Troubleshooting Kubernetes

Learning to identify, understand, and fix the most common issues in the cluster

Class Labs

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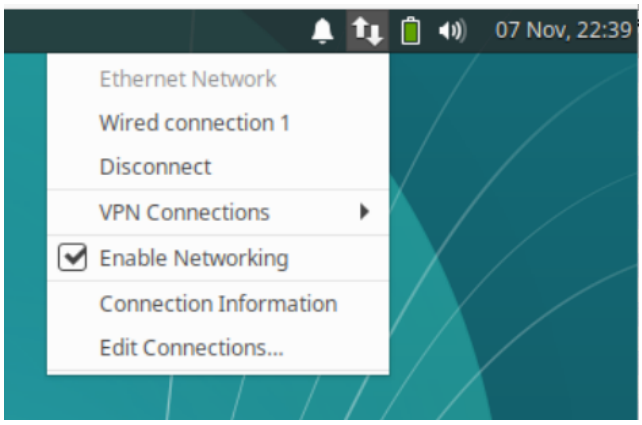
Important Prereq: These labs assume you have already followed the instructions in the separate setup document and have either setup your own cluster and applications per those instructions or have VirtualBox up and running on your system and have downloaded the *k8s-ps.ova* file and loaded it into VirtualBox. If you have not done that, please refer to the setup document for the workshop and complete the steps in it before continuing!

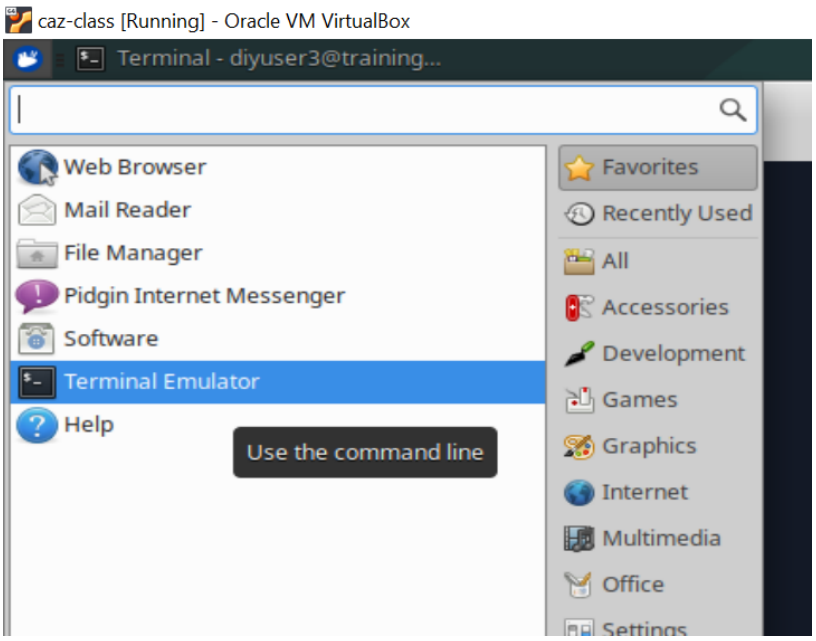
Throughout the labs, we will denote anything that is specific to the VirtualBox environment with a phrase like "**If running in the VM**".

Startup - to do before first lab

1. **If running in the VM,** enable networking. Enable networking by selecting the up/down arrow icon at top right and selecting the option to "Enable Networking". See screenshot below.



Open a terminal session by using the one on your desktop or clicking on the little mouse icon in the upper left corner and selecting **Terminal Emulator** from the drop-down menu.



2. Get the latest files for the class. For this course, we will be using a main directory *k8s-ps* with subdirectories under it for the various labs.

If running in the VM

In the terminal window, cd into the main directory and update the files.

```
$ cd k8s-ps

$ git pull
```

If NOT running in the VM

```
$ git clone https://github.com/skillrepos/k8s-ps

$ cd k8s-ps
```

3. **Whether running in the VM or not,** pre-pull images we will need for this workshop.

```
$ ./extra/image-prepull.sh
```

4. **If running in the VM**, start up the paused Kubernetes (minikube) instance on this system using a script in the *extras* subdirectory. This will take several minutes to run.

```
$ extra/start-mini.sh
```

5. Enable the Kubernetes metrics-server for the cluster.

If running in the VM

```
$ sudo minikube addons enable metrics-server
```

If NOT running in the VM, consult documentation for your cluster. (Note this is only needed for one step, so is not critical.)

6. Optional - setup alias. In these labs and on the VM, "k" is aliased to "kubectl". If you are not running in the VM, you can usually do this via the following command if you want:

```
$ alias k=kubectl
```

Lab 1 - Pod Startup

Purpose: In this lab, we'll look at ways to identify and remediate issues with system resources when trying to get pods scheduled on nodes.

1. Change to the ***roar-ts1*** subdirectory (roar is the name of the sample app we'll be working with.) In this directory, we have Helm charts to deploy the database and webapp parts of our application. Use the "tree" command to view the structure of the directory tree and note that it has charts and pieces for both a webapp and a database piece. Each of these will have their own pod, deployment, and service.

```
$ cd roar-ts1
$ tree
```

2. Create a namespace named "ts" to hold the deployment and set it as the default.

```
$ k create ns ts
```

```
$ k config set-context --current --namespace=ts
```

3. Finally, deploy the app into the cluster with the "helm install" command. (In the last command, the first occurrence of "ts" indicates the namespace, the second is the name of the release, and the "." means using the files from this directory.)

```
$ helm install -n ts ts .
```

4. Now let's see how things are progressing. Take a look at the overall status of the pods.

```
$ k get pods
```

5. Notice that we only have one pod - one for roar-web (and it currently is in PENDING). Because this app has two parts, a webapp and a database piece, we should also have a pod for the mysql database piece. Since we don't have a pod to investigate, let's start one level up with the replicasets. Take a look at the replicasets. What do you notice about the one for the mysql piece?

```
$ k get rs
```

6. Notice that the line for the database replicaset (starting with "mysql-") has 0's in the DESIRED, CURRENT, and READY columns. We would assume it would be 1 for all of these. Take a look at the deployments and you'll see the same thing. While we could (and eventually should) go back and fix this in the chart, for the sake of time, we can simply try to scale this replicaset up to 1 for now. Then check to see that the pod shows up.

```
$ k get deploy

$ k scale deploy/mysql --replicas=1

$ k get pods --show-labels
```

7. Although we can now see the mysql (database) pod, note that it is in PENDING state. Let's use one of the labels associated with the mysql pod and do a describe on it to see more information.

```
$ k describe pod -l app=mysql
```

8. Notice near the bottom there's an Event that says *"0/1 nodes are available: Insufficient memory."* This means there is not enough memory on the node to

schedule the pod. Run the commands below to see how much memory the pod is requesting and how much is available on the node we have.

```
$ k get pod -l app=mysql -o yaml | grep limits -A6

$ k describe node <node name> | grep memory
```

9. Our mysql pod is asking for an unrealistic large number (to provoke the error). Even if it were just under the amount available on the node, other processes running on the node in other namespaces could be using several Gi. You can see how much memory is being used on the node with the command below.

```
$ k top node <node name>
```

(Note: In order for this command to work, you need the Kubernetes Metric Server enabled as per the setup.)

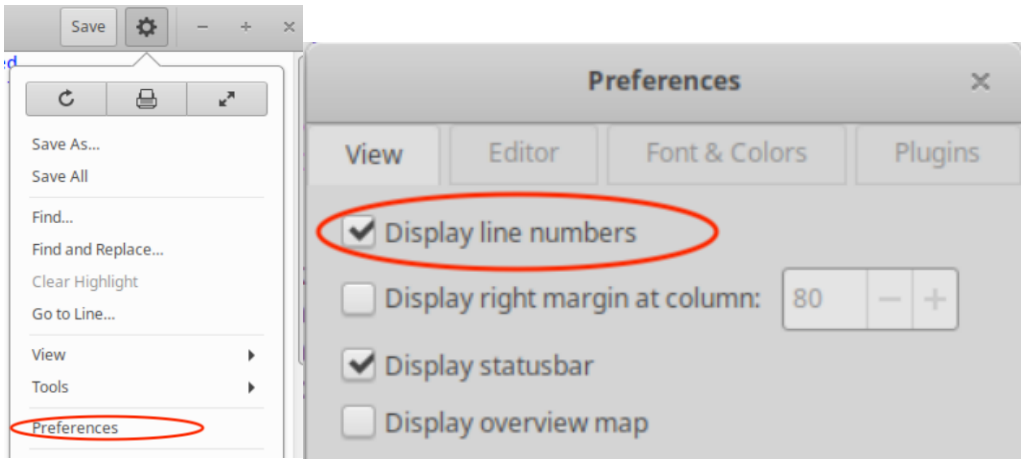
10. Getting back to our needs, let's drop the limit and request values down to 6 and 4 respectively and see if that fixes things. We'll do this with the kubectl edit command to edit the deployment in place.

```
(optional) $ export EDITOR=<editor on your system>
```

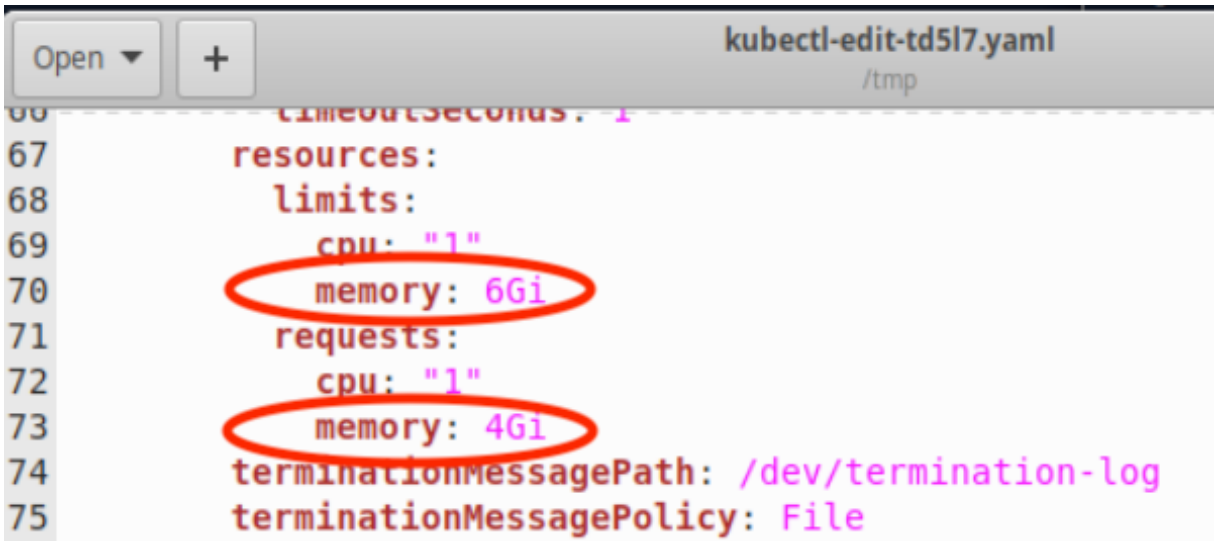
- **for the VM, you can set this to "gedit"**

```
$ k edit deploy/mysql
```

11. If you are running in the VM and using gedit, you can turn on line numbers in gedit by clicking on the gear icon at the top right, selecting Preferences, then clicking the top box in the "View" tab to "Display line numbers". Then click the "x" in the upper right to close the dialog box.



12. Change the two memory lines at line 70 and 73 as shown below. When you are done, save your changes and exit the editor.



13. After a few moments, you should see a new mysql pod with a status of Running. At this point you can go ahead and delete any extra, old Replicasets that are out there and that will remove the extra old pod.

```
$ k get pods

(optional)$ k delete rs/<name of older mysql rs>
```

Lab 2- Understanding issues with node selection and extended Pod debugging

Purpose: In this lab, we'll look at ways to identify and remediate issues with getting scheduled on particular nodes and debug and fix why a pod won't start up.

1. Since we have our mysql pod in a Running state, let's switch focus to the web one. It's still in a Pending state, so let's do a describe to see if we can figure out what's wrong. Run the describe command below on the pod with the label of app=roar-web.

```
$ k describe pod -l app=roar-web
```

2. At the bottom of the describe output, in the Events section, you should see an error similar to the following: *"Warning FailedScheduling 7m58s default-scheduler 0/1 nodes are available: 1 node(s) didn't match Pod's node affinity/selector."* Node selection here is based on labels. Let's look at what label the pod wants and which ones our node has.

```
$ k describe pod -l app=roar-web | grep Selector

$ k get nodes --show-labels
```

3. As you can see, there are a lot of labels on the node - added by the system. But there isn't one that matches the label the pod is expecting "type=mini". So, let's apply. one now. You can run a quick command to check afterwards.

```
$ k label node <node name> type=mini

$ k get nodes --show-labels | grep type
```

4. Now, if you check the pod list a few times (*via k get pods*) you should eventually see that the web pod's status moves out of Pending. Unfortunately, it still has an error status of ErrImgPull or ImagePullBackOff. So, we need to solve this issue next.

5. Let's run a command to look at the logs for the web pod.

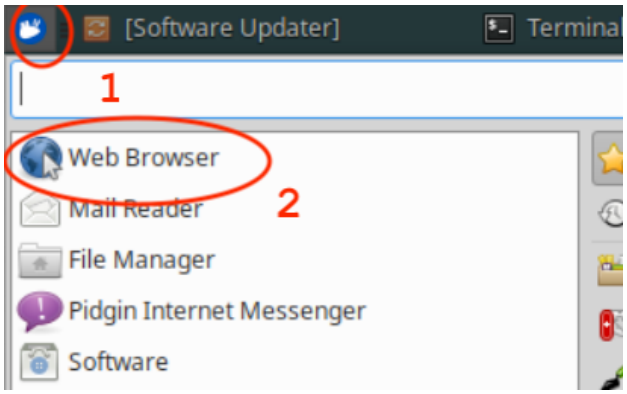
```
$ k logs -l app=roar-web
```

6. The output here confirms what is wrong – notice the part on "*trying and failing to pull image*" or *"image can't be pulled"*. We need to get more detail though - such as the exact image name. We could use a describe command, but there's a shortcut using "get events" that we can do too.

```
$ k get events | grep web | grep image
```

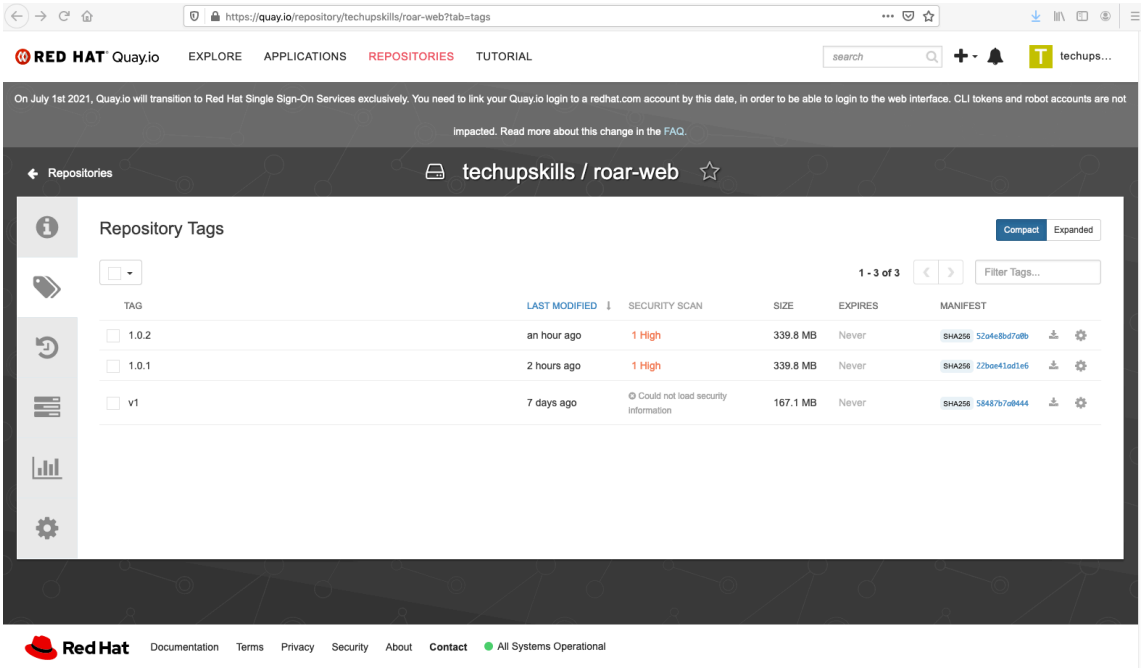
7. Notice that the output of the command from the step above gives us an image path and name: "*quay.io/techupskills/roar-web:1.10.1*". Since it says it can't pull it, let's check and see if it actually exists by going to the URL for it. Open the following URL in a web browser.

   If running in the VM, open a browser by clicking on the "mouse head" button in the upper left part of the VM window and then selecting "Web Browser" from the list.



8. After the browser window opens, put the following in the address bar

```
https://quay.io/repository/techupskills/roar-web?tab=tags
```



9. You can see that we don't have an image with the tag "1.10.1". Instead we have a "1.0.1". So there's probably a typo.

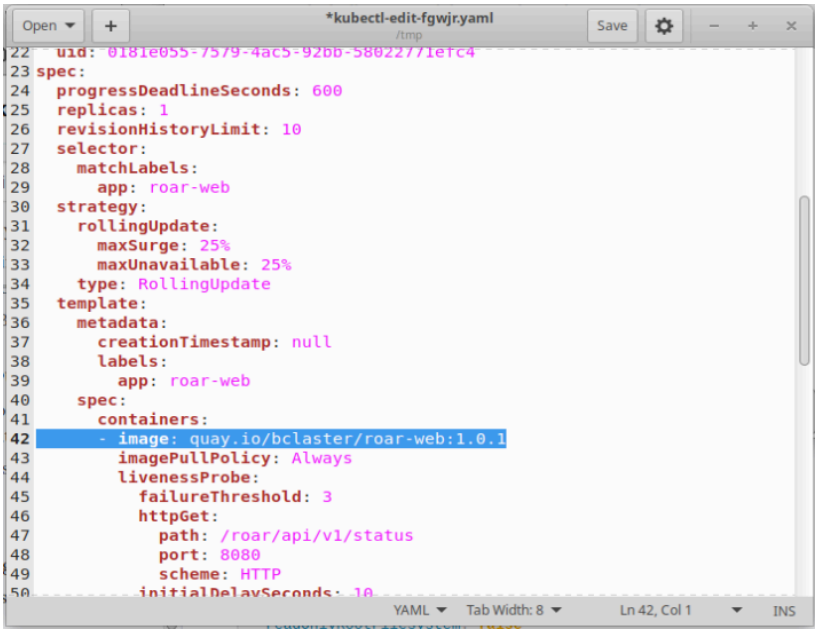
To validate if this will fix the problem, let's edit the existing object. We'll edit the deployment object and then also setup a watch command to watch the pod change.

(Do this one command in a **separate terminal session:**

$ k get pods -w)

$ k edit deploy/roar-web

Change line 42 to use 1.0.1 instead of 1.10.1.



10. Save your changes to the deployment and close the editor. Eventually, you should see a new pod finished creating and running. The previous web pod will be terminated and removed. However, momentarily, the pod will change to a CrashLoopBackOff status. We'll figure that out in the next lab.

    Leave the watch running in the other window for the next lab.

END OF LAB

Lab 3 - Debugging failed and crashed containers within Pods

Purpose: In this lab, we'll look at ways to troubleshoot failed containers within pods and how to spin up pods to debug them.

1. We know from our last lab that the web pod is having some more serious issues. Let's start by doing a describe and a log. For this one, grab the name of the pod from the output of a "get pods" and use that instead of the label.

```
$ k get pods  (this is to get the name)

diyuser3@training1:~/ts-k8s
NAME
mysql-6c9f9f9bf5-f26xl
roar-web-5f7f6cb598-pdcnw
```

```
$ k describe pod <web pod name>

$ k logs <web pod name>
```

2. The describe doesn't tell us much that's meaningful. But the logs note several errors. Run the command below to find the first SEVERE error. It will look like the output below.

```
$ k logs <web pod name> | grep -m1 SEVERE -A2
```

21-May-2021 22:02:20.234 SEVERE [main] org.apache.tomcat.util.digester.Digester.fatalError Parse fatal error at line [28] column [1]

org.xml.sax.SAXParseException; systemId: file:/usr/local/tomcat/webapps/roar/WEB-INF/web.xml; lineNumber: 28; columnNumber: 1; XML document structures must start and end within the same entity.

3. If we want to debug further, we have a challenge because the container has crashed. Depending on the timing (between restarts) we might be able to exec into it and work from there. You can try this command, although you may get "container not found" messages unless the timing happens to be just right.

   NOTE: On a Windows / Git Bash shell, it may be necessary to add the "winpty" tool in front of the command and spell out kubectl as in "winpty kubectl exec <web pod name> -- bash

```
$ k exec -it <web pod name> -- bash
```

4. If you did get in, you can just "exit" out of that. Another approach we have for getting into a pod like this is using the kubectl debug command to copy it to another pod and start it with a different command. Try the example below for this. Once inside you can look at the problem file.

```
$ k debug <web pod name> -it --copy-to=roar-debug --container=roar-web -- sh

$ cat /usr/local/tomcat/webapps/roar/WEB-INF/web.xml

(Note that when the restart cycle starts, your session will end.)
```

5. Since this is an XML error, we might want to run a debugging tool like an XML parser or linter to find out more. Unfortunately, we don't have any of those tools in this image. But I've created an image with the xmllint tool in it and we can use the *kubectl debug* command to create a debug container and attach to the pod. You can exit out of the previous connection if still in that and then run this command below.

```
$ k debug <web pod  name> -it --image=quay.io/techupskills/roar-
debug:1.0.2 --share-processes --copy-to=roar-debug2 --  bash
```

6. Once in this session, we are in the debug pod, but have shared access to processes running on the original pod. We can see the processes with simple commands such as:

```
$ ps ax
```

7. In this pod, we have the xmllint tool. And we can access some things on the file system via the syntax of *"/proc/<process id>/root/<path>"*. Assuming you are at a place where you can do "ps ax" and see the "tomcat" process running (starts with /usr/local/openjdk-11/bin/java) then you can copy and paste this command to run xmllint against the problem file.

(at prompt root@roar-debug2:/#)

```
xmllint /proc/$(ps ax | grep tomcat | awk '{print $1}' | head -
        n1)/root/usr/local/tomcat/webapps/roar/WEB-INF/web.xml
```

When this executes, you should see output similar to the following:

```
/proc/6/root/usr/local/tomcat/webapps/roar/WEB-INF/web.xml:28:
        parser error : EndTag: '</' not found



^
```

(If you can't seem to catch it when the process is running, you can try deleting the mysql pod and the debug pod, letting K8s generate a new pod and then repeating steps 5-7)

You can just **exit** out of the debug pod when done.

8. Since we have a problem with the existing container, there will need to be a new image created to fix it. I've already created one at quay.io/techupskills/roar-web:1.0.2. We can use kubectl debug again here - to make a copy of our pod and replace the existing image reference with our new one. Use the command below.

```
$ k debug <web pod name>  --copy-to=web-test --set-image=roar-web=quay.io/techupskills/roar-web:1.0.2
```

9. After this, you can see the new pod startup. And you can look at the logs to see that the new pod (web-test) has started successfully and isn't having the same issues. (It may take a couple of tries before you see it.)

```
$ k get pods | grep test

$ k logs web-test
```

10. Now that we know that this image works, we can update the image in our existing deployment that is having the issues. Do this with the set image command. Afterwards, you'll see a new image created that eventually be Running.

```
$ k set image deploy/roar-web roar-web=quay.io/techupskills/roar-web:1.0.2

$ k delete pod web-test roar-debug roar-debug2
```

11. We still have some old replicaSet revisions out there for the web deployment. We want to get rid of all but the most current. We could delete each one in turn, but we can also do this by changing the revisionHistoryLimit value in the deployment spec. Normally this has a default of 10, but we'll edit it and change it to 0.

```
$ k get rs  (to see the current list)

$ k edit deploy/roar-web

Change the line that has "revisionHistoryLimit: 10" to be "revisionHistoryLimit: 0", then save and exit the editor.

$ k get rs  (to see the updated list)
```

END OF LAB

Lab 4 - Working with Probes

Purpose: In this lab, we'll look at ways to debug issues when trying to use probes.

1. Take a look at the pods in our namespace again. You should see that while the web pod is running, the database pod is not ready. Now, let's do a "describe" operation on the mysql pod.

```
$ k get pods

$ k describe pod -l app=mysql
```

2. Note the error message near the bottom of the output mentioning the readiness probe failed. The readiness probe in this case is just an exec of a command to invoke mysql. The error implies that the call to "mysql" failed. But note that it doesn't say it couldn't find it. Rather, it wasn't valid to call it that way since it tried to invoke it without a valid name and password to login.

3. You can see the YAML for this in the deployment template in the corresponding Helm chart. In the terminal window, take a look at that and find the section near the bottom with the **readinessProbe** spec.

```
$ cat charts/roar-db/templates/deployment.yaml
```

4. We actually don't need to have a command login to verify readiness – we just need to know the mysql application responds. Let's fix this by trying something simpler such as calling the "version" command - which we should be able to do without a login.

5. You can edit the deployment as we've done before. Run the kubectl edit command. Add a line as shown below, paying careful attention to the spacing. (Remember to use spaces and not tabs.) When you are done, save your changes and exit the editor.

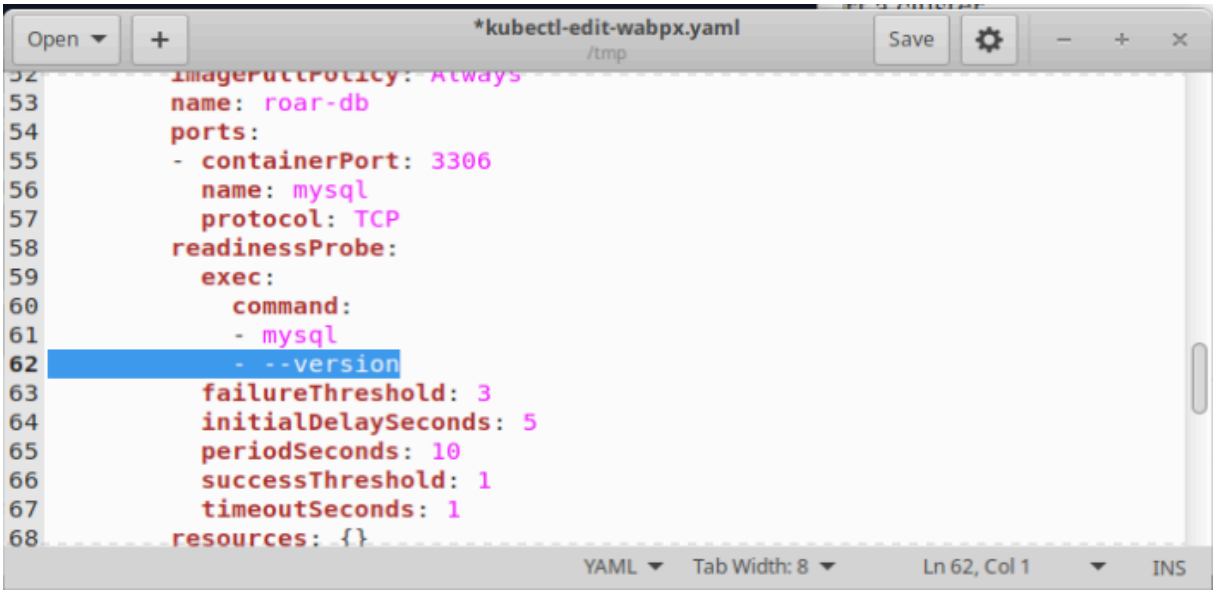
```
$ k edit deploy/mysql
```

And change (around line 58)

```
readinessProbe:
  exec:
    command:
    - mysql
  failureThreshold: 3
  initialDelaySeconds: 5
```

To add the line shown in bold (remember to use spaces)

```
readinessProbe:
  exec:
    command:
    - mysql
    - --version
  failureThreshold: 3
  initialDelaySeconds:  5
```



6. Save your changes and exit the editor. At this point, you can get the service's nodeport and then open up a browser on localhost to the URL below to see the application running.

```
$ k get svc
```

Look for the port > 30000 after the 8089: in the roar-web line. Plug that value in for <port> below and open the URL up in a browser. **(Note: depending on your setup, you may need to do a port-forward command or similar first.)**

```
$ k port-forward <roar-web pod name> <nodeport>:8080

        http://localhost:<nodeport>/roar/
```

7. You may have multiple mysql pods at this point. You can use any of the methods we've discussed to get rid of the oldest one.

8. When the application comes up, you may notice something interesting about it - there is no data being displayed. Let's do the typical *logs* and *describe* commands to see if we can determine the problem. (Verify that you only have the 2 pods. If not, you can delete the older replicaset.)

```
$ k logs -l app=mysql

$ k describe pod -l app=mysql
```

9. Since that didn't indicate any problem, let's verify that the database is actually accessible and has data in it. We'll do this with a *kubectl exec* command. You will need to copy the mysql pod name to use here.

```
$ k exec -it <mysql pod name> -- bash
```

10. Now, you'll be inside the db container. We can use one command to check that things look right here. (Type this at the /# prompt. Note no spaces between the options -u and -p and their arguments. You need only type the part in bold.) There are 2 separate steps. If everything looks good, then exit the container exec.

```
mysql@container-id:/$ mysql -uadmin -padmin registry -e 'select * from agents';

mysql@container-id:/$ exit
```

(Here -u and -p are the userid and password respectively and registry is the database name.)

11. Since the database looks ok, we need to look elsewhere for the problem. We'll next look at the service for the database in the next lab.

END OF LAB

Lab 5 - Troubleshooting Services

Purpose: In this lab, we'll troubleshoot how to determine the problem(s) when your service isn't accessible.

1. When there is a potential problem with a service, one of the first things to check is whether the networking is working as expected for the cluster. An easy way to get some simple info is to use the cluster-info command. You can get basic info in its simple form or you can add the "dump" option to see more info.

```
$ k cluster-info

$ k cluster-info dump
```

2. This shows some issues, but it's not easy to tell where they originated. Let's try a different approach. We'll start up a basic pod in the cluster and run some basic commands through it. In that way, you are limiting the variables

involved rather than using one of your custom pods to check this. Run the command below to start such a pod in the cluster. (Note the space between the last "--" and "sh".)

```
$ k run -it --rm debug --image=busybox:1.28 --restart=Never -n ts -- sh
```

With the pod running, let's check if the DNS is working. To do that, we'll simply use the nslookup command to see if can resolve Kubernetes.default (Kubernetes.default is a special service that provides a way for internal applications (in the cluster) to talk to the API server.) At the pod's prompt, run the command below.

```
/ # nslookup kubernetes.default
```

This should return output similar to this:

Server: 10.96.0.10
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local

Name: kubernetes.default
Address 1: 10.96.0.1 kubernetes.default.svc.cluster.local

(Note: busybox sometimes has an issue that would cause the second section above not to show. If you are running in the VM and that's the case, you can ignore it.)

Now, let's check to see if we can see our database services We'll use a similar command. Run the command in bold below and you should see similar output.

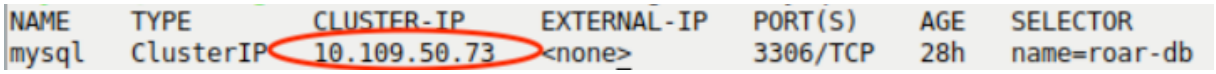
```
/ # nslookup mysql
```

Server: 10.96.0.10
Address 1: 10.96.0.10 kube-dns.kube-system.svc.cluster.local

Name: mysql
Address 1: 10.110.163.71 mysql.ts.svc.cluster.local

3. So far, so good. Next, we'll check to see if we can get to the services from within the cluster. To do this, we'll need the CLUSTER-IP address of our mysql service. Find this now with the following command (in a different terminal) and look for the item in the locations circled in red in the screenshot below.

```
$ k get svc mysql -o wide
```



4. Using the value from step 4, run the following command back in the busybox pod. Afterwards, you can exit this container. (That is the letter O, not the number 0 after the q.)

```
/ # wget -qO- <CLUSTER-IP for mysql>:3306

/ # exit
```

5. Notice the error message you got from that last operation (the "wget: can't connect to remote host…" output). This is a clue. To connect, a service needs endpoints. Let's check for those now. In a separate terminal:

```
$ k get ep
```

6. We have endpoints for the web service, but not for the database service. This is likely the problem. Endpoints are implemented via selectors between the service and the pods. Check the selector that's being used for the service. We'll use the jq tool here to easily parse the output. But if you don't have jq installed, you can also do a grep as in the alternate syntax.

```
$ k get svc mysql -o json | jq -j '.spec.selector'
```

The output should look like:

```
{
      "name":  "roar-db"
}
```

Alternative syntax (with grep):

```
$ k get svc mysql -o json | grep -A2 selector
```

The output should look like:

```
        "selector": {
            "name": "roar-db"
        },
```

7. Now we should check to see what labels are on the database pod to see if they match.

```
$ k get pods --show-labels | grep mysql-
```

You should see output something like this:

mysql-78fd7d4744-wqn82 0/1 Running 0 26h app=mysql,pod-template-hash=78fd7d4744

8. There is not a match for *name=roar-db.* But the pod does have an *app=mysql* label. So, we could either add the label in the deployment that the service is looking for (it will spin up a new pod) or add the pod's label in the service. We'll do the former using another method - *kubectl patch*. Note: If you prefer not to use the patch, you can do a *k edit* on the deployment and modify the label that way. Here's the patch command - the syntax is important so be careful. There should be a space after "path": .

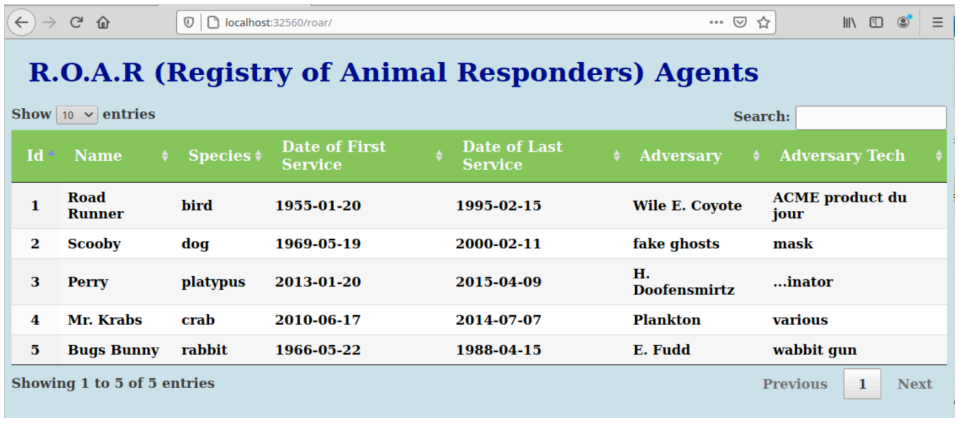
```
$ k patch deploy mysql --type=json -p='[{"op": "add", "path":
"/spec/template/metadata/labels/name", "value": "roar-db"}]'
```

9. If you still have 2 mysql pods, you can remedy that via getting rid of replicasets as we've done before, or scaling the deployment down to 0 and then back up to 1.

```
$ k scale deploy/mysql --replicas=0
$ k scale deploy/mysql --replicas=1
```

10. After the new pod gets done starting up, you should be able to refresh the browser and see data on the web page indicating everything is ok.

(You may need to run the port-forward command again if it is no longer running.)



END OF LAB