

Getting Started with Prometheus

Monitoring Kubernetes infrastructure and applications for reliability

Class Labs

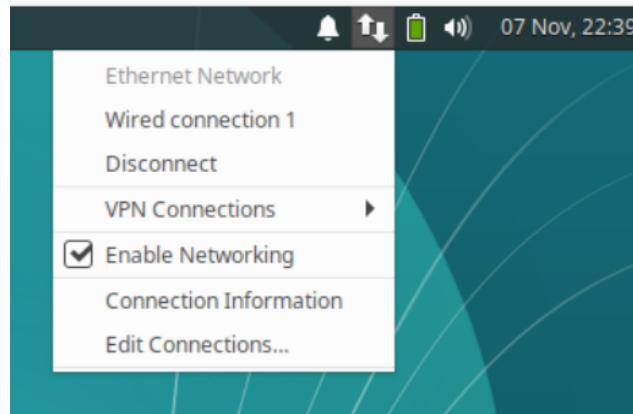
Version 1.2 by Brent Lesser on behalf of Tech Skills Transformations

01/13/2022

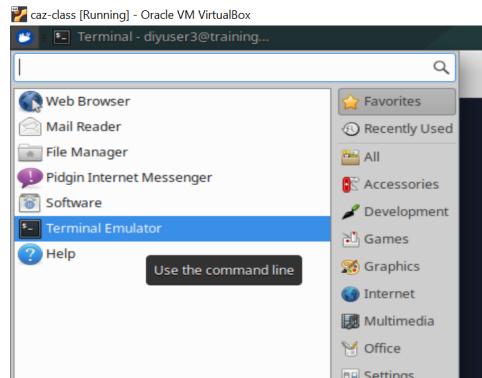
Important Prereq: These labs assume you have already followed the instructions in the separate setup document and have VirtualBox up and running on your system and have downloaded the *prom-start.ova* file and loaded it into VirtualBox. If you have not done that, please refer to the setup document for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

Startup - to do before first lab

1. Enable networking by selecting the up/down arrow icon at top right and selecting the option to "Enable Networking". See screenshot below.



2. 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.



3. First, let's make sure we have the latest files for the class. For this course, we will be using a main directory *prom-start* with subdirectories under it for the various labs. In the terminal window, cd into the main directory and update the files.

```
$ cd prom-start
$ git stash
$ git pull
```

3. Next, start up the paused Kubernetes (minikube) instance on this system using a script in the *extras* subdirectory. This will take several minutes to run to start up minikube and also it will be waiting for a directory to be in existence to fix a permissions issue with it. So you can just let it run while we do the first lecture portion.

```
$ extra/start-mini2.sh
```

4. (OPTIONAL IF NEEDED FOR LAB 1.) If you can't get the Prometheus home page at localhost:31000 to come up, it is probably because of a permissions issue with the mount that it is trying to use. This is a bug with the version of Prometheus we are using, but there is a fix. In the "extra" directory is a file named "fixtmp.sh". You can run it to change the permissions on the mount. After that you may need to wait for the "Prometheus-server" pod to restart in the namespace monitoring (or delete it and restart).

```
$ k get pods -n monitoring (look for Prometheus server pod as 1/2 ready or
crashloopbackoff, etc.)
```

```
$ extra/fixtmp.sh
```

Example:

```
diyuser3@training1:~/prom-start/extras$ k get pods -n monitoring | grep
server
```

NAME	READY	STATUS
RESTARTS	AGE	
pc-prometheus-server-85f8d4c78f-zdmnn	1/2	CrashLoopBackOff
6	3d19h	

```
diyuser3@training1:~/prom-start$ extra/fixtmp.sh
```

Lab 1 - Monitoring with Prometheus

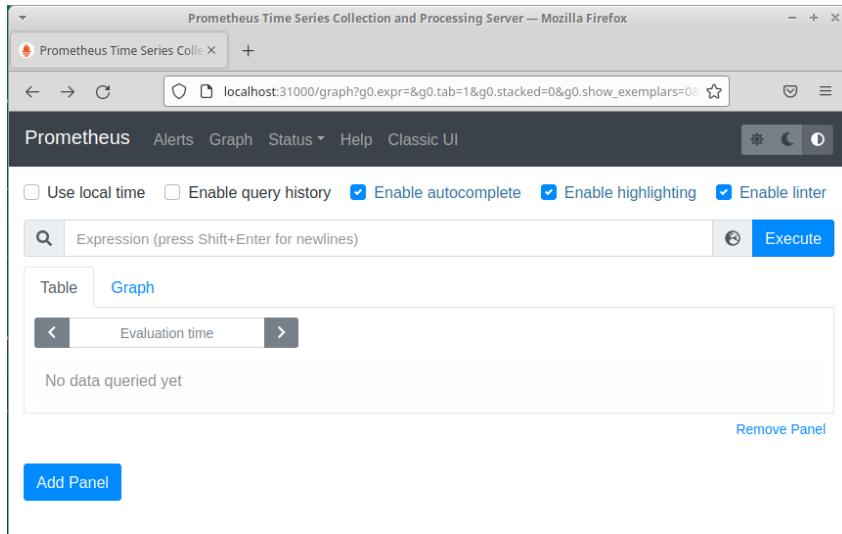
Purpose: In this lab, we'll run an instance of the node exporter and use Prometheus to surface basic data and metrics.

- For this lab, we have already setup an instance of the Prometheus Community edition main server running in a namespace in our cluster named monitoring. Take a quick look at the different pieces that we have running there since we installed the prometheus-community/prometheus helm chart.

```
$ k get all -n monitoring
```

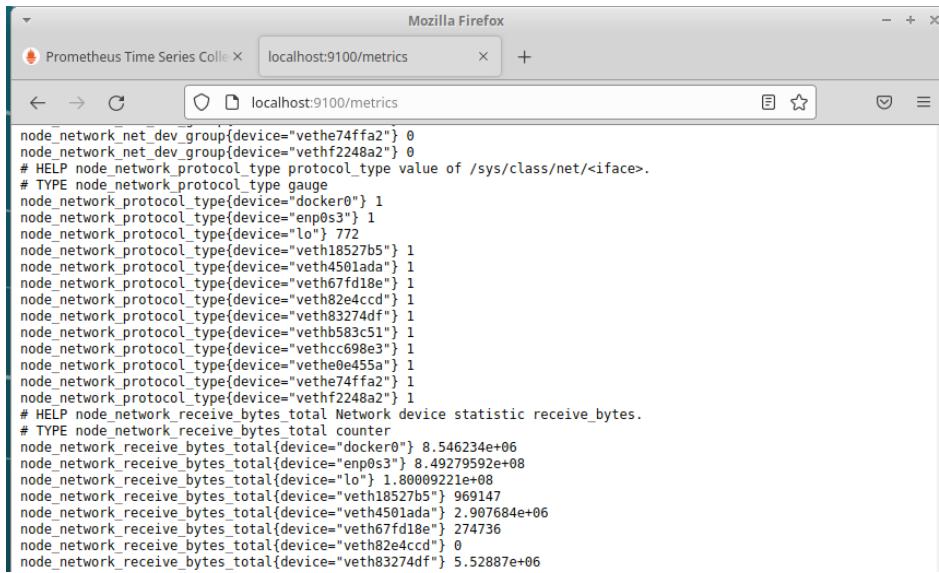
- Notice that we have both Prometheus itself and the node exporter piece running there (among others). Let's take a look at the Prometheus dashboard in the web browser. Open up a web browser and go to the url below to see it.

<http://localhost:31000/>



- We'll get to use the dashboard more in the labs. For now, lets open up the node exporter's metrics page and look at the different information on it. (Note that we only have one node on this cluster.) Go to the link below. Once on that page, scan through some of the metrics that are exposed by this exporter. Then see if you can find the "total number of network bytes received on device "lo". (Hint: look for this metric "node_network_receive_bytes_total{device='lo'}").

<http://localhost:9100/metrics>



```

Mozilla Firefox
Prometheus Time Series Collection
localhost:9100/metrics
localhost:9100/metrics

node_network_net_dev_group{device="vethc74ffa2"} 0
node_network_net_dev_group{device="vethf2248a2"} 0
# HELP node_network_protocol_type protocol_type value of /sys/class/net/<iface>.
# TYPE node_network_protocol_type gauge
node_network_protocol_type{device="docker0"} 1
node_network_protocol_type{device="enp0s3"} 1
node_network_protocol_type{device="lo"} 772
node_network_protocol_type{device="veth18527b5"} 1
node_network_protocol_type{device="veth4501ada"} 1
node_network_protocol_type{device="veth67fd18e"} 1
node_network_protocol_type{device="vethb82e4cc0"} 1
node_network_protocol_type{device="veth83274df"} 1
node_network_protocol_type{device="vethb583c51"} 1
node_network_protocol_type{device="vethcc698e3"} 1
node_network_protocol_type{device="veth0e455a"} 1
node_network_protocol_type{device="vethc74ffa2"} 1
node_network_protocol_type{device="vethf2248a2"} 1
# HELP node_network_receive_bytes_total Network device statistic receive_bytes.
# TYPE node_network_receive_bytes_total counter
node_network_receive_bytes_total{device="docker0"} 8.546234e+06
node_network_receive_bytes_total{device="enp0s3"} 8.49279592e+08
node_network_receive_bytes_total{device="lo"} 1.80009221e+08
node_network_receive_bytes_total{device="veth18527b5"} 969147
node_network_receive_bytes_total{device="veth4501ada"} 2.907684e+06
node_network_receive_bytes_total{device="veth67fd18e"} 274736
node_network_receive_bytes_total{device="vethb82e4cc0"} 0
node_network_receive_bytes_total{device="veth83274df"} 5.52887e+06

```

- Now, let's see which targets Prometheus is automatically scraping from the cluster. Back in the top menu (dark bar) on the main Prometheus page tab, select Status and then Targets (or go to <http://localhost:31000/targets>). Then see if you can find how long ago the last scraping happened, and how long it took for the *kubernetes-nodes-cadvisor* target.

The screenshot shows the Prometheus Targets page in Mozilla Firefox. The URL is `localhost:31000/targets`. The page displays three sections of targets:

- kubernetes-apiservers (1/1 up)**: Shows one target at `https://10.0.2.15:8443/metrics` with state **UP**, last scraped 6.200s ago, and scrape duration 91.943ms. Labels include `instance="10.0.2.15:8443"` and `job="kubernetes-apiservers"`.
- kubernetes-nodes (1/1 up)**: Shows one target at `https://kubernetes.default.svc/api/v1/nodes/training1/proxy/metrics` with state **UP**, last scraped 17.935s ago, and scrape duration 68.795ms. Labels include multiple beta and minikube keys.
- kubernetes-nodes-cadvisor (1/1 up)**: Shows one target at `https://kubernetes.default.svc/api/v1/nodes/training1/proxy/metrics` with state **UP**, last scraped 17.935s ago, and scrape duration 68.795ms. Labels include `beta_kubernetes_io_arch="amd64"`, `beta_kubernetes_io_os="linux"`, `instance="training1"`, `job="kubernetes-nodes"`, `kubernetes_io_arch="amd64"`, `kubernetes_io_hostname="training1"`, `kubernetes_io_os="linux"`, `minikube_k8s_io_commit="76d74191d82c47883dc7e1319ef7cebd3e00ee11"`, `minikube_k8s_io_name="minikube"`, `minikube_k8s_io_updated_at="2021-12-23T22:45:27.0700"`, and `minikube_k8s_io_version="v1.21.0"`.

- Let's setup an application in our cluster that has a built-in Prometheus metrics exporter - traefik - an ingress. The Helm chart is already loaded for you. So, we just need to create a namespace for it and run a script to deploy it. After a few moments, you should be able to see things running in the traefik namespace.

```
$ k create ns traefik
$ ~/prom-start/extra/helm-install-traefik.sh
$ k get all -n traefik
```

- You should now be able to see the metrics area that Traefik exposes for Prometheus as a pod endpoint. Take a look in the **Status -> Targets** area of Prometheus and see if you can find it (`localhost:31000/targets`) and use a **Ctrl-F** to try to find the text "traefik". Note that this is the pod endpoint and not a standalone target. (If you don't find it, see if the "kubernetes-pods (1/1 up)" has a "show more" button next to it. If so, click on that to expand the list.)

Prometheus Alerts Graph Status ▾ Help Classic UI

kubernetes-pods (1/1 up) [show more](#)

kubernetes-service-endpoints (3/3 up) [show less](#)

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
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Prometheus Time Series Collection and Processing Server — Mozilla Firefox

Prometheus Time Series Collection and Processing Server — Mozilla Firefox

localhost:31800/metrics

localhost:31000/classic/targets

Prometheus Alerts Graph Status ▾ Help New UI

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
http://172.17.0.10:9100/metrics	UP	app_kubernetes_io_instance="traefik" app_kubernetes_io_managed_by="Helm" app_kubernetes_io_name="traefik" helm_sh_chart="traefik-10.9.1"	55.615s ago	2.167ms	

traefik

You can then click on the link in the Endpoint column to see the metrics that Traefik is generating.

172.17.0.10:9100/metrics localhost:31800/metrics

172.17.0.10:9100/metrics

```

process_start_time_seconds 1.64080812031e+09
# HELP process_virtual_memory_bytes Virtual memory size in bytes.
# TYPE process_virtual_memory_bytes gauge
process_virtual_memory_bytes 8.15730688e+08
# HELP process_virtual_memory_max_bytes Maximum amount of virtual memory available in bytes.
# TYPE process_virtual_memory_max_bytes gauge
process_virtual_memory_max_bytes 1.8446744073709552e+19
# HELP traefik config_last_reload_failure Last config reload failure
# TYPE traefik_config_last_reload_failure gauge
traefik_config_last_reload_failure 0
# HELP traefik config_last_reload_success Last config reload success
# TYPE traefik_config_last_reload_success gauge
traefik_config_last_reload_success 1.640808121e+09
# HELP traefik config_reloads_failure_total Config failure reloads
# TYPE traefik_config_reloads_failure_total counter

```

traefik

7. While we can find it as a pod endpoint, we don't yet have the traefik metrics established as a standalone "job" being monitored in Prometheus. You can see this because there is no section specifically for "traefik (1/1 up)" in the Targets page. Also, Traefik is not listed if you check the Prometheus service-discovery page at <http://localhost:31000/service-discovery>

8. So we need to tell Prometheus about traefik as a job. There are two ways. One way is just to apply two annotations to the service for the target application. However, this will not work with more advanced versions of Prometheus. So, we'll do this instead by updating a configmap that the Prometheus server uses to get job information out of. First let's take a look at what has to be changed to add this job. We have a "before" and "after" version in the extra directory. We'll use a tool called "meld" to see the differences.

```
$ cd ~/prom-start/extra (if not already there)
```

```
$ meld ps-cm-start.yaml ps-cm-with-traefik.yaml
```

9. It's easy to see the difference here. When you're done viewing, just go ahead and close meld. Now we'll apply the new configmap definition with our additional job. (Ignore the warning.)

```
$ k apply -n monitoring -f ps-cm-with-traefik.yaml
```

10. Now if you refresh and look at the Status->Targets page in Prometheus at <http://localhost:31000/targets> and the Service Discovery page at <http://localhost:31000/service-discovery> and do a Ctrl-F to search for traefik, you should find that the new item shows up as a standalone item on both pages. (It may take a moment for the traefik target to reach (1/1 up) in the targets page, so you may have to refresh after a moment.)

The screenshot displays two instances of the Mozilla Firefox browser. Both are connected to the Prometheus Time Series Collection and Processing Server at localhost:31000.

Top Window (localhost:31000/targets):

- The URL bar shows "localhost:31000/targets".
- The search bar at the bottom contains the text "traefik".
- The main content area shows a table titled "Prometheus Targets" with one entry:

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
http://traefik.traefik.svc.cluster.local:9100/metrics	UP	instance="traefik.traefik.svc.cluster.local:9100" job="traefik"	36.310s ago	1.664ms	

- A message at the bottom of the table says "localhost:31000/targets#pool-traefik".
- The search bar at the bottom also has "traefik" entered.

Bottom Window (localhost:31000/service-discovery):

- The URL bar shows "localhost:31000/service-discovery".
- The search bar at the bottom contains the text "traefik".
- The main content area shows a list of targets:

 - Kubernetes-nodes-cauisor (1 / 1 active targets)
 - kubernetes-pods (1 / 21 active targets)
 - kubernetes-service-endpoints (3 / 13 active targets)
 - prometheus (1 / 1 active targets)
 - prometheus-pushgateway (1 / 14 active targets)
 - traefik (1 / 1 active targets)**
 - kubernetes-pods-slow (0 / 24 active targets)
 - kubernetes-service-endpoints-slow (0 / 15 active targets)
 - kubernetes-services (0 / 14 active targets)

- The search bar at the bottom also has "traefik" entered.

END OF LAB

Lab 2- Deploying a separate exporter for an application

Purpose: In this lab, we'll see how to deploy a separate exporter for a mysql application running in our cluster.

1. We have a simple webapp application with a mysql backend that we're going to run in our cluster. The application is named "roar" and we have a manifest with everything we need to deploy it into our cluster. Go ahead and deploy it now.

```
$ k create ns roar
```

```
$ k apply -f roar-complete.yaml
```

2. After a few moments, you can view the running application in the roar namespace and also in the browser at <http://localhost:31790/roar> .

```
$ k get all -n roar
```

R.O.A.R (Registry of Animal Responders) Agents						
Show 10 entries		Search:				
Id	Name	Species	Date of First Service	Date of Last Service	Adversary	Adversary Tech
1	Road Runner	bird	1955-01-20	1995-02-15	Wile E. Coyote	ACME product du jour
2	Scooby	dog	1969-05-19	2000-02-11	fake ghosts	mask
3	Perry	platypus	2013-01-20	2015-04-09	H. Doofensmirtz	...inator
4	Mr. Krabs	crab	2010-06-17	2014-07-07	Plankton	various
5	Bugs Bunny	rabbit	1966-05-22	1988-04-15	E. Fudd	wabbit gun

Showing 1 to 5 of 5 entries

Previous 1 Next

3. Since we are using mysql on the backend, we'd like to be able to get metrics on that. Let's see if there's already a mysql exporter available. The best place to look if you're using the Prometheus community edition is in the helm charts area of that. Open a browser tab to <https://github.com/prometheus-community/helm-charts/tree/main/charts>. Notice that there's a prometheus-mysql-exporter chart. You can click on that and look at the README.md for it.

Commits (main)

Author	Commit Message	Date
jimengze	[kube-prometheus-stack] update kubernetes-system-kube-proxy.yaml (#1629) ...	18 hours ago
	..	
alertmanager	[alertmanager] add podLabels value (#1429)	3 months ago
kube-prometheus-stack	[kube-prometheus-stack] update kubernetes-system-kube-proxy.yaml (#1629)	18 hours ago
kube-state-metrics	[kube-state-metrics] Version bump to 2.3.0 (#1600)	12 days ago
prometheus-adaptor	[prometheus-adaptor] Recommended Kubernetes labels , custom labels an...	2 months ago
prometheus-blackbox-exporter	[prometheus-blackbox-exporter] revert change from #1450 and fix servi...	2 months ago
prometheus-cloudwatch-exporter	Add missing whitespace to cloudwatch-exporter chart (#1533)	last month
prometheus-consul-exporter	[prometheus-consul-exporter] Add Pod Annotations Value (#1416)	2 months ago
prometheus-couchdb-exporter	feat(prometheus-couchdb-exporter): add configurable apiVersion (#384)	14 months ago
prometheus-druid-exporter	[prometheus-druid-exporter] Add nodeSelector, tolerations, and affini...	3 months ago
prometheus-elasticsearch-exporter	[prometheus-elasticsearch-exporter] Add support for indices mappings (#...	9 days ago
prometheus-json-exporter	[prometheus-json-exporter] New Exporter (#1460)	2 months ago
prometheus-kafka-exporter	[prometheus-kafka-exporter] - added SASL support and upgrade to lates...	3 months ago
prometheus-mongodb-exporter	Prep initial charts indexing (#14)	17 months ago
prometheus-mysql-exporter	[prometheus-mysql-exporter] Add namespace support to service monitor ...	6 days ago

values.yaml

[prometheus-mysql-exporter] Add namespace support to service monitor ... 6 days ago

README.md

Prometheus Mysql Exporter

A Prometheus exporter for MySQL metrics.

This chart bootstraps a Prometheus MySQL Exporter deployment on a Kubernetes cluster using the Helm package manager.

Get Repo Info

```
helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
helm repo update
```

See [helm repo](#) for command documentation.

Install Chart

```
# Helm 3
$ helm install [RELEASE_NAME] prometheus-community/prometheus-mysql-exporter

# Helm 2
$ helm install --name [RELEASE_NAME] prometheus-community/prometheus-mysql-exporter
```

4. As part of the configuration for this, we need to setup a new user with certain privileges in the database that's running for our backend. For simplicity, I've provided a simple script that you can run for this. You can take a look at the script to see what it does and then run it to add the user and privileges. (Note that it requires the namespace as an

argument to be passed to it.) This script and other files are in a different directory under prom-start named "mysql-ex".

```
$ cd ~/prom-start/mysql-ex
$ cat update-db.sh
$ ./update-db.sh roar (note we supply namespace where db is running)
```

5. Now we are ready to deploy the mysql helm chart to get our mysql exporter up and running. To do this we need to supply a values.yaml file that defines the image we want to use, a set of metrics "collectors" and the pod to use (via labels). We also have a data file for a secret that is required with information on the service, user, password, and port that we want to access. Take a look at those files.

```
$ cat values.yaml
$ cat secret.yaml
```

6. Now we can go ahead and deploy the helm chart for the exporter with our custom values. For convenience, there is a script that runs the helm install. After a few moments you should be able to see things spinning up in the monitoring namespace.

```
$ ./helm-install-mysql-ex.sh
$ k get all -n monitoring | grep mysql
```

7. Finally, to connect up the pieces, we need to define a job for Prometheus. We can do this the same way we did for Traefik in Lab 1. To see the changes, you can look at a diff between the configmap definition we used for Traefik and one we already have setup with the definition for the mysql exporter.

```
$ meld ./extra/ps-cm-with-traefik.yaml ps-cm-with-mysql.yaml
```

```

diff --git a/ps-cm-with-tr...h-mysql.yaml b/ps-cm-with-mysql.yaml
--- a/ps-cm-with-tr...h-mysql.yaml
+++ b/ps-cm-with-mysql.yaml
@@ -1,10 +1,10 @@
 scrape_interval: 1m
 scrape_timeout: 10s
 rule_files:
- /etc/config/recording_rules.yml
- /etc/config/alerting_rules.yml
- /etc/config/rules
- /etc/config/alerts
scrape_configs:
- job_name: traefik
  static_configs:
- targets:
    - traefik.traefik.svc.cluster.local:80
- job_name: prometheus
  static_configs:
- targets:
    - localhost:9090
- bearer_token_file: /var/run/secrets/kubernetes-service-account/token
  job_name: kubernetes-apiservers
  kubernetes_sd_configs:

```

8. Now you can apply the updated configmap definition.

```
$ k apply -n monitoring -f ps-cm-with-mysql.yaml
```

9. You should now be able to see the mysql item in the targets page (localhost:31000/targets) and also in the service-discovery page (localhost:31000/service-discovery#mysql). (Again, it may take a few minutes for the mysql target to appear and reach (1/1 up).)

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
http://mysql-exporter.prometheus-mysql-exporter.monitoring.svc.cluster.local:9104/metrics	UP	instances="mysql-exporter.prometheus-mysql-exporter.monitoring.svc.cluster.local:9104",job=mysql	39.483s ago	70.044ms	

Endpoint	State	Labels	Last Scrape	Scrape Duration	Error
mysql					

Service Discovery

- kubernetes-apiservers (1 / 20 active targets)
- kubernetes-nodes (1 / 1 active targets)
- kubernetes-nodes-cadvisor (1 / 1 active targets)
- kubernetes-pods (1 / 24 active targets)
- kubernetes-service-endpoints (3 / 18 active targets)
- mysql (1 / 1 active targets)
- prometheus (1 / 1 active targets)

10. (Optional) If you want to see the metrics that are exposed by this job, there is a small script named **pf.sh** (in mysql-ex) that you can run to setup port-forwarding for the mysql-exporter. Then you can look in the browser at <http://localhost:9104/metrics>.

```
$ ./pf.sh
```

```
go_memstats_stack_sys_bytes 425984
# HELP go_memstats_sys_bytes Number of bytes obtained from system.
# TYPE go_memstats_sys_bytes gauge
go_memstats_sys_bytes 7.4269704e+07
# HELP go_threads Number of OS threads created.
# TYPE go_threads gauge
go_threads 5
# HELP mysql_exporter_collector_duration_seconds Collector time duration.
# TYPE mysql_exporter_collector_duration_seconds gauge
mysql_exporter_collector_duration_seconds{collector="collect.binlog_size"} 0.004260215
mysql_exporter_collector_duration_seconds{collector="collect.global_status"} 0.003972186
mysql_exporter_collector_duration_seconds{collector="collect.global_variables"} 0.012792833
mysql_exporter_collector_duration_seconds{collector="collect.info_schema.clientsstats"} 0.005440051
mysql_exporter_collector_duration_seconds{collector="collect.info_schema.innodb_cmp"} 0.015794649
mysql_exporter_collector_duration_seconds{collector="collect.info_schema.innodb_cmpmem"} 0.016336161
```

END OF LAB

Lab 3 - Writing queries with PromQL

Purpose: In this lab, we'll see how to construct queries with the PromQL language.

1. We're now going to turn our attention to creating queries in the Prometheus interface using Prometheus' built-in query language, PromQL. First, to get ready for this, in the browser that is running the Prometheus interface, switch back to the main Prometheus window by clicking on "Prometheus" in the dark line at the top, or going to localhost:31000. Once there, click to enable the five checkboxes under the main menu.

2. There are a couple of different ways to find available metrics to choose from in Prometheus. One way is to click on the query explorer icon next to the blue "Execute" button on the far right. Click on that and

you can scroll through the list that pops up. You don't need to pick any right now and you can close it (via the "x" in the upper right) when done.

The screenshot shows the Prometheus Metrics Explorer interface. In the top navigation bar, 'Metrics Explorer' is selected. Below the navigation, there's a search bar labeled 'Expression (press Shift+Enter for newlines)' and tabs for 'Table' and 'Graph'. A message 'No data queried yet' is displayed. On the right, a list of metrics is shown, with the first few being: 'aggregator_openapi_v2_regeneration_count', 'aggregator_openapi_v2_regeneration_duration', 'aggregator_unavailable_apiservice', etc. At the bottom right of the list is a blue 'Execute' button, which has a red circle drawn around it to indicate it as a key action.

- Another way to narrow in quickly on a metric you're interested in is to start typing in the "Expression" area and pick from the list that pops-up based on what you've typed. Try typing in the names of some of the applications that we are monitoring and see the metrics available. For example, you can type in "con" to see the ones for containers, "mysql" to see the ones for mysql, "trae" to see the ones for traefik, and so on. You don't need to select any right now, so once you are done, you can clear out the Expression box.

The screenshot shows the same Metrics Explorer interface as above. The search bar now contains the prefix 'con'. A dropdown menu lists several metrics starting with 'con': 'container_blkio_device_usage_total', 'container_cpu_load_average_10s', 'container_cpu_system_seconds_total', 'container_cpu_usage_seconds_total', 'container_cpu_usage_seconds_total', 'container_file_descriptors', 'container_fs_inodes_free', 'container_fs_inodes_total', 'container_fs_io_current', and 'container_fs_in_time_seconds_total'. To the right of the dropdown, a tooltip box appears with the text 'Blkio Device bytes usage' and a small icon. The 'Execute' button is visible at the bottom right of the interface.

- Now, let's actually enter a metric and execute it and see what we get. Let's try a simple "time series" one. In the Expression box, type in "node_cpu_seconds_total". As the name may suggest to you, this is a metric provided by the node exporter and tracks the total cpu seconds for the node. In our case, we only have one node. After you type this in, click on the blue "Execute" button at the far right to see the results.

Prometheus Alerts Graph Status Help Classic UI

Use local time Enable query history Enable autocomplete Enable highlighting Enable linter

node_cpu_seconds_total Execute

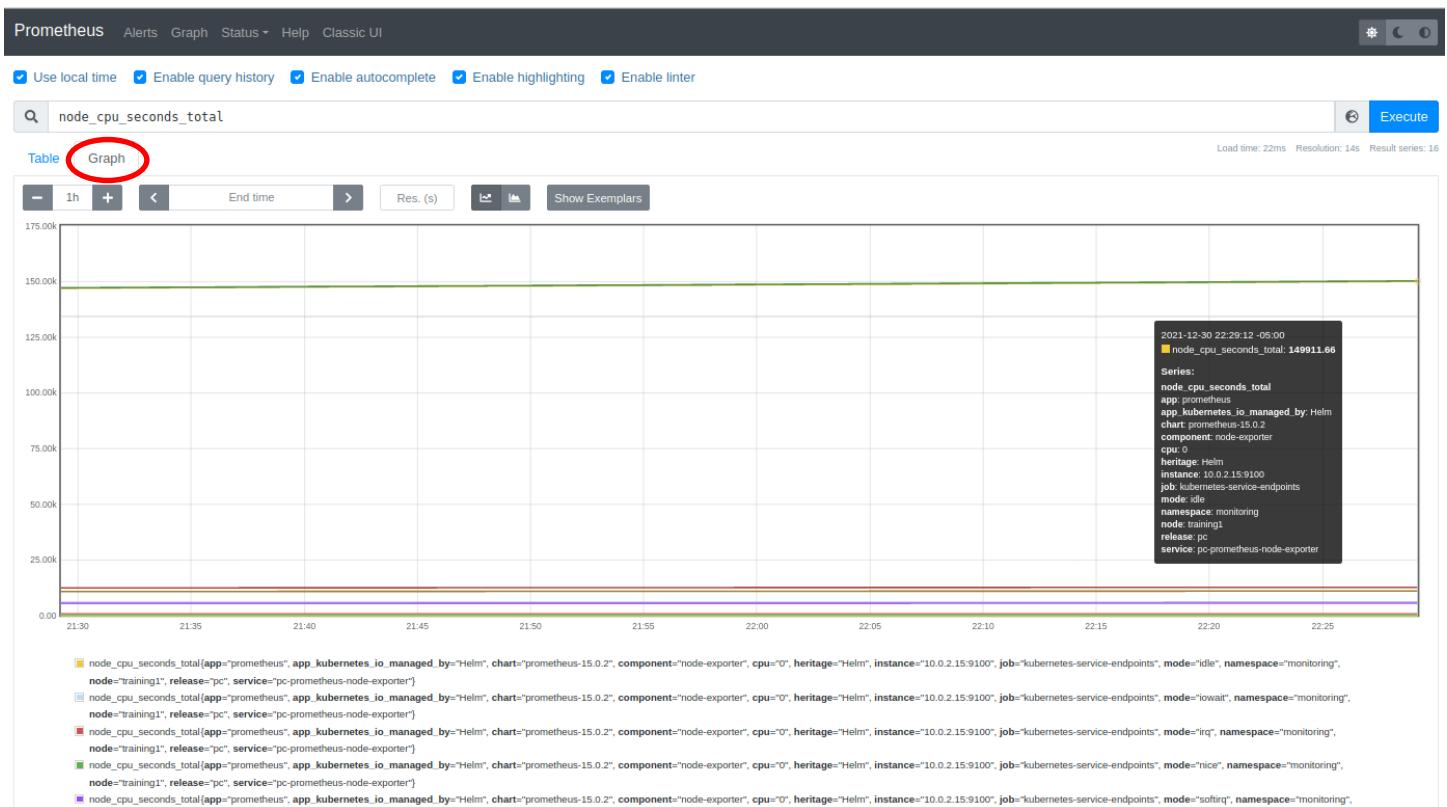
Table Graph

Evaluation time < >

```
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="idle", namespace="monitoring", 149642.6
node:"training1", release="pc", service="pc-prometheus-node-exporter"
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="lowlat", namespace="monitoring", node:"training1", release="pc", service="pc-prometheus-node-exporter"
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="irq", namespace="monitoring", 0
node:"training1", release="pc", service="pc-prometheus-node-exporter"
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="nice", namespace="monitoring", 80.2
node:"training1", release="pc", service="pc-prometheus-node-exporter"
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="softirq", namespace="monitoring", node:"training1", release="pc", service="pc-prometheus-node-exporter"
node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="steal", namespace="monitoring", 0
node:"training1", release="pc", service="pc-prometheus-node-exporter"}
```

Load time: 32ms Resolution: 14s Result series: 18

- Notice that we have a lot of rows of output from this single query. If you look closely, you can see that each row is different in some aspect, such as the cpu number or the mode. Rows of data like this are not that easy to digest. Instead, it is easier to visualize with a graph. So, click on the "Graph" link above the rows of data to see a visual representation. You can then move your cursor around and get details on any particular point on the graph. Notice that there is a color-coded key below the graph as well.



- What if we want to see only one particular set of data? If you look closely at the lines below the graph, you'll see that each is qualified/filtered by a set of "labels" within { and }. We can use the same syntax in the Expression box with any labels we choose to pick which items we see. Change your query to the one below and then click on Execute again to see a filtered graph. (Notice that Prometheus will offer

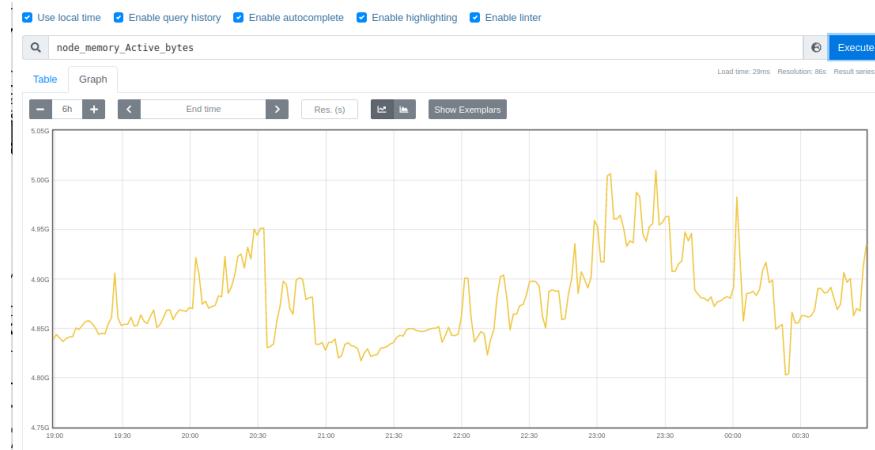
pop-up lists to help you fill in the syntax if you want to use them.) After you click Execute, you will see a single data series that increases over time.

```
node_cpu_seconds_total{cpu="0",mode="user"}
```



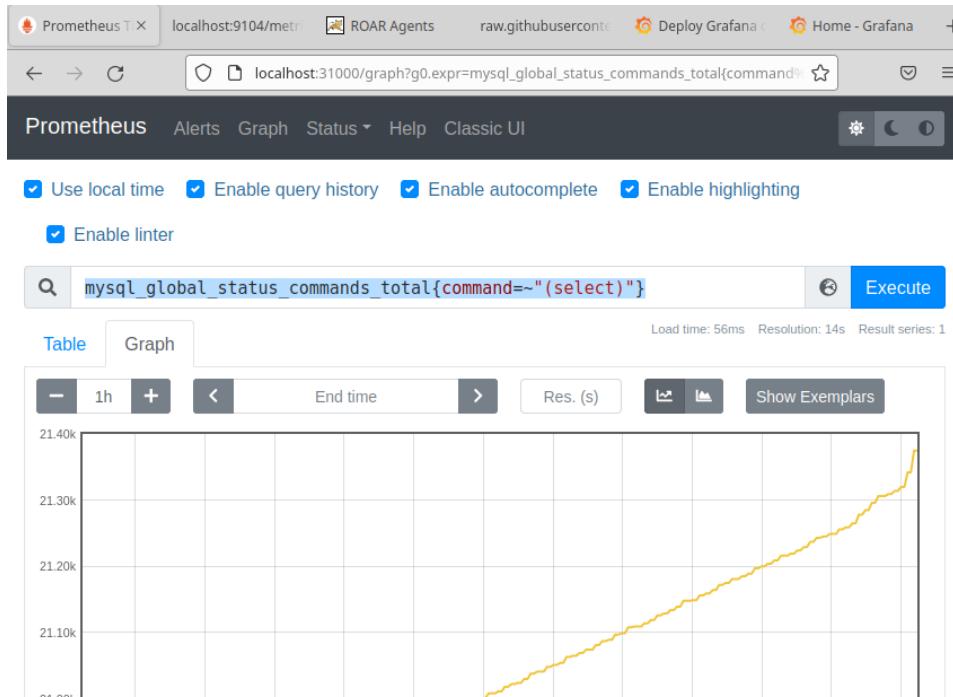
7. So far we have used counters in our queries - a value that increases (or can be reset to 0) as indicated by the "total" in the name. However, there are other kinds of time series such as "gauges" where values can go up or down. Let's see an example of one of those. Change your query to the expression below and then click the blue Execute button again.

```
node_memory_Active_bytes
```



8. Let's look at queries for another application. Suppose we want to monitor how much applications are referencing our database and doing "select" queries. We could use a mysql query to see the increase over time. Enter the query below in the query area and then click on **Execute**. A screenshot below shows what this should look like.

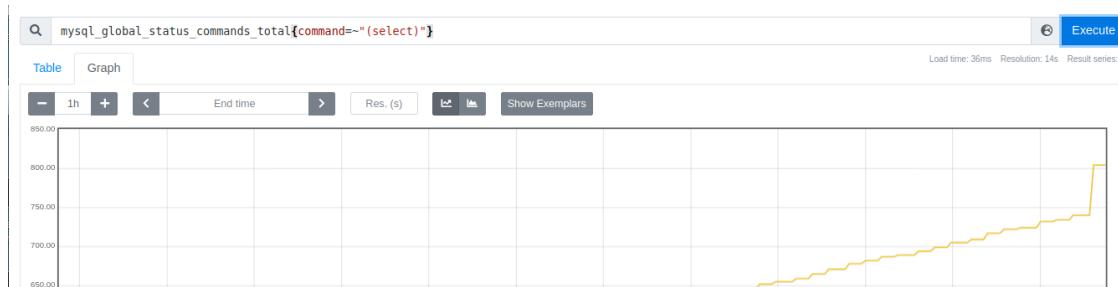
`mysql_global_status_commands_total{command=~"(select)"}`



- Now let's simulate some query traffic to the database. I have a simple shell script that randomly queries the database in our application x times while waiting a certain interval between queries. It's called ping-db.sh. Run it for 30 times with an interval of 1 second and then go back and refresh the graph again by clicking on the blue Execute button. (Note that you may need to wait a bit and refresh again to see the spike.)

```
$ ~/ping-db.sh roar 30 1
```

- After clicking on the Execute button to refresh, you should see a small spike on the graph from our monitoring. (It may take a minute for the monitoring to catch up.) This is something we could key off of to know there was a load, but it will always just be an increasing value. Let's focus in on a smaller timeframe so we can see the changes easier. In the upper left of the Prometheus Graph tab, change the interval selector down to 10m.





11. What we really need here is a way to detect any significant increase over a point in time regardless of the previous value. We can use the rate function we saw before for this. Change the query in Prometheus to be one that shows us the rate of change over the last 5 minutes and click on the **Execute** button again.

```
rate(mysql_global_status_commands_total{command=~"(select)"}[5m])
```

12. After clicking on the Execute button to refresh, you should see a different representation of the data. After you refresh, you'll be able to see that we no longer just see an increasing value, we can see where the highs and lows are.



END OF LAB

Lab 4 - Alerts and AlertManager

Purpose: In this lab, we'll see how to construct some simple alerts for Prometheus based on queries and conditions and use AlertManager to see them.

- Let's suppose that we want to get alerted when the "select" traffic spikes to high levels. We have a working "rate" query for our mysql instance gives us that information from the last lab. Take another look at that one to refresh your memory. Now let's change it to only show when our rate is above .35. And, let's also change it to use a scale of 0 to 100. We do this by multiplying the result by 100. Change the query to add the multiplier and "> 35" at the end and click on the blue "Execute" button. The query to use is shown below.

```
rate(mysql_global_status_commands_total{command=~"(select)"}[5m]) * 100 > 30
```

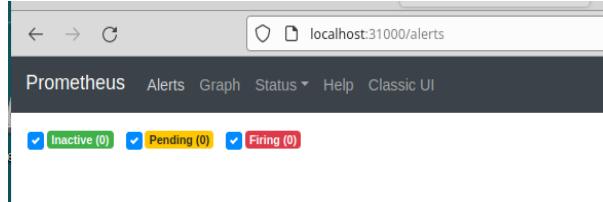
- After clicking on the Execute button to refresh, you will probably see an empty query result on the page. This is because we are targeting a certain threshold of data and that threshold hasn't been hit in the time range of the query (5 minutes). To have some data to look at, let's run our program to simulate the load again with the rate query in effect. Execute the same script we used before again with 30 iterations and a 2 second wait in-between.

```
$ ~/ping-db.sh roar 30 2
```

- After a couple of minutes and a couple of refreshes, you'll be able to see that we no longer just see an increasing value, we can see where the highs and lows are.



- While we can monitor by refreshing the graph and looking at it, it would work better to have an alert setup for this. Let's see what alerts we have currently. Switch to the alerts tab of Prometheus by clicking on "Alerts" in the dark bar at the top (or go to localhost:31000/alerts). Currently, you will not see any configured.



- Now let's configure some alert rules. We already have a configmap with some basic rules in it. gedit or cat the file extra/ps-cm-with-rules.yaml and look at the "alerting-rules.yml" definition under "data:".

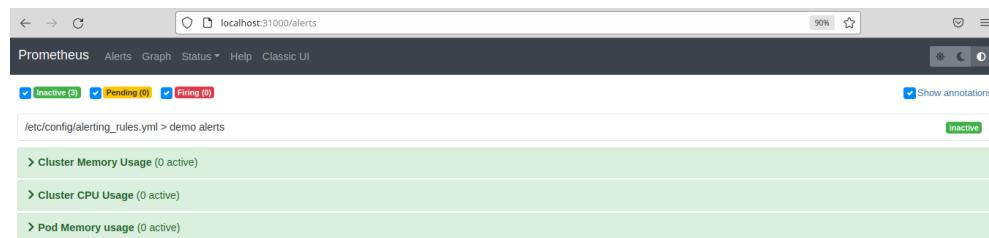
```
$ cat (or gedit ) extra/ps-cm-with-rules.yaml
```

```
1 apiVersion: v1
2 kind: ConfigMap
3 metadata:
4   labels:
5     app: prometheus
6     app.kubernetes.io/managed-by: Helm
7     chart: prometheus-15.0.2
8     component: server
9     heritage: Helm
10    release: pc
11   name: pc-prometheus-server
12   namespace: monitoring
13 data:
14   alerting_rules.yml: |-
```

The code block contains the YAML configuration for a ConfigMap named 'pc-prometheus-server' in the 'monitoring' namespace. It defines an 'alerting_rules.yml' file with three alert groups: 'demo alerts'. Each group contains an alert for 'Cluster Memory Usage' and 'Cluster CPU Usage'. The 'Cluster Memory Usage' alert triggers when the sum of container memory working set bytes exceeds 90% over 5 minutes. The 'Cluster CPU Usage' alert triggers when the sum of container CPU usage seconds total over 5 minutes divided by the sum of machine CPU cores exceeds 90%. Both alerts have a severity of 'page' and annotations for 'Cluster Memory Usage > 90%' and 'Cluster CPU Usage > 90%'. The 'Cluster CPU Usage' alert also has a description of 'Cluster CPU Usage on host {{\\$labels.instance}} : (current value: {{ \\$value }})'. There is also a section for 'Pod Memory usage' with an alert for the sum of container memory working set bytes for image {{\\$labels.image}}.

- Now, go ahead and apply that configmap definition. Then refresh your view of the Alerts and you should see a set of alerts that have been defined. (This is in the "extra" directory)

```
$ k apply -n monitoring -f ps-cm-with-rules.yaml
```



You can then expand those to see the alert definitions. Notice that each alert uses a PromQL query like we might enter in the main Prometheus query area.

The screenshot shows the Prometheus UI at `localhost:31000/alerts`. The top navigation bar includes Prometheus, Alerts, Graph, Status, Help, and Classic UI. Below the navigation, there are three tabs: Inactive (0), Pending (0), and Firing (0). The Pending tab is selected. The main content area displays three alert groups under the heading `/etc/config/alerting_rules.yml > demo alerts`:

- Cluster Memory Usage (0 active)**

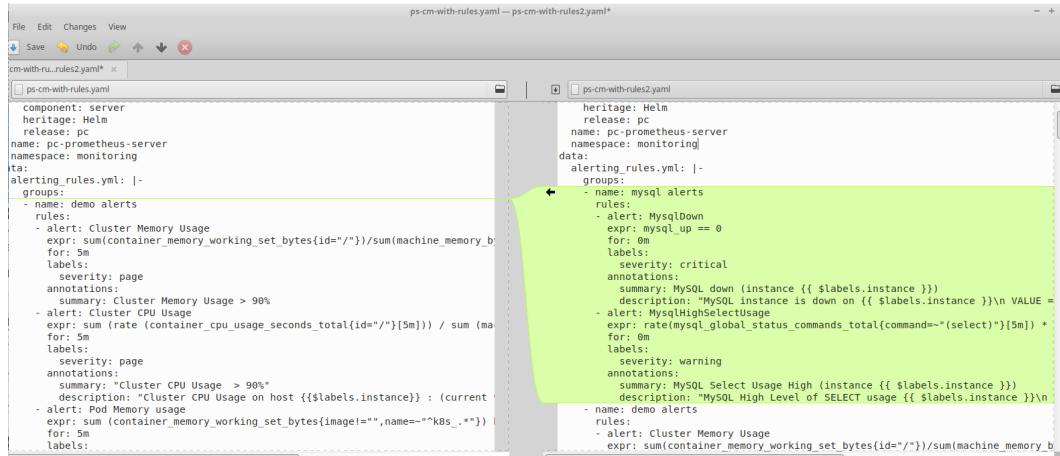
```
name: Cluster Memory Usage
expr: sum(container_memory_working_set_bytes{id="/"}) / sum(machine_memory_bytes) * 100 > 90
for: 5m
labels:
  severity: page
annotations:
  summary: Cluster Memory Usage > 90%
```
- Cluster CPU Usage (0 active)**

```
name: Cluster CPU Usage
expr: sum(rate(container_cpu_usage_seconds_total{id="/"})[5m]) / sum(machine_cpu_cores) * 100 > 90
for: 5m
labels:
  severity: page
annotations:
  description: Cluster CPU Usage on host {{$labels.instance}} : (current value: {{ $value }}).
  summary: Cluster CPU Usage > 90%
```
- Pod Memory usage (0 active)**

```
name: Pod Memory usage
expr: sum by(container_label_io_kubernetes_pod_name) (container_memory_working_set_bytes{image!="",name=~"^k8s_.+"}) > 4.026531841e+09
for: 5m
labels:
  severity: page
annotations:
  description: Pod Memory usage on host {{$labels.instance}} : (current value: {{ $value }}).
  summary: Pod Memory usage > 90%
```

- Let's add some custom alert rules for a group for mysql. These will follow a similar format as the other rules but using mysql PromQL queries, names, etc. There is already a file with them added - **ps-cm-with-rules2.yaml**. You can do a meld on that and our previous version of the cm data to see the new rules.

```
$ meld ps-cm-with-rules.yaml ps-cm-with-rules2.yaml
```



- When you're done, just close the meld application. Now, let's apply the updated configmap manifest and add the new mysql alerts. Then refresh the Alerts view (and after a period of time) you should see the new mysql rules.

```
$ k apply -n monitoring -f ps-cm-with-rules2.yaml
```

The screenshot shows the Prometheus Alerts interface at localhost:31000/alerts. There are two alert groups listed:

- /etc/config/alerting_rules.yml > demo alerts** (inactive)
 - > Cluster Memory Usage (0 active)
 - > Cluster CPU Usage (0 active)
 - > Pod Memory usage (0 active)
- /etc/config/alerting_rules.yml > mysql alerts** (inactive)
 - > MysqlDown (0 active)
 - > MysqlHighSelectUsage (0 active)

- Let's see if we can get our alert to fire now. Run our loading program to simulate the load again with the rate query in effect. Execute the same script we used before again with 60 iterations and a 0.5 second wait in-between.

```
$ ~/ping-db.sh roar 60 0.5
```

- After this runs, after you refresh, on the Alerts tab, you should be able to see that the alert was fired. You can expand it to see details.

The screenshot shows the Prometheus Alerts interface at localhost:31000/alerts. The 'MysqlHighSelectUsage' alert is expanded, showing its configuration and a single firing instance:

MysqlHighSelectUsage (1 active)

```

name: MysqlHighSelectUsage
expr: rate(mysql_global_status_commands_total[command=~"(select)"])[5m] * 100 > 35
labels:
  severity: warning
annotations:
  description: MySQL High Level of SELECT usage {{ $labels.instance }}
  VALUE = {{ $Value }}
  LABELS = {{ $Labels }}
  summary: MySQL Select Usage High (instance {{ $labels.instance }})

```

Labels	State	Active Since	Value
alertname=MysqlHighSelectUsage command=select instance=mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104 job=mysql	FIRING	2022-01-09T19:19:47.065791371Z	51.11111111111112

Annotations

```

description
MySQL High Level of SELECT usage mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104 VALUE = 51.11111111111112 LABELS = map[command:select instance:mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104 job:mysql]
summary
MySQL Select Usage High (instance mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104)

```

- Now, that our alert has fired, we should be able to see it in the Alert Manager application. On this machine, it is exposed at node port 31500. Open up that location and take a look.

The screenshot shows the Alertmanager interface at localhost:31500/#/alerts. At the top, there are tabs for Alertmanager, Alerts, Silences, Status, and Help, along with a New Silence button. Below the tabs, there are two tabs: Filter and Group. A search bar contains the placeholder "Custom matcher, e.g. env='production'". To the right of the search bar are buttons for "Receiver: All", "Silenced", and "Inhibited". A "Silence" button with a plus sign is also present. Below the search bar, there is a link to "Expand all groups". Under the "Not grouped" section, there is a box containing "1 alert". The alert details are as follows:

- Timestamp: 2022-01-09T19:19:47.065Z
- Info: + Info
- Source: [Source](#)
- Silence: [Silence](#)
- Alert details:
 - alertername="MysqlHighSelectUsage"
 - command="select"
 - instance="mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104"
 - job="mysql"
 - severity="warning"

12. If you click on the "Source" link next to the timestamp and "+ Info" it will take you back to the main Prometheus query screen. When you get there, click on Execute and open up the Graph view.

The screenshot shows the Prometheus query interface at [Prometheus](#). The top navigation bar includes Alerts, Graph, Status, Help, and Classic UI. There are several configuration checkboxes: Use local time, Enable query history, Enable autocomplete, Enable highlighting, and Enable linter. Below the navigation is a search bar with the query `rate(mysql_global_status_commands_total{command=~"(select)"}[5m]) * 100 > 35` and an Execute button. The results panel shows a single result series: `(command="select", instance="mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104", job=mysql)`. The bottom right corner has a Remove Panel button.

13. You can also Silence alerts for some period of time. Go back to the Alert Manager screen. Click on the Silence icon and enter the information for a temporary silence, such as 10m. You'll also need to add a Creator (author) and Comment for the silence. Then you can click on the Create button to save your changes.



New Silence

Start 2022-01-09T19:32:07.516Z ✓ **Duration** 10m ✓ **End** 2022-01-09T19:42:07.516Z ✓

Matchers Alerts affected by this silence

- alertname="MysqlHighSelectUsage" X
- command="select" X
- instance="mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104" X
- job="mysql" X
- severity="warning" X

Custom matcher, e.g. env="production" +

Creator User 1 ✓

Comment Demo silence ✓

Preview Alerts Create Reset

14. You'll then have a new Silence saved. You can Expire it in advance if needed, but while its active, if you repeat the load example, you should not get alerted in Alert Manager.

ID	97ab3bff-3dcd-4e5e-8ca9-bd5ec26ec9de
Starts at	2022-01-09T19:35:45.729Z
Ends at	2022-01-09T19:42:07.516Z
Updated at	2022-01-09T19:35:45.729Z
Created by	User 1
Comment	Demo silence
State	active
Matchers	alertname=MysqlHighSelectUsage command=select instance=mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104 job=mysql severity=warning
No affected alerts	

END OF LAB

Lab 5 - Grafana

Purpose: In this lab, we'll see how to use Grafana to display custom graphs and dashboards for Prometheus data.

- We already have an instance of Grafana running on this system. Open up a browser to the home page at <http://localhost:31750>. If you are prompted about changing your password, just select to skip that option. The default admin userid and password are both "admin".

The screenshot shows the Grafana home page with a dark theme. At the top, there's a navigation bar with links for Documentation, Tutorials, Community, and Public Slack. Below the header, there are three main panels: 'Basic' (with steps to set up Grafana), 'TUTORIAL DATA SOURCE AND DASHBOARDS' (with 'Grafana fundamentals' and a link to 'Learn how in the docs'), and 'DATA SOURCES' (with a 'Add your first data source' button). On the right, there's a 'DASHBOARDS' panel with a 'Create your first dashboard' button. Below these, there are sections for 'Starred dashboards' and 'Recently viewed dashboards'. To the right, there's a 'Latest from the blog' section with two posts: one by Jan 06 titled 'Building an effective remote-first team during the pandemic' and another by Jan 05 titled 'Don't miss our webinars on Grafana Tempo, Grafana Enterprise Traces, and the new Sentry plugin'. A sidebar on the left contains icons for search, add, configuration, and other settings.

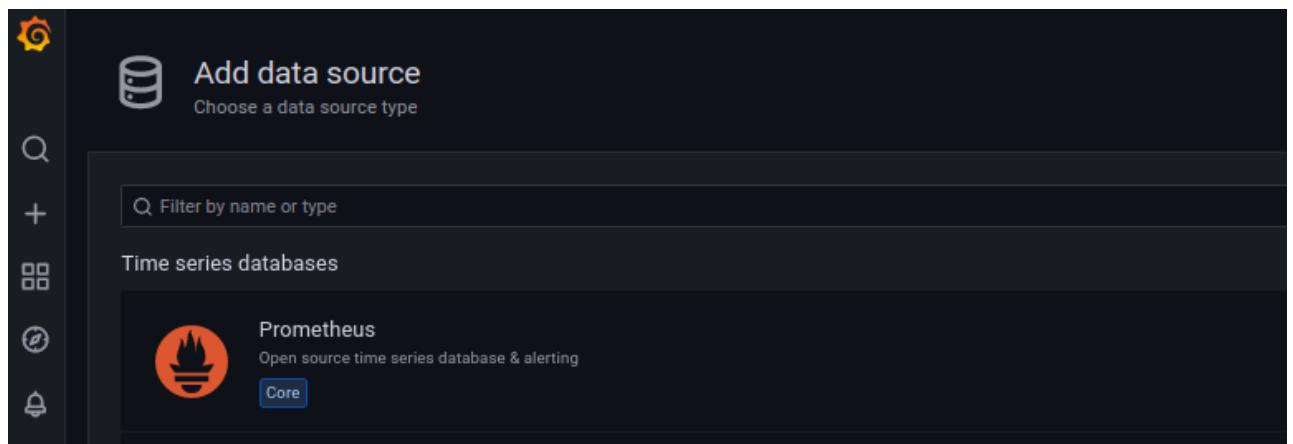
- Let's first add our Prometheus instance as a Data Source. Hover over or click on the "gear icon" on the side and select "Data Sources". Then click on the blue button for "Add data source".

The screenshot shows the Grafana Configuration page. The left panel has a sidebar with 'Configuration' selected, and the main area shows the 'Data sources' tab. The right panel also shows the 'Data sources' tab with a message 'No data sources defined' and a prominent blue 'Add data source' button. A pro tip message at the bottom right says 'ProTip: You can also define data sources through configuration files. [Learn more](#)'.

3. Select "Prometheus" and then for the HTTP URL field, enter

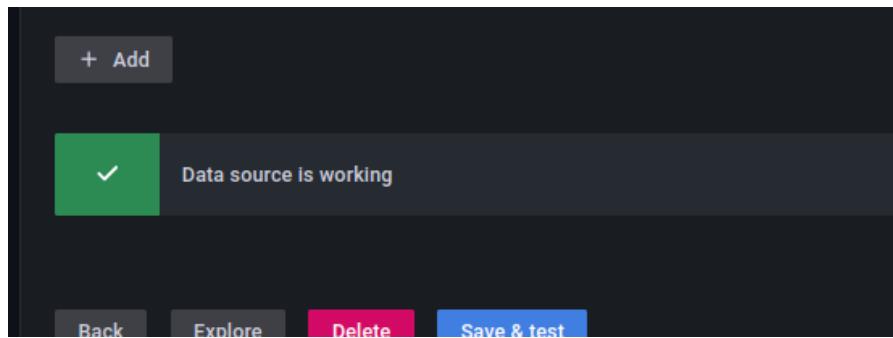
<http://pc-prometheus-server.monitoring.svc.cluster.local:80>

Then click on "Save and Test". After a moment, you should get a response that indicates the data source is working.

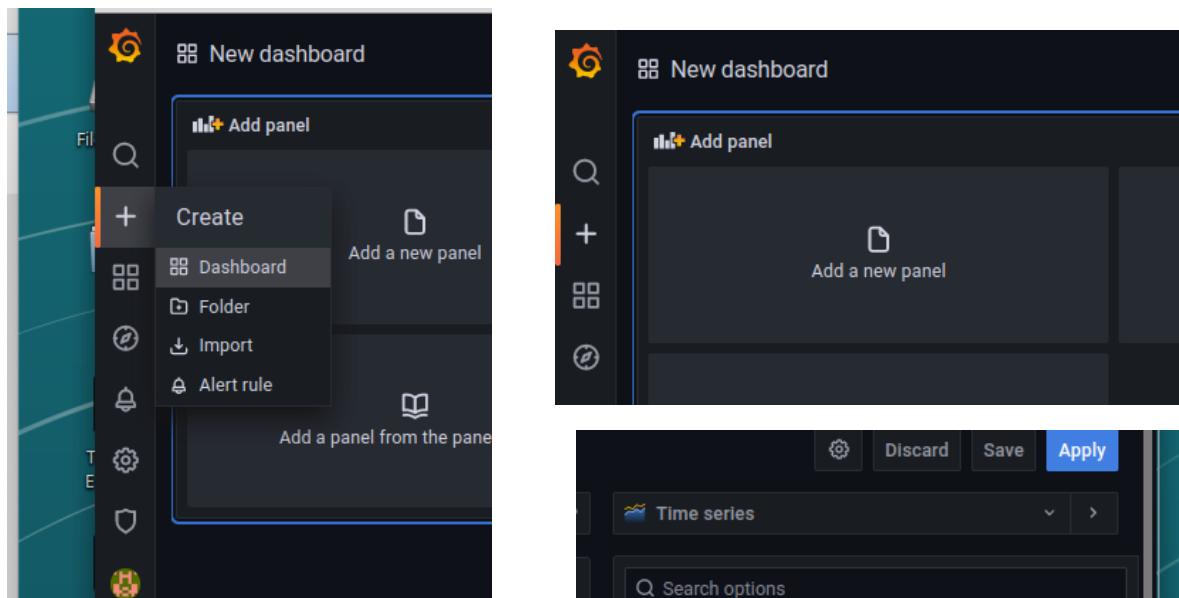


A screenshot of the Grafana 'Data Sources / Prometheus' configuration page. The top navigation bar shows the URL as 'localhost:31750/datasources/edit/F2bVzWJnk'. The left sidebar has the same icons as the previous screen. The main area shows the 'Settings' tab selected. It displays a 'Name' input field with 'Prometheus' and a 'Default' toggle switch which is turned on. Under the 'HTTP' section, there are three inputs: 'URL' with the value 'rometheus-server.monitoring.svc.cluster.local:80', 'Access' set to 'Server (default)', and 'Allowed cookies' with a placeholder 'New tag (enter key to add)'. The 'Dashboards' tab is also visible.

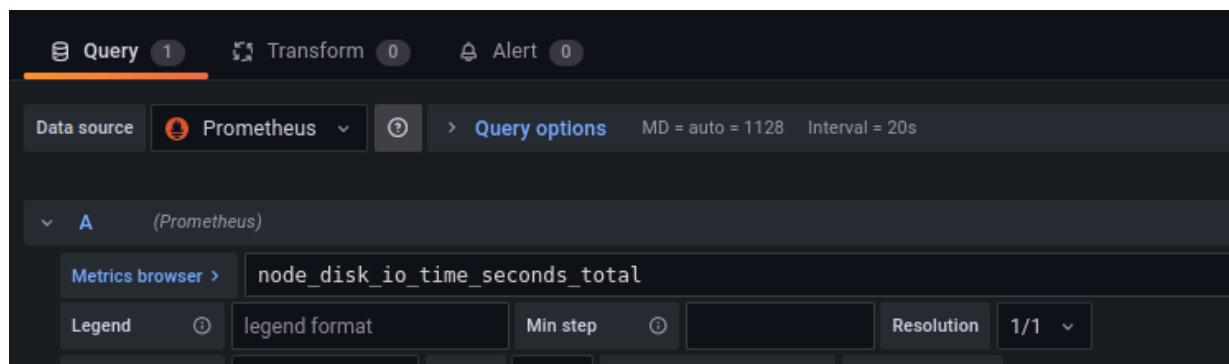
A screenshot of the 'Save & test' confirmation dialog in Grafana. It has a title 'Exemplars' and a 'Back' button. Below are 'Explore' and 'Delete' buttons. The central part contains a 'Save & test' button, which is highlighted in blue. At the bottom are 'Back' and 'Explore' buttons again.

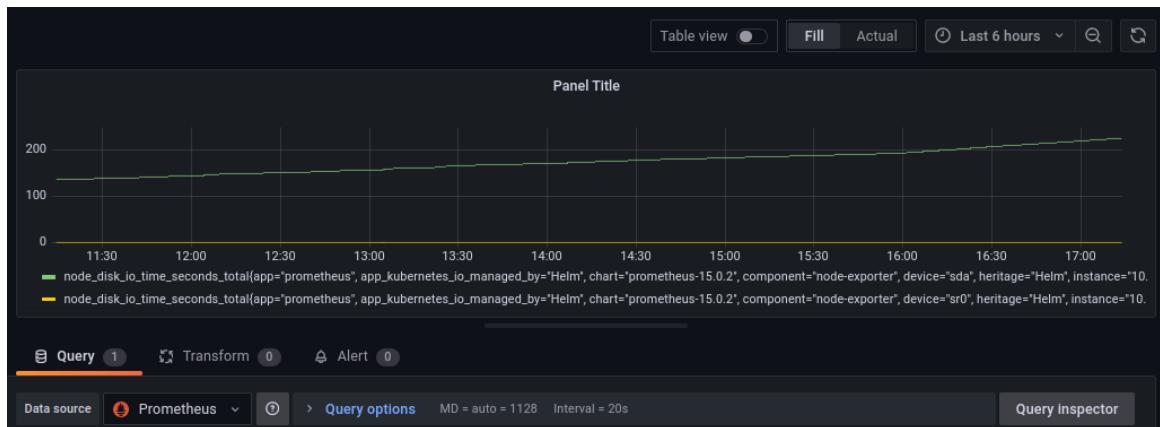


- Now, let's create a simple dashboard for one of our mysql metrics. Click on the "+" sign on the left and select Dashboard from the menu. Then click on "Add a new panel". In the upper right, make sure "Time series" is selected for the type of visualization.



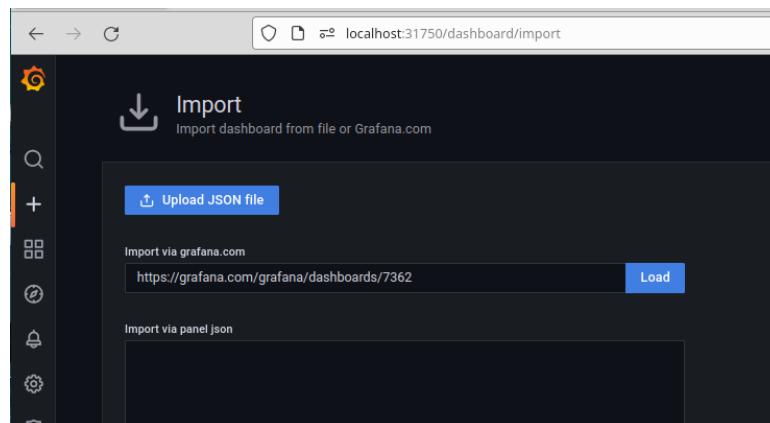
- In the Metrics Browser section, start typing "node" and then pick a sample metric, such as "node_disk_io_time_seconds_total". Then click in the Panel and you should see a new chart.



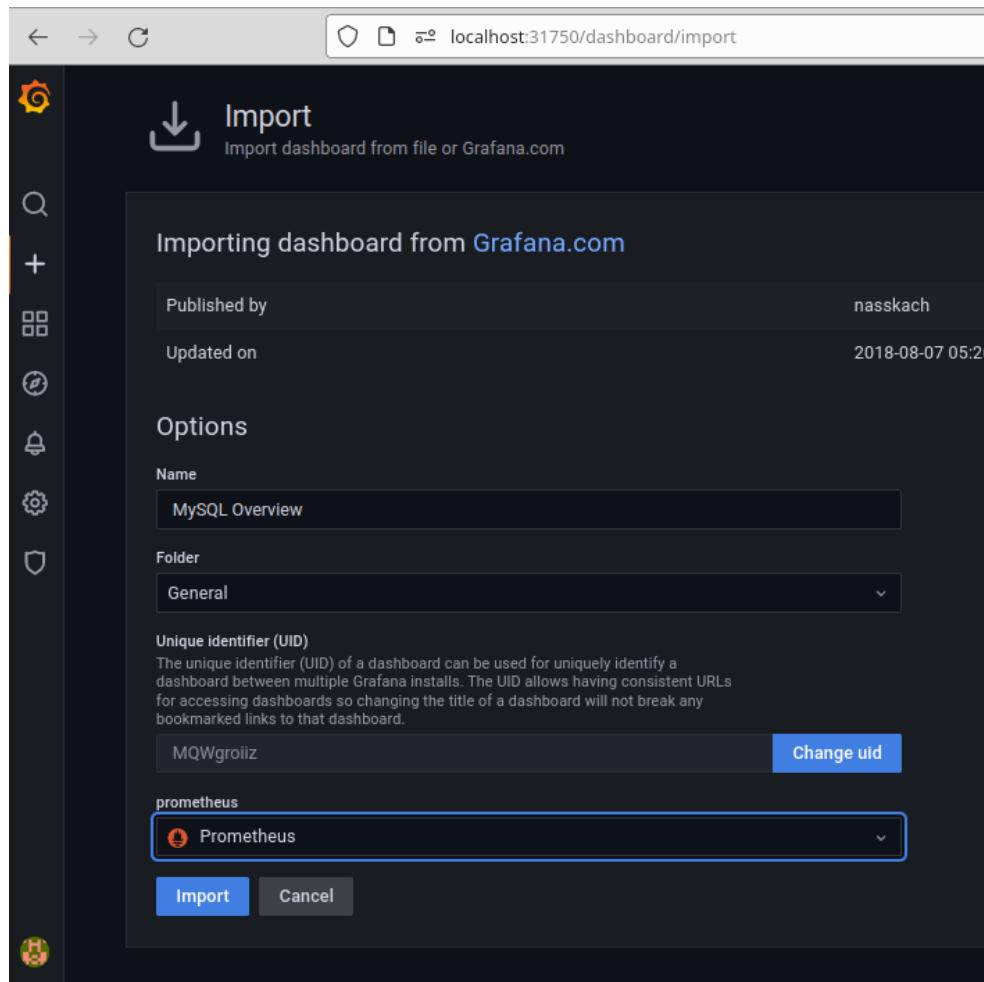


- While we can create individual dashboards with Grafana, that can take a lot of time and effort. The community has already created a number of dashboards that we can just import and use. Let's grab one for mysql. Click on the "+" on the left side, then select "Import". (You can save or discard the previous one if prompted.) In the field that says "Grafana.com dashboard URL or ID", enter the location below and click the blue "Load" button.

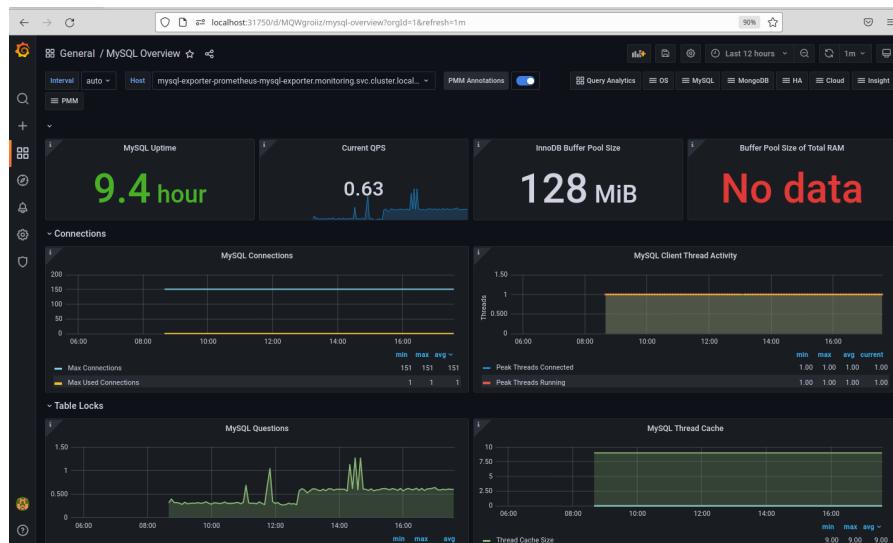
<https://grafana.com/grafana/dashboards/7362>



- On the next page, you can leave everything as-is, except at the bottom for the Prometheus source, click in that box and select our default Prometheus data source that we setup. Then click the blue "Import" button at the bottom.

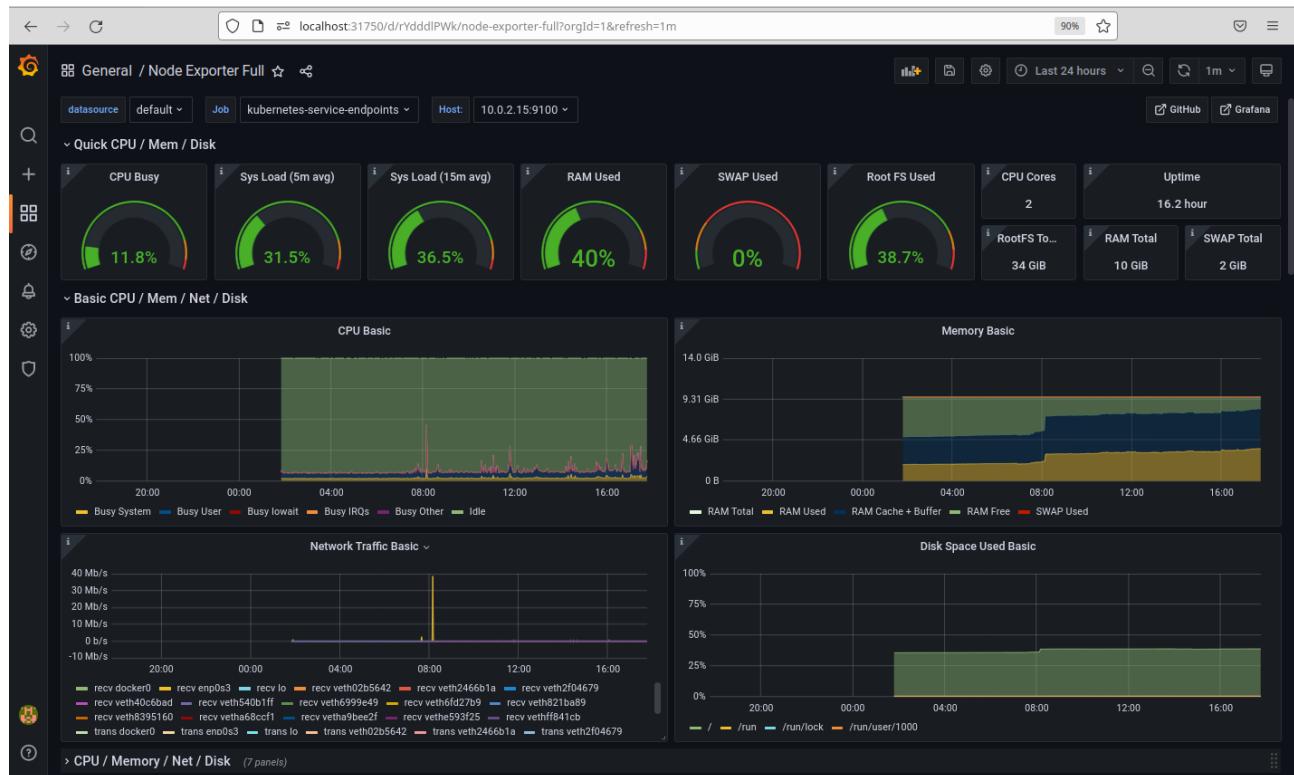


8. At this point, you should see a populated dashboard with a number of panels looking at the mysql exporter data from our system through Prometheus. You can scroll around and explore if you want.



9. Another cool one to import (via the same process) is the "Node Exporter Full" one. It's available from the link below. A screenshot is also included.

<https://grafana.com/grafana/dashboards/1860>



END OF LAB