Developing and Deploying Microservices into IBM Cloud Private

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Find the latest version here:

http://ibm.biz/StockTraderLab

1. Introduction

In this lab, you will use and update an application in an IBM Cloud Private environment, built on Kubernetes. The lab will use a Skytap-hosted virtual machine (VM), which, for the purpose of the lab can be considered to be your on-premises environment running IBM Cloud Private that hosts your application and its required services.

The Skytap VM provided to you contains all necessary artifacts for the lab. The application artifacts are also available for review at https://github.com/IBMStockTrader/ You can learn more about this application and how to deploy it in your own IBM Cloud Private environment via a series of blog posts from the IBM Hybrid Cloud CTO Office:

- Introduction to the StockTrader microservices application - https://www.ibm.com/developerworks/community/blogs/5092bd93-e659-4f89-8de2-a7ac980487f0/entry/Building_Stock_Trader_in_IBM_Cloud_Private_2_1_using_Production_Services?lang=en
- Developing Microservices for IBM Cloud private - https://www.ibm.com/developerworks/community/blogs/5092bd93-e659-4f89-8de2-a7ac980487f0/entry/Developing_microservices_for_IBM_Cloud_private?lang=en

The lab is divided into five main parts:

1. First, you will familiarize yourself with the StockTrader application and the Kubernetes cloud it's running in. StockTrader consists of multiple, small, specialized services (microservices) which work together as a stock portfolio-management system.

2. Second, you will learn how management of applications and services occurs within IBM Cloud Private and Kubernetes. You will learn how to scale up and down containers based upon workload requirements.

3. Third, you will edit Java code in one of the StockTrader microservices and deploy this new version into your IBM Cloud Private environment. This simulates the actual operations an administrator may perform when deploying and updating workloads. You will also use a Kubernetes tool to visualize how the various microservices interact at runtime.

4. Fourth, you will experience pulling a new repository from GitHub, for a Node.js-based client to StockTrader, and building and deploying and using it.

5. Lastly, you will experience deploying a helm chart from the catalog, to deploy your own instance of IBM MQ.

The Skytap VM features Ubuntu 16.04.3 LTS (xenial) as the operating system and has the following software installed:

- Docker 17.03.1-ce
- IBM Cloud Private - 2.1.0.1 (with Kubernetes 1.8.3)
- kubectl CLI version 1.9.1
- git CLI version 2.7.4
- Java 8
- Apache Maven version 3.5.0
- VS Code version 1.20

This particular Skytap VM is configured to host all portions of IBM Cloud Private: a master node for managing the environment, a proxy node for servicing network requests, and a worker node for hosting workloads. A more realistic environment would have separate virtual machines for each configuration, but for the purpose of this lab we've combined them into a single VM for convenience.

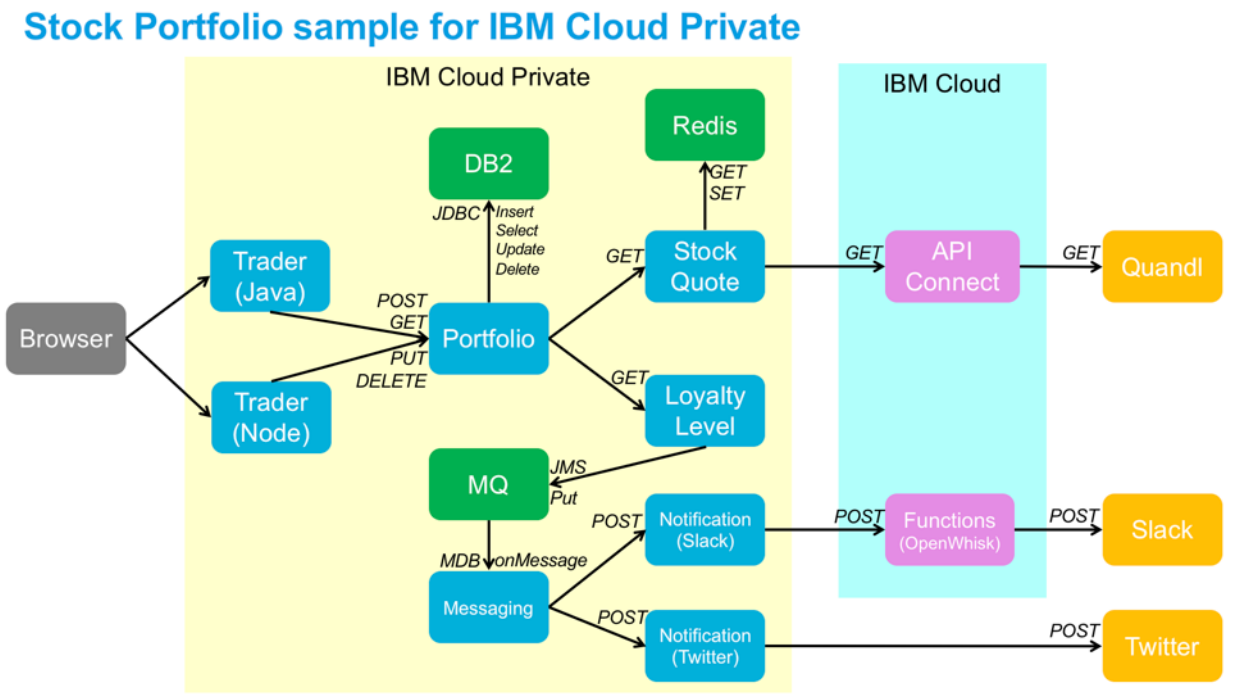
In addition to the above software, the Skytap VM also contains the artifacts needed to complete the lab. The following table points out the most important artifacts.

Directory	Description	Notes
`/StockTrader/trader`	Front-end User Interface	Java servlets
`/StockTrader/portfolio`	Portfolio management API	Uses JDBC to persist portfolios to DB2
`/StockTrader/stock-quote`	Stock prices via API Connect/Quandl	Uses Redis for caching
`/StockTrader/loyalty-level`	Determines a portfolio's level (Silver, Gold, etc.), and sends a message when it changes	Uses JMS to deliver messages to MQ
`/StockTrader/messaging`	Receives messages about loyalty level changes	Message Driven Bean (EJB)
`/StockTrader/notification-twitter`	Sends tweets	Uses Twitter4J
`/StockTrader/notification-slack`	Posts to a Slack channel **Not used in this lab**	Uses IBM Cloud Functions

You will download and use one more microservice, `tradr`, in a later section of this lab.

The application in this lab, **StockTrader**, is a microservice-based application utilizing various features of IBM WebSphere Liberty runtime (JAX-RS, JDBC, JMS, etc.) to interact with a set of database tables in DB2 via JDBC and to send notifications over MQ via JMS to Twitter. It also uses API Connect in the IBM public cloud to get stock quotes, and uses Redis for caching of those quotes.

As you can see in the following diagram (also shown at https://github.com/IBMStockTrader/trader, in its README.md), most microservice-to-microservice communication occurs via REST calls. There are two variants of the front-end web user interface – initially we'll use the Java Servlet based client for this lab, then we'll switch to the Node.js based client in a later section of the lab. The *portfolio* microservice uses JDBC to talk to DB2 for persistence. Two microservices, *loyalty-level* and *messaging,* use JMS to talk to MQ for their communications. Everything in the yellow box is running in IBM Cloud Private. Microservices are colored in blue, their prerequisites are green. They reach out to services in the IBM public cloud (cyan), shown as purple boxes (they also authenticate against IBMid, an OpenID Connect provider in the IBM public cloud). And some services out on the internet are used as well, shown in orange. You can see how the microservices work together in the following diagram (note that the Slack notification is not enabled in this lab, as the Slack server to which it posts requires an internal IBM intranet id/pwd – so all notifications will be via Twitter in this lab).



The end-to-end flow of the application is as follows: A user opens their browser and navigates to *trader*'s web page where they can interact with various stock portfolios. When the user takes an action, such as buying stock, *trader* makes a REST call to *portfolio* to perform the requested action. As part of the buy stock action *portfolio* calls the *stock-quote* service to get the current stock price. *stock-quote* first checks a **Redis** cache for the stock price and if the price is not found in the cache *stock-quote* calls an **API Connect** service that fronts a **Quandl** Stock Data API for the price and stores the value in **Redis**

before returning the value back to *portfolio*. Then *portfolio* calculates the total purchase price (number of shares * stock price) before storing that data in the user's portfolio within DB2. *portfolio* next calls *loyalty-level* to see if the new total portfolio value has changed the customer's loyalty level. If such a change occurs a message is put on an MQ queue and the new loyalty level is returned back to *portfolio* for storage in DB2. Finally, *portfolio* returns all this data as a JSON object back to *trader* for rendering in the user's browser. Asynchronously, an MDB in the *messaging* microservice receives the MQ message and calls either *notification-twitter* to send a tweet, or *notification-slack* (not used in this lab) to call IBM Cloud Functions to post to a Slack channel.

Finally, we will use the Consolas font for any commands you should enter in a terminal window. For example:

```
kubectl get deployments
```

should be entered in a terminal window (but not yet). Any actions you should take or forms to fill in will be **bolded**.

Prepare: Log Into Skytap

We are using Skytap, and each of you will have your own VM environment. Note that normally you would run IBM Cloud Private on your own on-premises hardware, but for the purposes of this lab, we have installed it into this cloud-based VM-hosting environment. Note the password is **`A1rb0rn3`**.

You can also click the keys icon  in the Skytap menu bar and click the **Insert** button next to the password for user **skytap**.

Skytap Tips:

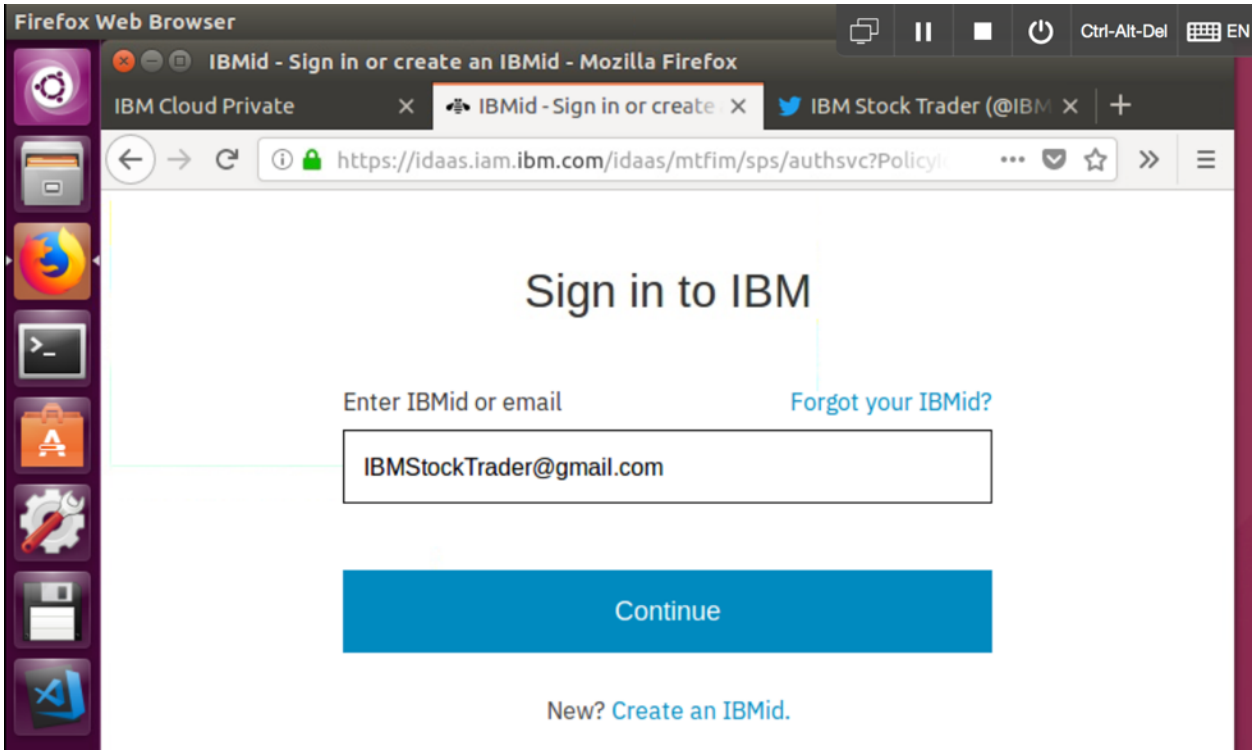
- All commands will be performed from a Terminal window within the Skytap VM in the browser (not directly from your laptop, which will not have connectivity to the Skytap VM other than working with its desktop via the web browser)
- Click out of the browser before performing any laptop keyboard shortcuts, otherwise the keyboard shortcuts will be done in the Skytap VM Linux OS
- Use the right click copy/paste, don't use keyboard shortcuts…they often don't work.
- To copy from the Skytap VM into your laptop, right click in the VM to copy the content, go to the top icon  and then copy the content again…this will add the content into your laptops cut/paste buffer.

2. Introduction to the StockTrader sample

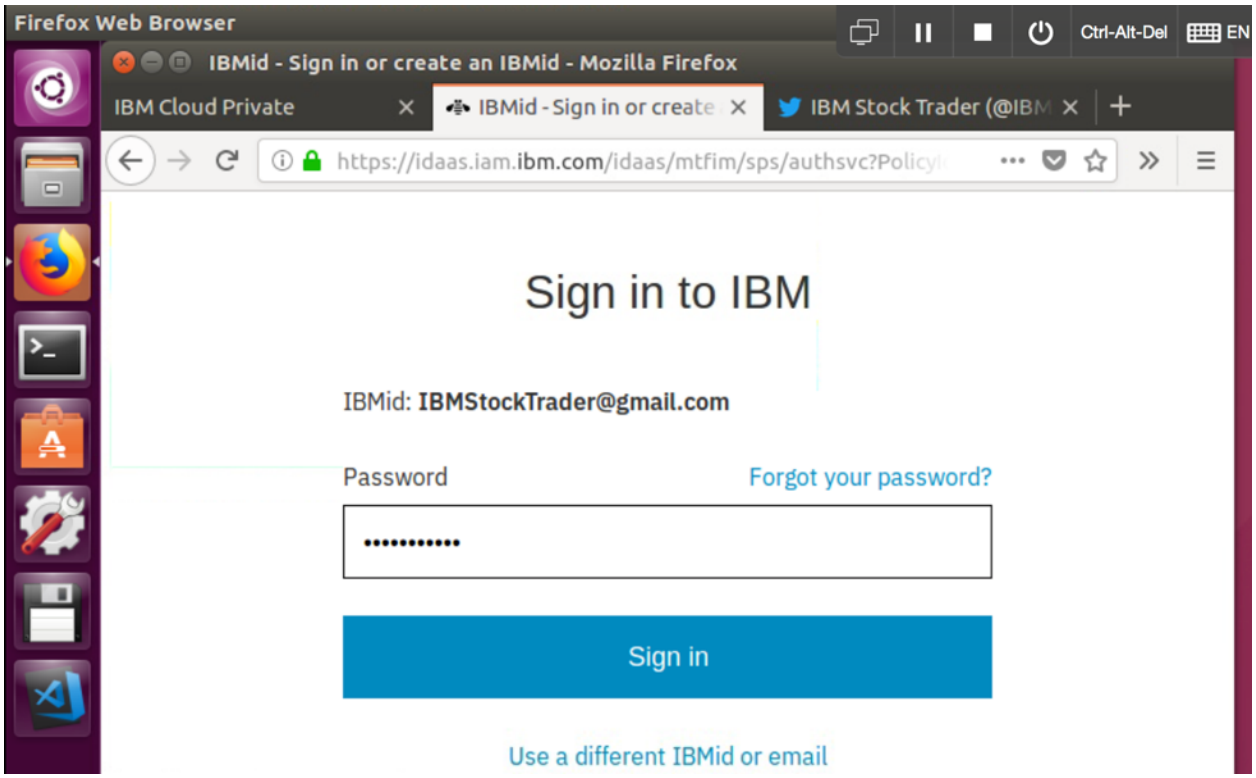
As noted in the introduction, StockTrader is a microservice-based stock portfolio management application which utilizes IBM WebSphere Liberty, IBM DB2, IBM MQ, Redis, and IBM API Connect as the underlying runtime and storage mechanisms. All services, except API Connect (which runs in the IBM public cloud), are configured to run in the IBM Cloud Private instance within your Skytap VM.

1. Open the Firefox browser and navigate to **https://10.0.0.1:32389/trader/summary**

2. You will be rerouted to an OpenID Connect authentication page. To log in, enter your **IBM ID**. Your IBM ID is the same email you used to register for this conference. If you don't have an IBM ID, click the "Create an IBMid" link and follow the instructions (an email will be sent with a confirmation code once you submit your info, and the account won't be activated until you enter that code).



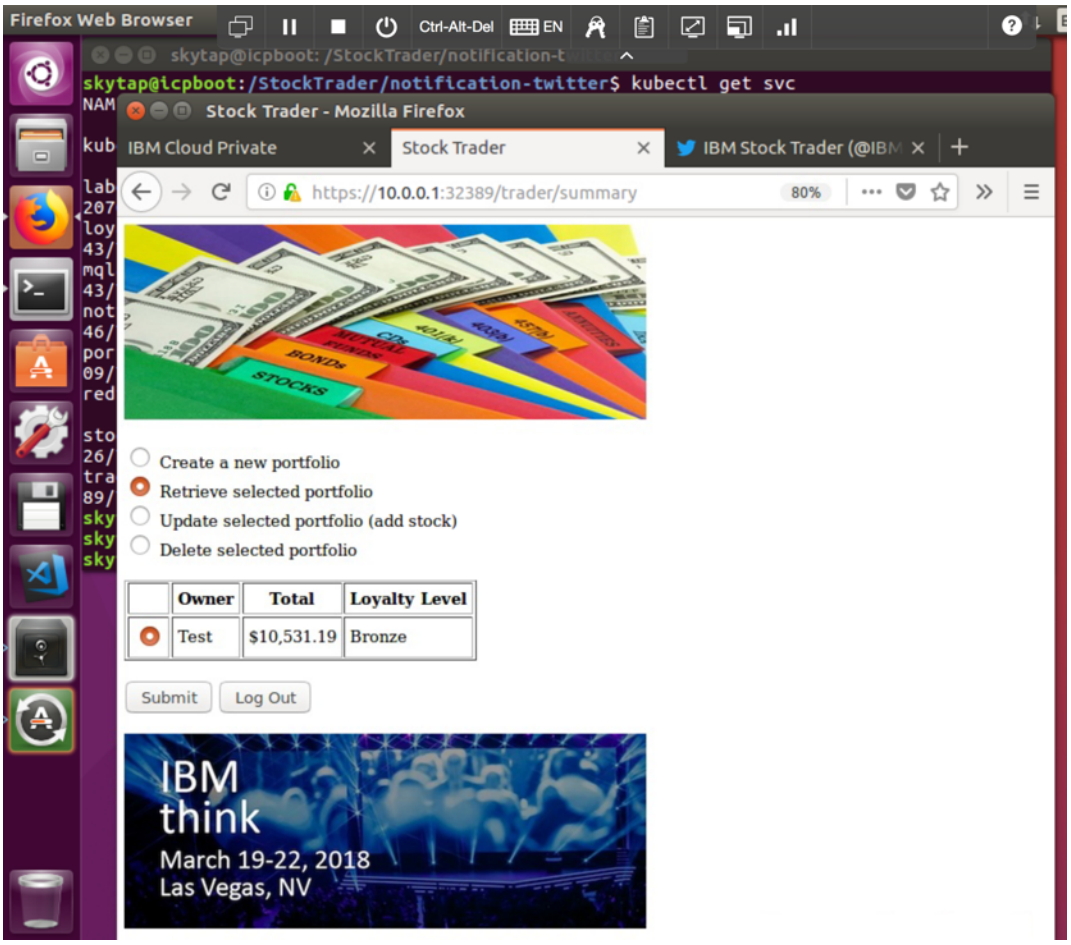
3. Enter your password for your IBM ID. Note that IBM employees using their work e-mail addresses will be routed to a different page to do a w3id login with their intranet ID and password.



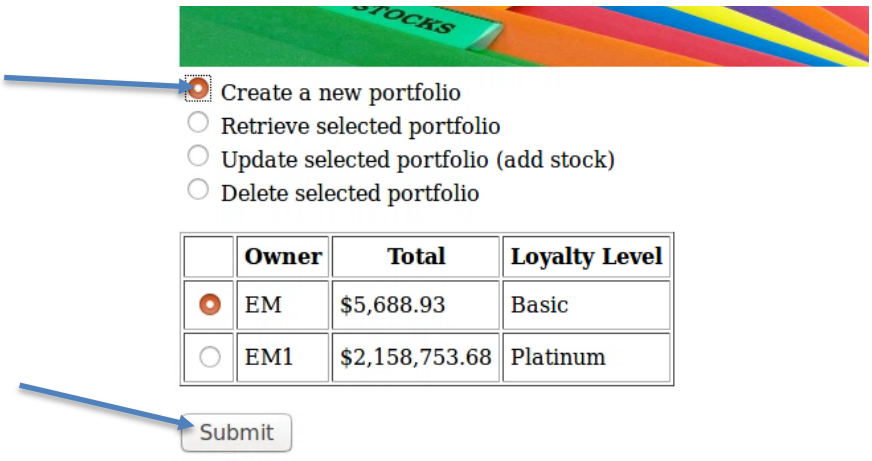
You may get told that you need to perform two-factor authentication, due to this being the first time your IBM ID has logged in from this location (in SkyTap). If so, it will send you a confirmation code, as a text to your mobile device or to your e-mail, and you will need to enter that code to complete your login.

4. Upon a successful login, you will see the StockTrader landing page, which provides a list of the stock portfolios you manage along with a set of actions you can take for each portfolio. The list should be pre-populated with a portfolio named Test, which contains a wide variety of stocks.

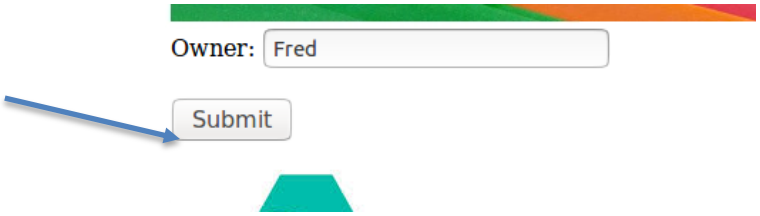
   Note that there is a daily limit on how many stock quotes can be served up from **Quandl** to our **API Connect** service, and with many lab participants all running the sample simultaneously, that rate limit may be hit. In that case, the sample will revert to using values already cached in Redis, and the price for any new stock symbols not already in Redis will not be available, resulting in the UI showing "Error" for that stock. This will also be shown if an invalid stock ticker symbol is entered.



5. Select the **Create a new portfolio** radio button and click **Submit** to create a new portfolio, as shown here.

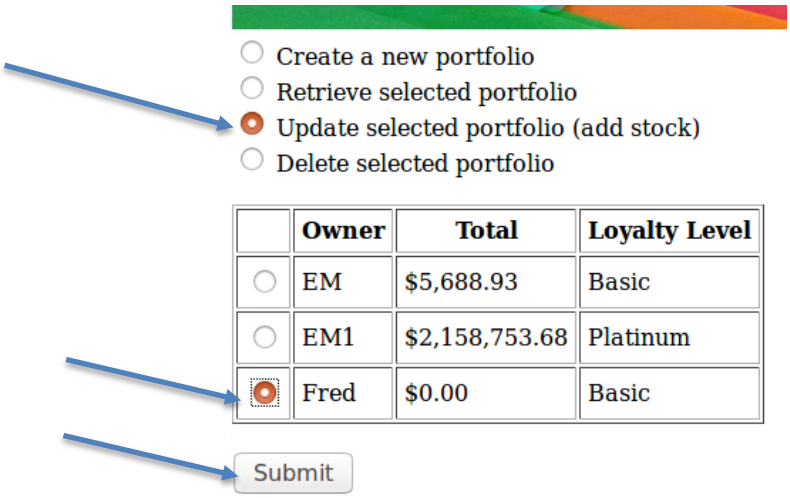


6. Provide a name for the new portfolio owner and click the **Submit** button to create the new portfolio. Make sure not to enter any spaces in the name, or other values that would be illegal as part of a URL.

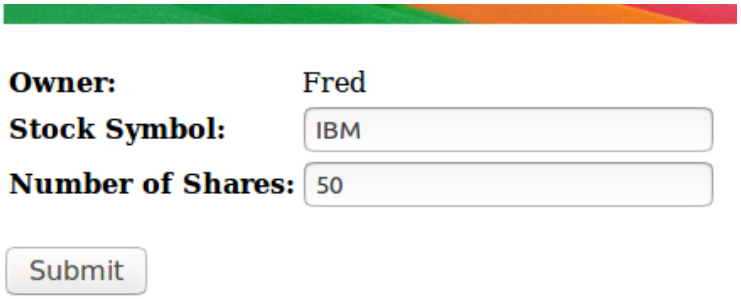


When you click Submit, the *trader* service (our user interface) makes a REST call to *portfolio* service which inserts a new row in DB2's portfolio table. Now that you've created a portfolio you need to buy some stocks for that person.

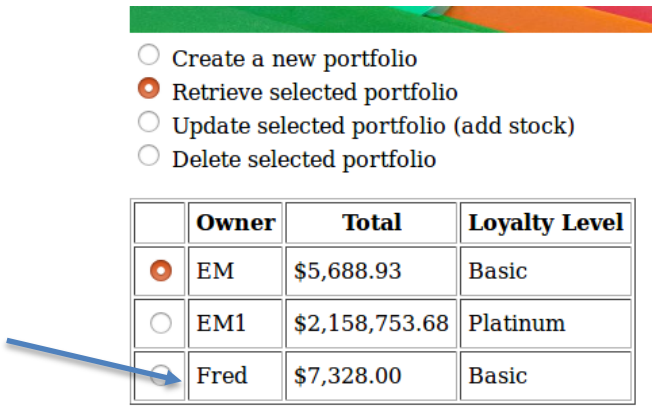
7. Click the **Update selected portfolio (add stock)** radio button and the radio button next to your newly created portfolio before clicking **Submit**.



8. On the Add Stock page you enter a **Stock Symbol** and a **Number of Shares** you want to buy. You can enter any actual NYSE stock symbol and any number of shares before clicking the **Submit** button (as shown on the next diagram).



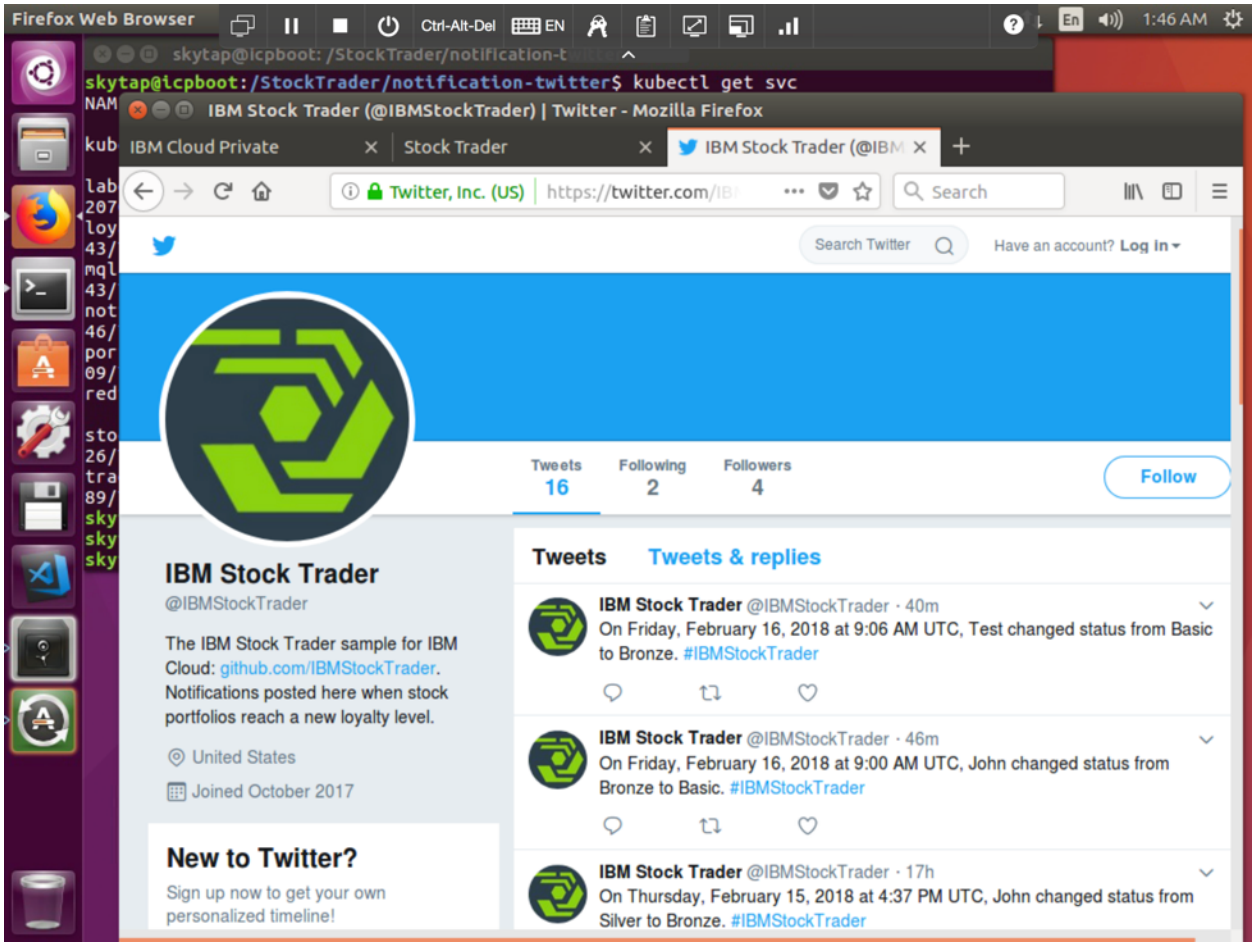
9. When you click Submit *trader* calls *portfolio* which then calls *stock-quote* to retrieve the current stock price for that stock. There are some smarts in *stock-quote*: A Redis database caches previously retrieved stock prices to reduce load against the Quandl back end stock quote service (and to improve performance). If there is no cached value in Redis, *stock-quote* calls an API Connect service, which calls Quandl for the most recent market price, stores the value in Redis, and returns the quote back to *portfolio*. The *portfolio* service updates DB2 with the new stocks and portfolio contents which you'll see when you're returned back to the main landing page.



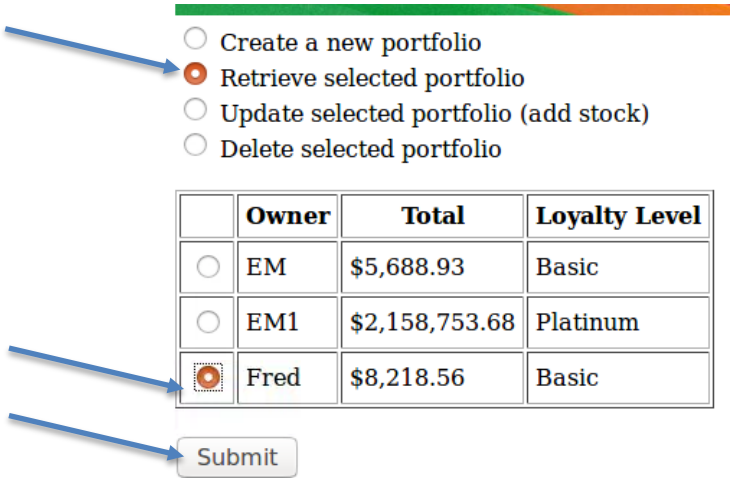
10. Feel free to add more stocks to your new portfolio by repeating step 8. If you want to ***sell*** a stock enter a **negative** number for the number of shares you'd like to buy. You may notice that the loyalty level changes from Basic when a certain portfolio value threshold is reached. Any time a stock transaction takes place *portfolio* calls the *loyalty-level* service to compute the current loyalty level for the portfolio. When a threshold is reached, the database is updated with the new loyalty value and a JMS message is put onto an MQ queue. The *messaging* service contains a Message Driven Bean which reads from this queue and calls a *notification-twitter* service, which sends a message to Twitter about that change in level.

11. The various loyalty levels are defined as:
    - Basic: < $10,000
    - Bronze: < $50,000
    - Silver: < $100,000
    - Gold: < $1,000,000
    - Platinum: > $1,000,000

12. Feel free to buy or sell more stocks to change the different loyalty levels. You can open a new tab in your browser and go to https://twitter.com/IBMStockTrader to see the tweets:



13. You can also view the full details for your selected portfolio by selecting the **Retrieve selected portfolio** radio button and the portfolio you'd like to see before clicking the **Submit** button.



Stock Portfolio for Fred:

Symbol	Shares	Price	Date Quoted	Total
IBM	50	$146.56	2017-09-26	$7,328.00
T	23	$38.72	2017-09-26	$890.56

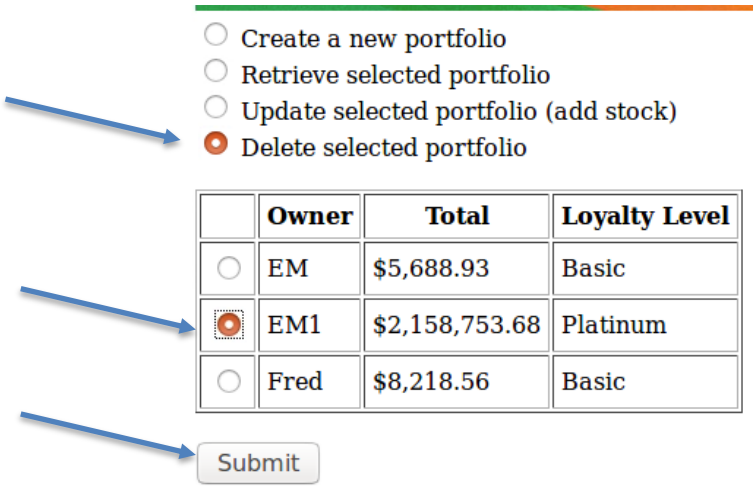
Total Portfolio Value: $8,218.56

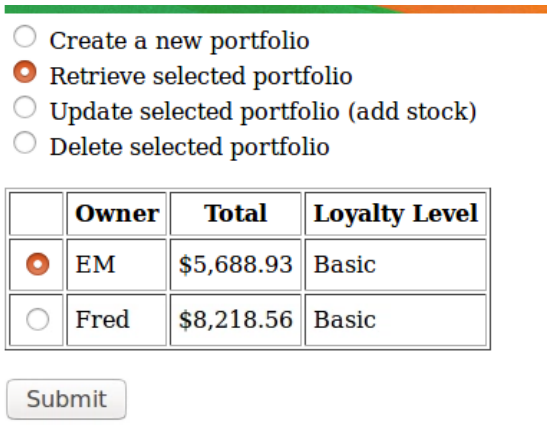
Loyalty Level: Basic

OK

Here, the *trader* service has again called *portfolio* to gather all the details for this particular portfolio from DB2. Click the **OK** button to return to the portfolio list.

14. You can also delete a portfolio (and all of its stocks) by clicking the **Delete selected portfolio** radio button, clicking on a portfolio, and then clicking **Submit**. This is shown in the following diagram.

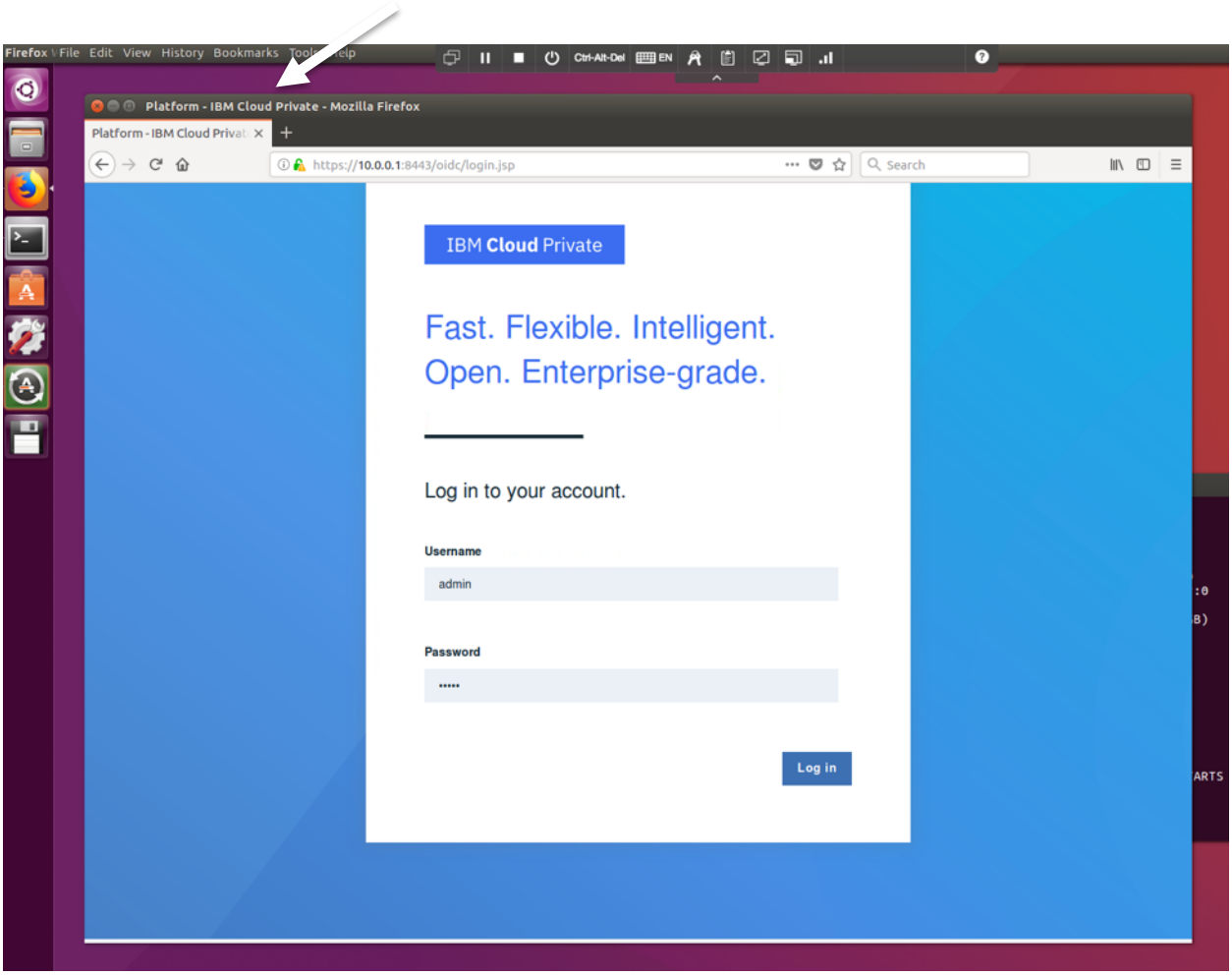




3. Introduction to IBM Cloud Private User Interface

In this section, you will utilize the IBM Cloud Private web console to view how StockTrader is deployed within IBM Cloud Private.

1. Within Firefox you should see a tab called **IBM Cloud private**. Click on this tab to continue.

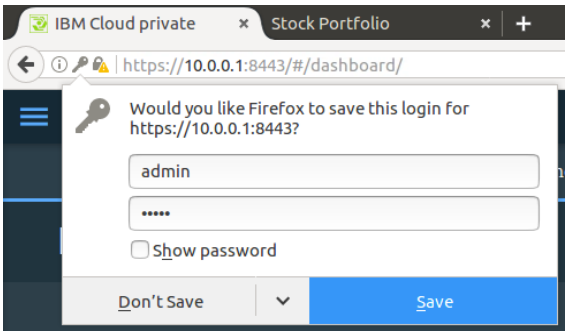


If there is no IBM Cloud Private tab in Firefox please navigate to **https://10.0.0.1:8443**

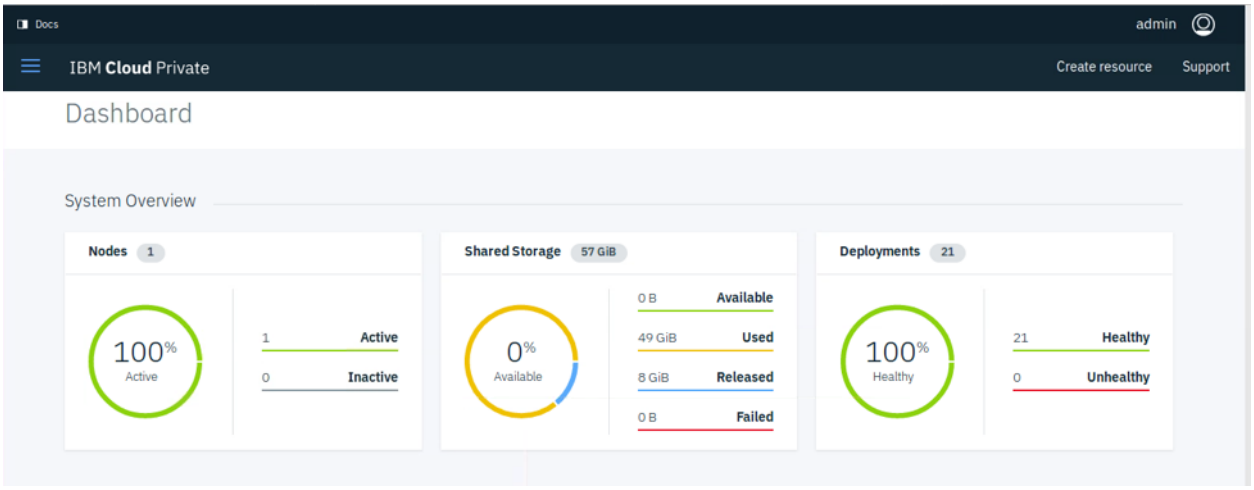
2. Enter the following usernames and passwords before clicking the "**Log in**" button:

User ID	**admin**
Password	**admin**

If prompted by Firefox to save this login select **Don't save** to dismiss the dialog.



You've arrived at the IBM Cloud Private Dashboard landing page which provides a brief overview of your environment.



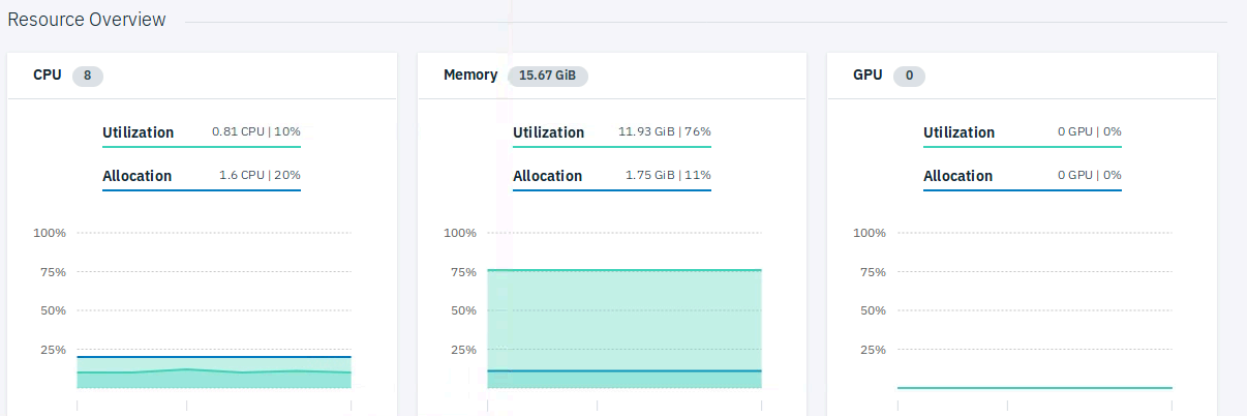
The **System Overview** section provides a high-level health about the worker nodes where workloads actually run (titled **Nodes**, first widget), the Shared Storage utilization for persistent workloads (titled **Shared Storage**, second widget), and the status of all deployed applications (titled **Applications**, final widget).

In the **Nodes** widget, we see there is one active worker node. This worker node is where our workloads, or applications and services, are deployed. These applications and services are Dockerized versions of IBM WebSphere Liberty, IBM DB2, IBM MQ, Redis, along with other Kubernetes internal services.

The **Shared Storage** widget shows that we have 49GB of shared storage utilized by workloads to store persistent data. This does not mean all 49GB have been utilized, only claimed. Since our workloads and services are Dockerized it is important to remember that Docker containers should be considered ephemeral and any data stored within a container will disappear if that container is deleted. Shared storage allows data persistence outside a Docker container and outside the Docker lifecycle.

The **Applications** widget shows that there are 17 applications/services deployed and started in our environment. This includes not only the various microservices for StockTrader but also the dependent services, like IBM DB2, StockTrader depends on along with other internal Kubernetes services.

If you scroll down the landing page you'll find the **Resources Overview** section. This includes current **CPU**, **Memory**, and **GPU** utilization and allocation.

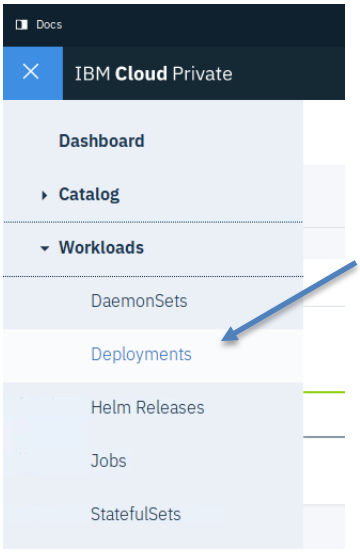


The **CPU** widget shows the total number of CPUs available across all the worker nodes, how much of the CPU is utilized and how much is allocated. Here we have 8 CPUs available across all workers (this VM has eight CPUs), the various workloads are using a total of 2.86 CPUs while only 0.4 CPUs have been directly assigned to a workload (dedicated compute resource)

Likewise, the **Memory** widget shows our workers have a total of 7.8 GB of RAM (this VM has 8GB of RAM), and that RAM is 90% utilized but only 7% has been directly requested or dedicated to a workload.

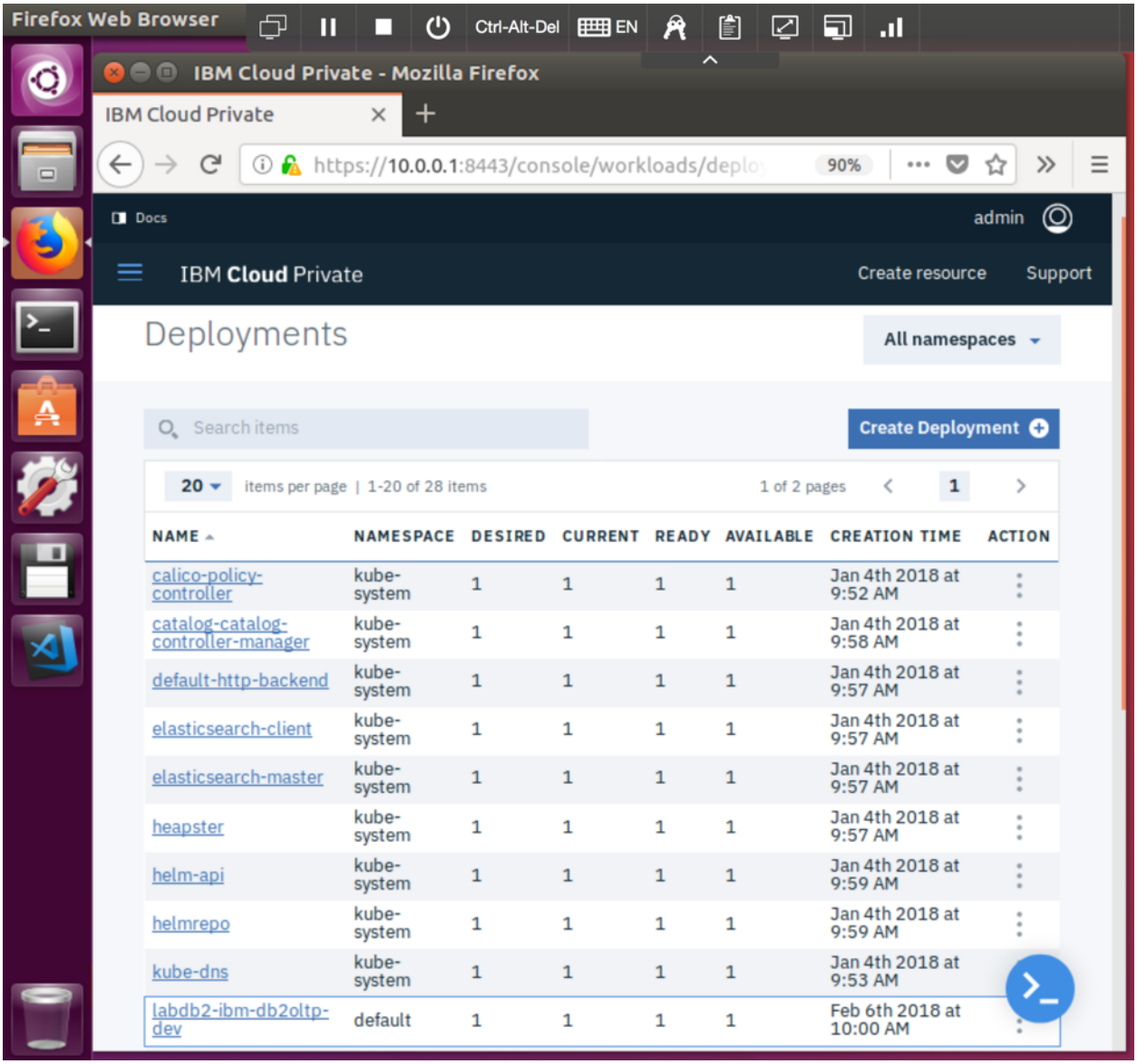
Finally, the **GPU** widget shows how many GPU resources are configured and available. If our workers had access to NVIDIA GPUs they would appear in this list and become available for analytics workloads to exploit.

3. Scroll back to the top of the browser window and select the menu icon in the upper left corner  . This opens the Menu sidebar.



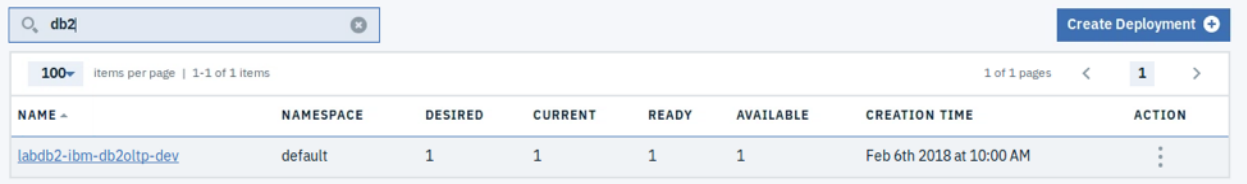
Click on **Workloads** and then **Deployments** in the menu.

This opens the list of applications and microservices (called *deployments* in Kubernetes) currently running in this IBM Cloud Private environment.



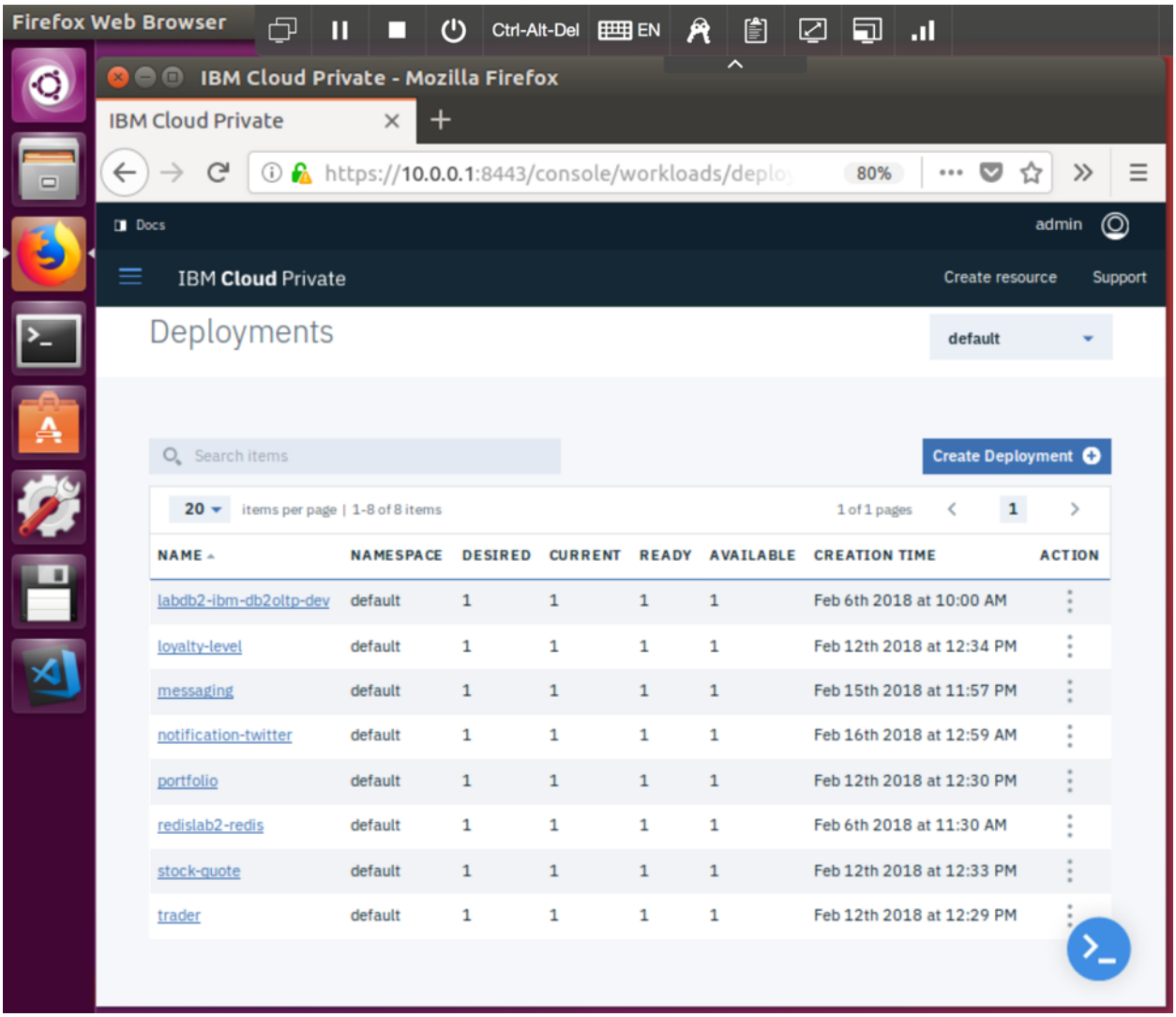
Items running in the *kube-system* namespace are internal IBM Cloud Private/Kubernetes services and can usually be ignored. StockTrader microservices and dependencies are running in the *default* namespace. Applications can also create their own custom namespaces; we will see an example of this later on, when we install Weave.

You will notice that there is a DB2 deployment named **labdb2-ibm-db2oltp-dev**; this hosts the DB2 database StockTrader uses for storing portfolio information. Endpoint and credential info for this DB2 database are stored in a Kubernetes secret (named *db2* in this case) used by *portfolio*, which allows such info to be configured at deployment time, rather than being hard-coded in the microservice's source code. Values in the secret are exposed to the microservice as environment variables, and can be updated (like if a password gets updated) without having to modify and redeploy the microservice.



The data in this table indicate that for this DB2 deployment, there is one desired container instance, one currently running instance, one instance which has the currently desired configuration, and one instance that is up and running (corresponding to columns *Desired*, *Current*, *Ready*, and *Available*, respectively).

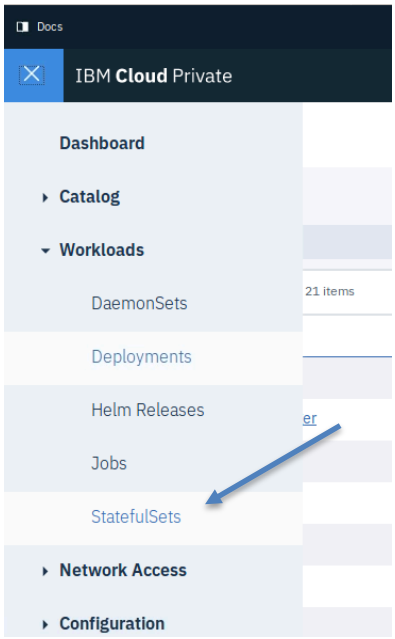
If you click on the namespace dropdown at the top right and choose *default,* it will filter the view down to just the StockTrader microservices: *trader, portfolio, stock-quote, loyalty-level, messaging,* and *notification-twitter* (and the *db2* and *redis* dependencies).

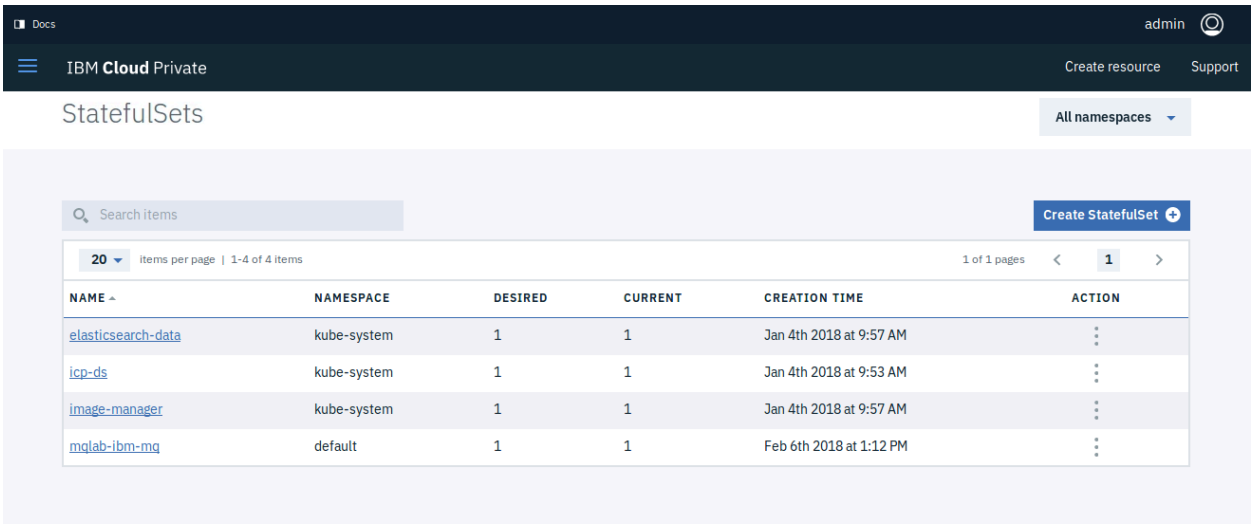


Later in this lab you will scale up and scale down one of our microservices. You can perform scaling operations on this page via the action icon (the three vertical dots) in the right-most column.

4. While most applications deploy as “Deployments”, a few services deploy as “Stateful Sets”, including MQ, used by Stock Trader. In fact, soon you will deploy your own instance of MQ.

   Open the menu again and click on **Workloads** then **StatefulSets**.

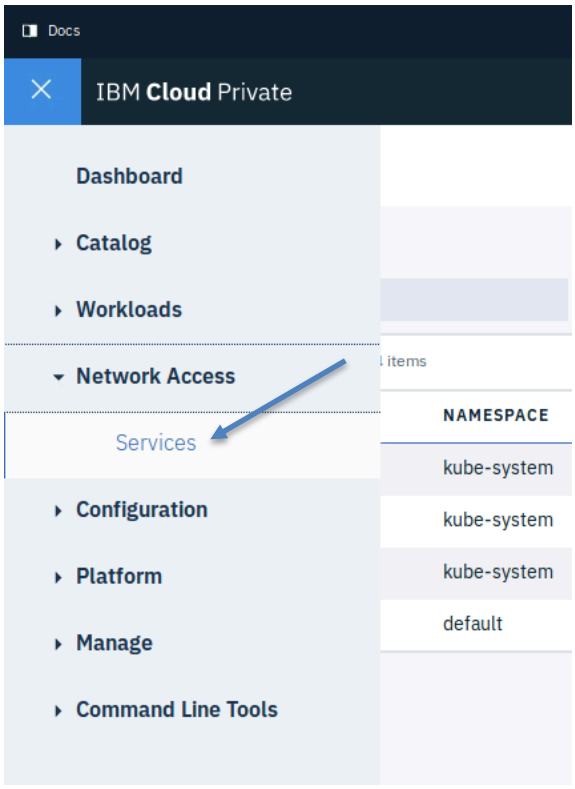


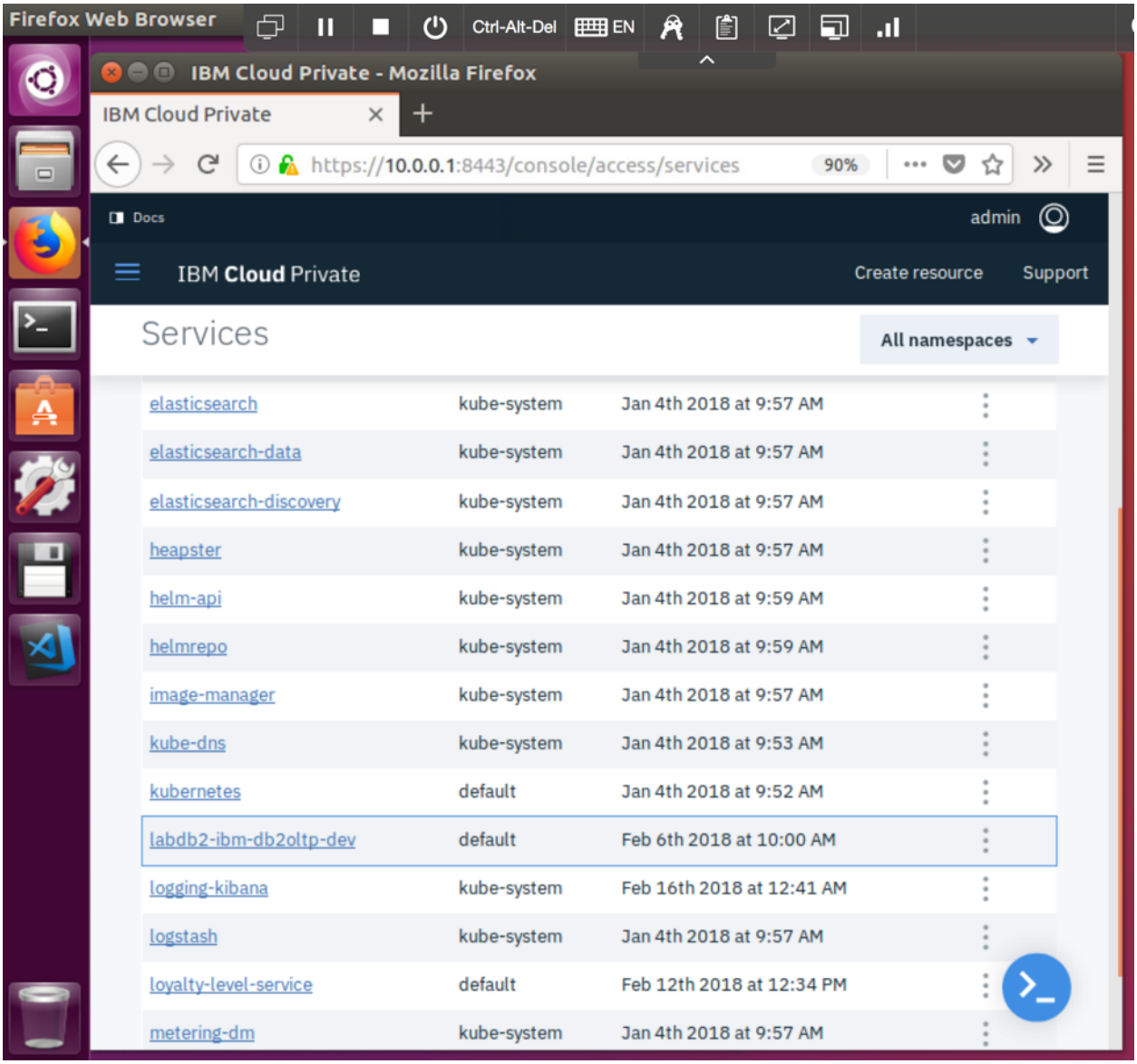


Here you can see there are four StatefulSets: one for IBM MQ (*mqlab-ibm-mq*) and three used by IBM Cloud Private itself. Remember, the *kube-system* namespace is used by IBM to run essential services like image management and elastic search. A StatefulSet allows you to maintain unique information

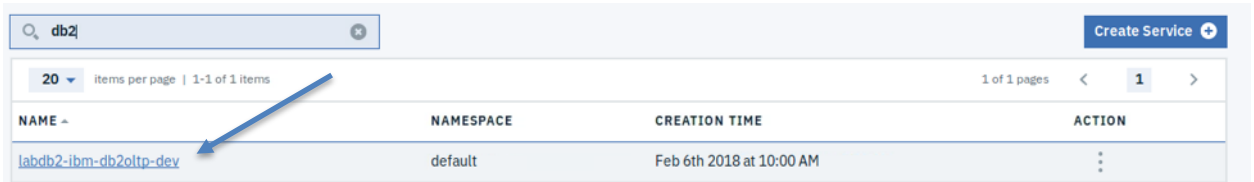
across pod reschedules or restarts. This is important for IBM MQ since it relies on unique server information to maintain internal state. If a container should fail this unique data is persisted and reused as part of recovery.

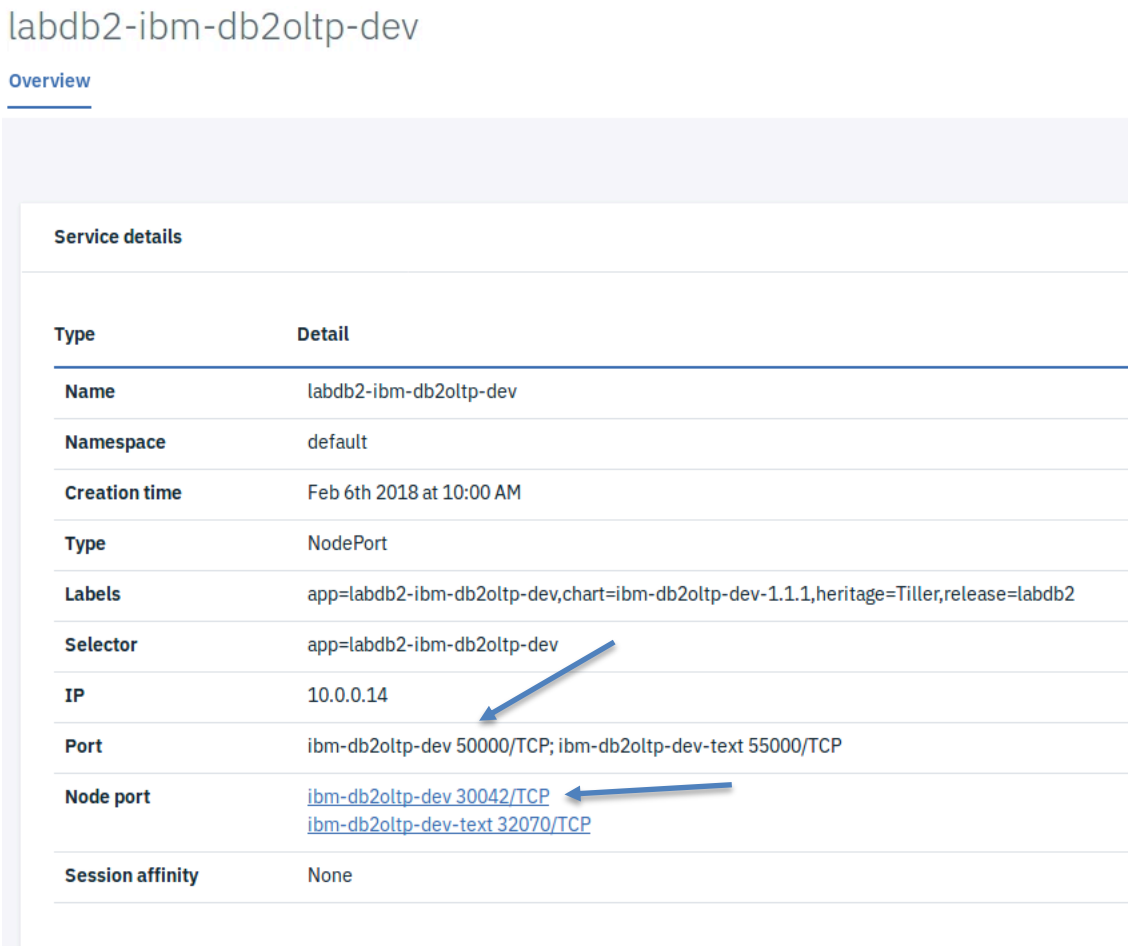
5. Back in the Menu  click on **Network Access** then **Services**. This page lists how our applications are exposed to the outside world and to each other.





You'll notice **labdb2-ibm-db2oltp-dev** is listed again. Click on the **labdb2-ibm-db2oltp-dev** link.

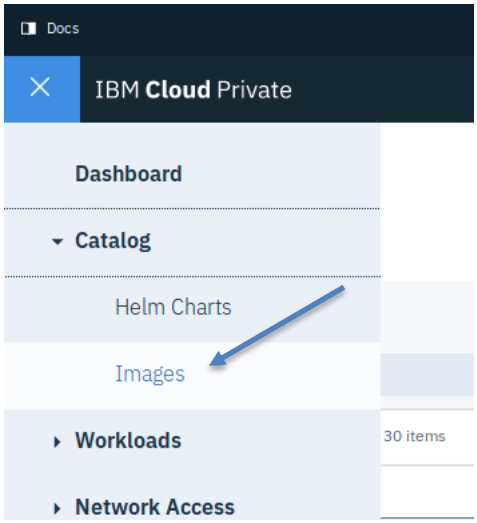


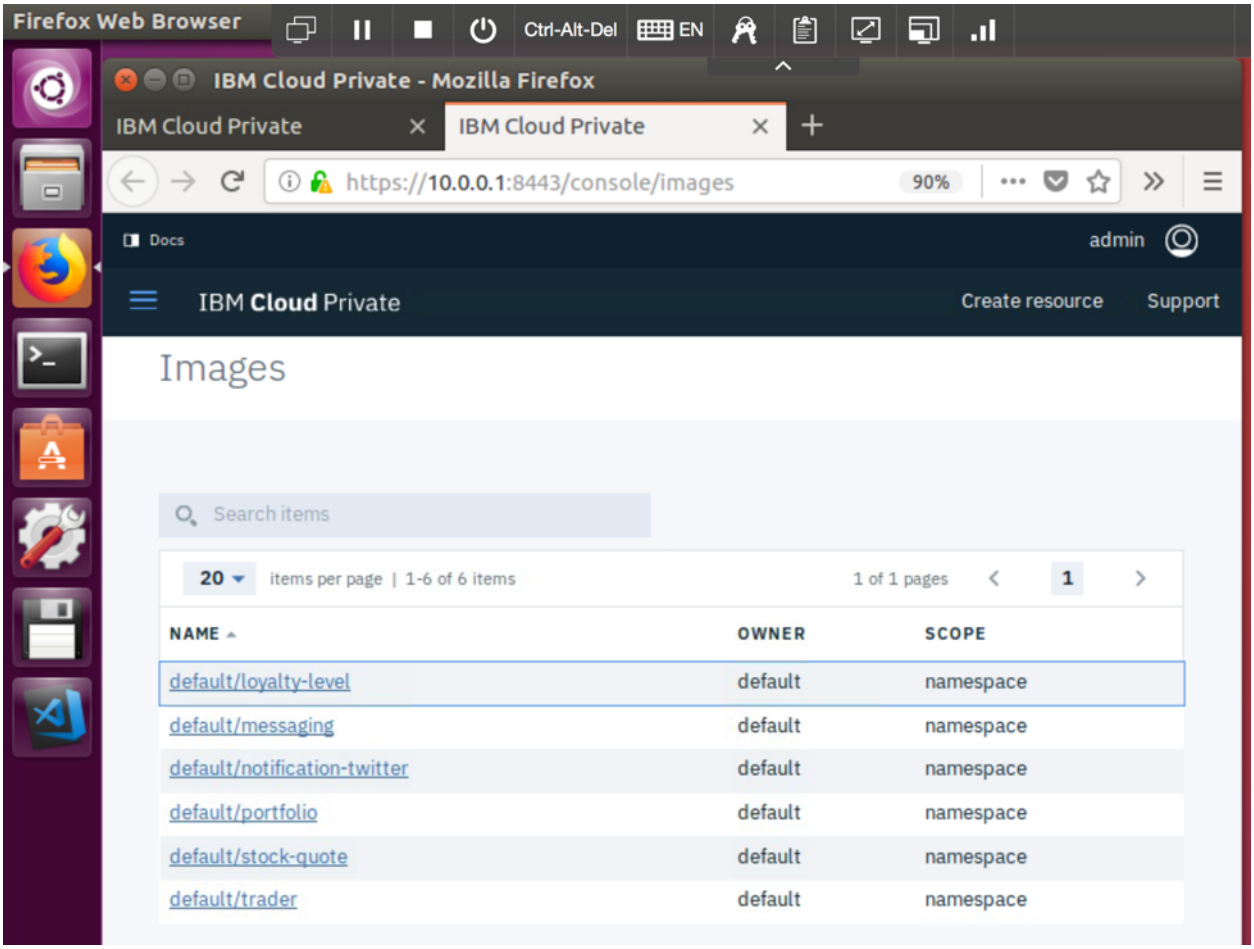


This data indicates that DB2 is exposed within IBM Cloud Private and Kubernetes to other services over port 50000 (the **Port** value) and that it is exposed *externally* at port 30042 (the **Node Port** value). By default, applications and services are not exposed outside of IBM Cloud Private or Kubernetes. They can be exposed to other services internally by specifying a port and externally by exposing a NodePort. IBM Cloud Private and Kubernetes then knows how to route any traffic received on port 30042 to the DB2 container's port 50000.

Back in the Service list you should also see entries for *loyalty-level-service, notification-service, portfolio-service, stock-quote-service,* and *trader-service*.

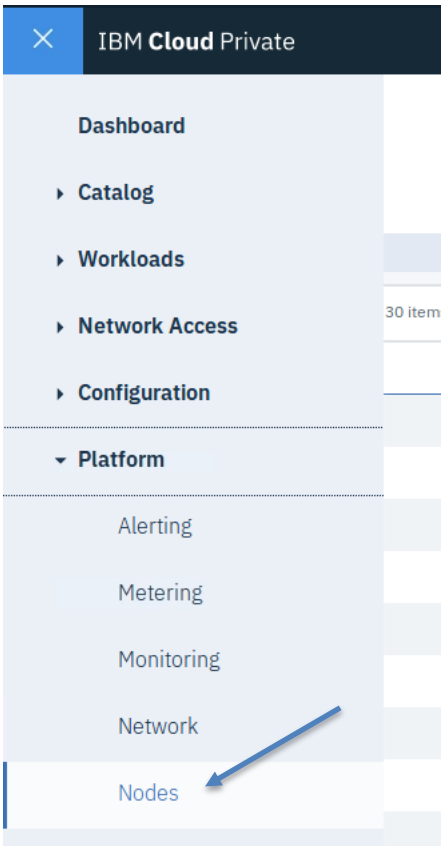
6. Go back to the Menu  , expand **Catalog**, and select **Images**.



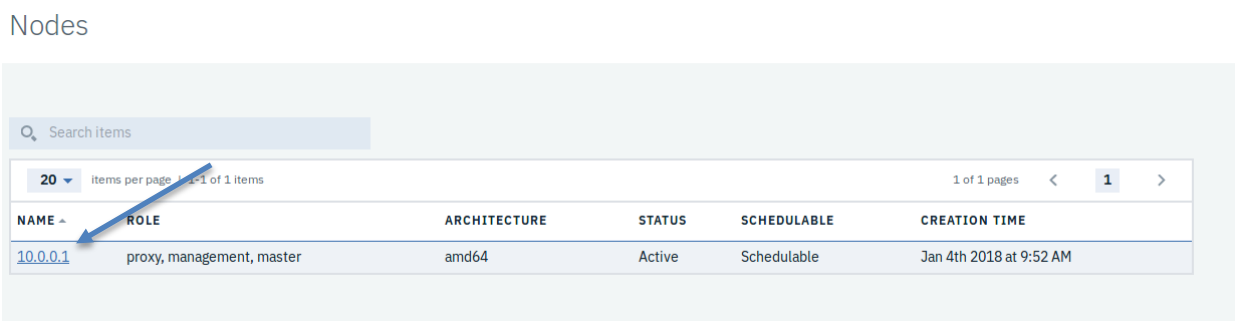


IBM Cloud Private ships with its own Docker Registry. This panel lets you view and interact with the Docker images already in the registry. Here you can see there are six images corresponding to the six microservices which comprise the StockTrader application. Clicking on an image name lets you see the different versions available for a given image along with some metadata about that image.

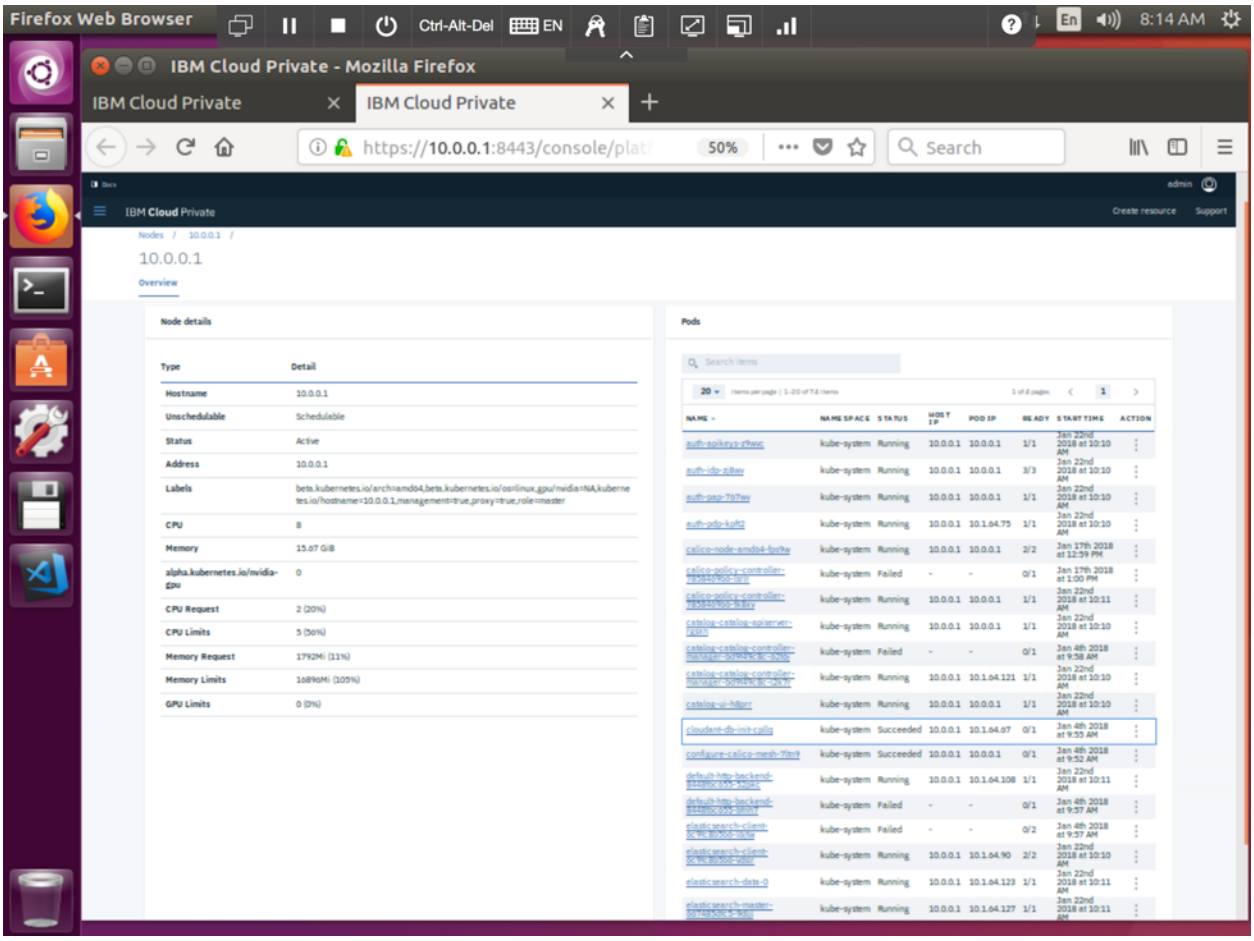
7. Go back to the Menu  expand **Platform**, and select **Nodes**.



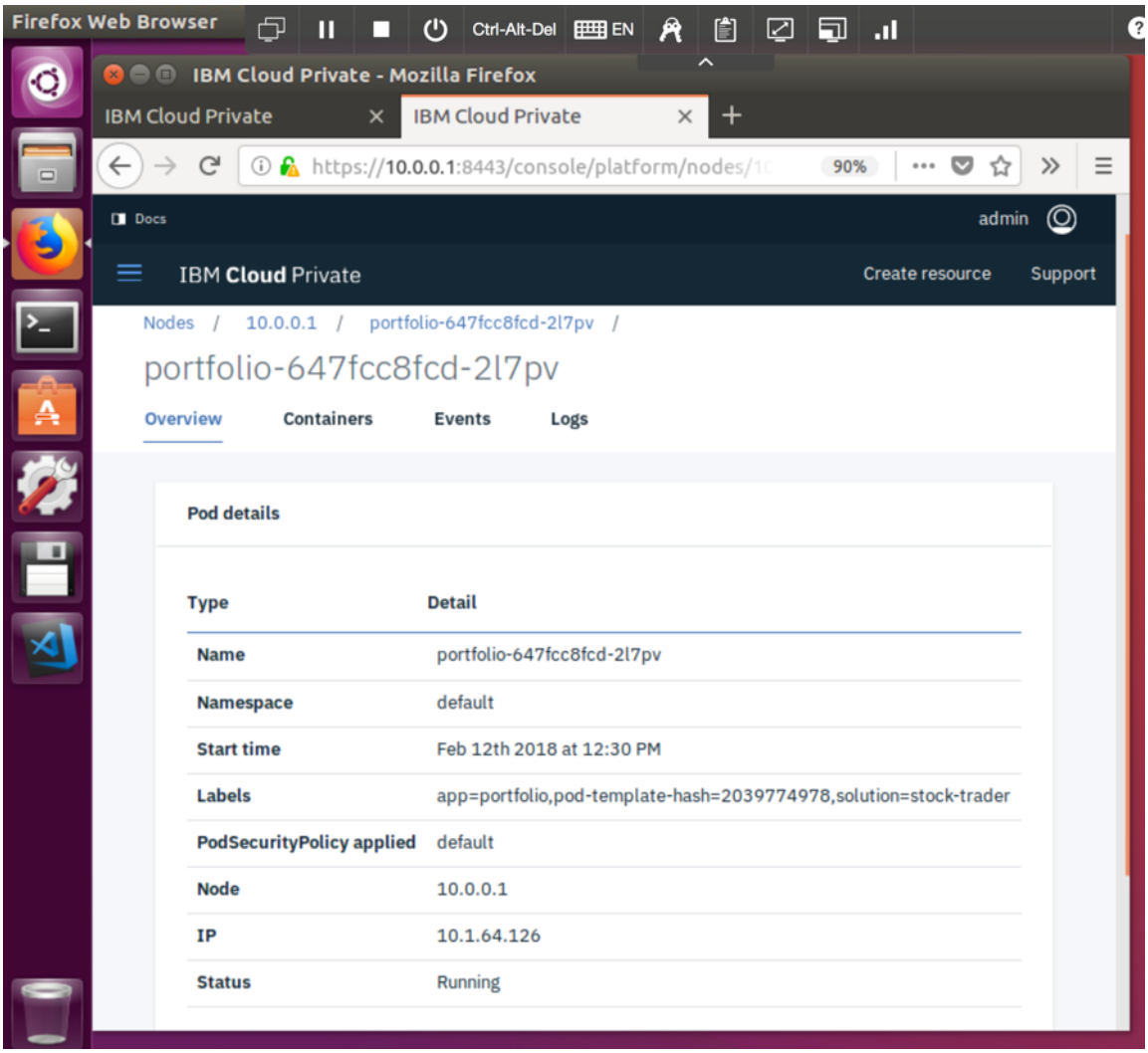
The Nodes page shows all nodes in this Kubernetes cluster, the role they play, their architecture (ICP runs on x86, Power Linux, and zLinux), as well as its status to receive additional deployments.



Since this VM contains all the IBM Cloud Private/Kubernetes roles you see only one node listed at the bottom of the page. If we separated each role into its own virtual machine you would see multiple nodes listed in the table of nodes. If you click on **10.0.0.1** you are taken to the live statistics and currently running workloads on that particular node.

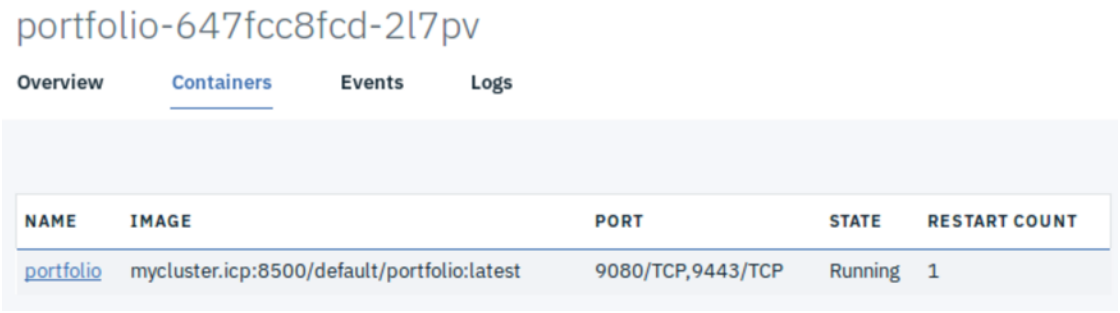


By default, 20 pods are shown per page; you can use the arrows at the top of the Pods section to see the later pages. If you click on a pod name, **portfolio-647fcc8fcd-2l7pv** for example (the generated suffix after **portfolio** may be different in your environment), you can see the details for that pod.

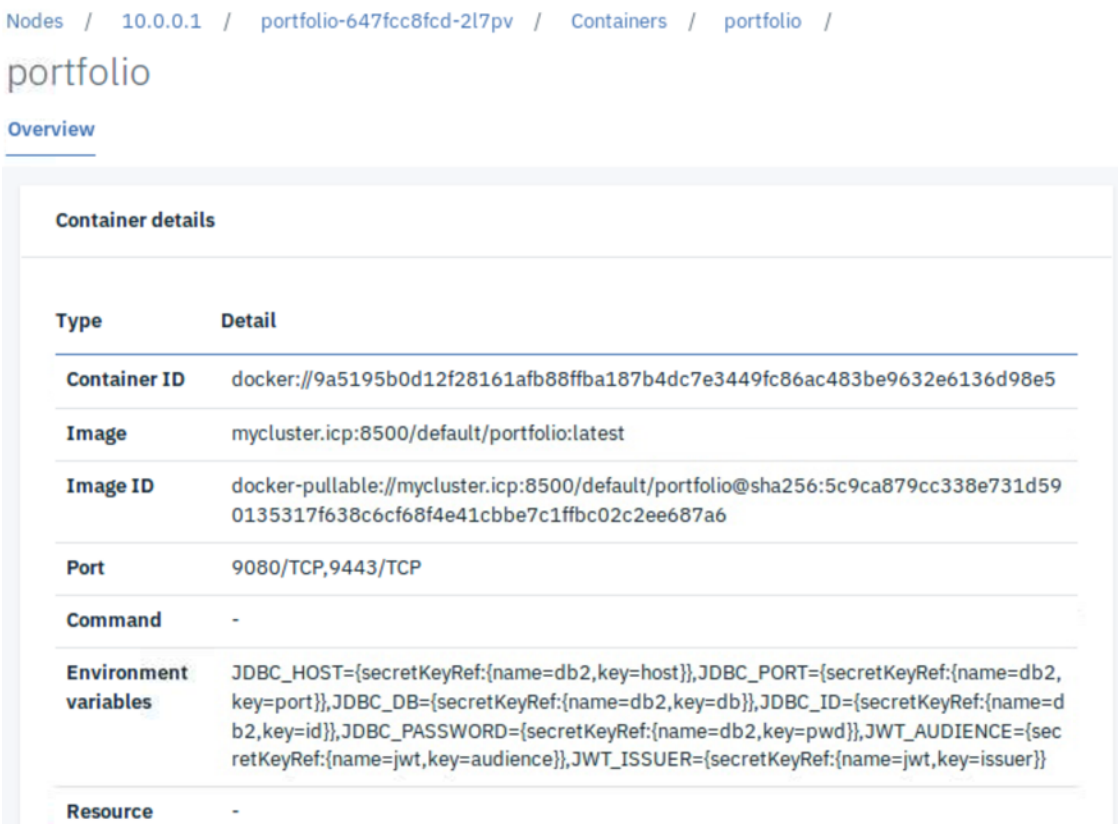


At the top of the pod details screen you will see four tabs with extra information: Overview, Containers, Events, and Logs. The **Overview** tab is shown above.

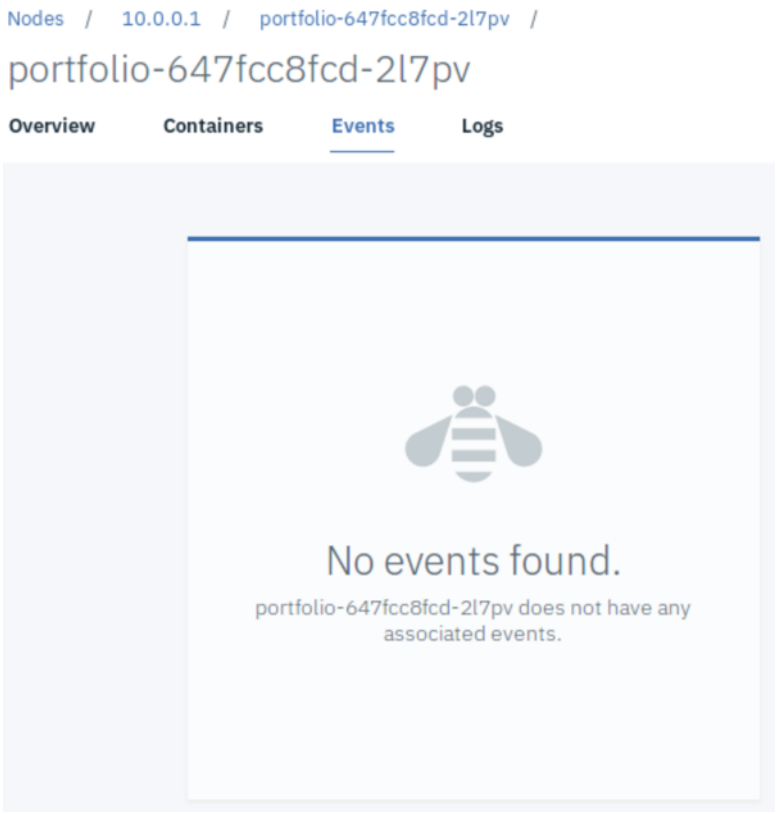
The **Containers** tab shows all the running containers in this pod. For the portfolio pod, there is only one container running.



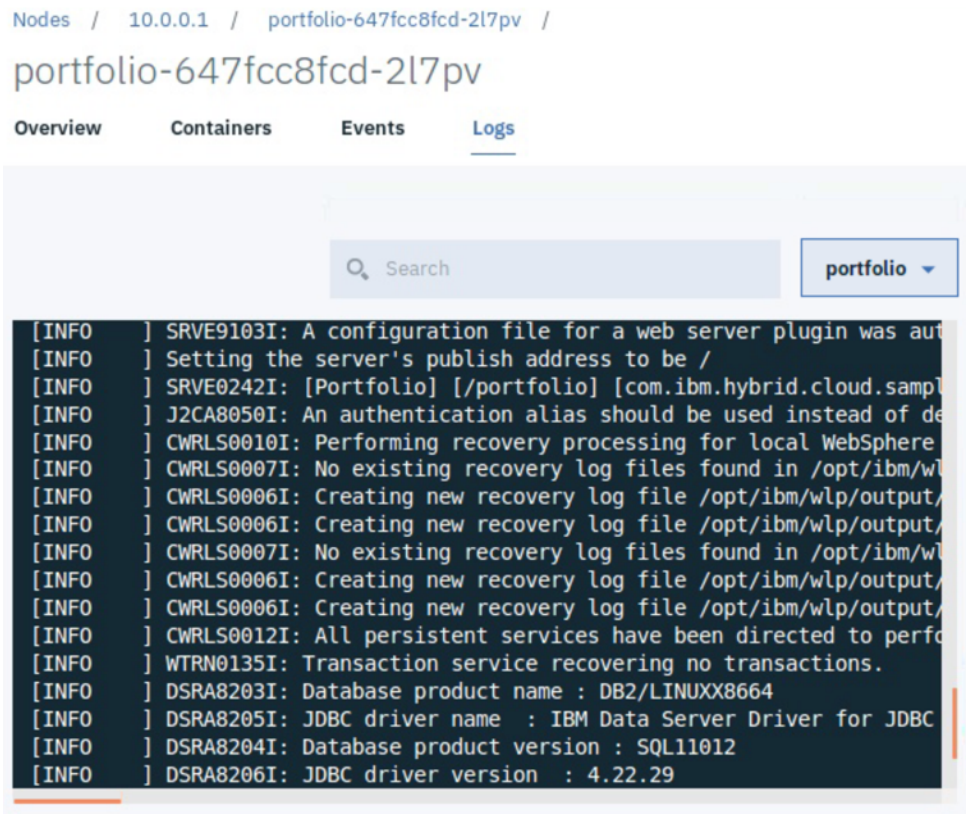
Clicking on the **portfolio** link shows details about that Docker container.



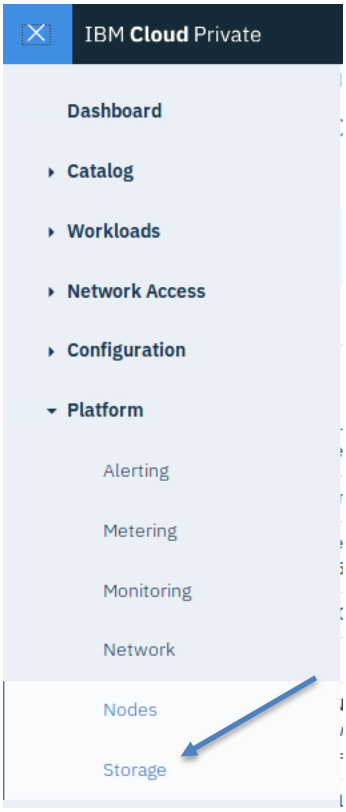
Back on the pod page, the **Events** tab is useful when debugging deployment problems for a given pod. In our case, there were no problems, so it says “No events found”.

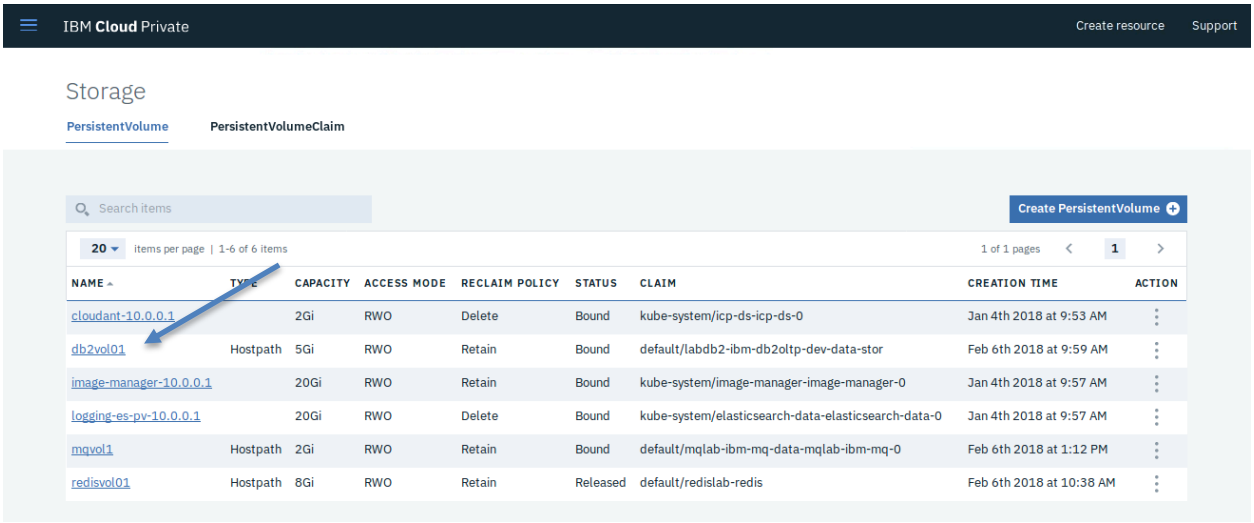


Finally, the **Logs** tab shows you the logs emitted by the container. For Liberty containers, you'll see messages written via Java's `System.out.println()` or methods of `java.util.logging.Logger` (depending on the `consoleLogLevel` set in the `logging` stanza in your microservice's `server.xml`). This is useful for debugging any application, middleware, or container configuration problems.

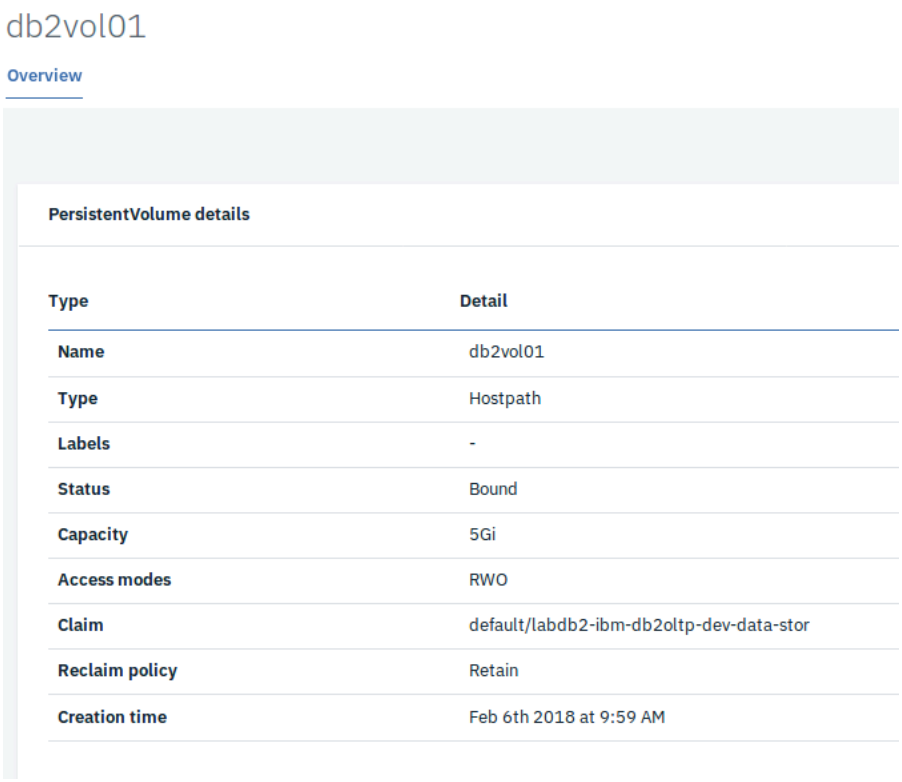


8. Go back to the Menu  expand **Platform**, and select **Storage**.





On this page, you can review the existing PersistentVolumes used by pods. These volumes allow data to exist throughout pod deletion and creation. You can also create new PersistentVolumes on this page.
Note: PersistentVolumes should be created with a highly available file system. For this lab, we are using an NFS server but you could use iSCSI, GlusterFS, or a cloud-provider storage solution.

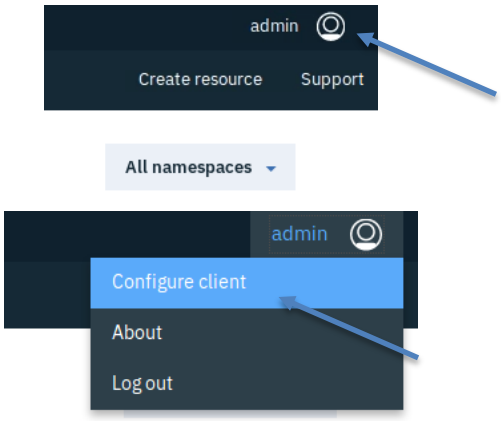


A PersistentVolume is claimed by a pod via a **PersistentVolumeClaim**. A PersistentVolumeClaim is an implementation of claim check pattern for storage. When a pod requires persistent storage it creates a claim against a PersistentVolume to hold that volume exclusively. When the pod finishes using a PersistentVolume (when a pod is deleted for example), the PersistentVolumeClaim is released and the PersistentVolume is made available. You can view the existing claims by clicking the **PersistentVolumeClaim** tab.

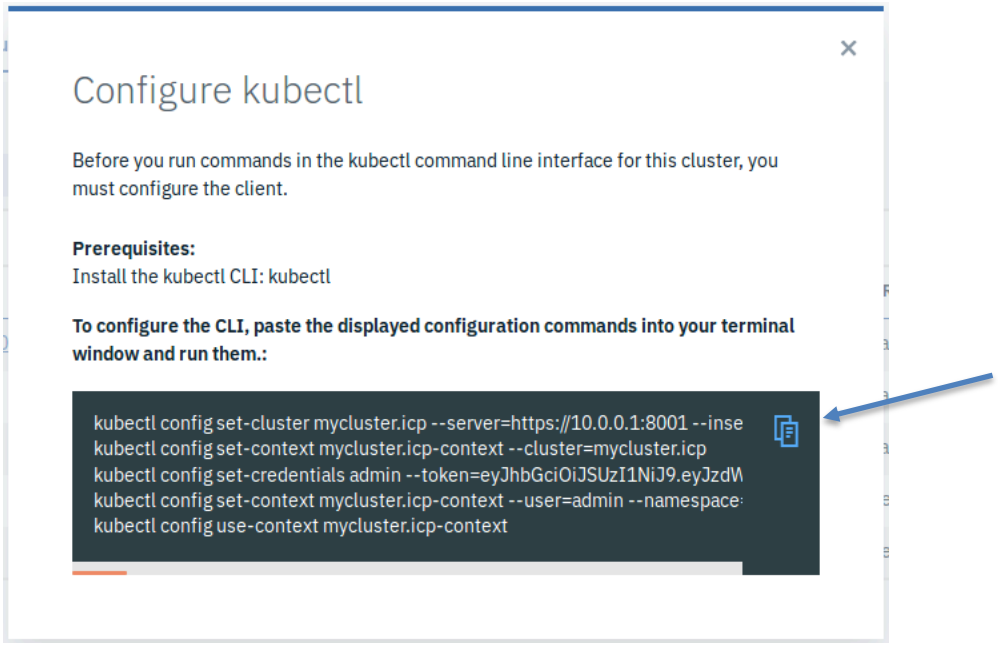
4. Using the Kubernetes CLI

In this section, you will utilize the Kubernetes command line interface, `kubectl`, to view information about the IBM Cloud Private environment, and view information about StockTrader.

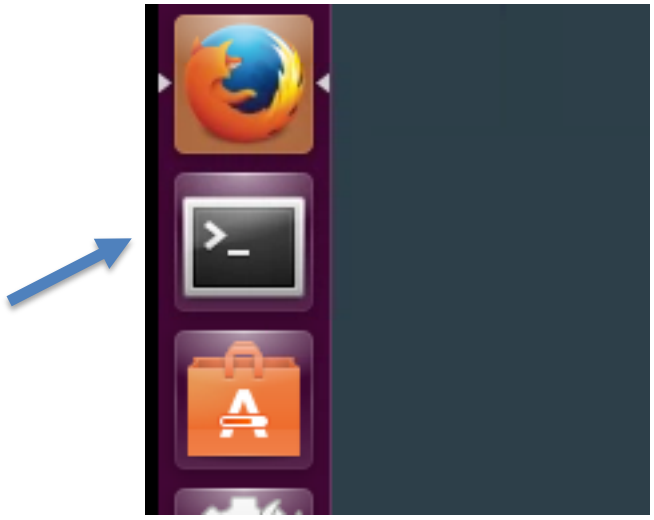
1. Before you can use the CLI you need to configure the command client with some connection information and credentials. You do this by clicking the username, **admin**, in the upper right corner of the web console and selecting **Configure Client**.



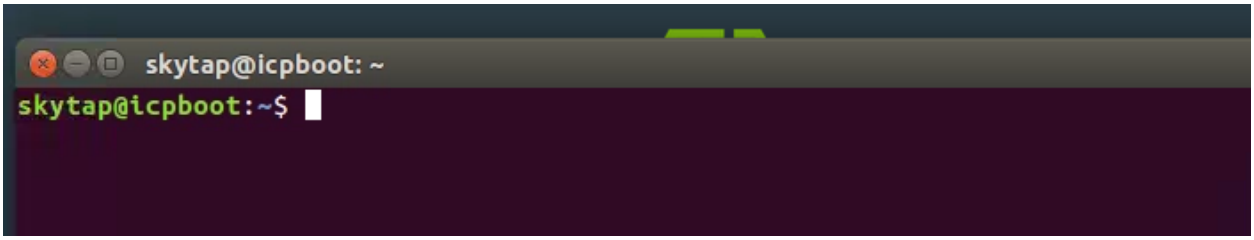
2. In the pop up box that appears, click on the blue icon to the right of the commands to copy them to the clipboard.



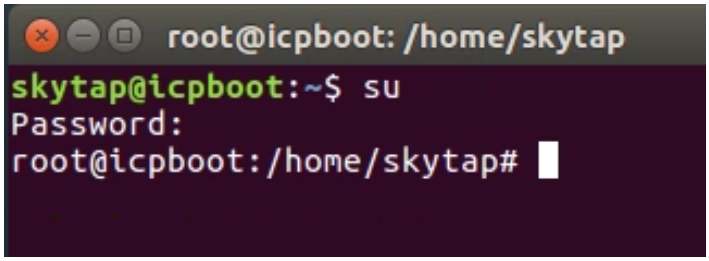
3. Now you need to open a terminal by clicking the Terminal icon in the sidebar on the left side of the screen.



You should now see the terminal appear in front of Firefox:

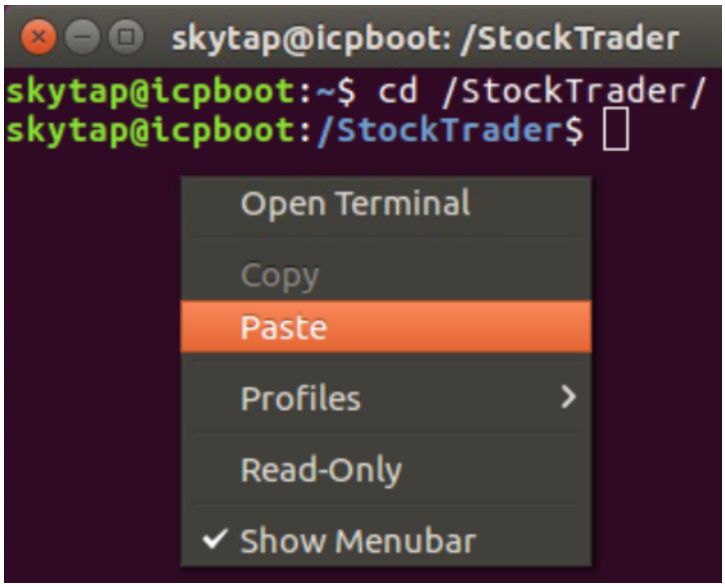


We need to switch to the root user and set up our command line. Type **`su`** and enter **`A1rb0rn3`** as the password.



Now enter the StockTrader directory by entering **`cd /StockTrader`**

4. Right click in the terminal window and select **Paste**. Note that in this Skytap VM, choosing Paste from the right-click menu works better than keyboard shortcuts like Ctrl-V.



This configures `kubectl` to talk to our IBM Cloud Private instance. The last line in the console should read '*Switched to context "mycluster.icp-context"*'.

```
Switched to context "mycluster.icp-context".
skytap@icpboot:/StockTrader$
```

5. First, find all the deployments in IBM Cloud Private. A deployment is a high-level abstraction which manages pods. As mentioned earlier, deployment is equivalent to the Workload/Deployments in the IBM Cloud Private web interface. You'll use deployments later in the lab. You can get the list of current deployments and their status by running **`kubectl get deployments`**

```
skytap@icpboot:/StockTrader$ kubectl get deployments
NAME                    DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
labdb2-ibm-db2oltp-dev  1         1         1            1           9d
loyalty-level           1         1         1            1           3d
messaging               1         1         1            1           8h
notification-twitter    1         1         1            1           7h
portfolio               1         1         1            1           3d
redislab2-redis         1         1         1            1           9d
stock-quote             1         1         1            1           3d
trader                  1         1         1            1           3d
skytap@icpboot:/StockTrader$
```

You will recognize these deployments as the StockTrader application. If you want more information about these deployments, such as what containers and Docker images are associated with a given deployment you can run **`kubectl get deployments -o wide`**

(Remember, if you copy from this document, make sure you select the Skytap clipboard menu item  *and paste the command so the VM adds that text to its clipboard)*

```
NAME                     DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE       CONTAINERS               IMAGES                                                  SELECTOR
labdb2-ibm-db2oltp-dev   1         1         1            1           10d       labdb2-ibm-db2oltp-dev   na.cumulusrepo.com/hcicp_dev/db2server_dec:11.1.2.2b    app=labdb2-ibm-db2oltp-dev
loyalty-level            1         1         1            1           4d        loyalty-level            mycluster.icp:8500/default/loyalty-level:latest         app=loyalty-level,solution=
stock-trader,version=v1
messaging                1         1         1            1           1d        messaging                mycluster.icp:8500/default/messaging:latest             app=messaging,solution=stoc
k-trader
notification-twitter     1         1         1            1           1d        notification-twitter     mycluster.icp:8500/default/notification-twitter:latest  app=notification,solution=s
tock-trader,version=twitter
portfolio                1         1         1            1           4d        portfolio                mycluster.icp:8500/default/portfolio:latest             app=portfolio,solution=stoc
k-trader
redislab2-redis          1         1         1            1           10d       redislab2-redis          bitnami/redis:4.0.7-r0                                  app=redislab2-redis
stock-quote              1         1         1            1           4d        stock-quote              mycluster.icp:8500/default/stock-quote:latest           app=stock-quote,solution=st
ock-trader
trader                   1         1         1            1           4d        trader                   mycluster.icp:8500/default/trader:latest                app=trader,solution=stock-t
rader,version=v1
```

6. For even more information about a deployment you can run `kubectl describe deployment <deploymentName>`. Try it for the *stock-quote* deployment by entering **`kubectl describe deployment stock-quote`**

In the returned data, you should recognize some of the same data from IBM Cloud Private's Workloads > Deployments web interface.

```
skytap@icpboot: /StockTrader
skytap@icpboot:/StockTrader$ kubectl describe deployment stock-quote
Name:                   stock-quote
Namespace:              default
CreationTimestamp:      Mon, 12 Feb 2018 12:33:05 -0800
Labels:                 app=stock-quote
                        solution=stock-trader
Annotations:            deployment.kubernetes.io/revision=1
Selector:               app=stock-quote,solution=stock-trader
Replicas:               1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType:           RollingUpdate
MinReadySeconds:        0
RollingUpdateStrategy:  1 max unavailable, 1 max surge
Pod Template:
  Labels:  app=stock-quote
           solution=stock-trader
  Containers:
   stock-quote:
    Image:  mycluster.icp:8500/default/stock-quote:latest
    Ports:  9080/TCP, 9443/TCP
    Environment:
      REDIS_URL:     <set to the key 'url' in secret 'redis'>         Optional: false
      QUANDL_KEY:    <set to the key 'quandl-key' in secret 'redis'>  Optional: false
      JWT_AUDIENCE:  <set to the key 'audience' in secret 'jwt'>      Optional: false
      JWT_ISSUER:    <set to the key 'issuer' in secret 'jwt'>        Optional: false
    Mounts:          <none>
  Volumes:           <none>
Conditions:
  Type           Status  Reason
  ----           ------  ------
  Available      True    MinimumReplicasAvailable
OldReplicaSets:  <none>
NewReplicaSet:   stock-quote-d7d8c4cf5 (1/1 replicas created)
Events:          <none>
skytap@icpboot:/StockTrader$
```

7. To get the list of pods in IBM Cloud Private type: **`kubectl get pods`**

```
skytap@icpboot:/StockTrader$ kubectl get pods
NAME                                      READY     STATUS    RESTARTS   AGE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   1          9d
loyalty-level-789465954c-gcmkq            1/1       Running   1          3d
messaging-64cf9848ff-wvpg8                1/1       Running   0          9h
mqlab-ibm-mq-0                            1/1       Running   1          9d
notification-twitter-79f4b9f465-h5g6x     1/1       Running   0          8h
portfolio-647fcc8fcd-2l7pv                1/1       Running   1          3d
redislab2-redis-c874b98d9-5q6t6           1/1       Running   1          9d
stock-quote-d7d8c4cf5-5zdwn               1/1       Running   1          3d
trader-5c75688d9-92brf                    1/1       Running   1          3d
skytap@icpboot:/StockTrader$
```

You will notice that this list of pods is shorter than the list reported in the web interface. This is because `kubectl` filters out the Kubernetes system pods by default (you can see all the pods across all namespaces, like the web interface shows by default, by adding the `--all-namespaces` flag, as in `kubectl get pods –all-namespaces`. You will also recognize some of the same pods for StockTrader as from the IBM Cloud Private web interface. If you want the location where the pods are running you can run `kubectl get pods –o wide`

```
skytap@icpboot:/StockTrader$ kubectl get pods -o wide
NAME                                      READY     STATUS    RESTARTS   AGE       IP             NODE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   1          9d        10.1.64.104    10.0.0.1
loyalty-level-789465954c-gcmkq            1/1       Running   1          3d        10.1.64.72     10.0.0.1
messaging-64cf9848ff-wvpg8                1/1       Running   0          9h        10.1.64.99     10.0.0.1
mqlab-ibm-mq-0                            1/1       Running   1          9d        10.1.64.124    10.0.0.1
notification-twitter-79f4b9f465-h5g6x     1/1       Running   0          8h        10.1.64.111    10.0.0.1
portfolio-647fcc8fcd-2l7pv                1/1       Running   1          3d        10.1.64.126    10.0.0.1
redislab2-redis-c874b98d9-5q6t6           1/1       Running   1          9d        10.1.64.67     10.0.0.1
stock-quote-d7d8c4cf5-5zdwn               1/1       Running   1          3d        10.1.64.113    10.0.0.1
trader-5c75688d9-92brf                    1/1       Running   1          3d        10.1.64.115    10.0.0.1
skytap@icpboot:/StockTrader$
```

8. If you need more detail about a pod you can run `kubectl describe pod <podName>` Try it for the *stock-quote* pod by running the following command (note the generated suffix after *stock-quote* might be different in your environment):

   `kubectl describe pod stock-quote-d7d8c4cf5-5zdwn`

```
skytap@icpboot:/StockTrader$ kubectl describe pod stock-quote-d7d8c4cf5-5zdwn
Name:           stock-quote-d7d8c4cf5-5zdwn
Namespace:      default
Node:           10.0.0.1/10.0.0.1
Start Time:     Mon, 12 Feb 2018 12:33:05 -0800
Labels:         app=stock-quote
                pod-template-hash=838470791
                solution=stock-trader
Annotations:    kubernetes.io/created-by={"kind":"SerializedReference","apiVersion":"v1","ref
erence":{"kind":"ReplicaSet","namespace":"default","name":"stock-quote-d7d8c4cf5","uid":"edcf
47cc-1033-11e8-9bc1-005056379c...
                kubernetes.io/psp=default
Status:         Running
IP:             10.1.64.113
Controlled By:  ReplicaSet/stock-quote-d7d8c4cf5
Containers:
  stock-quote:
    Container ID:   docker://234f662014b8e7bdc8a300f5900d9137cb19a45933d868f424f2ebb142c19371
    Image:          mycluster.icp:8500/default/stock-quote:latest
    Image ID:       docker-pullable://mycluster.icp:8500/default/stock-quote@sha256:cf3e59af4
5a065e7cb89a52ac6123bc3d00b7ce3c6e08c3ccfff1dc5aa304f92
    Ports:          9080/TCP, 9443/TCP
    State:          Running
      Started:      Thu, 15 Feb 2018 23:31:55 -0800
    Last State:     Terminated
      Reason:       Error
      Exit Code:    137
      Started:      Mon, 12 Feb 2018 12:33:07 -0800
      Finished:     Tue, 13 Feb 2018 14:07:18 -0800
    Ready:          True
    Restart Count:  1
    Environment:
      REDIS_URL:     <set to the key 'url' in secret 'redis'>         Optional: false
      QUANDL_KEY:    <set to the key 'quandl-key' in secret 'redis'>  Optional: false
      JWT_AUDIENCE:  <set to the key 'audience' in secret 'jwt'>      Optional: false
      JWT_ISSUER:    <set to the key 'issuer' in secret 'jwt'>        Optional: false
```

This provides a lot of container and runtime data for this particular pod. This is useful when debugging problems with pod deployments. Some of this data should look familiar from the deployment information gathered earlier. This pod utilized that data when instantiating itself.

9. You can also gather the node information by running **`kubectl get nodes`** and **`kubectl describe node <nodeName>`**

```
skytap@icpboot:/StockTrader$ kubectl get nodes
NAME        STATUS    ROLES     AGE       VERSION
10.0.0.1    Ready     <none>    42d       v1.8.3+icp+ee
skytap@icpboot:/StockTrader$
```

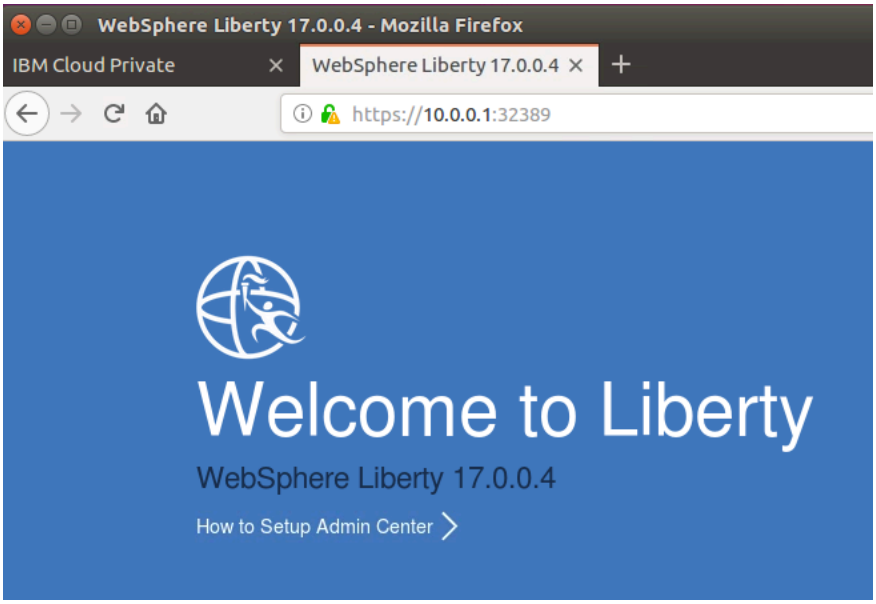
The `kubectl describe node` command can be rather verbose so you must scroll up in the terminal to see everything. The data returned is very similar to the graphs you saw in IBM Cloud Private's Node page in the web interface.

```
skytap@icpboot:/StockTrader$ kubectl describe node 10.0.0.1
Name:               10.0.0.1
Roles:              <none>
Labels:             beta.kubernetes.io/arch=amd64
                    beta.kubernetes.io/os=linux
                    gpu/nvidia=NA
                    kubernetes.io/hostname=10.0.0.1
                    management=true
                    proxy=true
                    role=master
Annotations:        alpha.kubernetes.io/provided-node-ip=10.0.0.1
                    node.alpha.kubernetes.io/ttl=0
                    volumes.kubernetes.io/controller-managed-attach-detach=true
Taints:             <none>
CreationTimestamp:  Thu, 04 Jan 2018 09:52:21 -0800
Conditions:
  Type             Status  LastHeartbeatTime                 LastTransitionTime
        Reason                          Message
  ----             ------  -----------------                 ------------------
        ------                          -------
  OutOfDisk        False   Fri, 16 Feb 2018 09:38:37 -0800   Thu, 04 Jan 2018 09:52:21
-0800   KubeletHasSufficientDisk     kubelet has sufficient disk space available
  MemoryPressure   False   Fri, 16 Feb 2018 09:38:37 -0800   Fri, 16 Feb 2018 06:58:43
-0800   KubeletHasSufficientMemory   kubelet has sufficient memory available
  DiskPressure     False   Fri, 16 Feb 2018 09:38:37 -0800   Fri, 16 Feb 2018 06:58:43
-0800   KubeletHasNoDiskPressure     kubelet has no disk pressure
  Ready            True    Fri, 16 Feb 2018 09:38:37 -0800   Fri, 16 Feb 2018 06:58:43
-0800   KubeletReady                 kubelet is posting ready status. AppArmor enabled
Addresses:
  InternalIP:  10.0.0.1
  Hostname:    10.0.0.1
Capacity:
 cpu:     8
 memory:  16431908Ki
 pods:    110
```

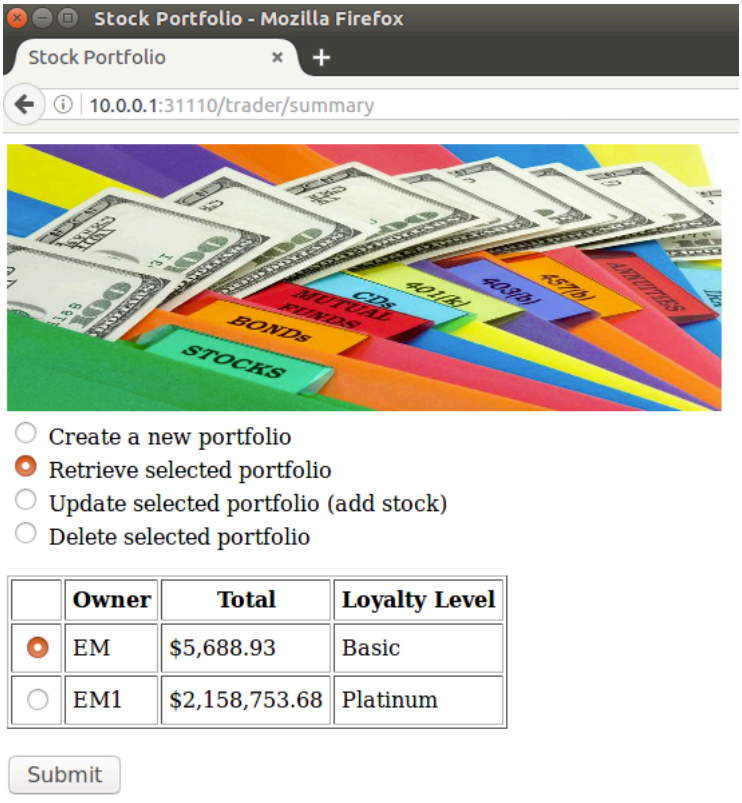
10. What if you've just deployed StockTrader to IBM Cloud Private and need to know which external port you should use when accessing StockTrader's web interface? You can determine the port by running **`kubectl get services`**

```
skytap@icpboot:/StockTrader$ kubectl get services
NAME                    TYPE        CLUSTER-IP    EXTERNAL-IP   PORT(S)                          AGE
kubernetes              ClusterIP   10.0.0.1      <none>        443/TCP                          42d
labdb2-ibm-db2oltp-dev  NodePort    10.0.0.14     <none>        50000:30042/TCP,55000:32070/TCP  9d
loyalty-level-service   NodePort    10.0.0.95     <none>        9080:31181/TCP,9443:32143/TCP    3d
mqlab-ibm-mq            NodePort    10.0.0.205    <none>        1414:30016/TCP,9443:32343/TCP    9d
notification-service    NodePort    10.0.0.231    <none>        9080:30043/TCP,9443:32046/TCP    8h
portfolio-service       NodePort    10.0.0.186    <none>        9080:31066/TCP,9443:32709/TCP    3d
redislab2-redis         NodePort    10.0.0.151    <none>        6379:31803/TCP                   9d
stock-quote-service     NodePort    10.0.0.169    <none>        9080:30302/TCP,9443:30826/TCP    3d
trader-service          NodePort    10.0.0.152    <none>        9080:32388/TCP,9443:32389/TCP    3d
```

We know that the *trader* microservice provides the user interface so we check the table for *trader-service.* Here you see that *trader-service*'s port 9443 (Liberty's default HTTPS port) is exposed to the outside world at port **32389**. If you go back to Firefox and enter https://**10.0.0.1:32389** you should see the "Welcome to Liberty" splash page.



If you add **/trader** to the end of the URL you should be redirected to the StockTrader user interface.



5. Edit and Deploy a New Version of a StockTrader Micro-Service

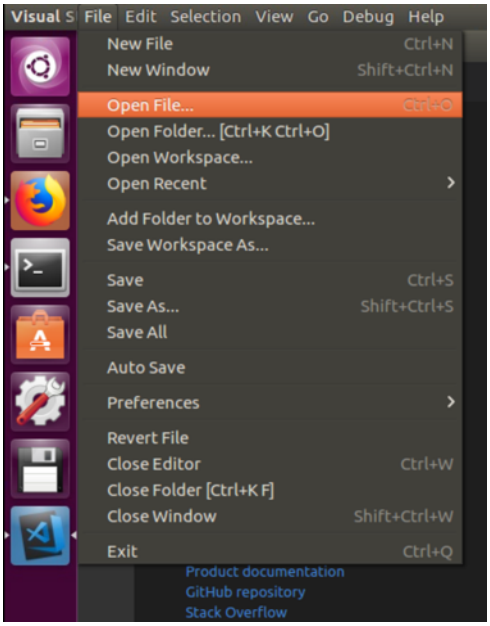
Earlier you saw how a tweet gets sent out when a portfolio's loyalty level changes. As a reminder, here's an example tweet, showing the message that the version of *notification-twitter* in GitHub (and on the lab VM) produces:

Update Code

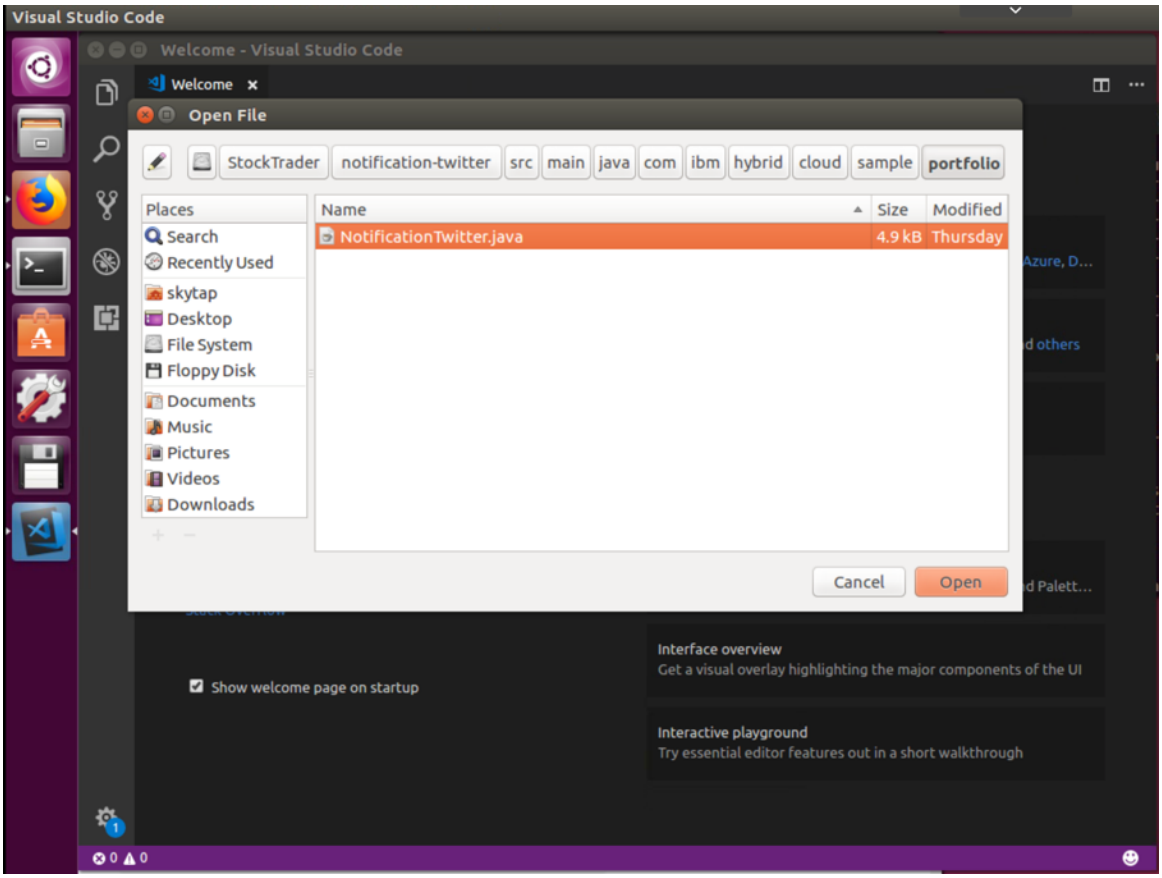
Let's go update that message, so we can see the process for how to build and deploy a new version of a microservice. First, open up the **VS Code** editor (https://code.visualstudio.com), which is pre-installed in the lab VM image, via the blue icon on the left palette:

You could use another editor if you prefer, like **nano** or **vi**, but I recommend **VS Code** (with its Java language extension installed) since it understands Java and will provide code highlighting and instant reporting of syntax errors.

Choose **File->Open File…** from the menu bar at the top of the screen:



Navigate to `/StockTrader/notification-twitter/src/main/java/com/ibm/hybrid/cloud/sample/portfolio/NotficationTwitter.java`



Notice how the time stamp in the tweet is in the *UTC* (London) time zone? Since this conference takes place in the *US Pacific Standard Time* (PST) time zone, let's edit the code to send the tweet in PST instead. Go to line 106 (in the **initialize()** method) and let's make two changes. First, replace the "UTC" with "PST" in the **SimpleDateFormat** constructor. Then add a line right under that one which says:

```
format.setTimeZone(java.util.TimeZone.getTimeZone("PST"));
```

(you could use the more formal "`America/Los_Angeles`" in place of "`PST`" if you desire). The `initialize()` method should now look like this:

NotificationTwitter.java

```
92      private void initialize() {
93          logger.fine("Initializing Twitter API");
94
95          ConfigurationBuilder builder = new ConfigurationBuilder();
96          builder.setDebugEnabled(true);
97          builder.setOAuthConsumerKey(System.getenv("TWITTER_CONSUMER_KEY"));
98          builder.setOAuthConsumerSecret(System.getenv("TWITTER_CONSUMER_SECRET"));
99          builder.setOAuthAccessToken(System.getenv("TWITTER_ACCESS_TOKEN"));
100         builder.setOAuthAccessTokenSecret(System.getenv("TWITTER_ACCESS_TOKEN_SECRET"));
101
102         TwitterFactory factory = new TwitterFactory(builder.build());
103         twitter = factory.getInstance(); //initialize twitter4j
104
105         //Example: Monday, October 16, 2017 at 3:45 PM UTC
106         format = new SimpleDateFormat("EEEE, MMMM d, yyyy 'at' h:mm a 'PST'");
107         format.setTimeZone(java.util.TimeZone.getTimeZone("PST"));
108
109         logger.fine("Initialization completed successfully!");
110         initialized = true;
111     }
```

Let's also include the hashtag for the conference. The Think conference is known by `#Think2018`, so let's go add that to the tweet message, in line 120 (I split the line for readability). Then save the file. Here's what the new tweet() method looks like after that:

NotificationTwitter.java

```
113     /** Tweet a message to our @IBMStockTrader account.
114      * @throws TwitterException
115      */
116     private String tweet(String owner, String oldLoyalty, String loyalty) throws TwitterException {
117         if (!initialized) initialize();
118
119         Date now = new Date();
120         String message = "On "+format.format(now)+", "+owner+" changed status from "+oldLoyalty+
121             " to "+loyalty+". #IBMStockTrader #Think2018";
122
123         logger.fine("Sending following tweet: "+message);
124         twitter.updateStatus(message);
125
126         logger.info("Message tweeted successfully!");
127         return message;
128     }
```

Build the project

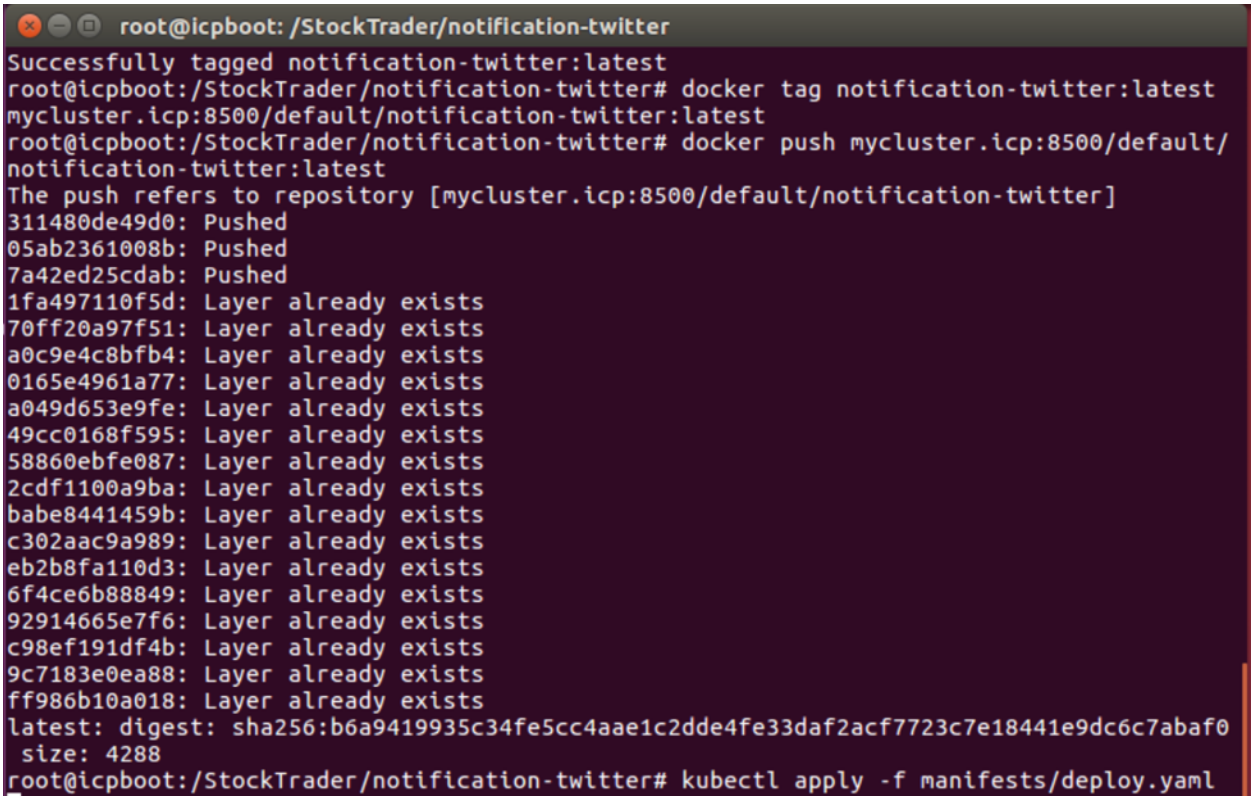
Now return to the Terminal window (where "`su`" has been run), switch to the `/StockTrader/notification-twitter` directory, and run "`mvn package`".

```
skytap@icpboot:~$ cd /StockTrader/notification-twitter/
skytap@icpboot:/StockTrader/notification-twitter$ su
Password:
root@icpboot:/StockTrader/notification-twitter# mvn package
```

That command produces several screens of output. Once it completes, you should see output like the following. If so, then run "`docker build -t notification-twitter .`" (note the trailing dot, meaning current directory), as shown below:

```
[INFO] ------------------------------------------------------------------------
[INFO] BUILD SUCCESS
[INFO] ------------------------------------------------------------------------
[INFO] Total time: 43.497 s
[INFO] Finished at: 2018-02-18T04:53:48-08:00
[INFO] Final Memory: 16M/144M
[INFO] ------------------------------------------------------------------------
root@icpboot:/StockTrader/notification-twitter# docker build -t notification-twitter .
```

This make take a couple of minutes. When it completes, run "`docker tag notification-twitter:latest mycluster.icp:8500/default/notification-twitter:latest`", followed by "`docker push mycluster.icp:8500/default/notification-twitter:latest`".



Deploy to IBM Cloud Private

We now have the updated microservice in the Docker image registry. So we're ready to deploy the updates to IBM Cloud Private. First, let's undeploy the old version, via "`kubectl delete -f manifests/deploy.yaml`". Then do a "`kubectl get pods`" to confirm it's gone. Then you can do a "`kubectl create -f manifests/deploy.yaml`", and another "`kubectl get pods`" to confirm the new version is deployed and running.

```
root@icpboot: /StockTrader/notification-twitter
root@icpboot:/StockTrader/notification-twitter# kubectl delete -f manifests/deploy.yaml

deployment "notification-twitter" deleted
service "notification-service" deleted
ingress "notification-ingress" deleted
root@icpboot:/StockTrader/notification-twitter# kubectl get pods
NAME                                  READY     STATUS    RESTARTS   AGE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   2          11d
loyalty-level-789465954c-gcmkq            1/1       Running   2          5d
messaging-64cf9848ff-wvpg8                1/1       Running   1          2d
mqlab-ibm-mq-0                            1/1       Running   2          11d
portfolio-647fcc8fcd-sqxtm                1/1       Running   1          14h
redislab3-redis-7887cb7c46-qqqkp          1/1       Running   7          1d
stock-quote-d7d8c4cf5-vw2cl               1/1       Running   1          1d
trader-5c75688d9-8mjpd                    1/1       Running   1          14h
root@icpboot:/StockTrader/notification-twitter# kubectl create -f manifests/deploy.yaml
deployment "notification-twitter" created
service "notification-service" created
ingress "notification-ingress" created
root@icpboot:/StockTrader/notification-twitter# kubectl get pods
NAME                                  READY     STATUS    RESTARTS   AGE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   2          11d
loyalty-level-789465954c-gcmkq            1/1       Running   2          5d
messaging-64cf9848ff-wvpg8                1/1       Running   1          2d
mqlab-ibm-mq-0                            1/1       Running   2          11d
notification-twitter-79f4b9f465-nhzcl     1/1       Running   0          13s
portfolio-647fcc8fcd-sqxtm                1/1       Running   1          14h
redislab3-redis-7887cb7c46-qqqkp          1/1       Running   7          1d
stock-quote-d7d8c4cf5-vw2cl               1/1       Running   1          1d
trader-5c75688d9-8mjpd                    1/1       Running   1          14h
root@icpboot:/StockTrader/notification-twitter#
```

Run the code

Now go add some stock to cause a change in loyalty level, and then take a look at the new tweet.

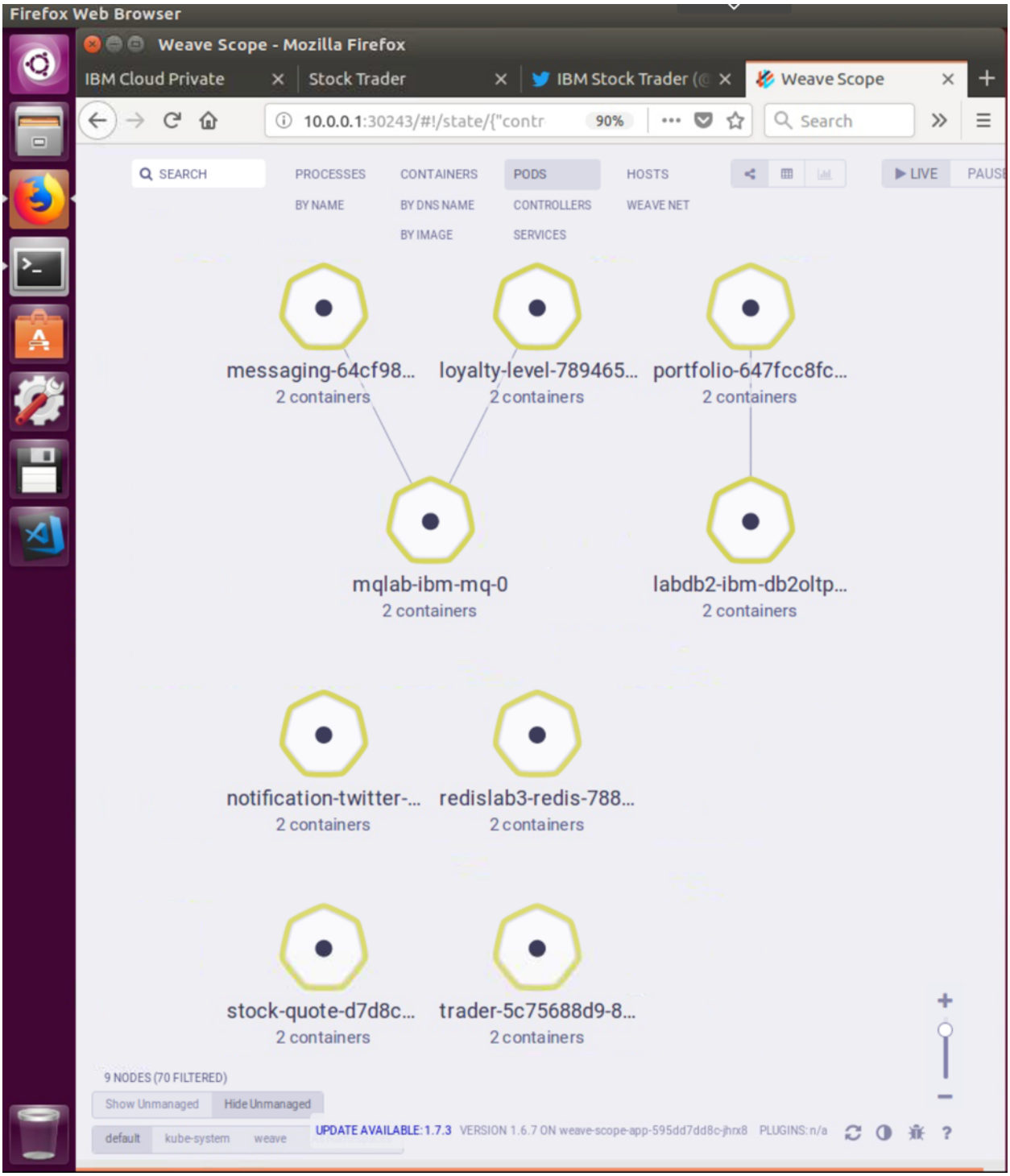
Congratulations, you've now seen the full edit->compile->deploy->run cycle for a microservice in IBM Cloud Private. But before we wrap up this section, let's do one more thing. Let's deploy a tool that will show the various microservice interactions that led from you clicking in the browser to the tweet getting sent, which is a fairly long call path.

Visualize the interactions

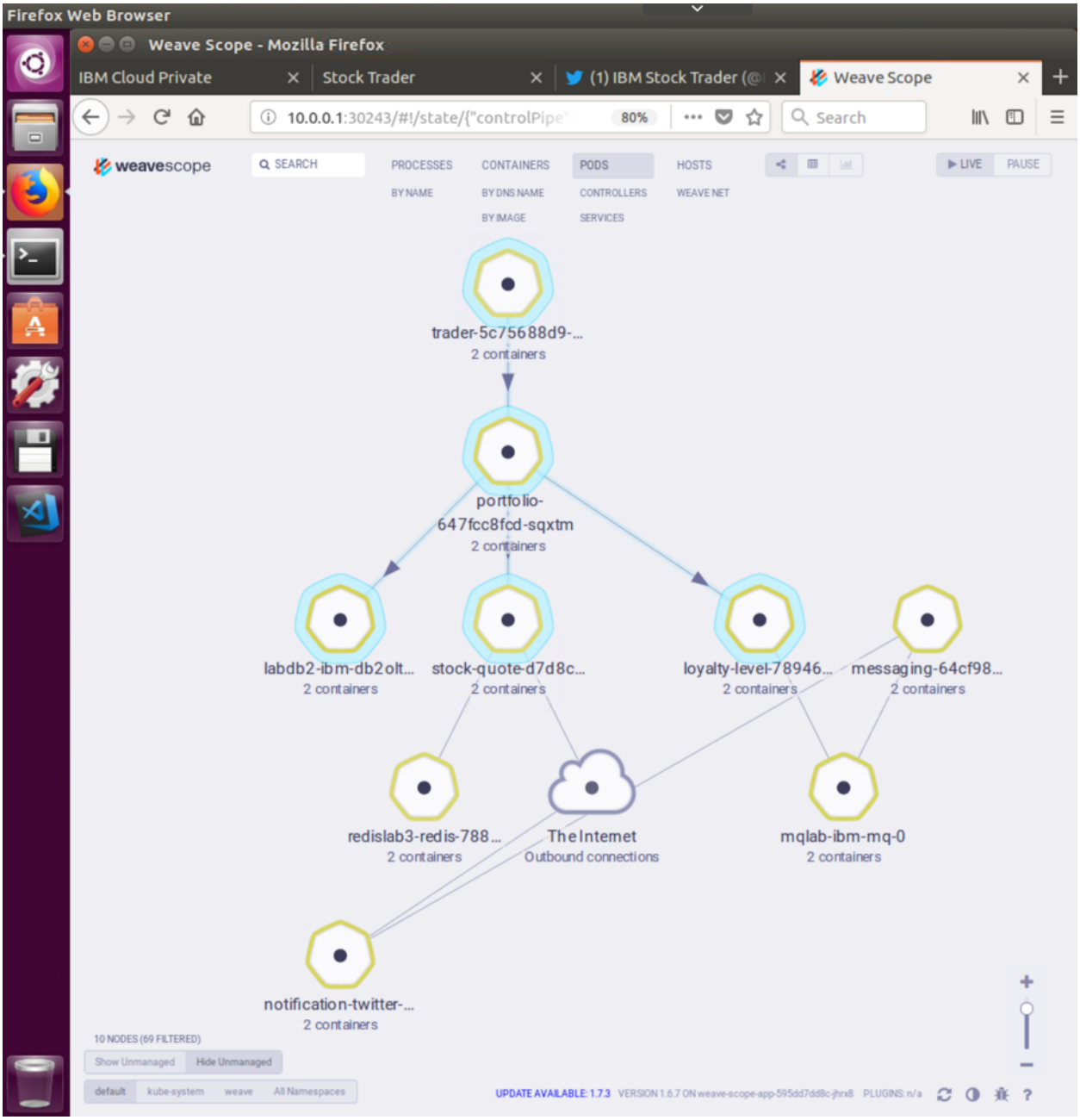
WeaveWorks has a cool tool (https://www.weave.works/docs/net/latest/kubernetes/kube-addon/) that plugs in to Kubernetes, that among other things provides dynamic discovery and visualization of interaction between the pods. For convenience, the lab VM has its deployment yaml already downloaded and in the `/StockTrader` directory. Just go there and run "`kubectl create -f weave.yaml`". This will create a new "`weave`" namespace (rather than dumping everything in the "`default`" namespace, like where StockTrader is) and creates several resources in that namespace. We'll have to use the "`-n`" flag to kubectl to tell it to target that new namespace. For example, you can run "**`kubectl get pods -n weave`**" to see the new pods it made available, and "**`kubectl get services -n weave`**" to see its service, which will tell you the node port that you need to enter in the browser to access its UI.

```
skytap@icpboot:/StockTrader$ ls
loyalty-level  notification-twitter  stock-quote  weave.yaml
messaging      portfolio             trader
skytap@icpboot:/StockTrader$ kubectl create -f weave.yaml
namespace "weave" created
serviceaccount "weave-scope" created
clusterrole "weave-scope" created
clusterrolebinding "weave-scope" created
deployment "weave-scope-app" created
service "weave-scope-app" created
daemonset "weave-scope-agent" created
skytap@icpboot:/StockTrader$ kubectl get pods -n weave
NAME                              READY     STATUS    RESTARTS   AGE
weave-scope-agent-zrzlb           1/1       Running   0          30s
weave-scope-app-595dd7dd8c-jhrx8  1/1       Running   0          30s
skytap@icpboot:/StockTrader$ kubectl get services -n weave
NAME              TYPE       CLUSTER-IP    EXTERNAL-IP   PORT(S)        AGE
weave-scope-app   NodePort   10.0.0.186    <none>        80:30243/TCP   40s
```

As you can see in this example, it got assigned a node port of 30243 (you may get a different value when you run this – if so, use that instead). So let's go back to Firefox and hit http://10.0.0.1:30243 and give it a try. At first it shows way too much, so let's filter it down to just what we want, by clicking **Pods** in the top middle, and clicking on the **default** namespace at the bottom left:



So we can see our pods, but with the app “at rest”, the only connections it could discover were the ones to DB2 and MQ (the non-http connections). So now let’s go use the Stock Trader app, making sure to cause a change in loyalty level. Then quickly return to this tab, since some of the http links between pods disappear after only a few seconds. If you hover over a pod, it will highlight and the links to and from it become directional arrows, such as when I hovered over the portfolio pod.



So other than being oriented top down rather than left to right, this dynamically discovered diagram (*note: yours may layout differently, but should have the same connections between nodes*) does exactly match my PowerPoint slide shown at the very beginning of the lab, showing who calls whom, who uses the prereqs like DB2, MQ and Redis, and who reaches out to services on the internet (note the link from `messaging` to `notification-twitter` only appears to go through the internet – really, that's just a sloppy layout thing). Plugins to Kubernetes, like this Weave tool, can help you view and manage things at an application level, rather than dealing with machines, memory, networks, etc.

6. Scaling StockTrader

Scaling deployments in IBM Cloud Private can occur in a few different places: the IBM Cloud Private web interface, the kubectl command line, or the Kubernetes management console (not shown in this lab). Within those places there are two different methods of scaling up and down. First, you can directly tell IBM Cloud Private and Kubernetes to scale up or down the deployment. Alternatively, if you find that you always have to change the number of replicas for a given service you can provide an updated deployment YAML file with a new `replicas` value to IBM Cloud Private and Kubernetes. This allows you to version control your configuration in an external source code repository and track changes which occur over time. We will focus on scaling directly via the command line in this lab.

1. Now let's scale up the number of instances for the *trader* microservice. Back in the terminal enter the command **`kubectl get deployments`** again.

```
skytap@icpboot:/StockTrader$ kubectl get deployments
NAME                      DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
labdb2-ibm-db2oltp-dev    1         1         1            1           11d
loyalty-level             1         1         1            1           5d
messaging                 1         1         1            1           2d
notification-twitter      1         1         1            1           1d
portfolio                 1         1         1            1           9h
redislab3-redis           1         1         1            1           1d
stock-quote               1         1         1            1           5d
trader                    1         1         1            1           9h
```

Notice that the *trader* service currently expects and has a single container supporting it. Let's try scaling up *trader* by running the command

`kubectl scale --replicas=3 deployment trader`

```
skytap@icpboot:/StockTrader$ kubectl scale --replicas=3 deployment trader
deployment "trader" scaled
```

If you re-run **`kubectl get deployments`** you should now see there are three containers as part of the *trader* deployment.

```
skytap@icpboot:/StockTrader$ kubectl get deployments
NAME                      DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
labdb2-ibm-db2oltp-dev    1         1         1            1           11d
loyalty-level             1         1         1            1           5d
messaging                 1         1         1            1           2d
notification-twitter      1         1         1            1           1d
portfolio                 1         1         1            1           9h
redislab3-redis           1         1         1            1           1d
stock-quote               1         1         1            1           5d
trader                    3         3         3            3           9h
```

Also, if you run **`kubectl get pods`** you should now see three separate *trader* pods.

```
skytap@icpboot:/StockTrader$ kubectl get pods
NAME                                    READY     STATUS    RESTARTS   AGE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   1          11d
loyalty-level-789465954c-gcmkq          1/1       Running   1          5d
messaging-64cf9848ff-wvpg8              1/1       Running   0          2d
mqlab-ibm-mq-0                          1/1       Running   1          11d
notification-twitter-79f4b9f465-h5g6x   1/1       Running   0          1d
portfolio-647fcc8fcd-sqxtm              1/1       Running   0          9h
redislab3-redis-7887cb7c46-qqqkp        1/1       Running   6          1d
stock-quote-d7d8c4cf5-vw2cl             1/1       Running   0          1d
trader-5c75688d9-8mjpd                  1/1       Running   0          9h
trader-5c75688d9-dpvqd                  1/1       Running   0          3m
trader-5c75688d9-tbnx9                  1/1       Running   0          3m
```

2. To scale down the number of trader pods you can run

`kubectl scale --replicas=1 deployment/trader`

```
skytap@icpboot:/StockTrader$ kubectl scale --replicas=1 deployment trader
deployment "trader" scaled
```

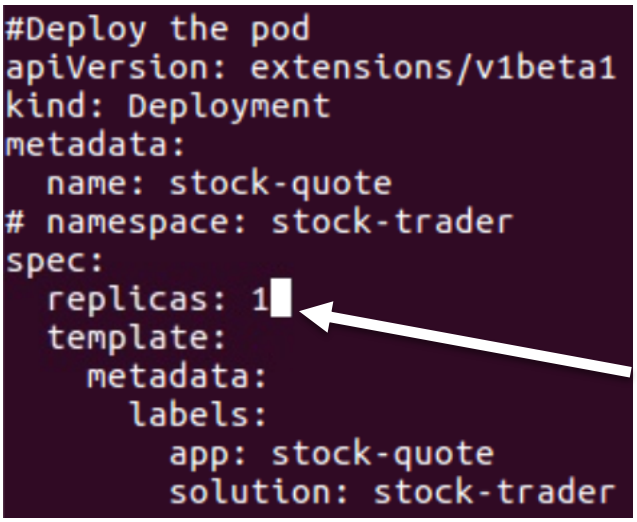
And if you re-run **`kubectl get deployments`** and **`kubectl get pods`** you see the new values for *trader*.

```
skytap@icpboot:/StockTrader$ kubectl get deployments
NAME                   DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
labdb2-ibm-db2oltp-dev   1         1         1            1           11d
loyalty-level          1         1         1            1           5d
messaging              1         1         1            1           2d
notification-twitter   1         1         1            1           1d
portfolio              1         1         1            1           9h
redislab3-redis        1         1         1            1           1d
stock-quote            1         1         1            1           5d
trader                 1         1         1            1           9h
skytap@icpboot:/StockTrader$ kubectl get pods
NAME                                    READY     STATUS    RESTARTS   AGE
labdb2-ibm-db2oltp-dev-6dfcb56b8d-r6dg9   1/1       Running   1          11d
loyalty-level-789465954c-gcmkq          1/1       Running   1          5d
messaging-64cf9848ff-wvpg8              1/1       Running   0          2d
mqlab-ibm-mq-0                          1/1       Running   1          11d
notification-twitter-79f4b9f465-h5g6x   1/1       Running   0          1d
portfolio-647fcc8fcd-sqxtm              1/1       Running   0          9h
redislab3-redis-7887cb7c46-qqqkp        1/1       Running   6          1d
stock-quote-d7d8c4cf5-vw2cl             1/1       Running   0          1d
trader-5c75688d9-8mjpd                  1/1       Running   0          9h
```

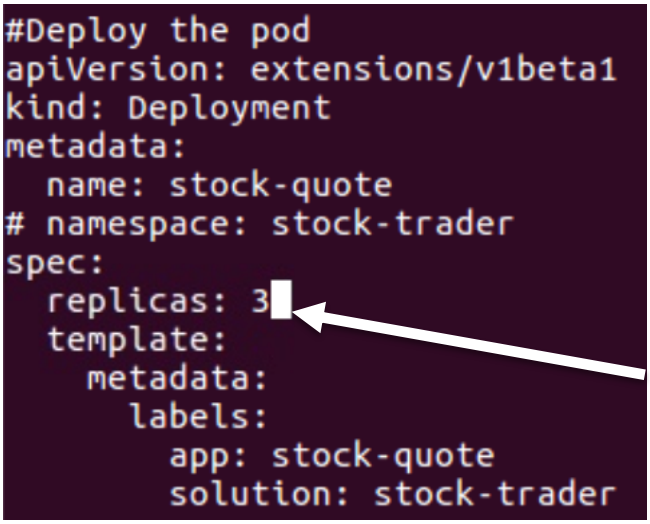
3. You can also scale up and down by editing the deployment YAML file for a given deployment and sending the updated value to IBM Cloud Private. To scale up the *stock-quote* service, in the terminal enter **`nano stock-quote/manifests/deploy.yaml`**

```
skytap@icpboot:/StockTrader$ nano stock-quote/manifests/deploy.yaml
```

In the editor look for the line **`replicas: 1`** under the **`spec`** header**.**



Change the 1 to **3** then save and exit the file by pressing and releasing **Ctrl+O**, then press **Enter**. Finally press **Ctrl+X** to exit the editor. Note you must have done the "su" command described earlier, or you won't have authority to save the file.



4. Now scale out stock quote by typing

   `kubectl apply -f stock-quote/manifests/deploy.yaml --record`

```
skytap@icpboot:/StockTrader$ kubectl apply -f stock-quote/manifests/deploy.yaml --record
Warning: kubectl apply should be used on resource created by either kubectl create --sav
e-config or kubectl apply
deployment "stock-quote" configured
Warning: kubectl apply should be used on resource created by either kubectl create --sav
e-config or kubectl apply
service "stock-quote-service" configured
Warning: kubectl apply should be used on resource created by either kubectl create --sav
e-config or kubectl apply
ingress "stock-quote-ingress" configured
```

You can ignore the warnings. Any time you take an action against a deployment that action is saved as part of the deployment's history. The `--record` flag saves the triggering command into that history for future reference.

If you run **`kubectl get deployments`** you'll see that stock-quote has scaled up to three.

```
skytap@icpboot:/StockTrader$ kubectl get deployments
NAME                    DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
labdb2-ibm-db2oltp-dev  1         1         1            1           11d
loyalty-level           1         1         1            1           5d
messaging               1         1         1            1           2d
notification-twitter    1         1         1            1           2d
portfolio               1         1         1            1           10h
redislab3-redis         1         1         1            1           1d
stock-quote             3         3         3            3           5d
trader                  1         1         1            1           10h
```

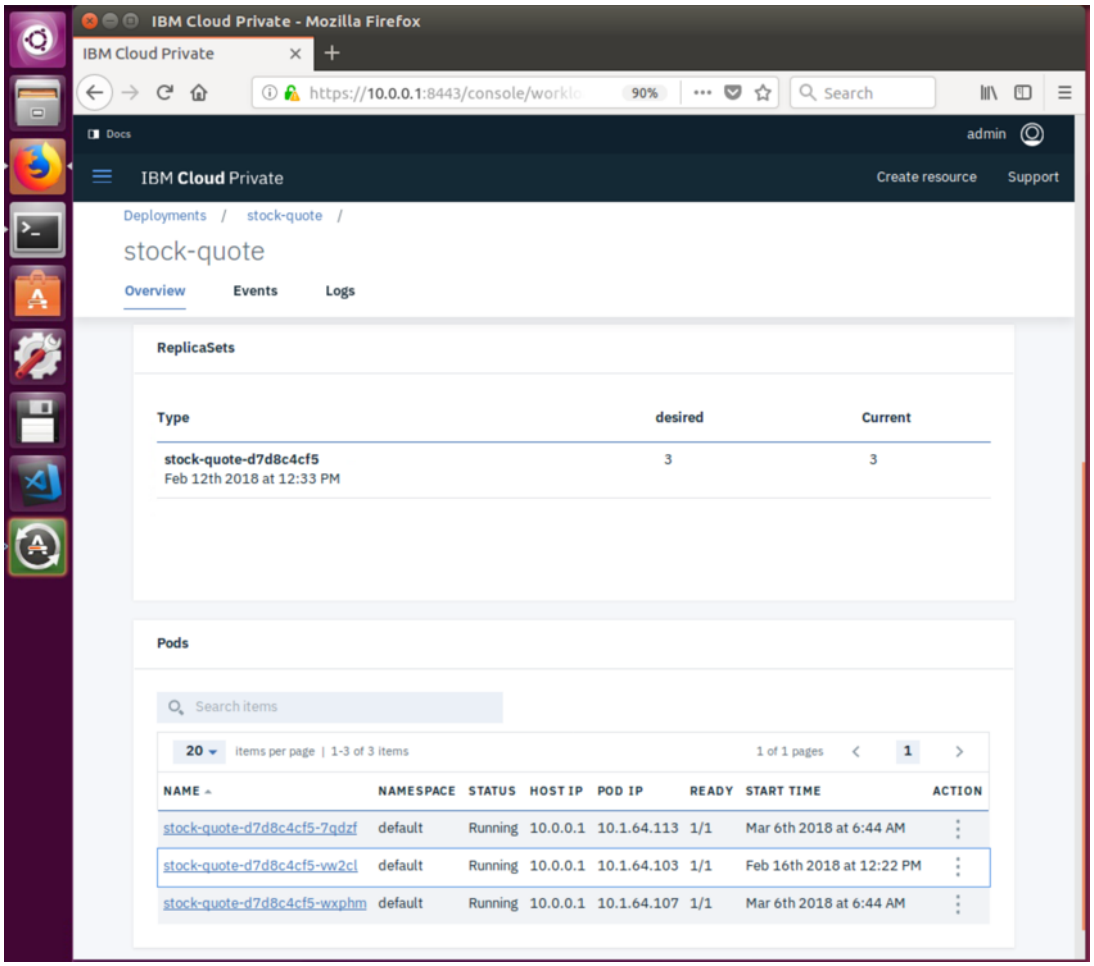
5. Now let's review recorded history. Run the command

`kubectl rollout history deployment/stock-quote`

```
skytap@icpboot:/StockTrader$ kubectl rollout history deployment/stock-quote
deployments "stock-quote"
REVISION  CHANGE-CAUSE
1         kubectl apply --filename=stock-quote/manifests/deploy.yaml --record=true
```

Notice there is only one change to this deployment, the scale out we just performed. If we performed another scale out we could tell IBM Cloud Private to revert the deployment to an earlier state in case an operation fails. This roll back is controlled by the `kubectl rollout undo` command.

Of course, we can also see the result of the scaling in the ICP UI, at *Deployments->stock-quote:*



If you want to return to one replica, repeat Steps 3 and 4 above replacing the replica value of 3 with **1**.

The deploy.yaml file allows you to version control your deployment configuration. You could make this part of a DevOps pipeline so any changes, once proven correct through a pipeline deployment, would eventually reach production. It lets you treat your deployments as another governable artifact.

You've now seen how to adjust the scaling of a microservice in a Kubernetes environment such as IBM Cloud Private. For high availability reasons, in production environments, it is recommended to have at least two replicas running of each microservice, so that if one goes down for any reason, the other can continue processing requests until Kubernetes automatically restarts the failed pod (which it does quite quickly, once the pod's process (such as a Liberty JVM) has exited/abended, or a health check has failed). You can also use this scaling feature to increase the number of concurrent requests that your microservice can handle before slowing down to an unacceptable level of performance.

7. Download, Build, and Deploy a Node.js microservice

So far, you have worked with all Java-based microservices. But since IBM Cloud Private is polyglot, you can deploy microservices written in any language to run in its Kubernetes-based environment. The user interface microservice, named *trader*, is a deliberately simple sample implemented using old-fashioned Java servlets. It is pure server-side rendering; you don't even need JavaScript enabled in your browser to run it. But nowadays, people expect more professional looking web-based user interfaces, so we have an alternate, more sophisticated one written in Node.js and using the Vue.js (https://vuejs.org) UI framework. Let's go pull that from GitHub and deploy it to our environment and use it.

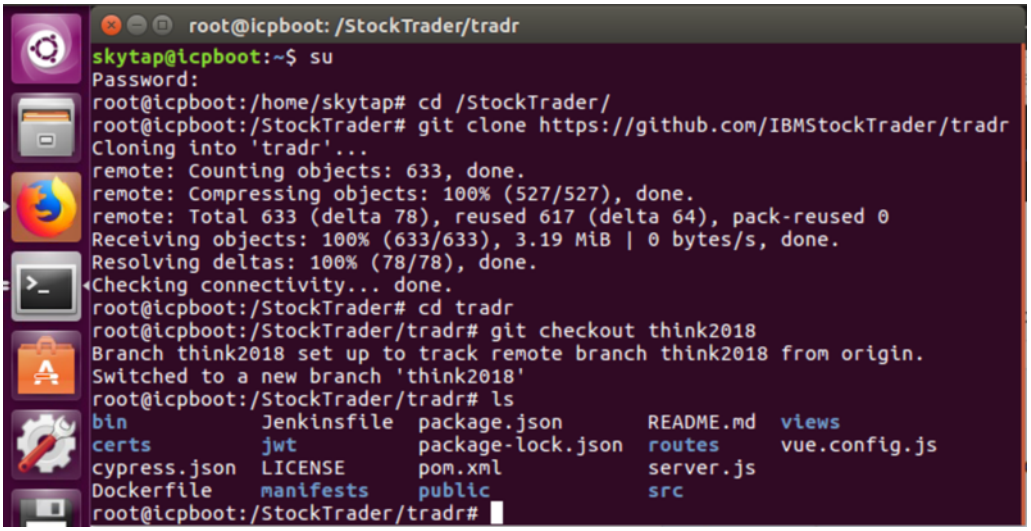
Download code from GitHub

This alternate client is not preloaded on your VM image. It is called *tradr* (note no "e" in the name), and we'll need to clone its repository from GitHub. Go to your Terminal window, make sure you've done an "`su`" so you have full authority, return to the /StockTrader directory, and run the following command:

```
git clone https://github.com/IBMStockTrader/tradr
```

This will make a new *tradr* directory. Change into that directory via "`cd tradr`". Note that, due to an Ingress issue in the old build of IBM Cloud Private that we are using in this lab (a newer 2.1.0.2 version should have been released just before the conference), we need to grab a workaround to make this client work with a Node Port instead. We can get that workaround by running the following command:

```
git checkout think2018
```



Build the project

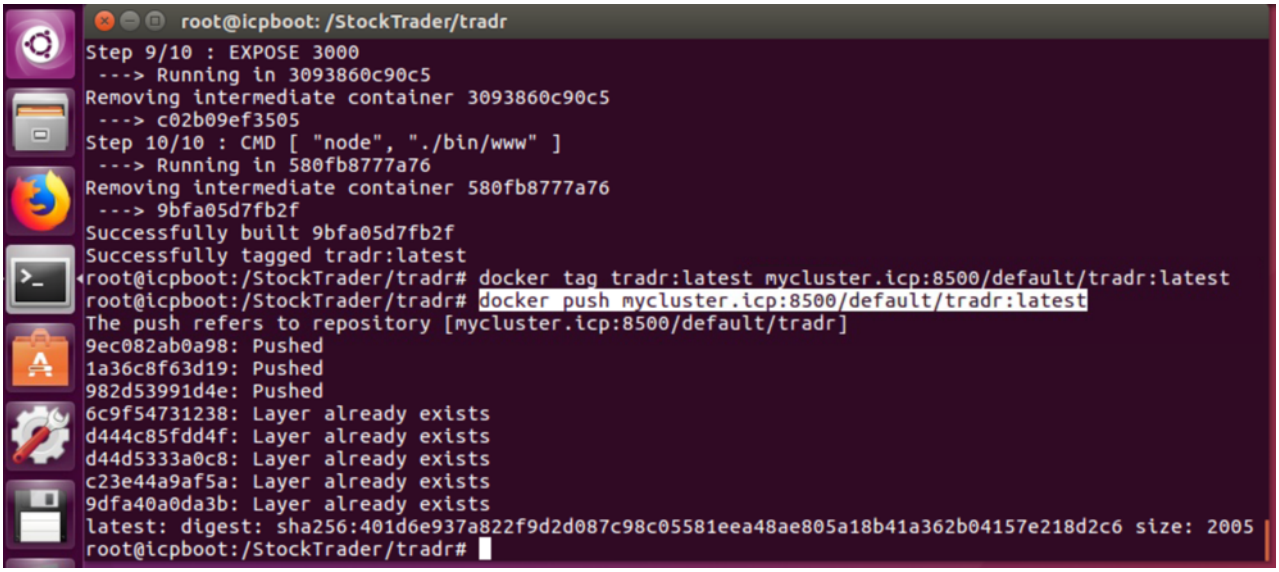
Unlike the Java-based project we worked with earlier, there is no need to use Maven to compile and package anything with this Node.js-based project. So we can jump straight to building its Docker container, via the following command (note the trailing dot, which means "current directory"):

```
docker build -t tradr .
```

Note that the build will likely take several minutes, as it has to download and unzip a lot into the container. If the build is taking a long time, you may wish to skip ahead to section 8, then return here once it completes. Next, tag and push this Docker image, via the following commands:

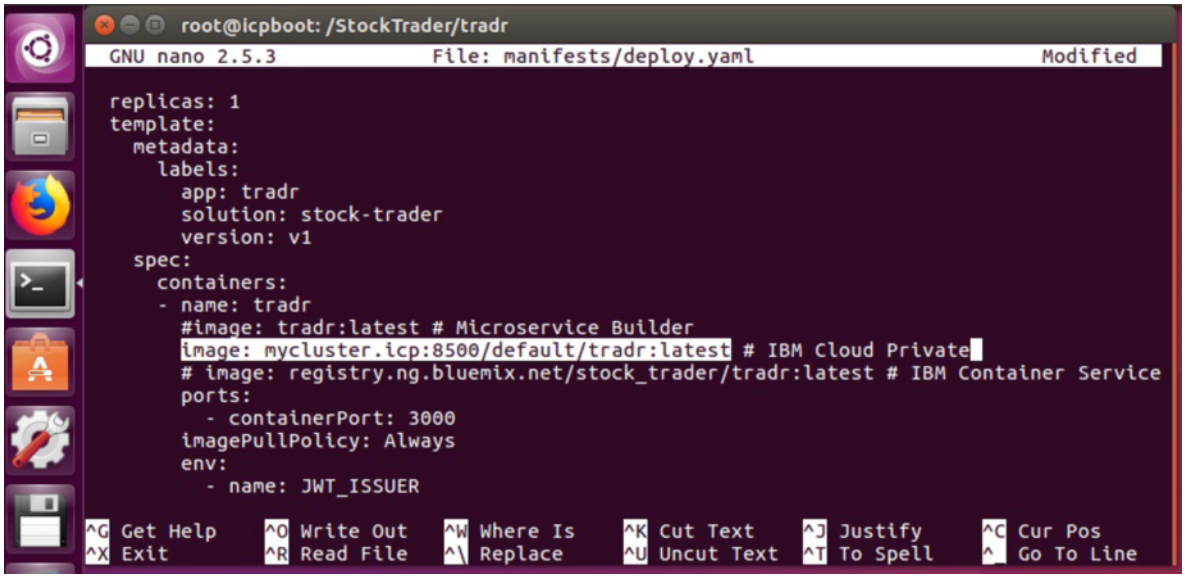
```
docker tag tradr:latest mycluster.icp:8500/default/tradr:latest
```

```
docker push mycluster.icp:8500/default/tradr:latest
```



Deploy to IBM Cloud Private

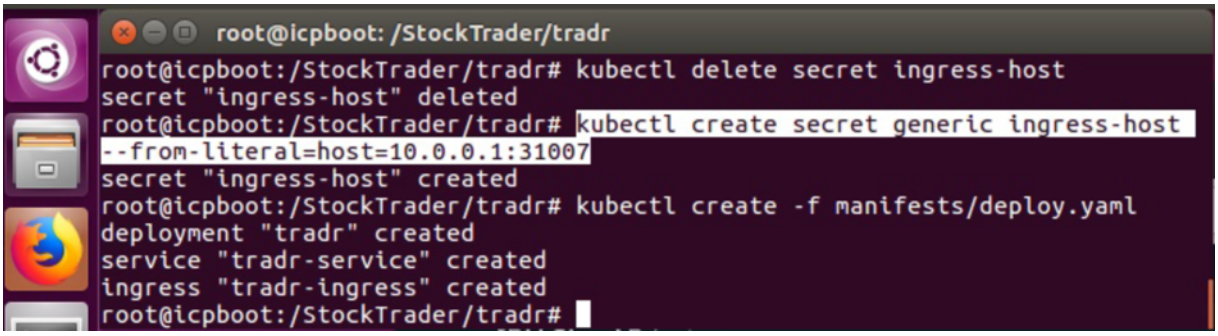
You will need to edit the `deploy.yaml`, in the `manifests` directory, to specify an image tag to match what you just pushed into the docker image registry. That is, it needs to be set to `mycluster.icp:8500/default/tradr:latest` (you'll need to comment out the line setting it to just `tradr:latest` and uncomment the line for IBM Cloud Private). Run the command `nano manifests/deploy.yaml`, and scroll down to the image tag and set it as shown below:



Then press Ctrl-X to exit, hit "y" to save, and press Enter to accept the original file name. Of course, if you prefer using a different editor, such as **VS Code**, you are welcome to do so. Once you have saved the deploy.yaml file, we'll need to do one more step before feeding this deploy.yaml to IBM Cloud Private.

Due to the Ingress bug mentioned earlier, we need to change the *ingress-host* secret to point to the Node Port for the *tradr* service, which the deploy.yaml defines to be port 31007. So first, let's delete any existing *ingress-host* secret, via "`kubectl delete secret ingress-host`". Then we will recreate it, passing `10.0.0.1:31007` as the value for the "host" field. Run the command "`kubectl create secret generic ingress-host --from-literal=host=10.0.0.1:31007`".

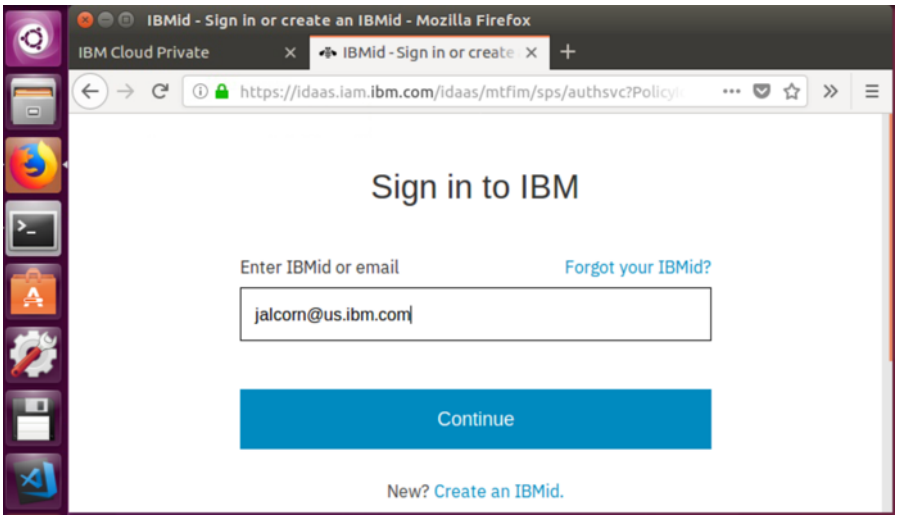
With the updated *ingress-host* secret in place, we can now feed the deploy.yaml to IBM Cloud Private, via "`kubectl create -f manifests/deploy.yaml`", as shown below:



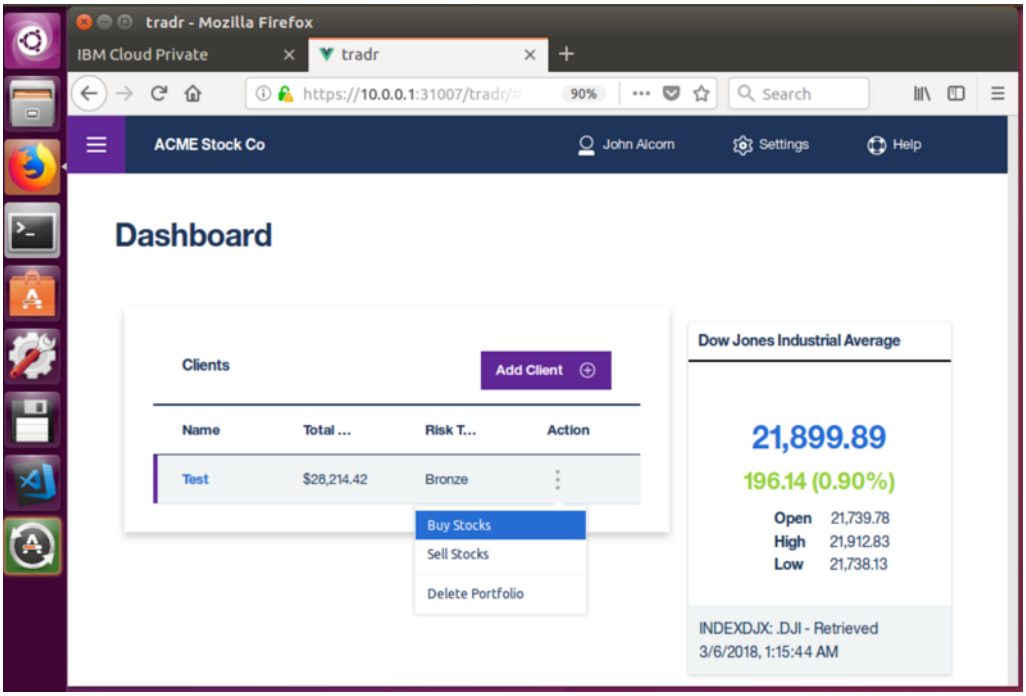
Congratulations, you have just deployed your first Node.js-based microservice!

Run the code

Now that we've deployed our new Node.js/Vue.js based client for Stock Trader, let's give it a try. In a new tab in your browser, enter https://10.0.0.1:31007/tradr in the address bar. You will be redirected to do an IBMid login, just like with the Java-based client:

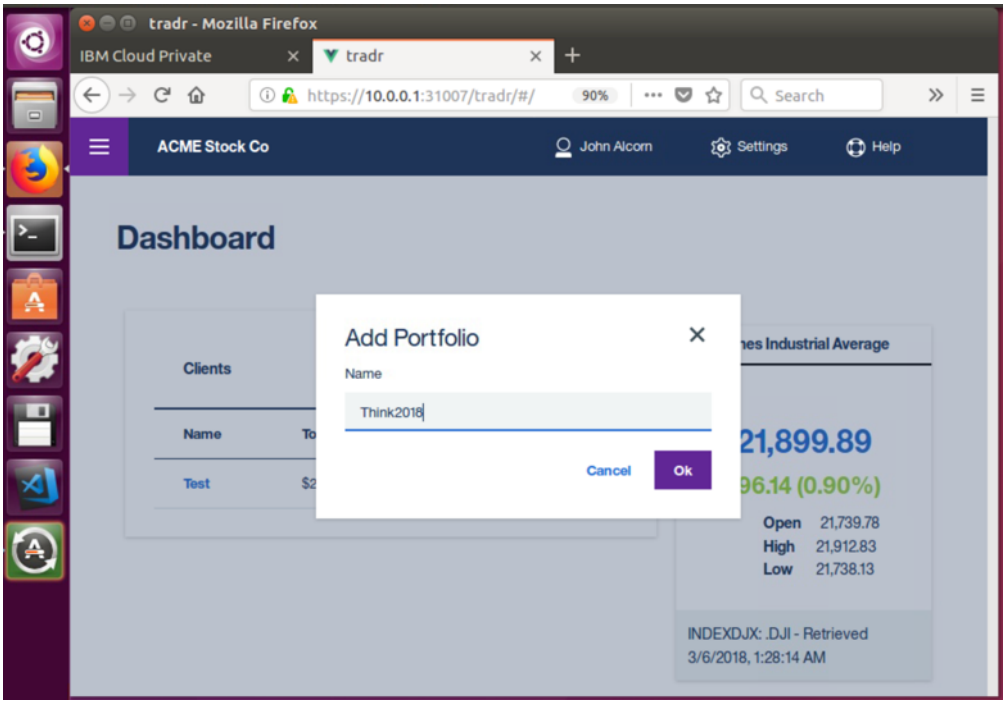


Once you complete the IBMid login, you will be redirected to the Node.js client's landing page:

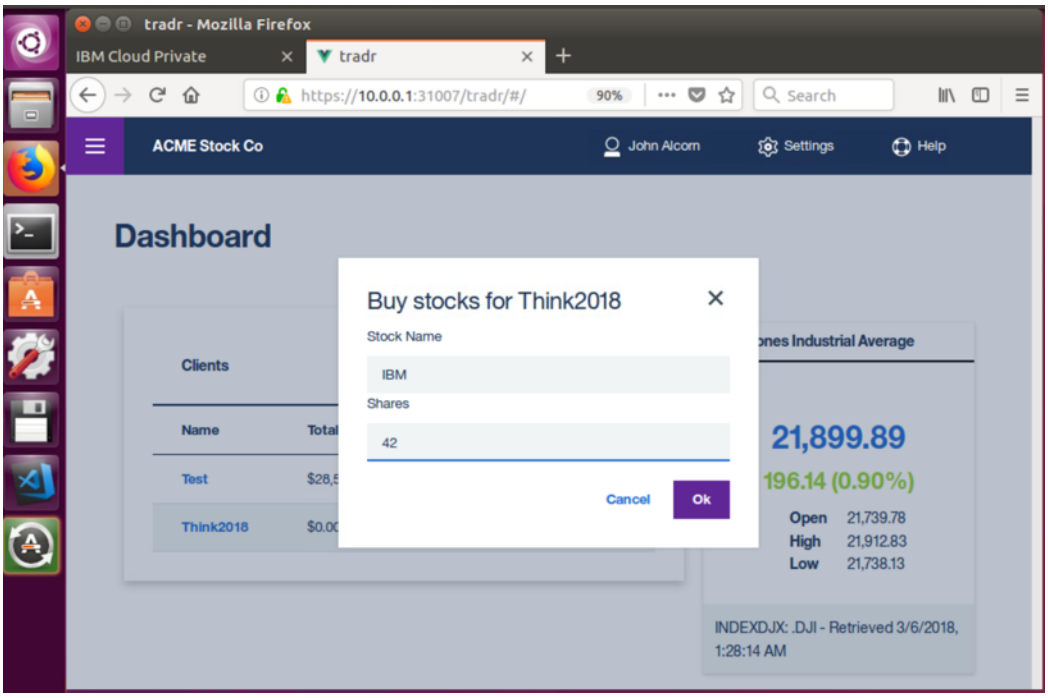


You will notice that you see a list of all of your portfolios, which *tradr* calls "Clients". It also calls the loyalty level "Risk Tolerance". And at the top, you can see the name associated with the IBMid that you used to log in. You can click on the hyperlink name of a "client", such as "Test", to see the stocks in that portfolio. You can also click the vertical ellipsis under the Action column to access a menu that will let you buy or sell stocks, or delete a portfolio. All of these actions are calling the exact same REST services on the *portfolio* microservice that the Java-based client did; this client is simply rendering the results that come back in a different, more visually appealing way. This client also shows how the markets are doing on the far right, such as the latest value of the Dow Jones Industrial Average.

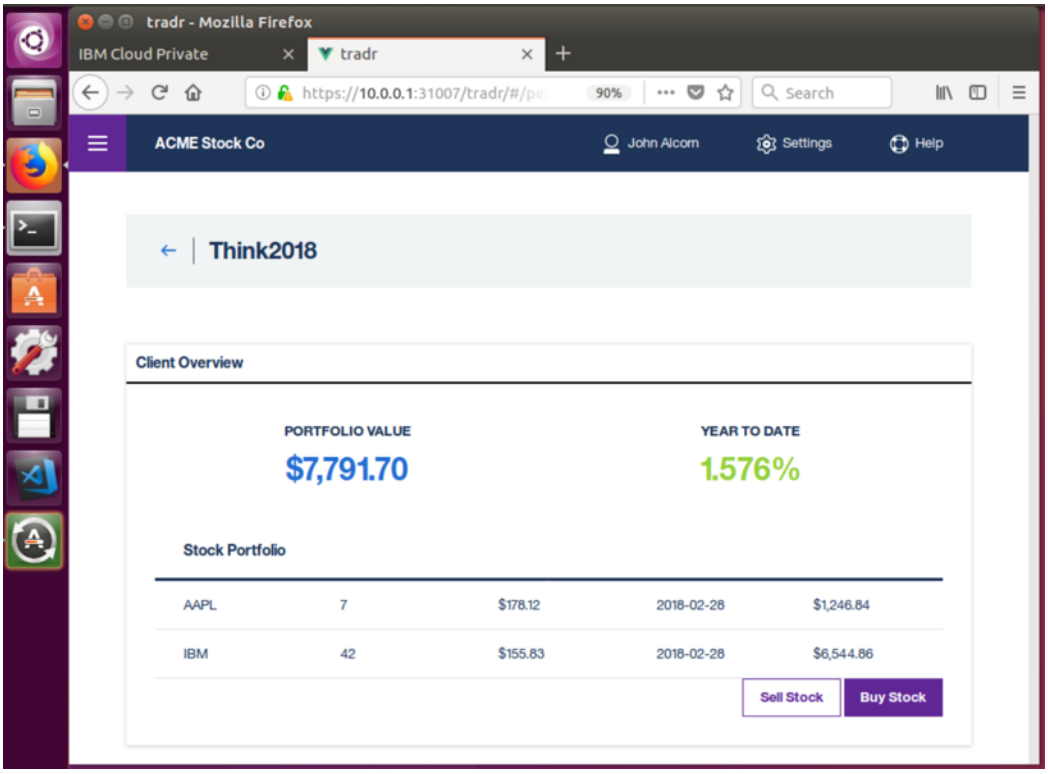
Let's run through creating a new portfolio (what *tradr* calls a "client"), and adding a stock to it. First, click on the purple `Add Client` button. Then fill in a name, such as "Think2018" (as before, avoid names with spaces or any other characters invalid in a URL), and click the purple `OK` button.



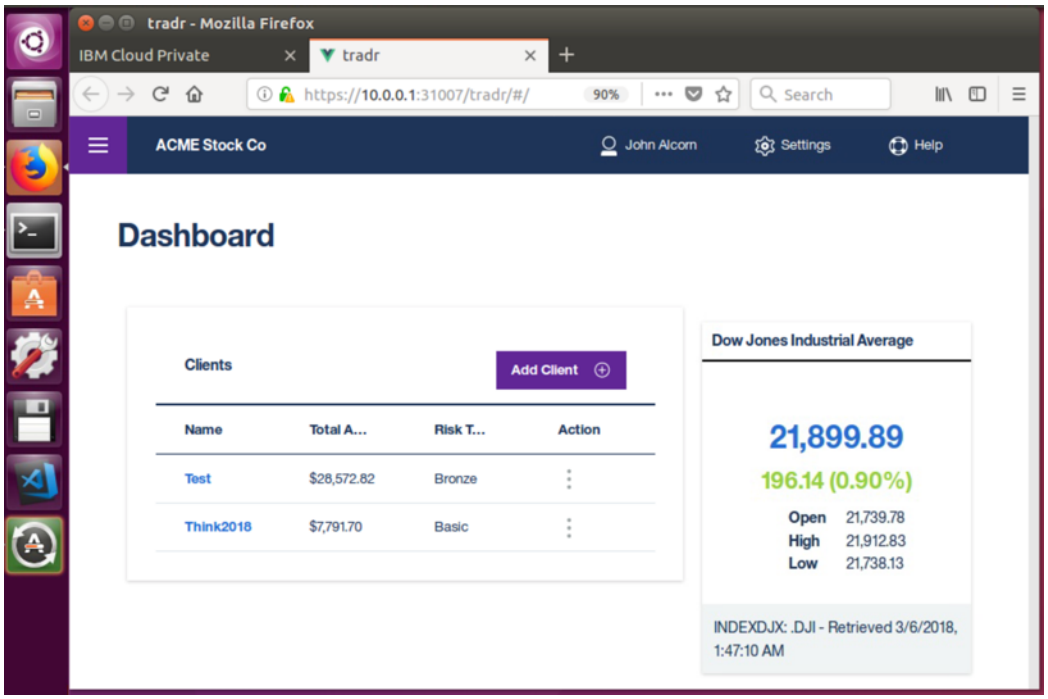
Now you will see your new "Think2018" client/portfolio on the main landing page. Click on the vertical ellipsis under Action and choose `Add Stock`. Then enter your stock ticker symbol and the number of shares to buy, such as "IBM" and "42", and click on the purple `OK` button.



Now you will see the updated values for the Think2018 portfolio on the main landing page. Add another stock, such as 7 shares of AAPL stock, so we'll have more than one stock in our portfolio table. Then click on the Think2018 hyperlink to view that portfolio.



You can click the left-pointing arrow to the left of the portfolio name to go back to the main landing page.



Feel free to play with this alternate client to the Stock Trader application to create or delete more portfolios, or to buy or sell more stocks.

Congratulations, in addition to working with a bunch of Java-based microservices, you have now used your first Node.js-based microservice. Due to the polyglot nature of Kubernetes and IBM Cloud Private, you can write your microservices in whatever languages you prefer, and in fact mix and match them, such as we just did, with a microservice written in Node.js calling one written in Java.

8. Optional: Deploying a Helm Chart from the Catalog

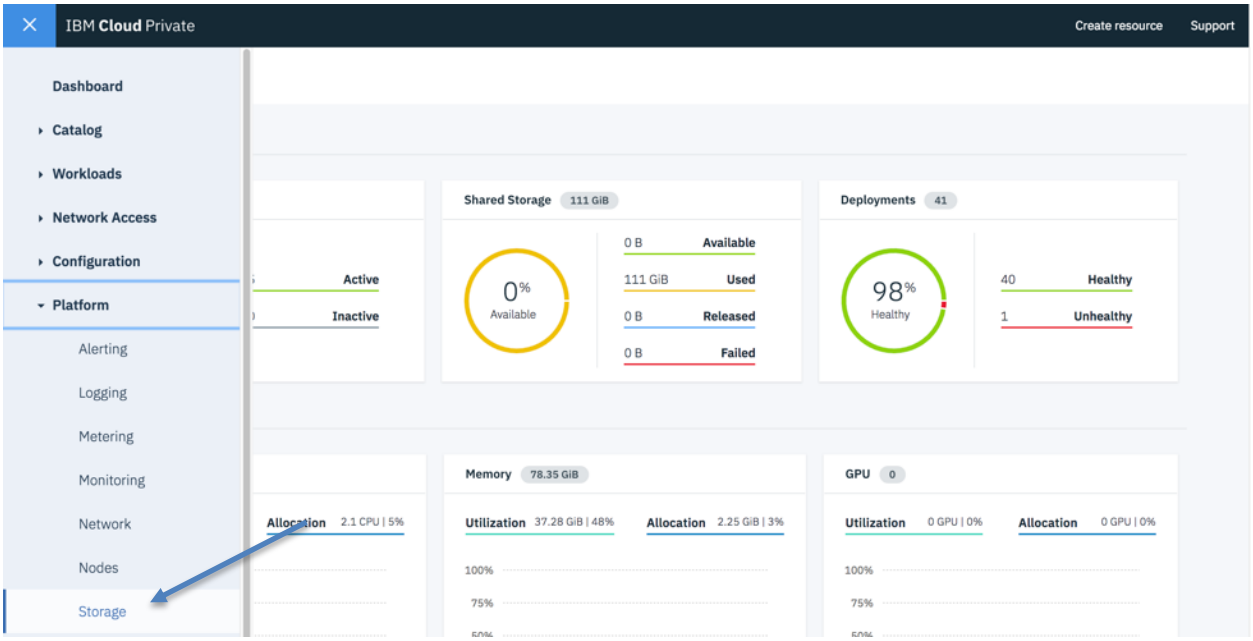
NOTE: This is an optional section. If you are short on time, feel free to skip ahead to the final section.

To have you experience the value of Helm Charts, this section will involve you installing and configuring **MQ**. While this traditionally took hours to install, with a containerized service deployed through Helm Charts, it really only takes minutes.

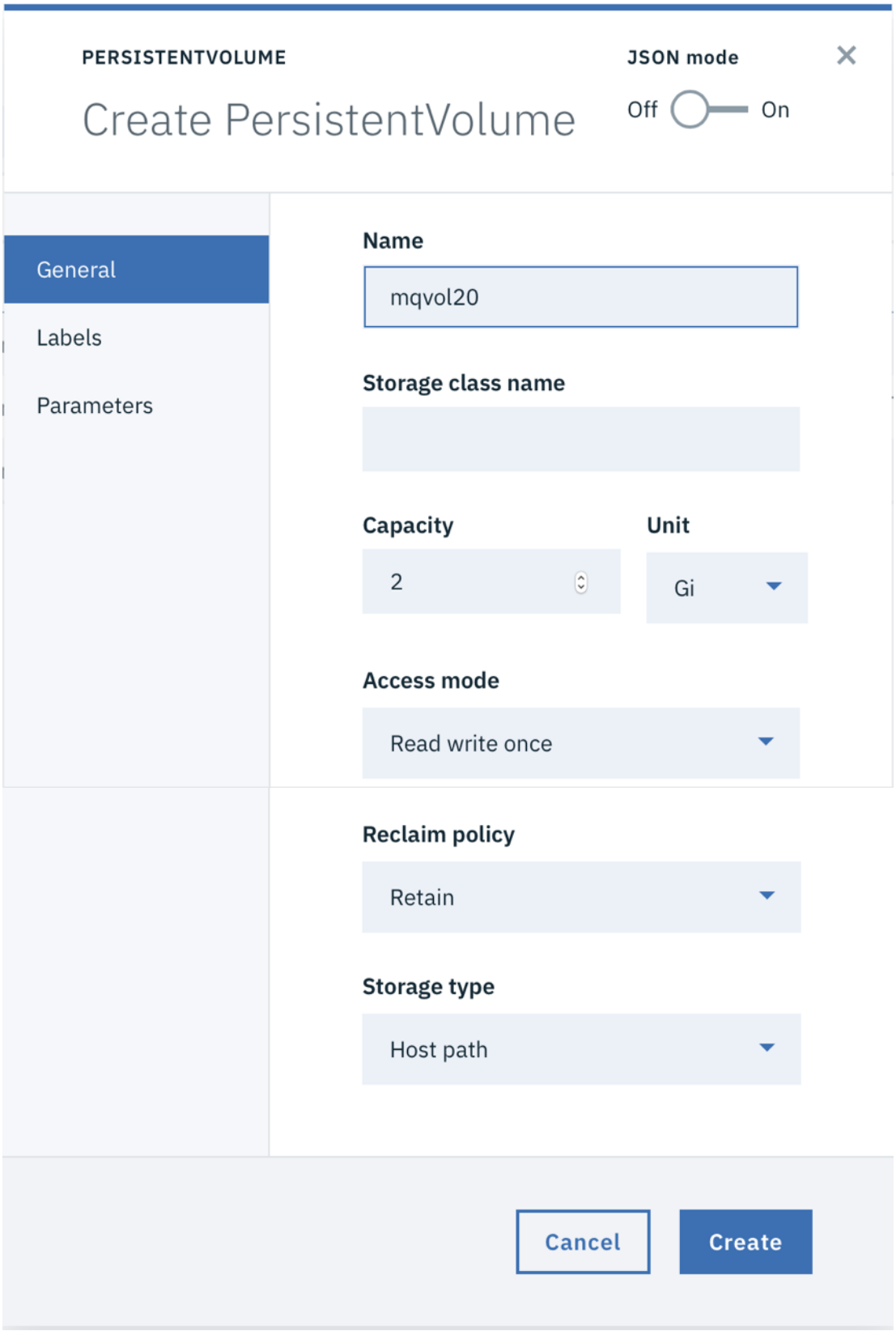
Create Persistent Volume

To deploy IBM MQ-Dev, you need to create a persistent volume that uses the "ReadWriteOnce" (RWO) access mode. You can create the storage volume from the UI, and should ideally be created before the deployment. However, you could create it after the deployment as well…Kubernetes will pause the deployment until it can find a matching persistent volume.

To create the volume, log into IBM Cloud Private, and use the upper left menu to navigate to the Storage page by selecting **Platform > Storage**

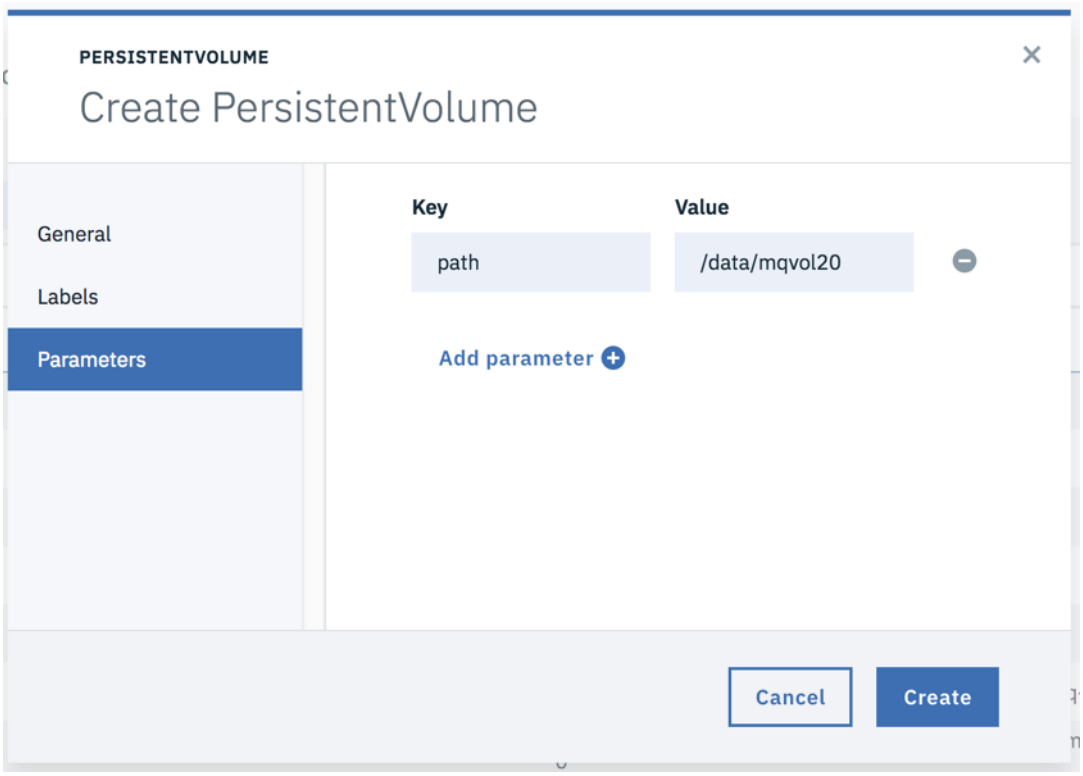


Once on the storage page, click **Create PersistentVolume**


PERSISTENTVOLUME
JSON mode
Create PersistentVolume
Off
On
General
Labels
Parameters
Name
mqvol20
Storage class name
Capacity
Unit
2
Gi
Access mode
Read write once
Reclaim policy
Retain
Storage type
Host path
Cancel
Create

In this example, name: **mqvol20,** I created a Capacity: **2GB** Storage Type: **Host Path** with **"Read Write Once"** access mode.

Click the **Parameters** tab, and then enter **path**, and **/data/mqvol20**.



Click **Create**.

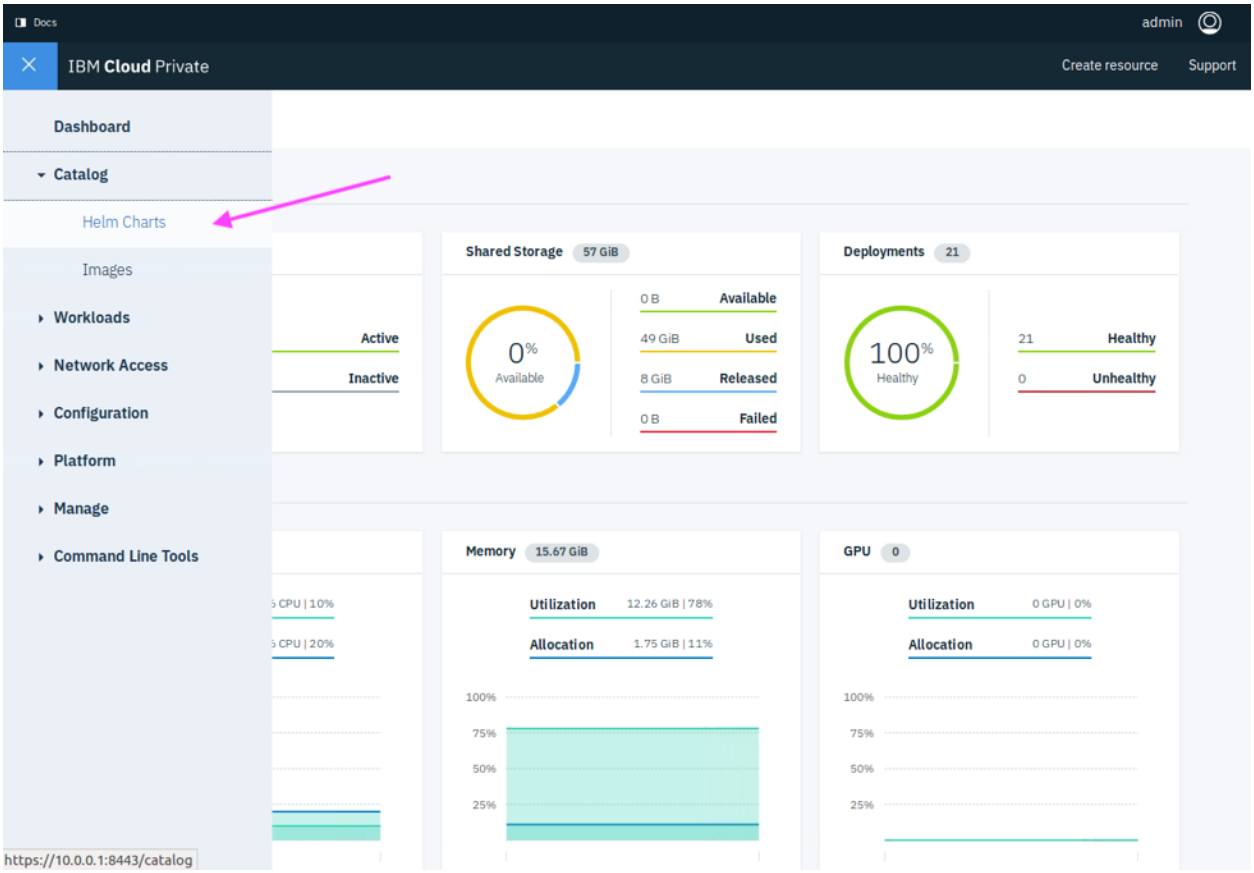
The value of using a persistent volume is that even though this recipe only deploys a single MQ queue manager, you can still achieve a level of availability in that if the queue manager pod or the node itself were to fail, IBM Cloud Private automatically re-schedules the queue manager to another node.

Get to the MQ Helm Chart

Next, install MQ itself.

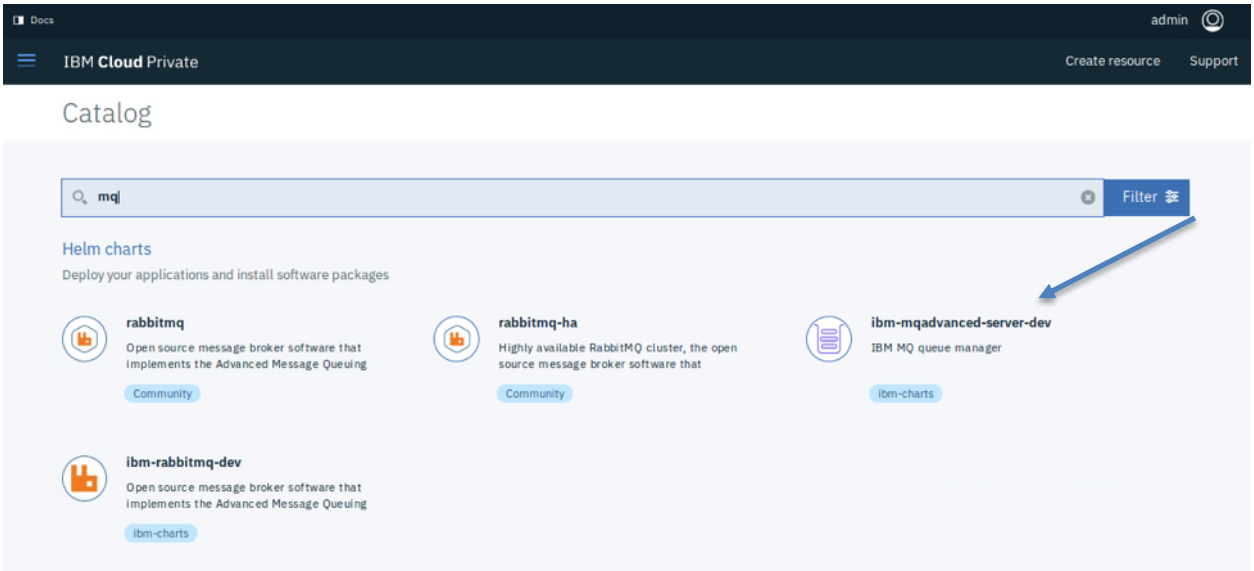
For this example, we will use the catalog. However, if you want to use the command line, you can directly access the helm charts here: https://github.com/IBM/charts. Either path is fine, and as we both know, if you love kubectl and helm commands, then using the helm charts directly is a great option (you can get helm command line here)

For the UI path, open IBM Cloud Private, and navigate to the catalog.



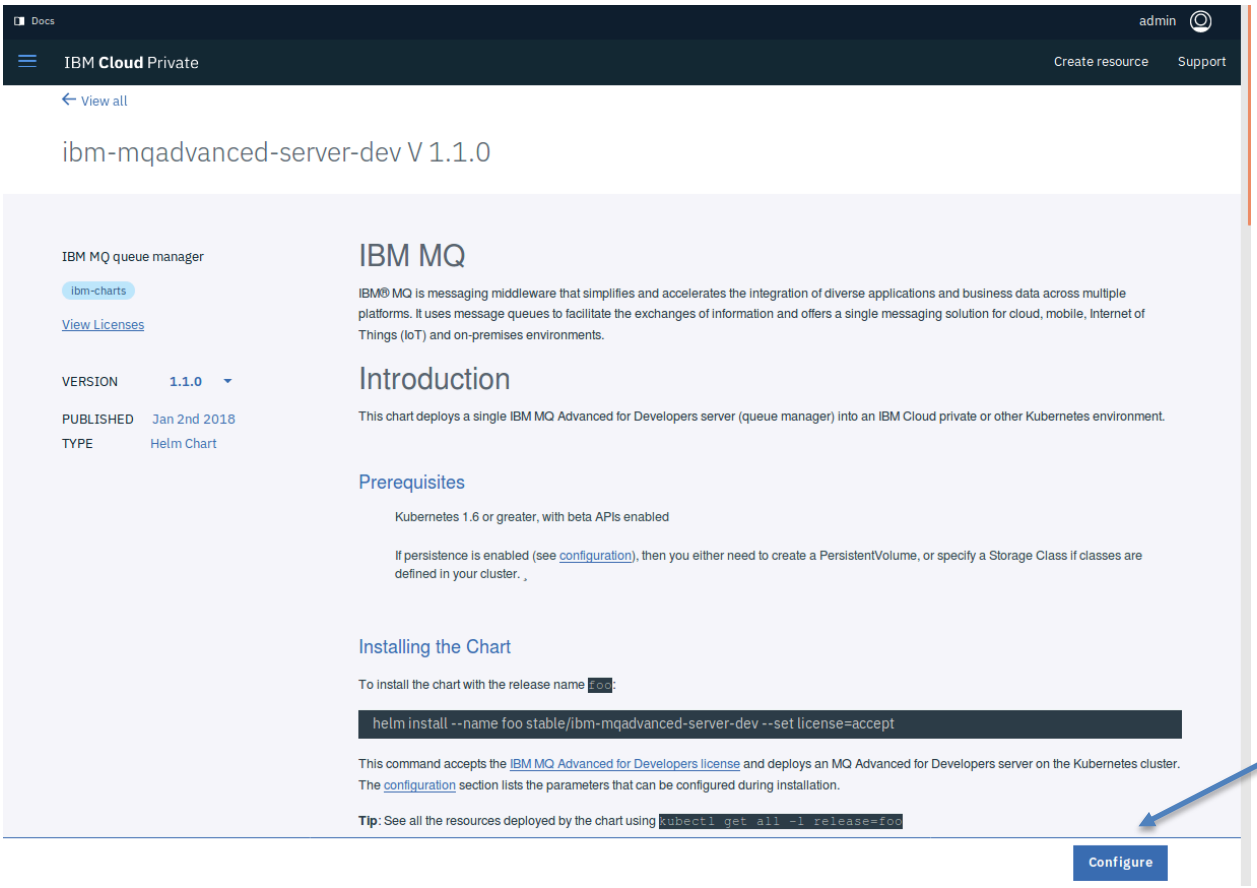
The catalog lists all the content you can install into IBM Cloud Private. Notice some are marked **community** Community and some are marked **ibm-charts** ibm-charts

Enter **mq** in the search to find MQ.



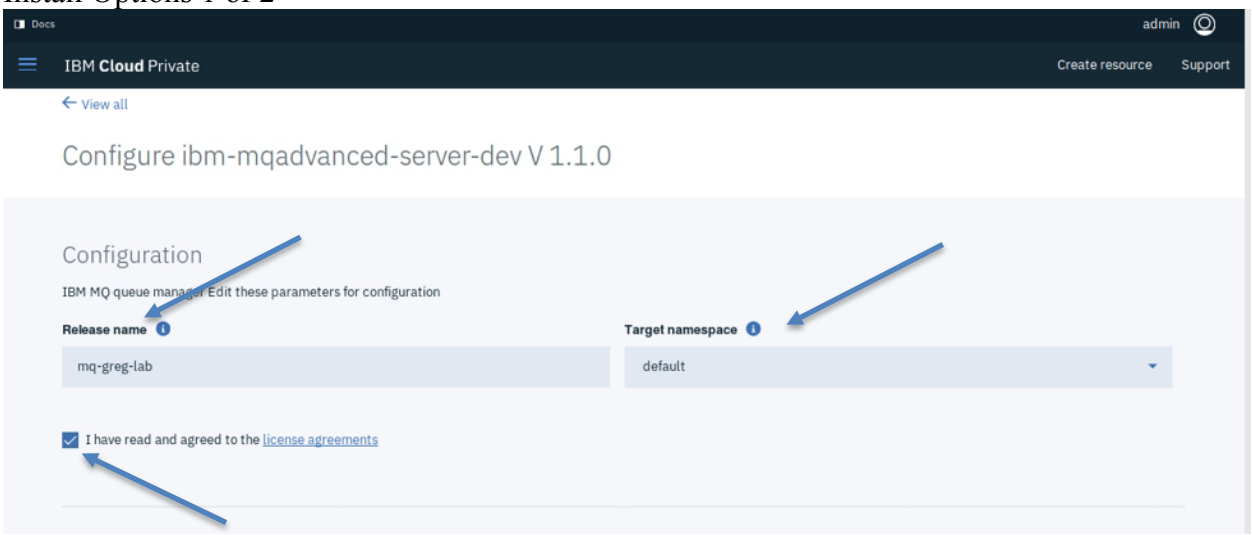
Click on **ibm-mqadvanced-server-dev**

From this details view, select the “Configure” button at the bottom, then go to the next step.



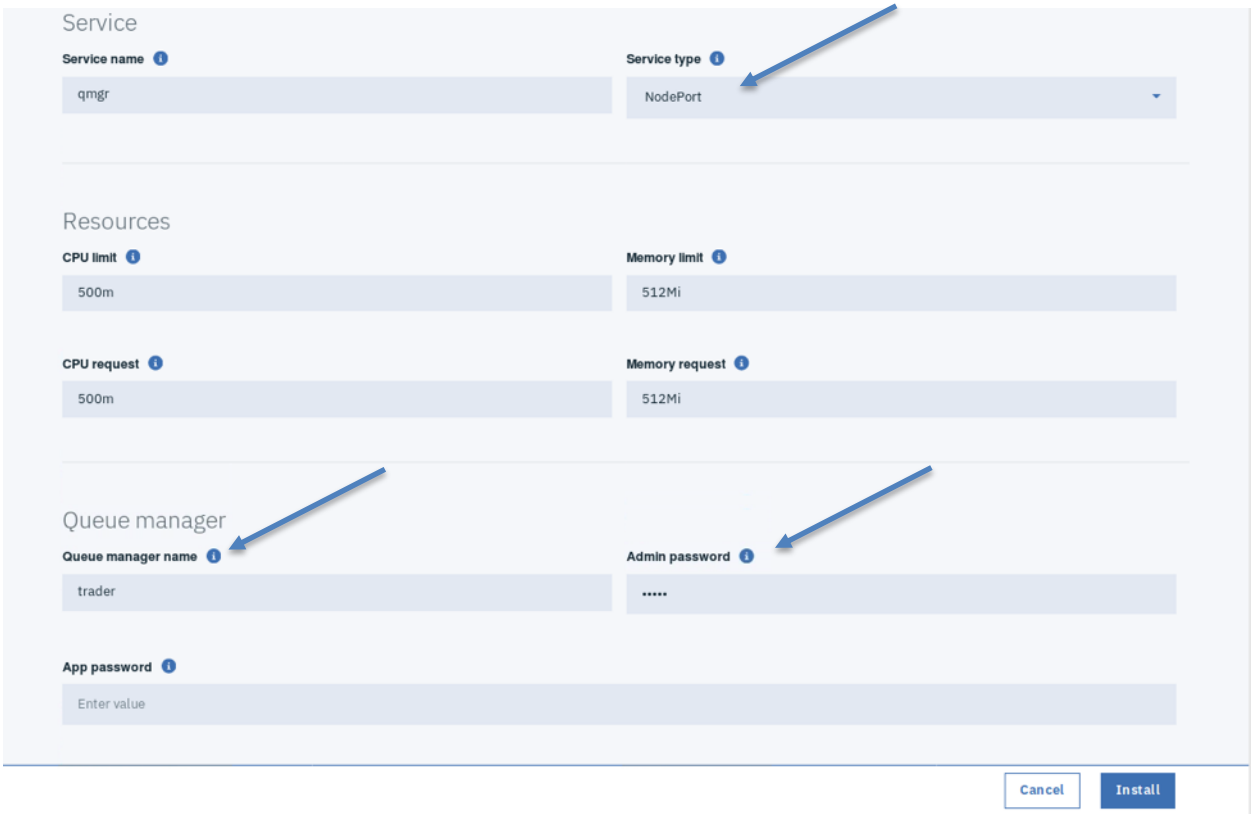
There are quite a few settings in the MQ install, but I’ll just highlight the ones you need to worry about.

Install Options 1 of 2



In this first section you need to give your deployment a name **mq-myname-lab**, select **default** namespace, then accept the license, otherwise the deployment will fail.

Install Options 2 of 2:



There are 4 fields you should consider in this last section.

dataPVC.size

Enter 2Gi. This is where you can customize how large you want your storage to be, but remember, it can't be bigger than the persistent volume you created earlier.

service.type

Select **NodePort**. If you keep it 'ClusterIP', then only apps running inside the IBM Cloud Private cluster will be able to access the MQ service. However, if you change it to 'NodePort', then you will be able to call the MQ service from the web browser.

queueManager.name

Enter **trader**, which is the name of the queue manager that your app will use.

queueManager.dev.adminPassword

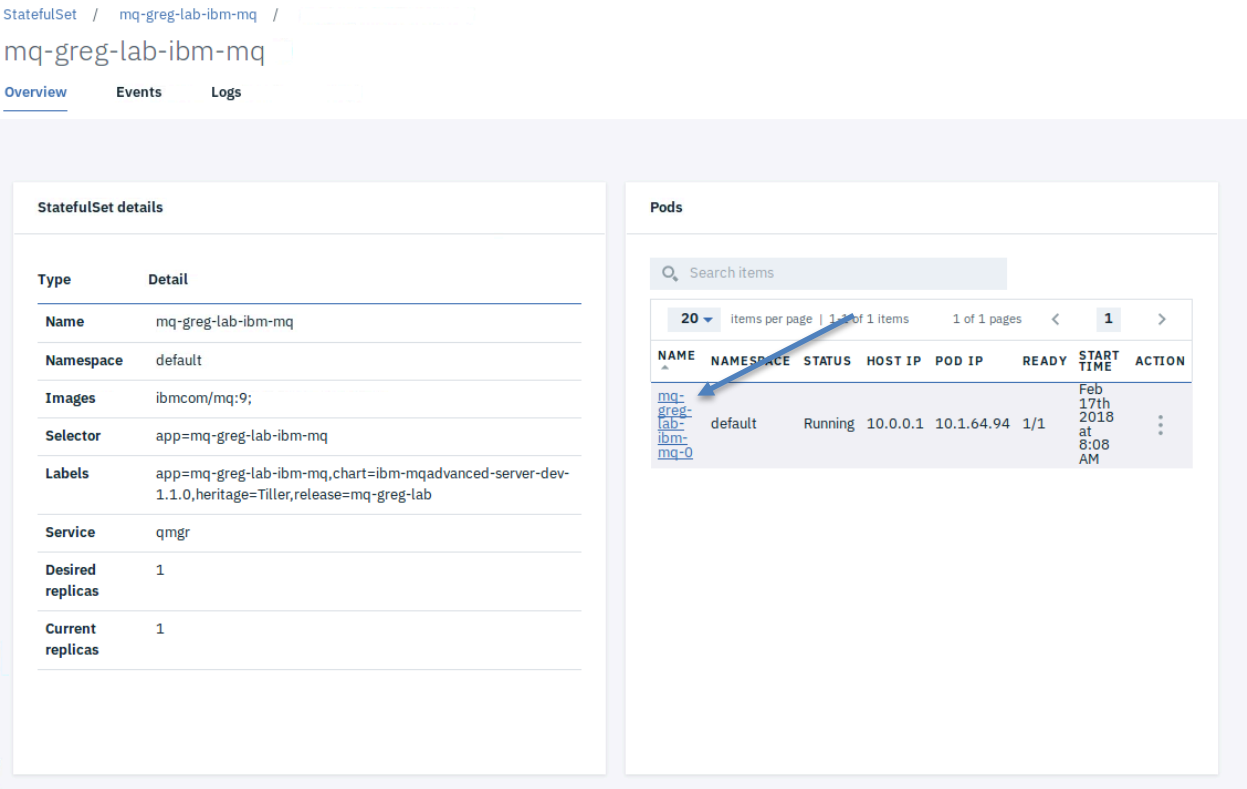
Enter **admin** for the admin password.

Deploy the MQ Helm Chart

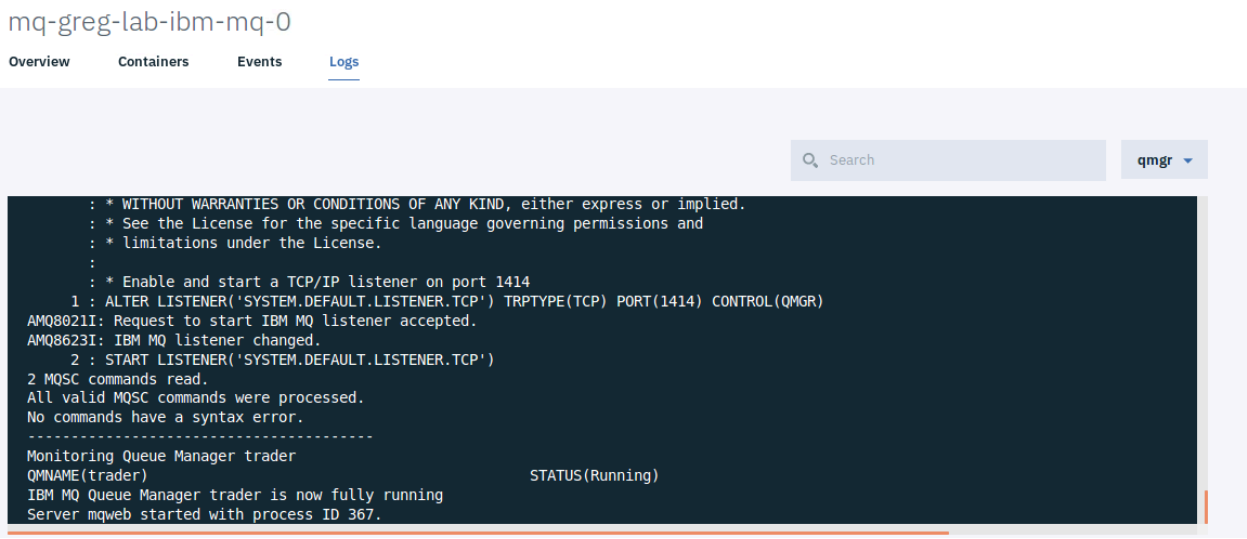
Once you are ready (you have accepted the license, created your persistent volume, and filled in all the advanced installation details) click **Install** and you are installing!

Depending on compute and storage speeds, it may take a few minutes to install since it needs to create default queues, and start the management UI.

To monitor the progress, select **View Helm Releases**, then scroll to **StatefulSet.** You'll see the pod running, select it and you can view logs.



From the UI, click on “Workloads”, select the MQ Stateful Set, locate the pod and select it, then select the Logs tab.



From the command line: find the pod name and monitor its log:

```
kubectl get pods

kubectl logs <podname> -f
```

Start Using MQ

To open the MQ UI, you need to find what service MQ is listening through. To find which URLs to use, run the following to get the list of services:

```
kubectl get svc
```

Then once you identify the service name, run:

```
kubectl describe service <service Name>
```

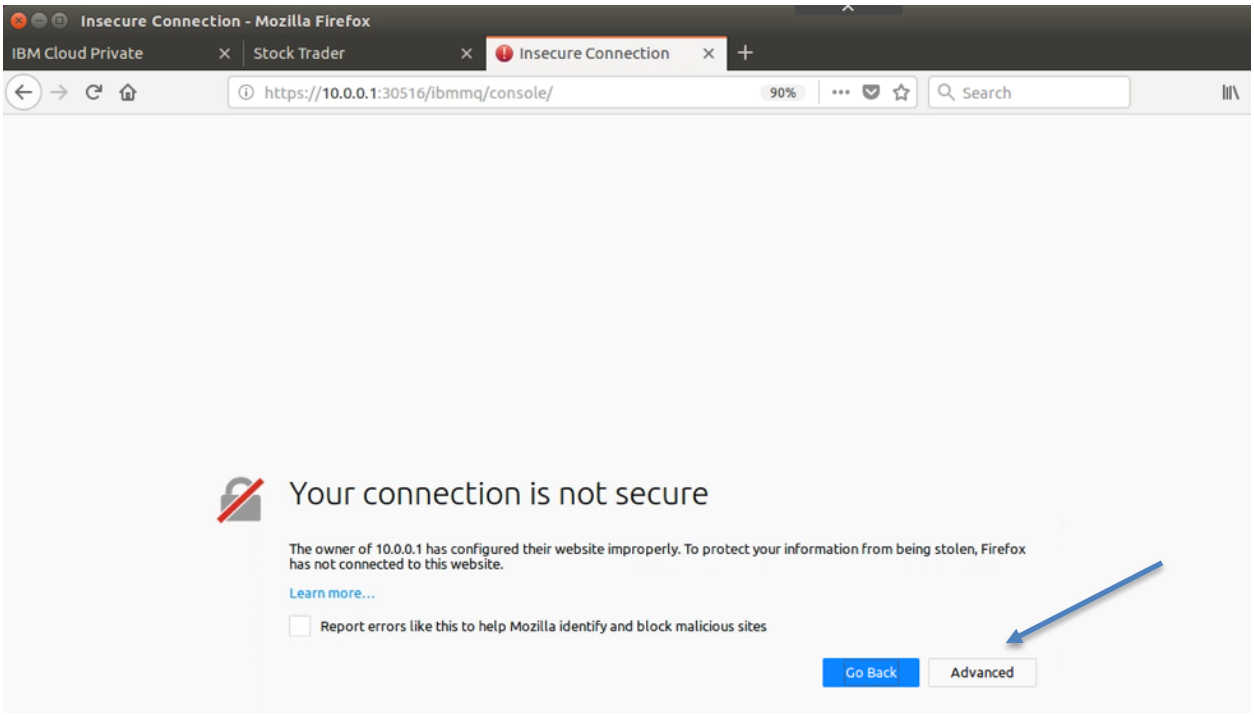
Here is an example of what you will see:

```
Name:                     mqlab-ibm-mq
Namespace:                default
Labels:                   app=mqlab-ibm-mq
                          chart=ibm-mqadvanced-server-dev-1.1.0
                          heritage=Tiller
                          release=mqlab
Annotations:              <none>
Selector:                 app=mqlab-ibm-mq
Type:                     NodePort
IP:                       10.0.0.205
Port:                     qmgr-server  1414/TCP
TargetPort:               1414/TCP
NodePort:                 qmgr-server  30016/TCP
Endpoints:                10.1.64.117:1414
Port:                     qmgr-web  9443/TCP
TargetPort:               9443/TCP
NodePort:                 qmgr-web  32343/TCP
Endpoints:                10.1.64.117:9443
Session Affinity:         None
External Traffic Policy:  Cluster
Events:                   <none>
```

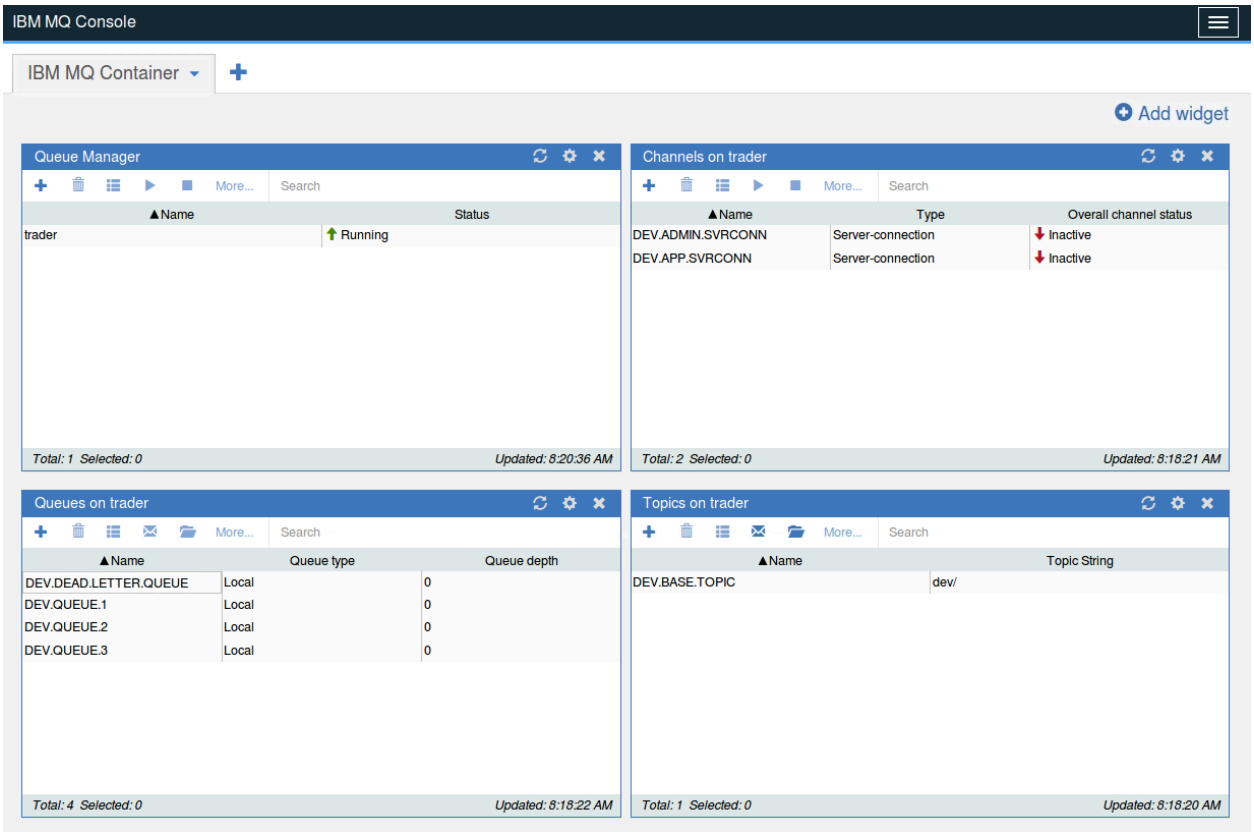
Notice there are 2 sets of ports. MQ uses 1414 for the API, and 9443 for the web UI. Make sure you use the correct NodePort when accessing the UI (in the above example, **32343**.

Paste this (with the correct node port) into a new browser tab:
https://10.0.0.1:**NodePort**/ibmmq/console/

You should get a “not secure” page, click **Advanced**, **Add Exception**, then **Confirm Security Exception**



Once you see the login on the console, you can start with the default userID and password you entered earlier: **admin/admin**

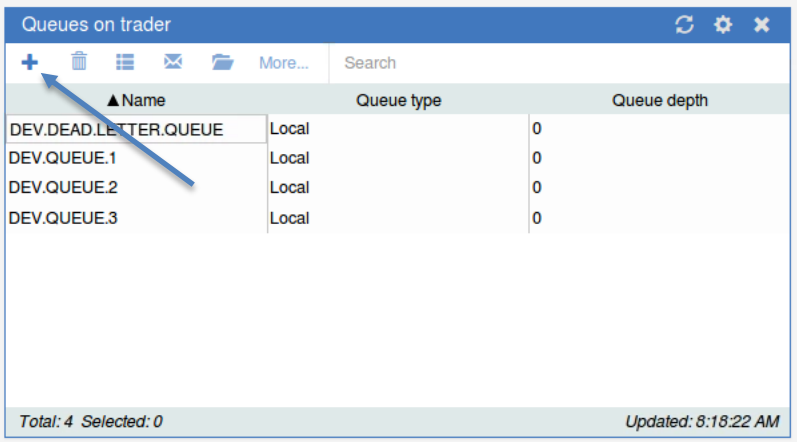


To start using MQ from an application, you will want to use the application user ID, not the admin user ID. The application user ID is “app” (with no default password). Click here to learn more and see examples.

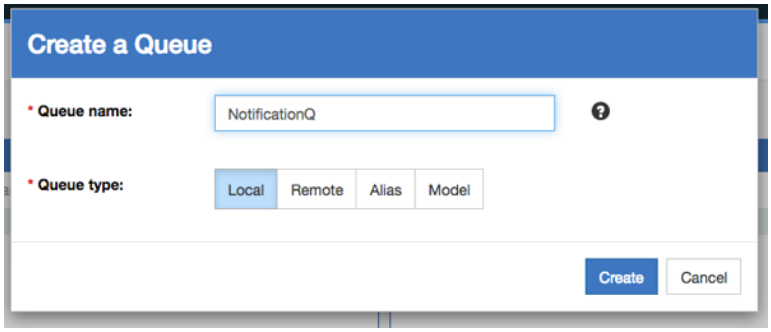
Configuring MQ

Once MQ is running, we need to create the message queue that the app expected.

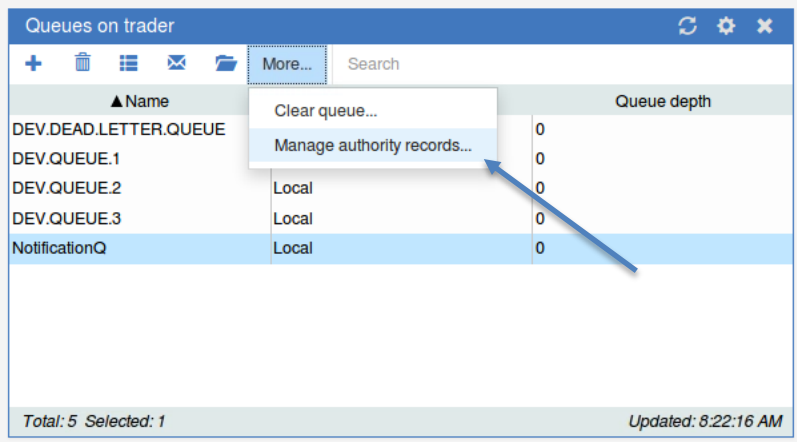
Select the **+** icon



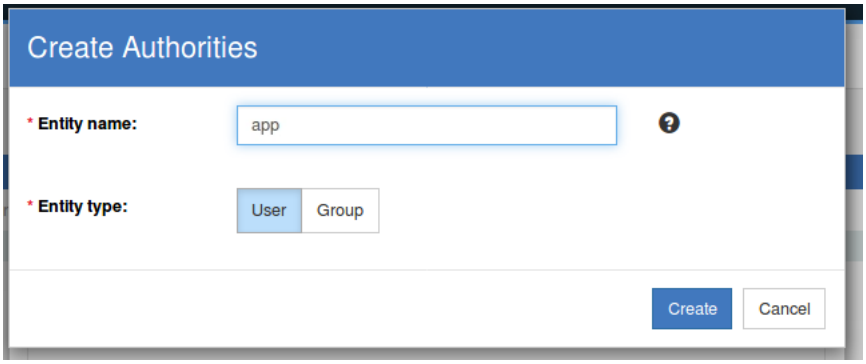
Create a queue called, **NotificationQ**



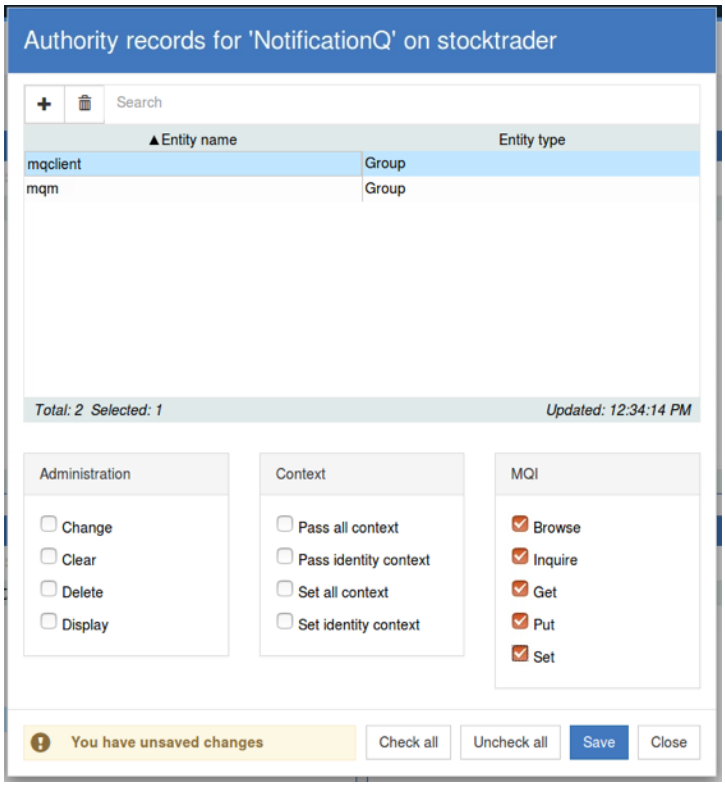
Next, we authorize the app user ID ‘app’ to the queue. The MQ instructions says NOT to use the default admin ID, but to use the default application ID, ‘app’. To do that, select **NotificationQ**, the **More…** menu, then **Manage Authority Records**.



Click the plus button, and enter **app**



You will then see the group mqclient in the list. Select **mqclient** and select all the check boxes on the right.



Finally, click **Save** then **Close**.

Create Secrets

We have a recipe describing why secrets are so useful, and you can read it here (in a nutshell they make your application portable by letting you define custom, cloud-specific information regarding how the app can use each service):

https://developer.ibm.com/recipes/tutorials/use-kubernetes-secrets-to-make-your-app-portable-across-clouds/

Switch to use YOUR MQ service

In this section you will use Kubernetes Secrets to switch from using the MQ service we deployed to the MQ service you just deployed. As we mentioned earlier, our Stock Trader microservices use Kubernetes secrets to “learn” how to connect to services. This allows the cloud admin to “pivot” from using different versions of the services, even to pivot to use services not even running in IBM Cloud Private.

In this case, you’ll want to delete the existing Kubernetes secret for MQ:

```
kubectl delete secret mq
```

Then, find your MQ service name

```
kubectl get svc
```

Then viewed the properties

```
kubectl describe service your-mq-service-name
```

Now **create** the secret that lists your MQ instance:

```
kubectl create secret generic mq --from-literal=id=app
--from-literal=pwd= --from-literal=host=<your-mq-service-name>
--from-literal=port=1414 --from-literal=channel=DEV.APP.SVRCONN
--from-literal=queue-manager=trader --from-literal=queue=NotificationQ
```

Finally, for the Stock Trader application to use your new MQ service, you should delete the **loyalty-level** and **messaging** pods (via `kubectl delete pod <pod name>`). Kubernetes will immediately replace them (since the associated deployment has a Desired pod count of 1, and you just reduced the actual number to 0) and as a result the new pods will pick up the new secret.

NOTE: If you want to go back to the MQ service we created earlier, just delete your secret and run this command:

```
kubectl create secret generic mq --from-literal=id=app
--from-literal=pwd= --from-literal=host=mqlab-ibm-mq
--from-literal=port=1414 --from-literal=channel=DEV.APP.SVRCONN
--from-literal=queue-manager=stocktrader
--from-literal=queue=NotificationQ
```

9. Conclusions

Congratulations! You have successfully managed and updated a microservice-based application running in IBM Cloud Private. You now know how to package and build a Docker image containing WebSphere Liberty and your application; and how to update existing application instances running in IBM Cloud Private. You have also deployed a Node.js based microservice. You have explored the scaling and auto-recoverability features of IBM Cloud Private. Finally, you have deployed a helm chart from the catalog.

We hope you have enjoyed exploring IBM Cloud Private, and this little sample meant to showcase it. Please share any feedback you might have, on the lab instructions, the Stock Trader sample, Kubernetes, IBM Cloud Private, or anything else regarding your experience in this lab.

Note that IBM also has an IBM Container Service, which is an IBM-hosted Kubernetes environment, and Stock Trader runs great there too. If you wish, you can try it out at https://myibmcloudcluster.us-south.containers.mybluemix.net:32389/trader. This is the exact same microservice code, just running in the IBM public cloud (though note it isn't integrated with IBMid, so you just login as stock/trader).

If you wish to play with the Stock Trader sample on your own later, all of its code is in public GitHub, at https://github.com/IBMStockTrader. Built versions of the Docker container for each microservice are also in public DockerHub, at https://hub.docker.com/r/ibmstocktrader.

Thank you for attending, and for your interest in microservices, Kubernetes, and IBM Cloud Private!

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Acknowledgements and Disclaimers