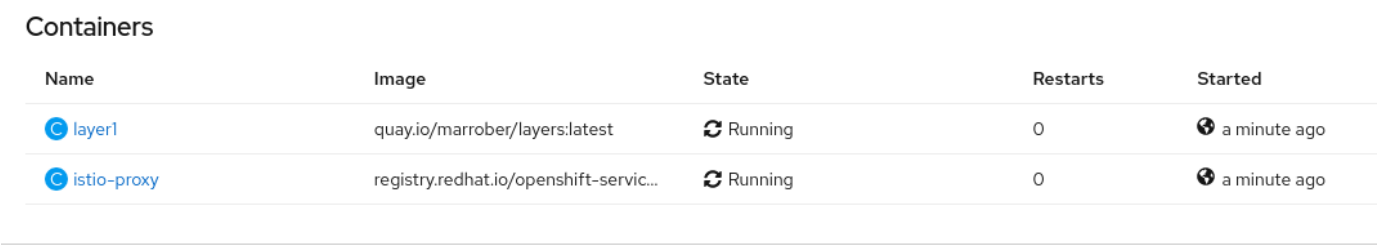
Phase 1 -Initial application

The micro-service based application that you are about to create is very simple and uses a rest interface that can be asked to call another downstream version of itself. This can continue for as many application instances as needed to illustrate the features of the service mesh.

To create the first application instance do the following :

```
cd phase1
oc create -f layer1.yaml --save-config
```

Switch to the web user interface and select the developer view for your current project. Select the topology view and you will see the application start to be created. Click on the centre of the blue circle for the application and you should see the fly out menu on the right with details of the service and the running pod. Select the pod and scroll down the details of the pod until you see a section titled *Containers*. This should show two containers as indicated below which are the *layers* application container and the Istio sidecar container.



Expose the service using a route by executing the following command :

```
oc expose service/layer1
```

At this point the application has all of the components required for network communication without the use of Istio. The resources required that exist can be viewed with the command :

```
oc get all
```

This will list the following resources :

- deployment
- pod
- replicaset
- service
- route

The route, service and pod are shown in the diagram below to indicate the network communication to the application.

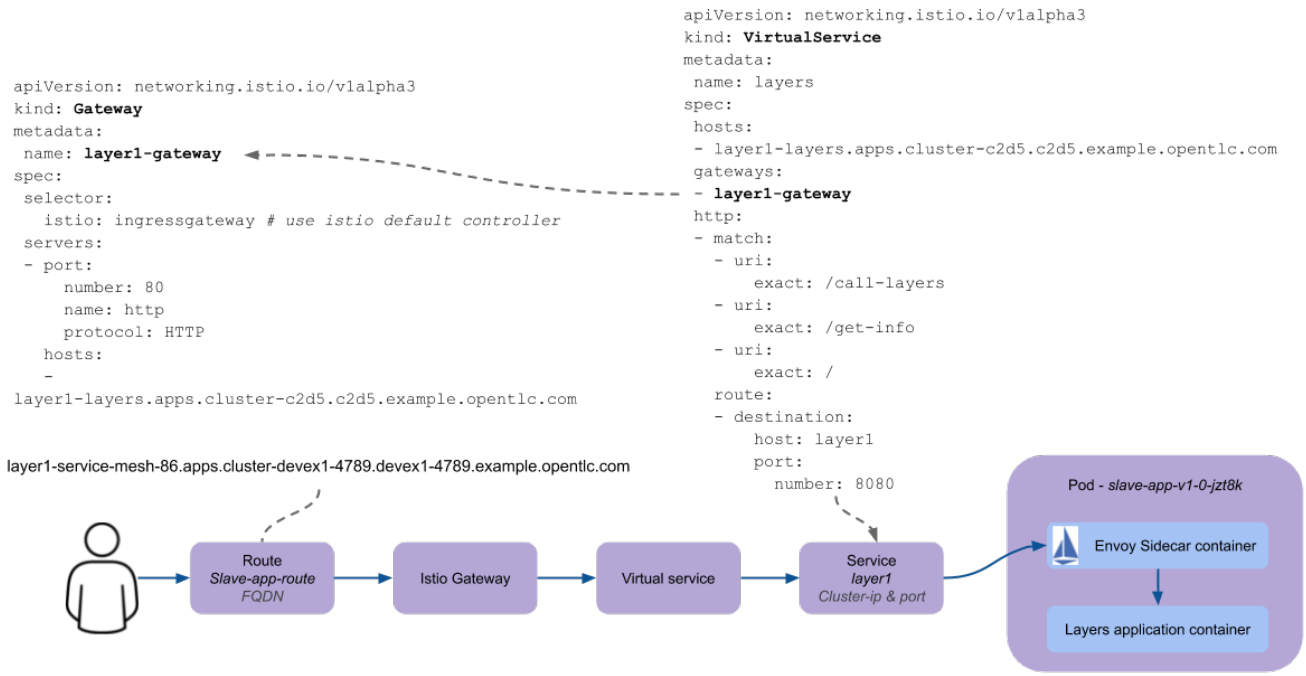
Communication to the application will work as expected using the above resources. This can be tested by pasting the following command into the terminal window to make 100 calls to the application,

approximately ever 0.2 seconds.

```
export ROUTE=$(oc get route -o jsonpath='{.items[0].spec.host}{"/call-layers"}')
for i in {1..100}; do curl $ROUTE; echo ""; sleep .2;done
```

Adding Istio capability

To enable the service mesh communication requires further resources to be created. The initial resources to be created are the gateway and the virtual service. The gateway resource identifies a host for which communication should be intercepted and directed to the istio-ingress gateway. The virtual service acts as a communication director selecting traffic that matches specific criteria for routing to a destination service. The gateway and virtual service yaml content is shown in the diagram below which also shows schematically how the communication is directed.



Create the gateway and the virtual service with the commands below:

```
oc create -f gateway-layer1.yaml
oc create -f virtual-service-layer1.yaml
```

View the istio related resources

The oc command *oc get all* is often used to generate a list of all resources within a project. This is fine for listing the deployment configurations, services, replicasets and pods but it does not list the resources used to manage the service mesh. To view the istio related resources use the command

below :

```
oc get istio-io
```

The above command will list the gateway and the virtual service. The virtual service also shows the gateway to which it relates and the hosts for which it is controlling traffic as shown in the example below.

```
NAME                                          GATEWAYS           HOSTS
AGE
virtualservice.networking.istio.io/layers   [layer1-gateway]   [layer1-
layers.apps.cluster-c2d5.c2d5.example.opentlc.com]   54s

NAME                                           AGE
gateway.networking.istio.io/layer1-gateway   63s
```

Service mesh visualisation with Kiali

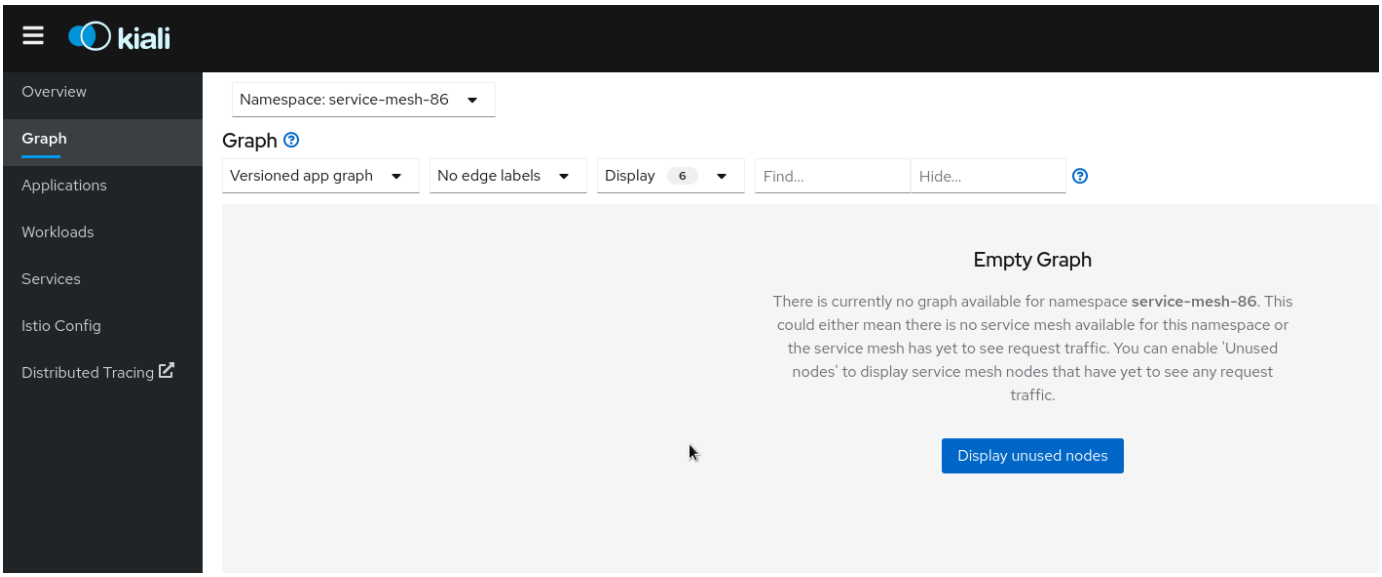
Red Hat Service mesh includes a component called Kiali which provides a visualization of the components of the mesh to assist in monitoring and managing the communication processes within a micro-service based application. To find the URL for the Kiali web application enter the command :

```
echo "kiali-istio-system."$(oc whoami --show-console=true | cut -d'.' -f2-7)
```

This command will create the URL for the Kiali system in use within the cluster. Open this URL in a new browser tab.

Press the blue *Log In With OpenShift* button to authenticate with your OpenShift credentials and then select the blue *1 application* link in the box labelled with your service-mesh-XX project.

On the left hand side of the Kiali screen select 'Graph and you should see a screen similar to that shown below :



If your screen shows application nodes and services then Kiali is responding to the traffic that was sent in the 100 calls to the application a few minutes ago. Kiali will display a discovered configuration of applications and services if there has been traffic for it to observe.

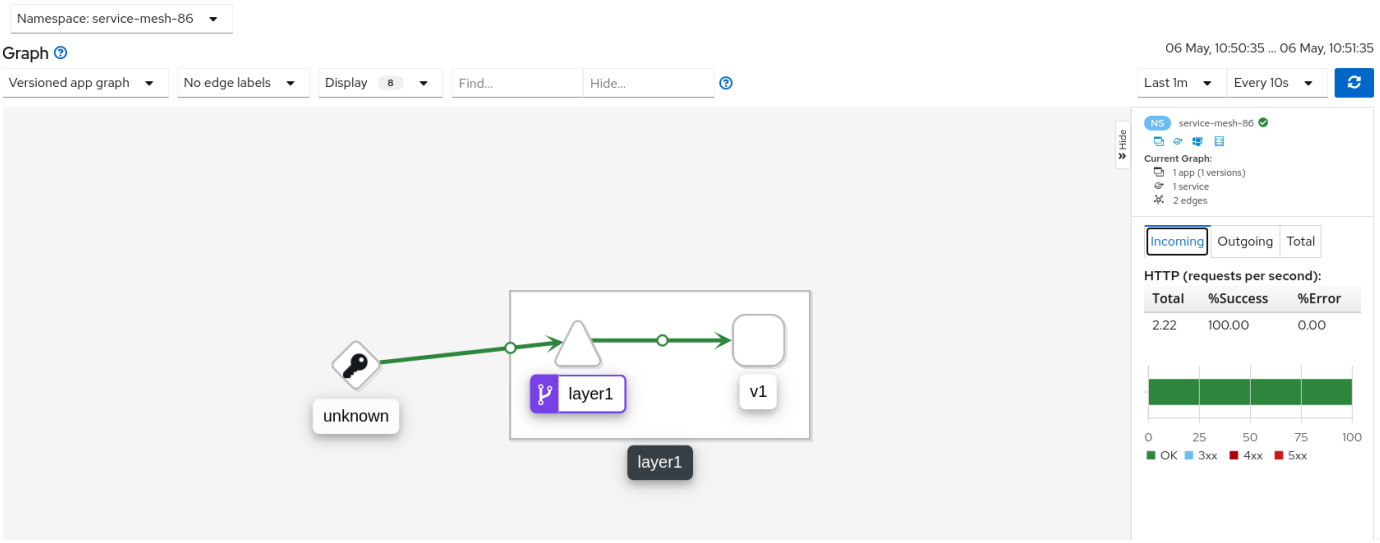
If the Kiali view has timed out and removed the discovered services oyu will see a screen identical to that which is shown above. In that case press the blue button with the text *Display unused nodes* and you will see the nodes and services of the application.

You will now see the layer-1 application which is broken out as the service (dotted triangle) and the application (dotted square). Press the legend button to see the key to the objects in the browser window. You will also see that the service has an Istio virtual service associated with it.

Press the display drop down menu at the top of the screen and select the traffic animation option. Back at the terminal window start sending traffic to the service again using the for loop shell script used previously (and repeated below) :

```
for i in {1..100}; do curl $ROUTE; echo ""; sleep .2;done
```

Switch back to the Kiali window and watch the animation of the traffic flow in the graph. It will take a few seconds for the animation to start, but eventually you will see a screen similar to that which is shown below.



Kiali has a number of sources of information which are selected from the left hand side menu. The animation display is shown on the graph view. If the for loop to send requests to the application has ended then restart it and you may want to change the number of calls to 1000 and change the sleep delay to 0.5 or 1.0 seconds to give more traffic while you explore the user interface.

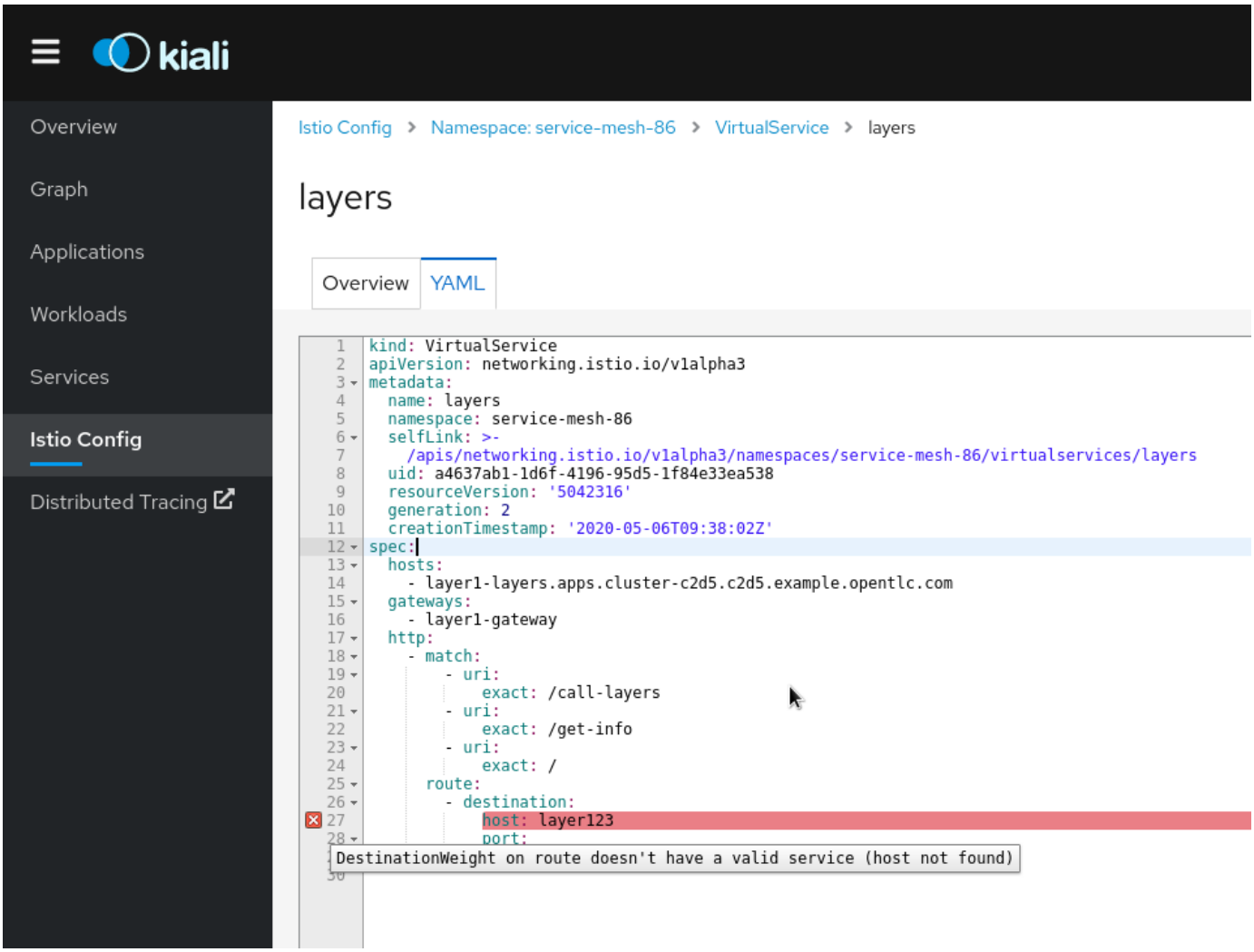
On the Kiali graph view click on the service (triangle) for layer1 and you will see information about the service on the right hand side panel. The panel shows information about the messages entering and leaving the service. Click on the application for layer1, identified as v1 (square) and the right hand side panel changes to display information about the application which only has inbound traffic.

The top menu of the Graph screen has a number of different viewing modes. The first drop down menu allows users to display information on different versions of applications, to only show services or to display the workloads. The versioned application graph is particularly useful as it groups multiple versions of applications together along with their associated services.

The second drop down menu allows for the display of requests per second, request percentage and response time on each communication line. The request percentage is particularly useful when splitting traffic between versions later.

The third drop down menu allows users to select which objects to display on the main screen.

On the left hand side of the Kiali screen there are options to display information about applications, workloads and services. These displays show useful information on the health of the resource. The Istio Config menu shows information about the istio resources (virtual services, gateways and many other Istio related resources). This is a useful source of information if something is wrong in the configuration of a resource as it will be highlighted clearly as shown below.



Phase 2 - Further content in the communication chain

The next phase of building the service mesh is to introduce another application and service.

Change directory to phase 2 and create the new application for layer 2 with the following commands:

```
cd ../phase2
oc create -f layer2.yaml --save-config
```

In the topology view of the web user interface you will see that two deployments are created for the two different versions of layer2, with two pods for each application.

Create the additional virtual service for the component with the commands:

```
oc create -f virtual-service-layer2.yaml
```

Reconfigure layer1 to send messages to layer2 using the command:

```
oc apply -f layer1.yaml
```

Switch to the OpenShift browser window and ensure that you are using the developer mode on the top left corner, you have the service-mesh-XX project selected and you are viewing the Topology view. You should see the *layers* application grouping with layer1-v1 and layer2 (with versions v1 and v2) grouped together within the application group. Click on layer1-v1 and you will see on the fly-out window on the right hand side that it has one pod. This pod contains the running application container and the istio sidecar container too. If you select one of the layer 2 applications you will see that it has 2 replica pods as directed by the layer2.yaml deployment file.

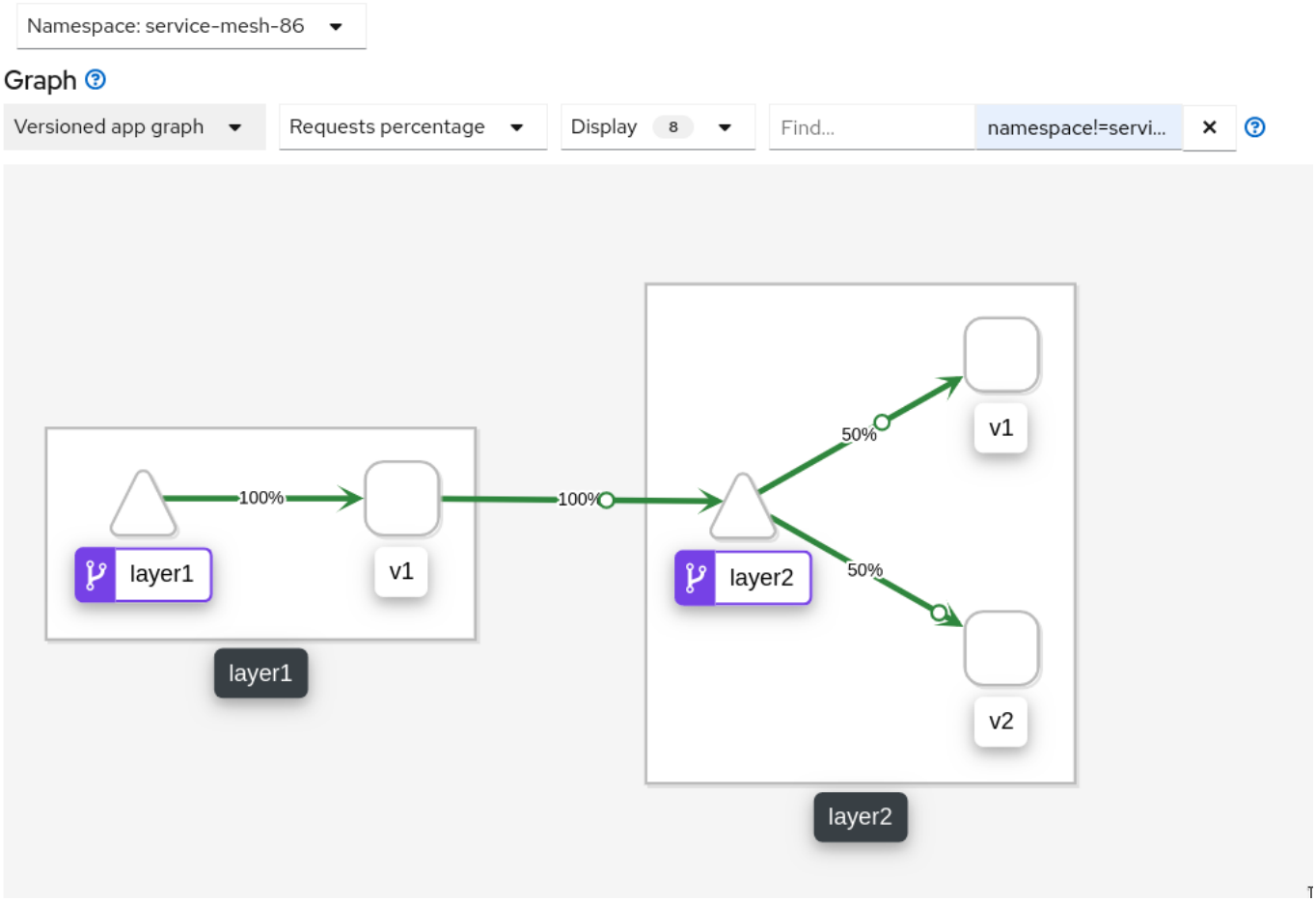
In the OpenShift terminal window restart the for loop to start sending http requests to layer1. You should now see that layer1 is sending requests on to layer 2 and you should see the IP address of the nodes on which those two layers are running as shown below. This also shows the distribution of traffic to the different versions of layer2.

```
"layer1 (v1) [10.128.3.13] ----> layer2 (v1) [10.130.3.146]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v2) [10.130.3.147]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v1) [10.131.1.184]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v2) [10.128.3.12]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v1) [10.130.3.146]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v2) [10.130.3.147]"
"layer1 (v1) [10.128.3.13] ----> layer2 (v1) [10.131.1.184]"
```

In most micro-service based applications messages will not conveniently display application versions or IP addresses as in this example application. Consequently Kiali visualization is very important to show what actually happens in the *real world*.

Switch to the Kiali browser view and select the graph view. Wait until the traffic starts to appear. You may see some extraneous traffic going to nodes that are not in the current project namespaces. These are genuine messages being send to the Istio system to provide the monitoring capability. To hide the unwanted nodes use a filter in the *Hide* text field at the top of the graph and use a filter of "namespace!=service-mesh-XX". Replace XX with your user number and do not include quote characters.

The Kiali graph view (shown below) is currently displaying the communication into layer 1 and then from layer 1 to layer 2. Layer 2 has a virtual service which is governing the conditions under which layer 2 will get any network traffic such as protocol filtering, path filtering etc. In the absence of a destination rule to govern the flow of traffic a (roughly) 50% - 50% split of traffic is seen between version 1 and version 2 of layer 2. Select "Request percentage" in the second dropdown menu to see the distribution to version 1 and version 2 of layer2. Restart the for loop to send traffic in the terminal window if necessary.



Phase 3 - Further multi-versioned applications in the communication chain

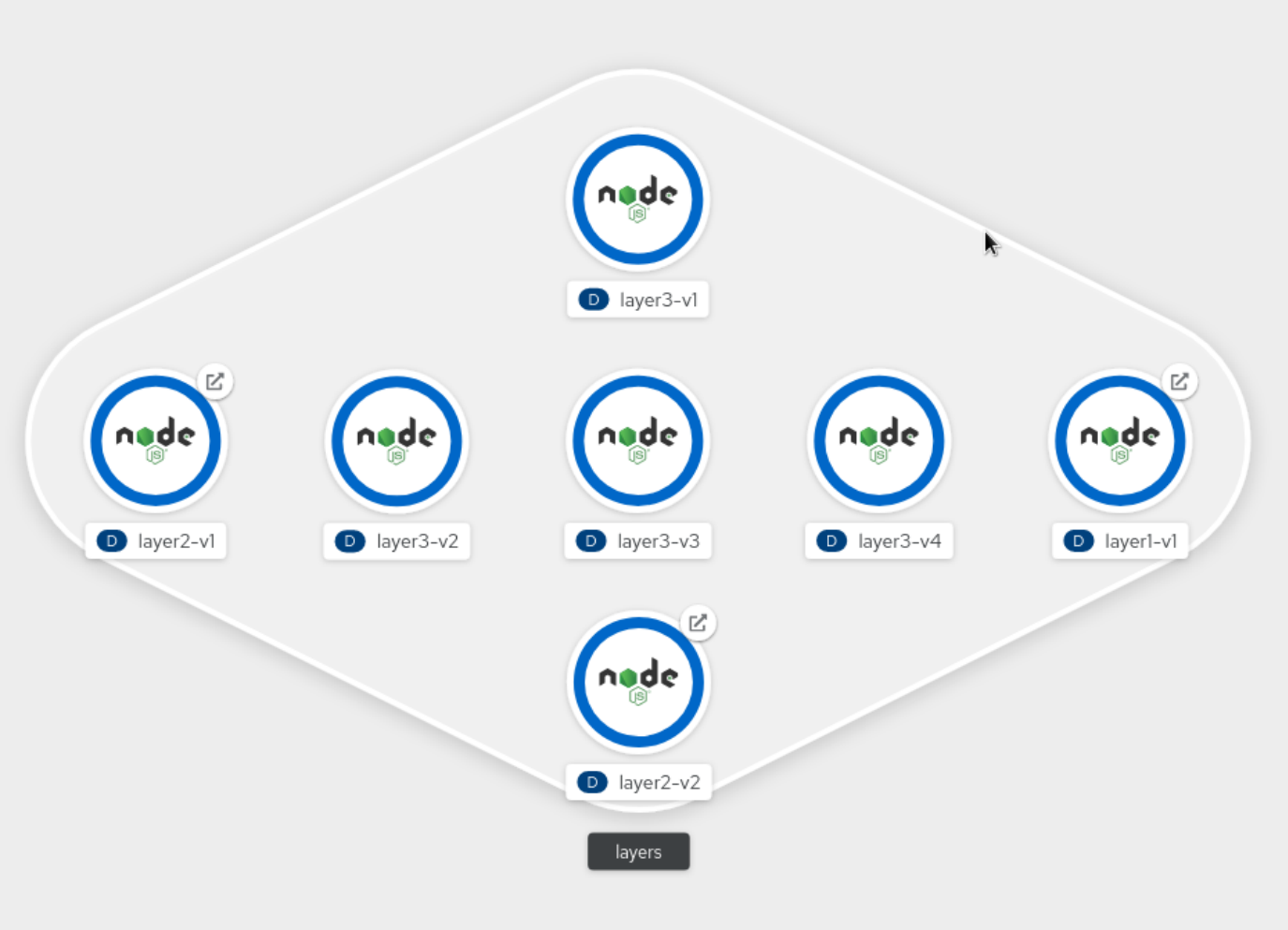
The next phase of building the service mesh is to introduce another multi-versioned application and service.

Change directory to phase 3 and create the new application for layer 3 with the following commands:

```
cd ../phase3
oc create -f layer3.yaml
```

You will see that four deployments are created for the four different versions of layer3.

Switch to the OpenShift browser window and ensure that you are using the developer mode on the top left corner, you have the service-mesh-XX project selected and you are viewing the Topology view. You should see the *layers* application grouping now has six micro-services within it. This is shown below:



Under more common circumstances of a development project then names will often be cryptic and it will be hard to gain any understanding of the communication logic, sequence or hierarchy of an overall application. This is when the Kiali visualization view becomes extremely useful.

To tie the service mesh together for the different versions of layer3 a virtual service and a destination rule will be used.

Virtual Services and Destination Rules

Virtual services and destination rules work hand-in-hand to define the routing of traffic. The virtual service is evaluated first and decides how to route traffic to a specific destination and then the destination rule is used to direct the traffic for the identified destination. The virtual service used in this phase is shown below:

```
apiVersion: networking.istio.io/v1alpha3
kind: VirtualService
metadata:
  name: layer3
spec:
  hosts:
  - layer3
  http:
  - match:
    - uri:
        exact: /call-layers
    - uri:
        exact: /get-info
    - uri:
        exact: /
  - route:
    - destination:
        host: layer3
        subset: v1
      weight: 50
    - destination:
        host: layer3
        subset: v2
      weight: 30
    - destination:
        host: layer3
        subset: v3
      weight: 20
```

The above will direct http traffic with the uri path of /call-layers, /get-info or / sent to application layer3 (spec: → hosts: → layer3) to the destinations subset v1 (50% of traffic), subset v2 (30% of traffic) and subset v3 (20% of traffic). At the present time no traffic is directed to subset v4.

The destination rule associated with the above virtual service is shown below which ties the subsets shown in the virtual service to the specific versions of the applications :

```
apiVersion: networking.istio.io/v1alpha3
kind: DestinationRule
metadata:
  name: layer3
spec:
  host: layer3
  subsets:
  - name: v1
    labels:
      version: v1
  - name: v2
    labels:
      version: v2
  - name: v3
    labels:
      version: v3
```

The destination rule defines to where the different subsets will direct traffic. Subset v1 directs traffic to the pod with the label v1 and subset v2 directs traffic to the pod with the label v2 etc.

The command below will display all pods and the labels defined on them:

```
oc get pods -o jsonpath='{range.items[*]}{.metadata.name}{"
"}{.metadata.labels.version}{"\n"}'
```

The result of the above command will be similar to that shown below:

```
layer1-v1-5cdbdc64bc-hbm77  v1
layer2-v1-747594d6d9-rd586  v1
layer2-v1-747594d6d9-wlrhr  v1
layer2-v2-7f8b4674cc-vbvt9  v2
layer2-v2-7f8b4674cc-zs9lk  v2
layer3-v1-85db7f87c6-rdz8c  v1
layer3-v2-5649897bbf-6f99m  v2
layer3-v3-769cfb5446-jcs4v  v3
layer3-v4-858765c8c9-m5lzf  v4
```

The above shows that there is 1 version for layer1, 2 versions for layer 2 that are replicated pods (two instances) and 4 versions for layer 3.

Destination rules require a virtual services and there cannot be more destinations than virtual services. For this reason when a destination rule is used the virtual service is either created at the same time or the virtual service already exists.

```
oc create -f destination-rule-virtual-service-layer3.yaml
```

In the previous test it was seen that there was a 50% - 50% distribution of traffic going into layer 2. The command below will introduce a destination rule and add a distribution clause to the virtual service for layer 2 to distribute the traffic 80% to 20% in favour of version 1.

```
oc apply -f destination-rule-virtual-service-layer2.yaml
```

Reconfigure layer2 to send messages to layer3 using the command:

```
oc apply -f layer2.yaml
```

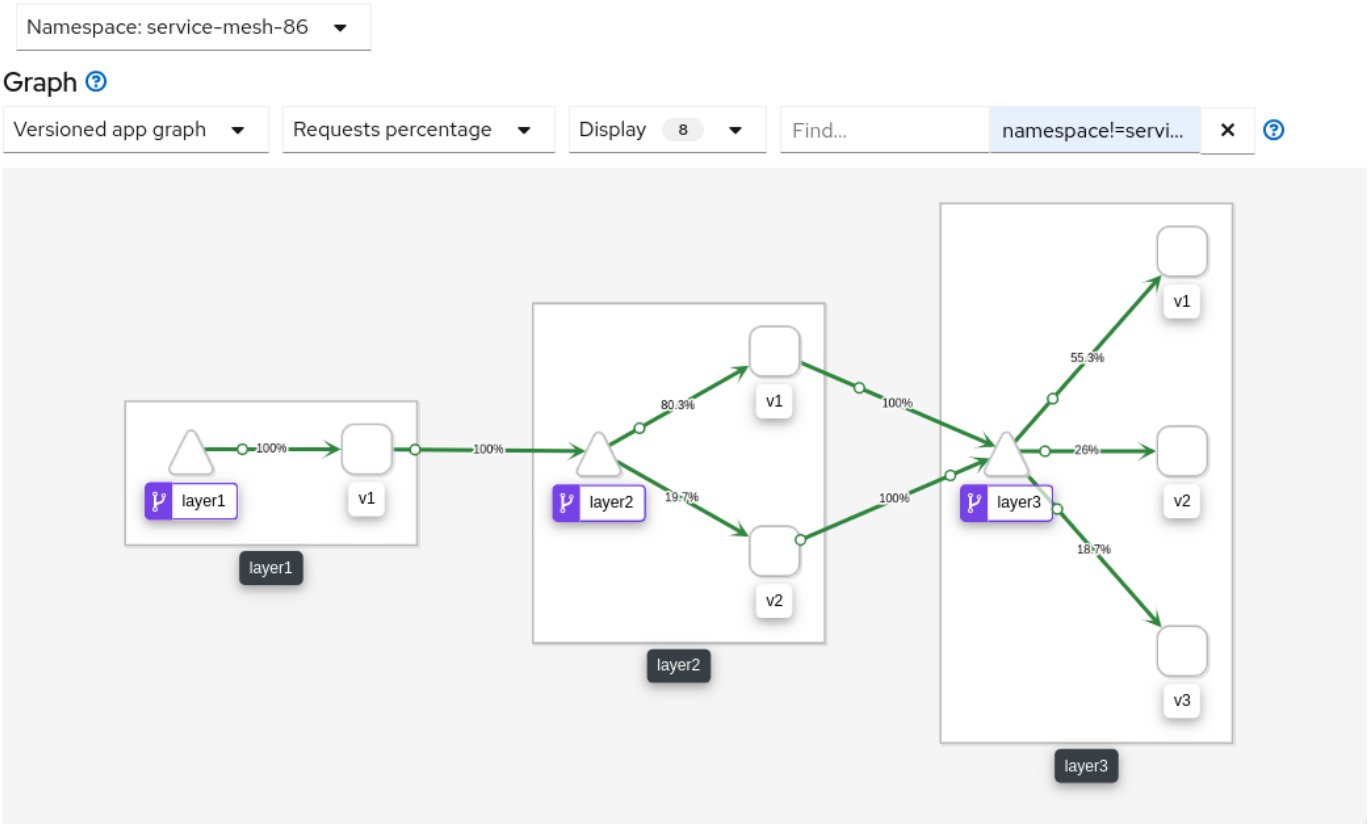
In the OpenShift terminal window recall the for loop that sends messages to the applications and change the total number of messages to 200 and the sleep value from .2 to .5. This will give more time to explore the traffic in Kiali. Execute the command when the changes have been made. You should now see that layer1 is sending requests on to layer 2 which is sending requests on to layer 3 and you should see the IP address of the nodes on which those two layers are running as shown below. You will also see a distribution of workload across layer 3 v1, v2 and v3 in the percentages defined in the virtual service.

```
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
```

```
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v2 (v2)
[10.128.2.145]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v1 (v1)
[10.128.2.143]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
"layer1 (v1) [10.130.2.240] ----> layer2 (v1) [10.128.2.151] ----> layer3-v3 (v3)
[10.128.2.144]"
```

Of the above 25 calls, 10 are for v1 (40%), 8 are for v2 (32%) and 7 are for v3 (28%). The distribution percentages become more accurate the more messages are sent. When more calls are made the distribution gets closer to the desired values.

Switch to the Kiali browser view and wait until the traffic starts to appear. On the second to left drop down option menu at the top of the Kiali screen select the option "Requests percentage". This will show the breakdown of traffic similar to that which is shown below:



Phase 4 - Service timeout

The service mesh has a capability to manage traffic flow in a number of different ways. This includes a circuit breaker function to remove applications from participation in communication and a timeout function to control the abandonment of communication with a service, to name just two. In this phase a timeout will be introduced to control the traffic flow such that version A of the application layer will force a timeout after 1.5 second and version B will force a timeout after 1 seconds.

Change directory to phase 3 and create the new applications for layers 2A and 2B with the following commands:

```
cd ../phase4
oc create -f layer2-A.yaml --save-config
oc create -f layer2-B.yaml --save-config
```

Create the virtual service and destination rule for each of the new applications. The destination rule and virtual service for application 2A is shown below :

```
apiVersion: networking.istio.io/v1alpha3
kind: DestinationRule
metadata:
  name: layer2-a
spec:
  host: layer2-a
  subsets:
  - name: inst-1
    labels:
      instance: instance1
  - name: inst-2
    labels:
      instance: instance2
---
apiVersion: networking.istio.io/v1alpha3
kind: VirtualService
metadata:
  name: layer2-a
spec:
  hosts:
  - layer2-a
  http:
  - match:
    - uri:
        prefix: /call-layers
    - uri:
        exact: /get-info
    - uri:
        exact: /
    route:
    - destination:
        host: layer2-a
        port:
          number: 8080
        subset: inst-1
      weight: 80
    - destination:
        host: layer2-a
        port:
          number: 8080
        subset: inst-2
      weight: 20
    timeout: 1.500s
```

The virtual service shows a traffic distribution of 80 % to inst-1 and 20% to inst-2. The final statement shows the timeout that applies to the entire route of 1.5 seconds.

A similar configuration applies to the virtual service and destination rules for application 2-B with a distribution of 30% to 70% and a timeout of 1 second.

Create the virtual services and destination rules with the commands :

```
oc create -f destination-rule-virtual-service-layer2-A.yaml --save-config
oc create -f destination-rule-virtual-service-layer2-B.yaml --save-config
```

Modify layer 1 application so that it sends traffic to applications 2A and 2B.

```
oc apply -f layer1.yaml
```

In the OpenShift terminal window recall the for loop that sends messages to the applications and execute it again.

You should now see that layer1 is sending requests on to layer 2a (instances 1 and 2) and to layer 2b (instances 1 and 2) Take a look at the graph in Kiali and you will also see a distribution of workload across layer 2 in the percentages defined in the virtual service.

```
layer1 (v1) [10.128.2.62] ----> layer2-a (instance-2) [10.128.2.60]
layer1 (v1) [10.128.2.62] ----> layer2-a (instance-1) [10.128.2.59]
layer1 (v1) [10.128.2.62] ----> layer2-a (instance-1) [10.128.2.59]
layer1 (v1) [10.128.2.62] ----> layer2-b (instance-1) [10.128.2.61]
layer1 (v1) [10.128.2.62] ----> layer2-b (instance-2) [10.131.0.86]
layer1 (v1) [10.128.2.62] ----> layer2-a (instance-2) [10.128.2.60]
layer1 (v1) [10.128.2.62] ----> layer2-a (instance-2) [10.128.2.60]
```

Introducing application delay

To show the impact of the timeout function a different rest endpoint is used. Reconfigure the ROUTE environment variable to use the alternative endpoint with the command :

```
export ROUTE=$(oc get route -o jsonpath='{.items[0].spec.host}{"/call-layers-sleep"}')
```

Call the applications with a delay of 900ms. This should result in no interruption to service. Execute the following shell command to make 100 calls.

```
for i in {1..100}; do curl $ROUTE:900; echo "";done
```

This will result in a display similar to that which is shown below. Instances 1 and 2 of layers 2a and 2b are responding.

```
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-b (instance-1) [10.128.2.61] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-b (instance-2) [10.131.0.86] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-b (instance-1) [10.128.2.61] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-b (instance-2) [10.131.0.86] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(900 ms)
layer1 (v1) [10.128.2.62] sleep (900 ms) ----> layer2-b (instance-2) [10.131.0.86] sleep
(900 ms)
```

Increase the delay to 1100 ms using the command :

```
for i in {1..100}; do curl $ROUTE:1100; echo "";done
```

This will result in a display similar to that which is shown below. Instances 1 and 2 of layers 2a are responding, while the delayed response from instances 1 and 2 of layer 2b are being timed out.

```
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> upstream request timeout
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(1100 ms)
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> upstream request timeout
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> upstream request timeout
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(1100 ms)
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> layer2-a (instance-2) [10.128.2.60] sleep
(1100 ms)
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> layer2-a (instance-2) [10.128.2.60] sleep
(1100 ms)
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> layer2-a (instance-1) [10.128.2.59] sleep
(1100 ms)
```

Increase the delay to 1600 ms using the command :

```
for i in {1..100}; do curl $ROUTE:1600; echo "";done
```

This will result in a display similar to that which is shown below in which all calls are being timed out.

```
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> upstream request timeout
layer1 (v1) [10.128.2.62] sleep (1100 ms) ----> upstream request timeout
```

While the for loop is running make a change to the timeout of one of the virtual services to increase the delay to 2500 ms. This can be done in two different ways.

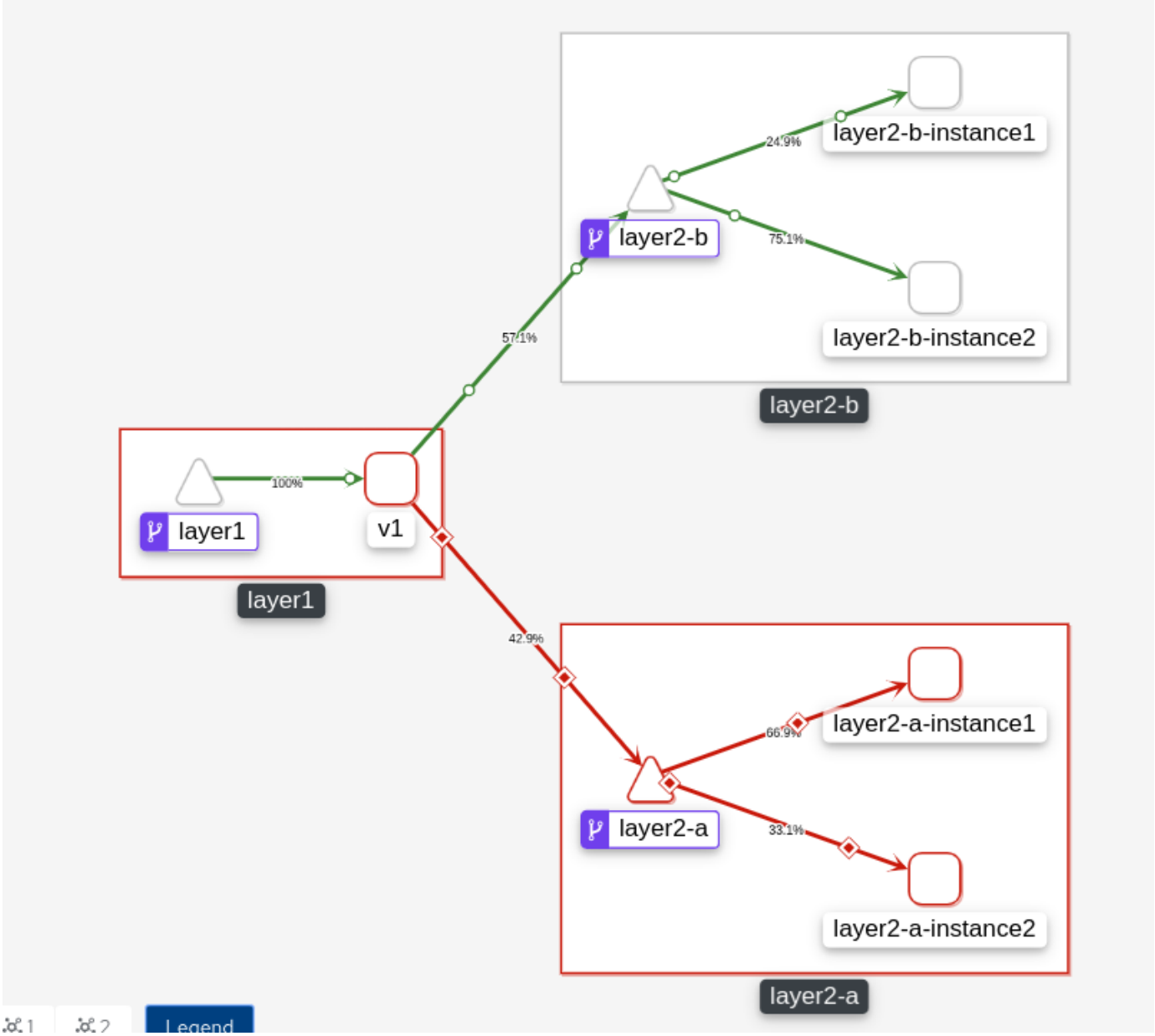
1. Make a change to one the virtual service files using the vi editor and then re-apply the virtual service using the following :

```
vi destination-rule-virtual-service-layer2-A.yaml
oc apply -f destination-rule-virtual-service-layer2-A.yaml

or

vi destination-rule-virtual-service-layer2-B.yaml
oc apply -f destination-rule-virtual-service-layer2-B.yaml
```

Alternatively use the Kiali browser window, switch to the istio-config section on the left hand side and select the virtual service for either layer2-A or layer2-A. Edit the yaml within the window to alter the timeout value and save the changes. One of the good things about using this editor is the immediate validation of the yaml code.

Observe that traffic starts to be allowed through to that application only.

Take a look at the traffic flow in the graph view of Kiali and you should see a display similar to that which is shown below (once Kiali has had the opportunity to catch up).



The above image shows red to indicate the communication that is being rejected by the timeout.

Cleaning up

To tidy up the cluster now that the chapter is complete please use the command

```
oc delete project service-mesh-XX
```

_where XX is your user ID number.

OpenShift and the Quay Image Repository [INNOVATION]

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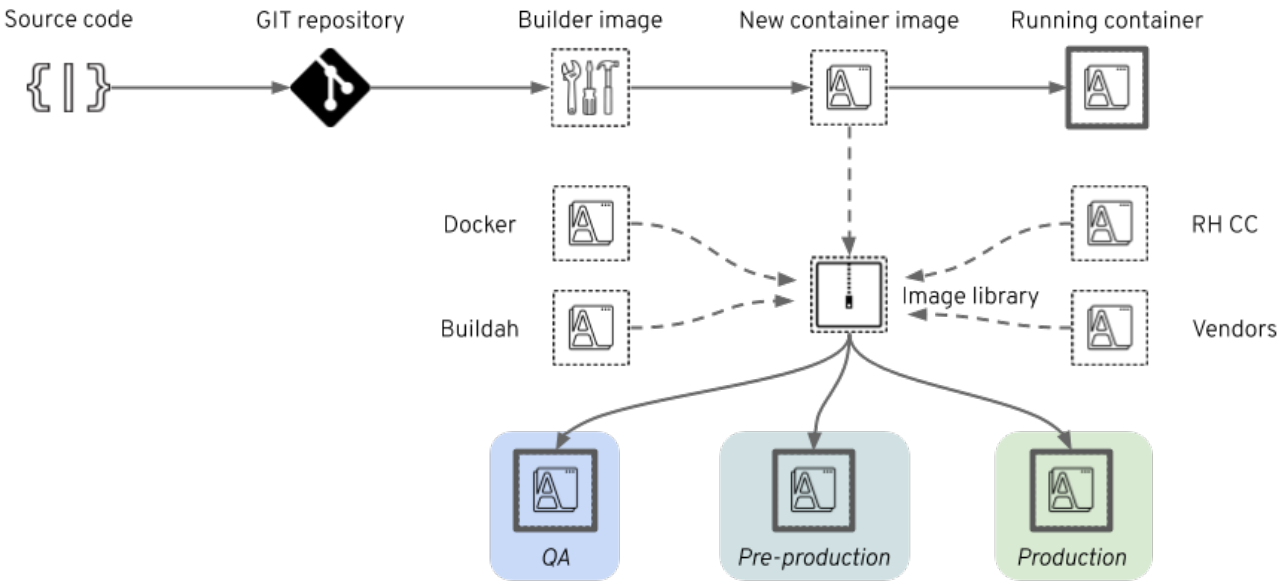
Introduction

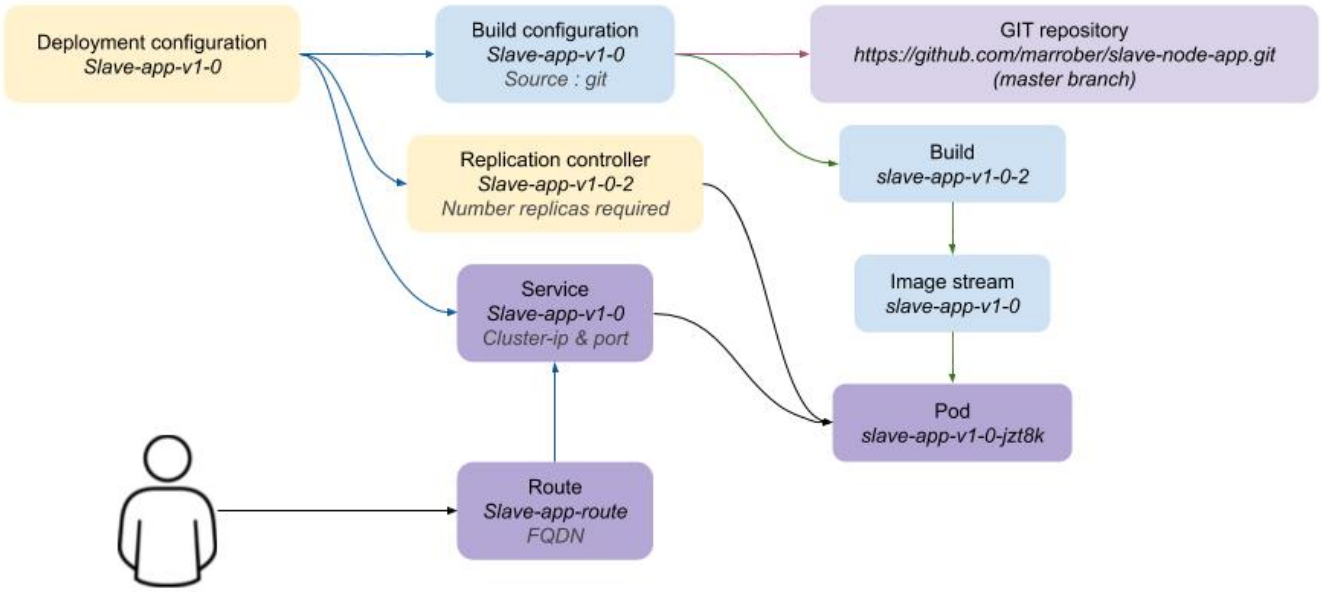
During the development process a number of container images will be produced. The source-2-image capability described in the basic workshop creates images catalogued under an image stream within a project. Other container images may be created using command line functions such as docker or buildah (both using docker files potentially) or images may be downloaded from the Red Hat Container Catalogue here, window="_blank", or other vendor supplied images may be used. From a variety of sources and through a variety of mechanisms images will be created that form the microservices of an application. Such images need to be managed through a lifecycle as they progress from Development to QA and finally to production in a process described in the diagram below. The purpose of Red Hat Quay is to provide a repository for the secure and structured storage of images that may be accessed by multiple users from multiple clusters. Quay also provides an image vulnerability scanning capability to identify issues with images stored within it.

Note on the workshop

At the present time there is an issue with the Red Hat demonstration Quay instance so if you wish to do this chapter please create an account on quay.io and use that URL instead of a URL supplied by the workshop leaders. Also the terminal that we use for the workshops cannot be used for the Buildah commands so you will need to install Buildah locally to complete this section. We apologize for this issue at this time and we are working to overcome these challenges as quickly as we can.



The image below shows an OpenShift project and the various artefacts that are created. The image stream object is shown here within the context of the builder process that creates it and the running pod that consumes it.



The structure of Quay

The Quay image repository uses a number of specific objects to manage the structure, security an maintenance of images.

1. Organisation - An organisation maps neatly to a project within OpenShift and is a structural container for a number of repositories.
2. Repository - A repository maps neatly to an image stream within OpenShift (or any other single source of images). A repository may contain multiple tagged versions of a single image.

The organisation may have the following characteristics:

1. Default permissions to be applied to any new repositories created within the organisation.
2. Teams that control access to the organisation and its repositories.
3. Robot accounts for automated access to the repositories from scripted or command line processes.

The objectives of this chapter are:

1. To understand the Quay user interface and the objects created within Quay
2. To create a process for pushing images from the OpenShift image repository to the Quay repository
3. To pull images from Quay to a new project in OpenShift to simulate the use of the images in a QA cluster

Using the Quay workshop cluster

In order to use the Quay instance for the workshop you need to request that an id is created for you by the workshop administrators. This will take very little time and will result in the creation of the following:

1. An organisation will be created in Quay using the same name as the OpenShift project used in this section, for example master-slave-user23.
2. A Quay user matching the OpenShift username and password.
3. The Quay user will have read/write access to the organisation, but you will have to create access to the specific repositories as part of the steps to follow.

Creating the OpenShift Project

In order to interact with Quay each user requires an OpenShift project containing images. While the administrator is creating your Quay content use the commands below to quickly create the OpenShift project and the required content:

```
oc new-project master-slave-userXX

oc new-app --name node-app-slave  https://github.com/marrober/slave-node-app.git

oc new-app --name node-app-master  https://github.com/marrober/master-node-app.git

oc expose service node-app-master --name="master-app-route"
```

where XX is your user number

The above commands will create image streams for the master and the slave which can be viewed using the command below.

```
oc get is
```

This will display image streams similar to that which is shown in the table below:

NAME	IMAGE REPOSITORY	TAGS	UPDATED
node-app-master	default-route-openshift-<reduced>.com/master-slave-userX/node-app-master	latest	22 hours ago
node-app-slave	default-route-openshift-<reduced>.com/master-slave-userX/node-app-slave	latest	22 hours ago

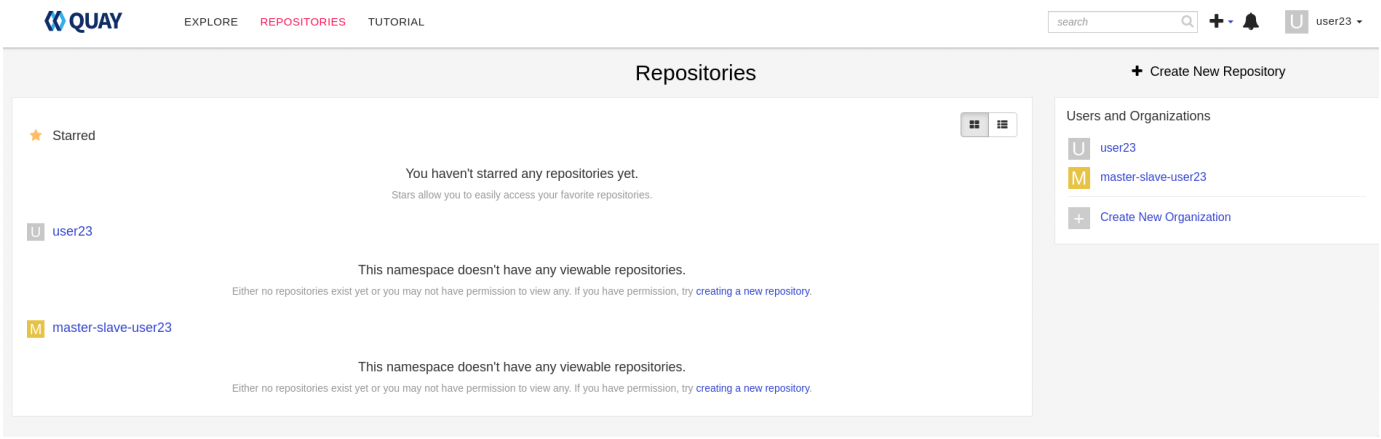
The image repository field will show the route to use to get access to the container images within the container image repository. Now that you have some images to manage it is necessary to create the repositories in Quay.

Creating the Quay image repositories

When the workshop administrator tells you that they have created your user and organisation in Quay you may login at the provided Quay URL. The username and password for Quay will be the same as those used for OpenShift.

The example screen shots below show a user ID of user23, but obviously yours may be different.

When you have logged into Quay you will see the web user interface similar to that shown below.

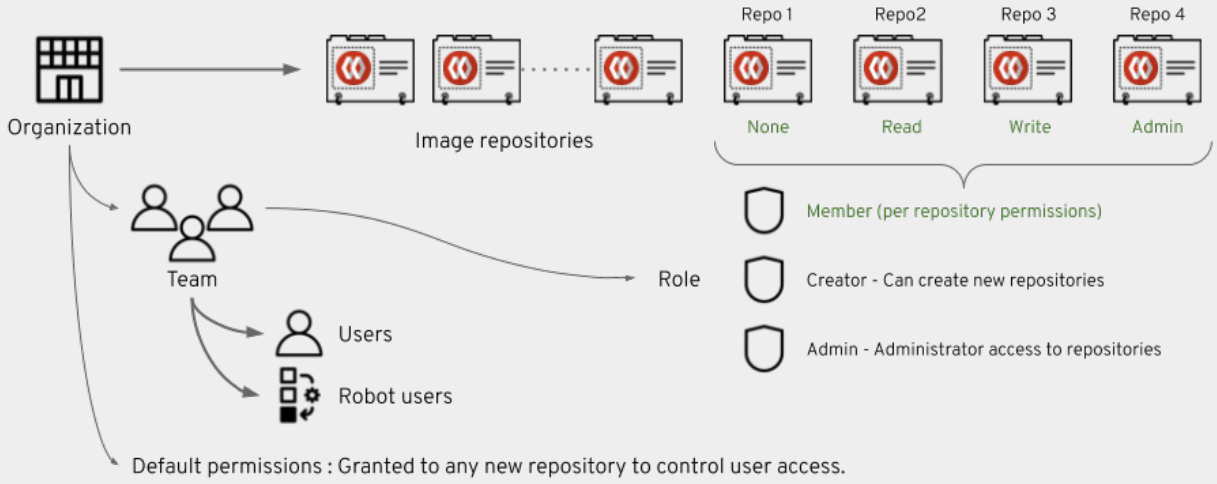


You see two namespaces within Quay for the storage of repositories. The namespace identified by your user name can hold repositories outside the scope of an organization. The organization can hold repositories with the added benefits provided by the organization which are :

1. Default permissions may be set on the organization that apply to new repositories created within it.
2. The use of teams and users to manage the allocation of permissions to the organisation and the repositories created within it.

Quay permissions

The diagram below shows the permission structure for an organization.



1. Teams contain users and robot (automation) users who have permissions on specific repositories.
2. Teams can have a role of *Creator* - Create new repositories which will inherit the organisation default permissions)or *Admin* - perform all actions including delete, or *member* - permission is indicated by each repository.
3. Member permissions are allocated on a per repository basis and can include *none* - no access, *read* - can pull images, *write* - can pull and push images, *admin* - can pull, push and perform admin functions such as delete and manage permissions.

Managing the Quay organization and repositories

Select the Quay organisation called master-slave-userXX.

This will show a largely blank screen with options down the left hand side.

Click on the + *Create New Repository* link at the top right of the screen.

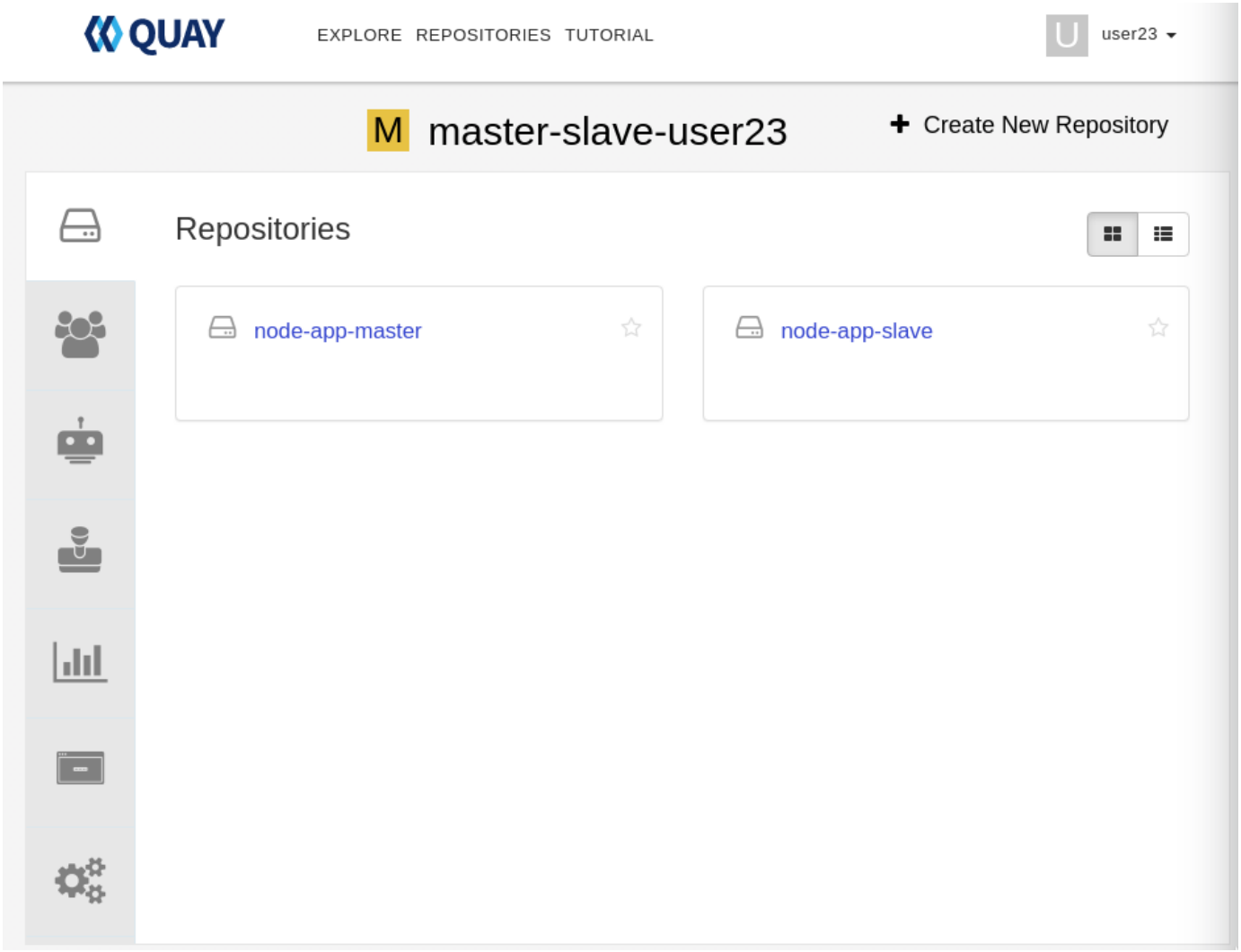
Since the names of the repositories need to match the names of the image streams in OpenShift refer back to the command line window and the names of the image streams from the *oc get is* commands used above.

Enter the name of one of the image streams for the repository, select public for access and then click on *Create Public Repository*.

Click the browser back button to go back to the repository creation screen and repeat the repository creation process for the second image stream.

Press the left facing arrow on the top left of the screen to go back to the list of repositories.

Select the master-slave-userXX organization and you should see the details of the organization as shown below.



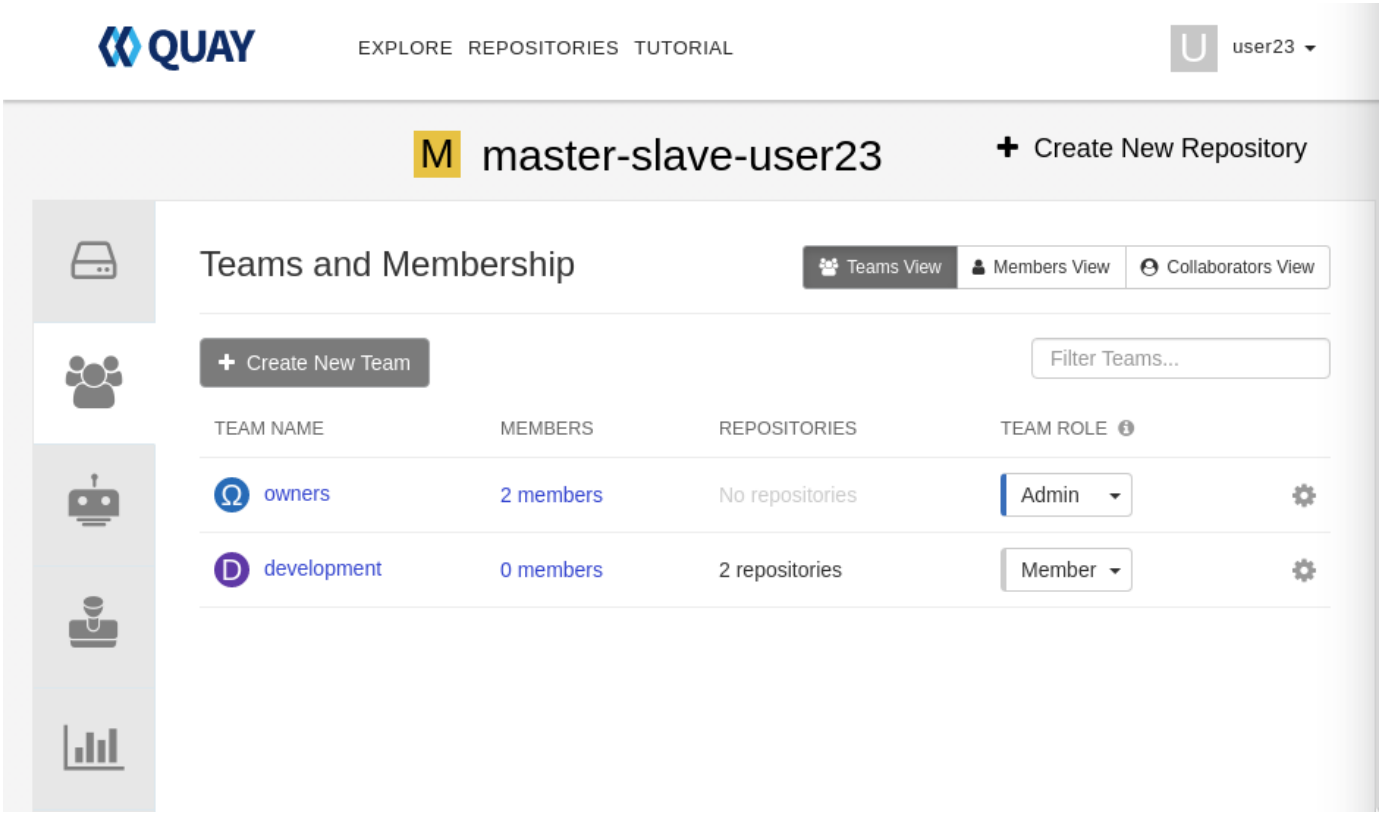
Granting permissions to repositories

Select the Teams and Membership tab on the left hand side of the screen (2nd icon down). Here you can create new teams and manage the users and permissions of existing teams.

Create a new team called *development* (only lower case letters and numbers are allowed).

You will then be prompted to add permissions for the two existing repositories. Select *Write* permission for both repositories.

When the permissions have been added for the development team you will see the summary for teams and memberships as shown below.



At this point the development team has no members so click on the link stating *0 members* and add userXX to the team, by typing the user name into the *add user* field on the right hand side. Press the left pointing arrow at the top left corner to return to the organization and you should see that the development team has 1 member and 2 repositories.

Creating a robot account

Click on the next tab down from the teams and memberships tab on the left hand side of the screen to select Robot accounts. Create a new robot account called userXX_automation (where XX is you user number). You may optionally add a description if you want to.

Grant write permission to the robot account on both repositories and then click *close*.

Click on the cog on the right hand side of the robot account name and select *view credentials*.

You will see a list of many different types of credentials that you can generate such as token, Kubernetes secret, rkt configuration, Docker login, Docker configuration and Mesos credentials. For the access required in the workshop copy the username and token from the Robot Token tab and store them in a local editor or notepad ready to use later. Once they are copied close the dialog box.

Back on the organisation screen take a look at the options for creating default permissions (the next tab down on the left). It is possible to create default permissions to be applied to new repositories for specific uses, teams and robot users as appropriate.

Summary of Quay UI work

The organization, repositories, user, robot user and permissions are all now in place within Quay for the images to be pulled from OpenShift and pushed to Quay.

Pulling OpenShift images and pushing to Quay

Buildah will be used to pull images to a local repository, re-tag the images for the location on Quay and then push the images to Quay.

Image management tools

A number of tools exist for the management of images, three of which are described below.

buildah	Buildah is an image building open source project that can either use Buildah specific commands to build an image or it can simply use an existing docker file. One major advantage of Buildah for some users is that it does not require a docker process to be constantly running on the workstation as root. In the workshop Buildah will be used to get images from / to OpenShift and from / to Quay.
podman	Podman overlaps somewhat with Buildah but its main focus is with regard to the running and interaction with container images.
skopeo	Skopeo can be used to copy container images from one image repository to another. It can also be used to convert images between formats. It is possible to perform many of the actions in this workshop with Skopeo but by using Buildah it is possible to see what is being created in an intermediate local repository which may add some value for users.

Login to the OpenShift registry using Buildah

In order to pull the images it is necessary to login to the OpenShift image repository using the Buildah command even though you may already be logged into the OpenShift cluster using the oc command. The URL for the OpenShift repository is the address in the image repository table up to and including .com.

To get just the image repository URL use the command :

```
oc get is -o jsonpath={.items[0].status.publicDockerImageRepository} | cut -d'/' -f1
```

This will return a string similar to :

```
default-route-openshift-image-registry.apps.cluster-wfh1-8946.wfh1-
8946.example.opentlc.com
```

The Buildah login command takes the form :

```
buildah login --username <username> --password <token> repository-URL
```

The token for the login command will be generates from the command :

```
oc whoami -t
```

Combined together the Buildah login command (for the example repository-URL, and where XX is replaced by your user number) becomes :

```
buildah login --username userXX --password $(oc whoami -t) default-route-openshift-image-
registry.apps.cluster-wfh1-8946.wfh1-8946.example.opentlc.com
```

You should get a response of "Login Succeeded!"

Login to Quay using Buildah

It is also necessary to login to the Quay image repository using the Buildah command so that images can be pushed to Quay. The URL for the Quay repository is the address in the browser window for Quay up to and including .com and excluding the https:// part.

The username and password are those which were generated and noted earlier on for the Quay robot user.

The Quay login command will be similar to :

```
buildah login --username master-slave-user23+user23_automation --password
6A6ODEQT39ID52S9HZ4IRCBO3EK4O5KNAGZ2HWKSOQQUMU9QSKMBBPYNO6A3ED0O quay-b2b3.apps.shared-
rhpds.rhpds.openshift.opentlc.com
```

You should get a response of "Login Succeeded!"

You are now logged into both OpenShift and Quay with buildah and you are ready to pull and push images.

Examine the local buildah repository

Use the command below to view the local buildah image repository. You should see that it contains no images.

```
buildah images
```

Use the command below to list the images and their location within the OpenShift image repository :

```
oc get is -o jsonpath='{range.items[*]}{.metadata.name}{"
"}{.status.publicDockerImageRepository}{"\n"}'
```

This command will generate a list of all image streams and the registry location to use in the pull command. To pull the image use the full docker image repository name in the command below :

```
buildah pull docker://<full-image-path>
```

for example

```
buildah pull docker://default-route-openshift-image-registry.apps.cluster-wfh1-8946.wfh1-
8946.example.opentlc.com/master-slave-user23/node-app-master
```

The command will show the progress of pulling image layers and will complete with a message similar to that which is shown below :

```
Getting image source signatures
Copying blob 455ea8ab0621 done
Copying blob 6a4fa4bc2d06 done
Copying blob bb13d92caffa done
Copying blob 2dd72bf14df1 done
Copying blob ff52b8e1303b done
Copying blob 84e620d0abe5 done
Copying config abc6f7ad19 done
Writing manifest to image destination
Storing signatures
abc6f7ad19646ed135d9b76946ccce2ae9b4c796a66472f34d853df009dbd18e
```

View the local image repository with the command :

```
buildah images
```

The result will be similar to that which is shown below:

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
default-route-openshift-image-registry.apps.cluster-wfh1-8946.wfh1-8946.example.opentlc.com/master-slave-user23/node-app-master	latest	abc6f7ad1964	6 hours ago	547 MB

An image now exists in a local repository - either on your laptop or within the terminal container depending on where you ran the command.

Repeat the process to pull the image for the slave too. Notice this time that some of the layers are skipped as those layers already exist within the local repository.

Tagging images for the Quay repository

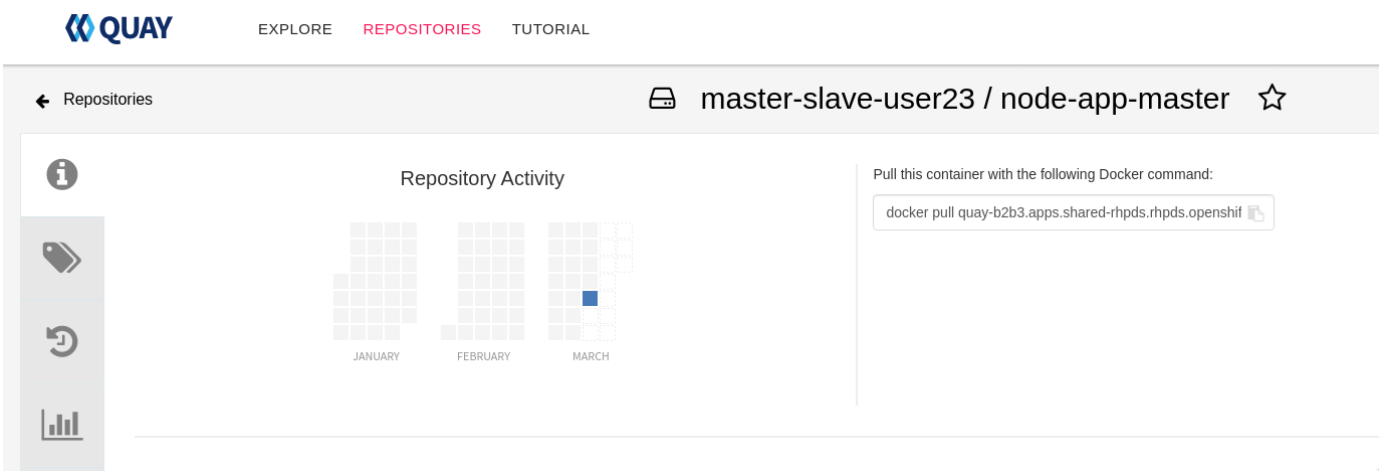
In order to push images to Quay they must have a repository identifier and tag attached to them. This is done using the Buildah tag command. The Buildah tag command takes the format :

```
buildah tag <existing-repository-location>:<tag> <new-repository-location>:<tag>
```

The actual tag names used for the existing location need to match what is in the repository, while the new tag can be whatever is appropriate such as an incremental number, *latest* or some other useful identifier. To reduce the amount of command line copy and paste operations when creating the existing repository location and tag the command below can be used :

```
oc get is -o jsonpath='{range.items[*]}{.metadata.name}{"
"}{.status.publicDockerImageRepository}{":"}{.status.tags[0].tag}{"\n"}'
```

The new repository location is the Quay URL address, organization and repository name. The easiest way to get this is to go to the Quay web user interface, select *Repositories* on the top menu and then select the master repository within the master-slave organization. This will show a screen similar to that which is shown below:



Under the heading "Pull this container with the following Docker command:", copy the URL after the *docker pull* text in the text field. It will look similar to the below:

quay-b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master-slave-user23/node-app-master

Create the Builah tag command from the information collected above such that it looks similar to the below:

```
buildah tag default-route-openshift-image-registry.apps.cluster-wfh1-8946.wfh1-
8946.example.opentlc.com/master-slave-user23/node-app-master:latest quay-
b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master-slave-user23/node-app-master:1
```

Note that the tag used in the command for the destination tag is 1.

Execute the command and then use the command below to list the images :

```
buildah images
```

Repeat the similar command for the slave image.

Push the images to Quay

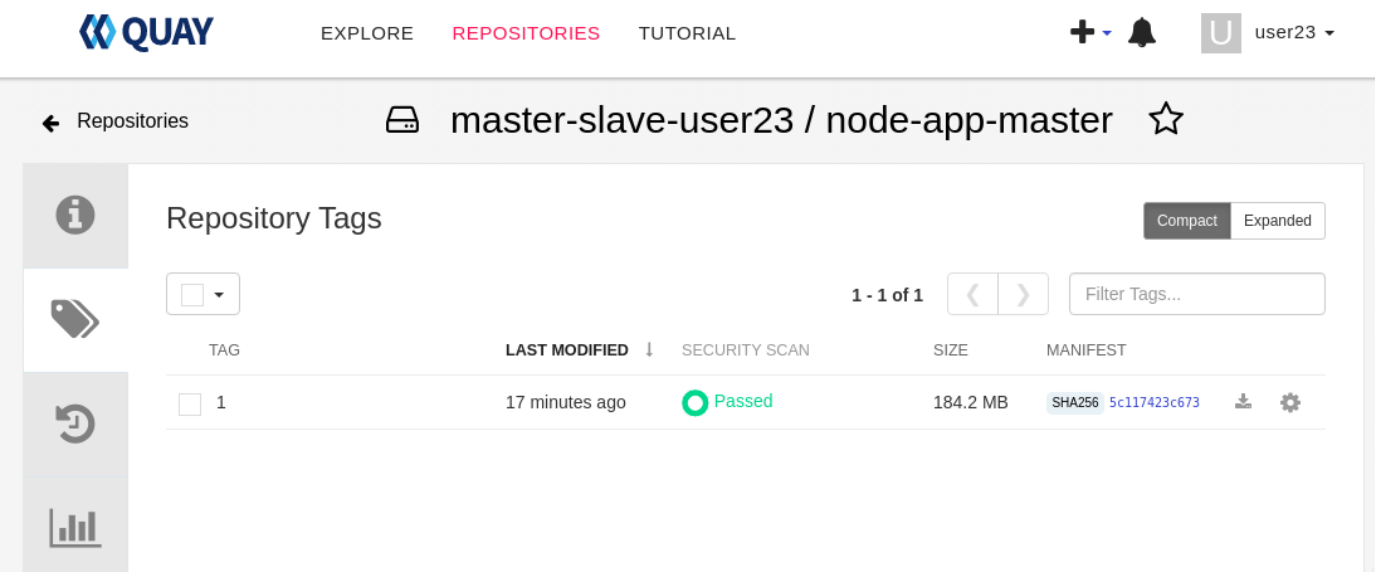
Push the images to Quay using the commands of the format :

```
buildah push <new-repository-location>:<tag>
```

for example :

```
buildah push quay-b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master-slave-
user23/node-app-master:1
buildah push quay-b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master-slave-
user23/node-app-slave:1
```

Switch to the Quay web user interface. If you are still displaying the repository information page where the image pull / push URL was copied from then refresh the browse window and then select the *tags* view (2nd option down on the repository menu). This will show the tags view similar to that which is shown below.



The tags view shows information on the image tag and the buttons on the right of each line allow the user to select different mechanisms for extracting and manipulating the image.

Using the images in a QA environment

Referring to the image at the top of this section the image may now be pulled to different clusters such as a QA cluster, pre-production cluster and production cluster. Specific users will have the appropriate role based permissions to pull the images into those clusters to control the necessary separation of responsibilities within an organization. For this exercise you will create a new project with the same name as the existing project but with -qa on the end of the name to simulate the deployment to QA.

The original commands used to create the images at the start of this section used the source-2-image capability and pulled the source code. The process from this point forward has no interaction with the application source code and pulls the immutable images into each successive cluster (simulated in the case of the workshop), with environment specific information being injected into the running containers using config maps. This use of immutable images is one significant advantage of containers and hence is another reason for the use of a secure image repository.

Creating the OpenShift Project for QA

Use the commands below to create the OpenShift project using the content from Quay as the source:

```
oc new-project master-slave-userXX-qa

oc new-app --docker-image=<master image URL & tag that was pushed above> --name=node-app
-master
oc new-app --docker-image=<master image URL & tag that was pushed above> --name=node-app
-slave
oc expose service node-app-master --name="master-app-route"
```

where XX is your user ID

For example:

```
oc new-app --docker-image=quay-b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master
-slave-user23/node-app-master:1 --name=node-app-master
oc new-app --docker-image=quay-b2b3.apps.shared-rhpds.rhpds.openshift.opentlc.com/master
-slave-user23/node-app-slave:1 --name=node-app-slave
oc expose service node-app-master --name="master-app-route"
```

To test the application get the route with the command:

```
oc get route -o jsonpath='{.items[0].spec.host}{"/ip\n"}'
```

Then issue the following curl command :

```
curl -k <url from the above command>
```

The response should be the ip address of the master node and the slave node similar to that which is shown below:

```
"master ip address 10.131.0.174    ----> slave ip address 10.128.2.157 v1.0"
```

Cleaning up

Finally, lets clean up the project by typing

```
oc delete project master-slave-userXX
oc delete project master-slave-userXX-qa
```

where XX is your user ID

This will delete the projects