

Getting Started with Prometheus

Monitoring Kubernetes infrastructure and applications for reliability

Class Labs

Version 2.0 by Brent Lester on behalf of Tech Skills Transformations

03/19/2023

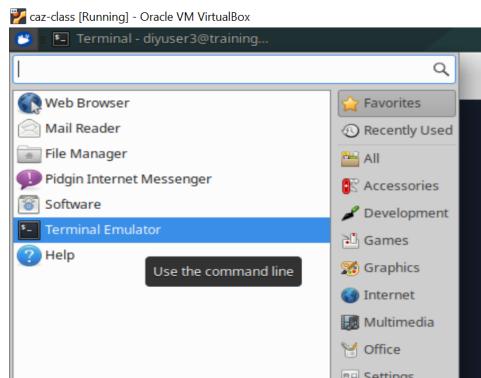
Important Prereq: These labs assume you have already followed the instructions in the separate setup document and have VirtualBox up and running on your system and have downloaded the *prom-start2.ova* file and loaded it into VirtualBox. If you have not done that, please refer to the setup document for 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. Note: At the end of this running, you will see some error messages about a pod not being reading and it "waiting for pod". This is normal and it should finish shortly.

```
$ extra/start-mini.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 % 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

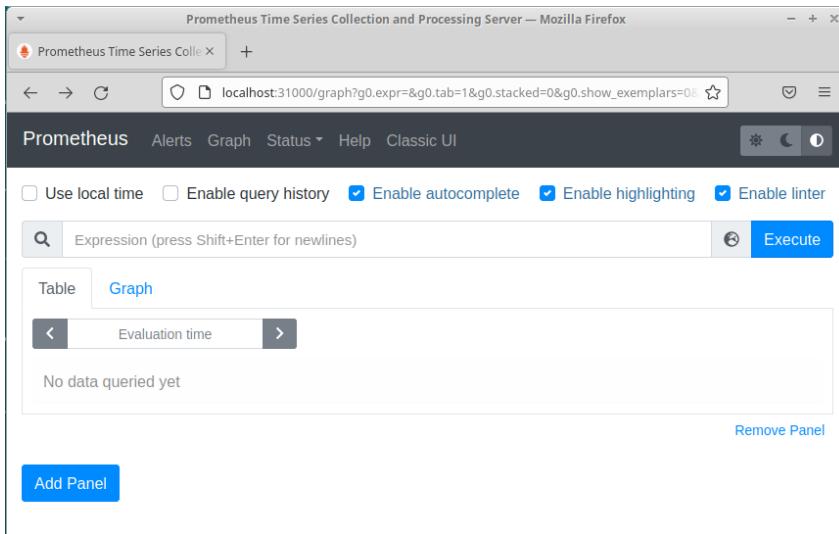
Purpose: In this lab, we'll run an instance of the node exporter and use Prometheus to surface basic data and metrics.

- 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
```

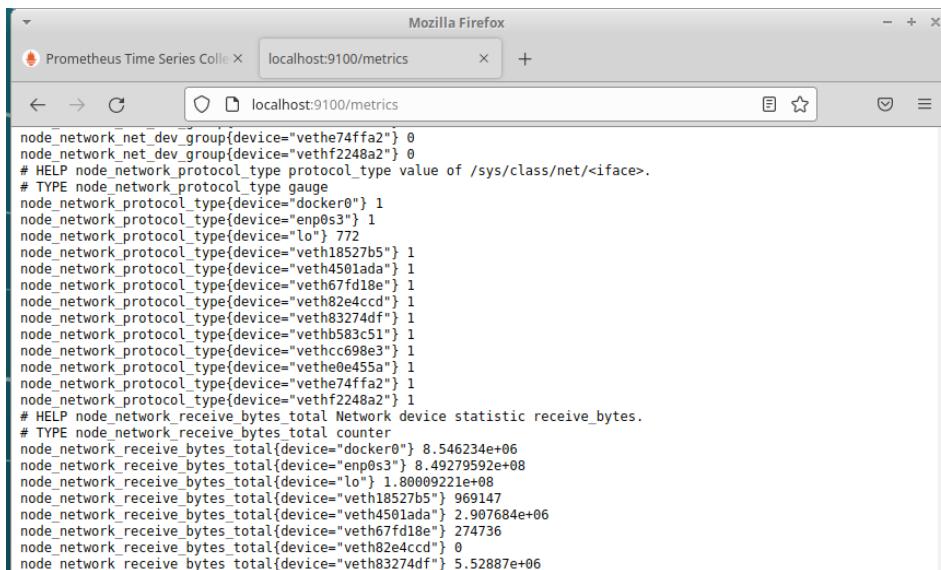
- Notice that we have both Prometheus itself and the node exporter piece running there (among others). Let's take a look at the Prometheus dashboard in the web browser. Open up a web browser and go to the url below to see it.

<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>

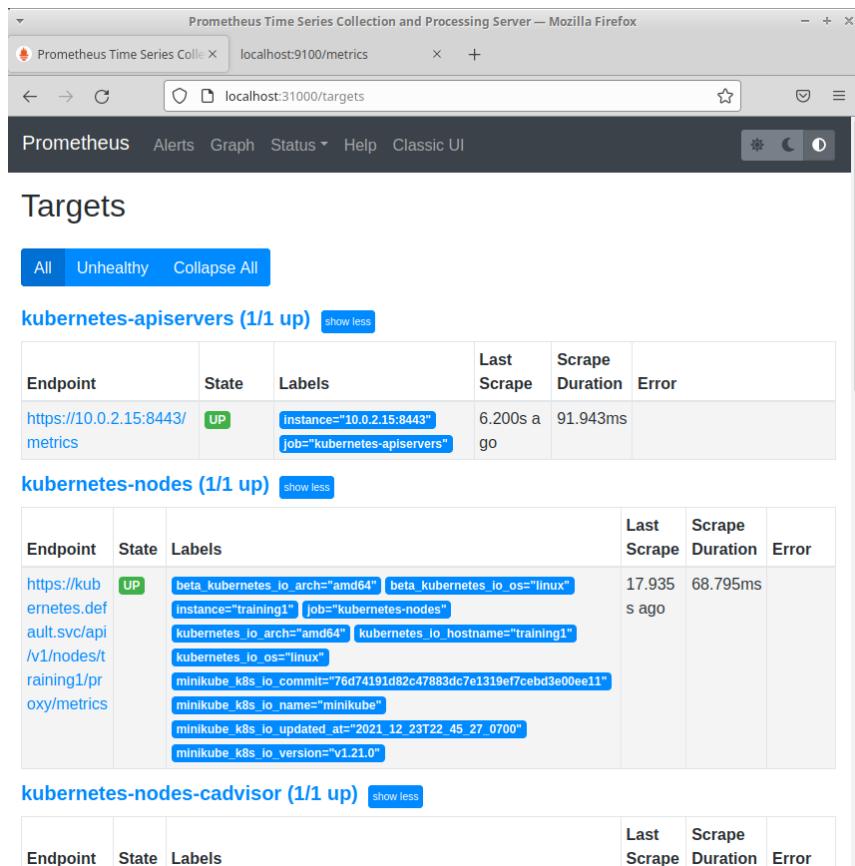


```

node_network_net_dev_group{device="veth74ffa2"} 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="veth82e4ccd"} 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="veth7afffa2"} 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="veth82e4ccd"} 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.



Endpoint		State	Labels	Last Scrape	Scrape Duration	Error
https://10.0.2.15:8443/	UP	instance="10.0.2.15:8443" job="kubernetes-apiservers"	6.200s ago	91.943ms		

Endpoint		State	Labels	Last Scrape	Scrape Duration	Error
https://kubernetes.default.svc/api/v1/nodes/training1/proxy/metrics	UP	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", minikube_k8s_io_version="v1.21.0"	17.935s ago	68.795ms		

Endpoint		State	Labels	Last Scrape	Scrape Duration	Error

5. 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
```

6. 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.)

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	

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	

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

```

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

```

- 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>

Prometheus Time Series Collection and Processing Server — Mozilla Firefox

localhost:9100/metrics localhost:31000/service-discovery

Prometheus Alerts Graph Status Help Classic UI

- kubernetes-nodes-cadvisor (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 / 13 active targets)
- kubernetes-pods-slow (0 / 24 active targets)
- kubernetes-service-endpoints-slow (0 / 15 active targets)
- kubernetes-services (0 / 13 active targets)

kubernetes-apiservers [show more](#)

kubernetes-nodes [show more](#)

traefik [Highlight All](#) [Match Case](#) [Match Djacritics](#) [Whole Words](#) [Phrase not found](#)

- 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
```

```

diff --git a/ps-cm-start.yaml b/ps-cm-with-traefik.yaml
--- a/ps-cm-start.yaml
+++ b/ps-cm-with-traefik.yaml
@@ -1,10 +1,10 @@
apiVersion: v1
data:
  alerting_rules.yml: |
    {}
  alerts: |
    {}
  prometheus.yml: |
    global:
      evaluation_interval: 1m
      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: prometheus
        static_configs:
          - targets:
              - localhost:9090
            bearer_token_file: /var/run/secrets/kubernetes-apiservers
            job_name: kubernetes-apiservers
            kubernetes_sd_configs:

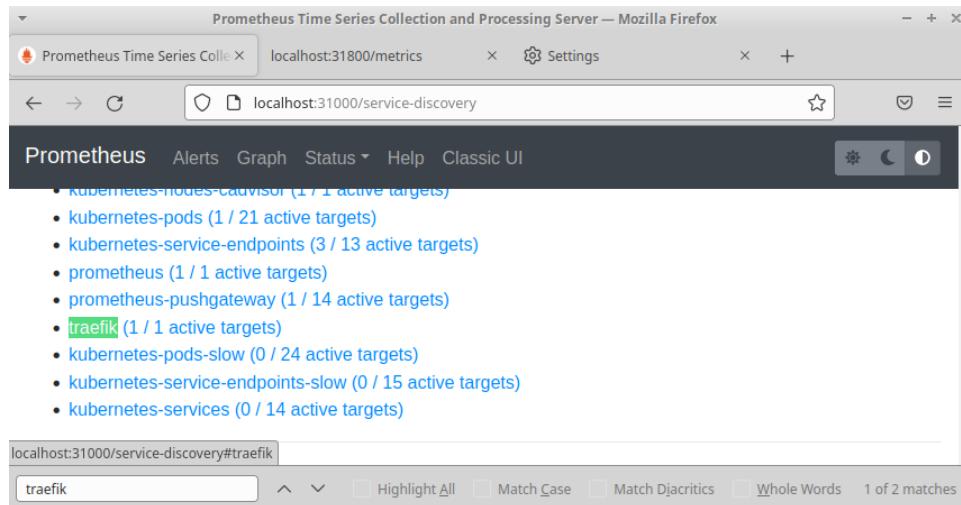
```

- 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
```

- 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.)

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	



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.

```
$ cd ~/prom-start/roar-k8s
```

```
$ 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

- 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.

Getting Started

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prometheus-community / helm-charts Public

Code Issues 68 Pull requests 29 Actions Projects Wiki Security Insights

main helm-charts / charts /

ijmengze [kube-prometheus-stack] update kubernetes-system-kube-proxy.yaml (#1629) ... f33b075 18 hours ago History

..

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

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
```

- 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)
```

- 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
```

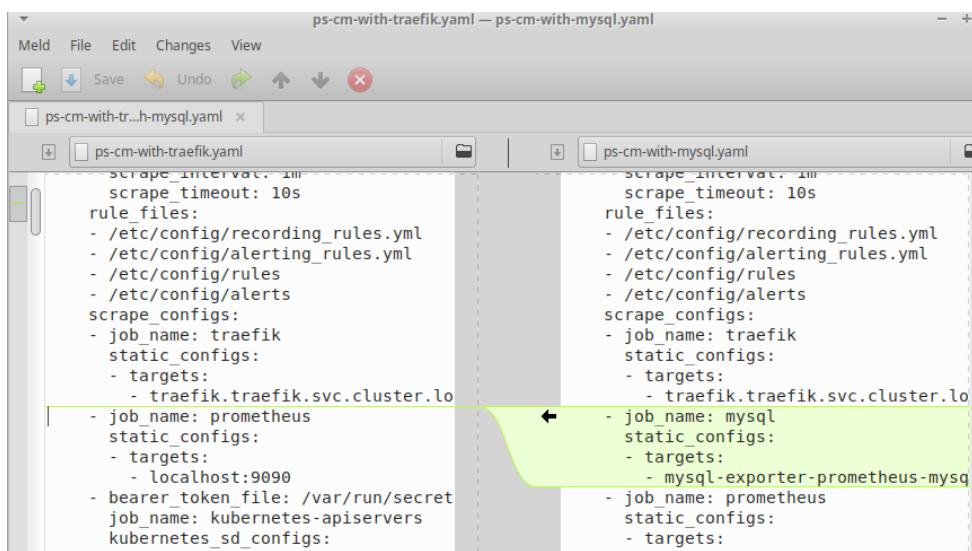
```
$ cat secret.yaml
```

- 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
```

- 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. You can exit meld when done.

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



- Now you can apply the updated configmap definition.

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

- 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).)

The screenshot shows two browser tabs. The top tab is 'localhost:31800/metrics' titled 'Prometheus Time Series Collection and Processing Server — Mozilla Firefox'. It displays a table of targets under the heading 'mysql (1/1 up)'. The table has columns: Endpoint, State, Labels, Last Scrape, Scrape Duration, and Error. One entry is shown: 'http://mysql-exporter-prometheus.mysql-exporter.monitoring.svc.cluster.local:9104' with state 'UP', labels 'namespace="monitoring", node="training1", release="pc", service="pc-prometheus-node-exporter"', last scrape '39.483s ago', and scrape duration '70.044ms'. Below this is another section for 'prometheus (1/1 up)' with a single entry for 'mysql'. The bottom tab is 'localhost:31000/targets' titled 'Prometheus — Mozilla Firefox'. It shows a search bar with 'mysql' and a table with one row matching the search results.

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
```

```
localhost:9104/metrics
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.clientstats"} 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.

The screenshot shows the Prometheus Graph interface. At the top, there are five checkboxes: 'Use local time', 'Enable query history', 'Enable autocomplete', 'Enable highlighting', and 'Enable linter'. Below the checkboxes is a search bar labeled 'Expression (press Shift+Enter for newlines)'. Underneath the search bar are two tabs: 'Table' and 'Graph', with 'Graph' being the active tab. Below the tabs is a button labeled 'Evaluation time' with arrows for adjustment. A message 'No data queried yet' is displayed. At the bottom left is a blue 'Add Panel' button.

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 Graph interface with the 'Metrics Explorer' panel open. The panel lists various metrics: aggregator_openapi_v2_regeneration_count, aggregator_openapi_v2_regeneration_duration, aggregator_unavailable_apiservice, apilextensions_openapi_v2_regeneration_count, apiserver_admission_controller_admission_duration_seconds_bucket, apiserver_admission_controller_admission_duration_seconds_count, apiserver_admission_controller_admission_duration_seconds_sum, and apiserver_admission_step_admission_duration_seconds_bucket. On the right side of the panel, there is a red circle around the 'Execute' button, which is located next to a small 'x' icon. The rest of the interface is visible in the background.

3. 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, and so on. You don't need to select any right now, so once you are done, you can clear out the Expression box.

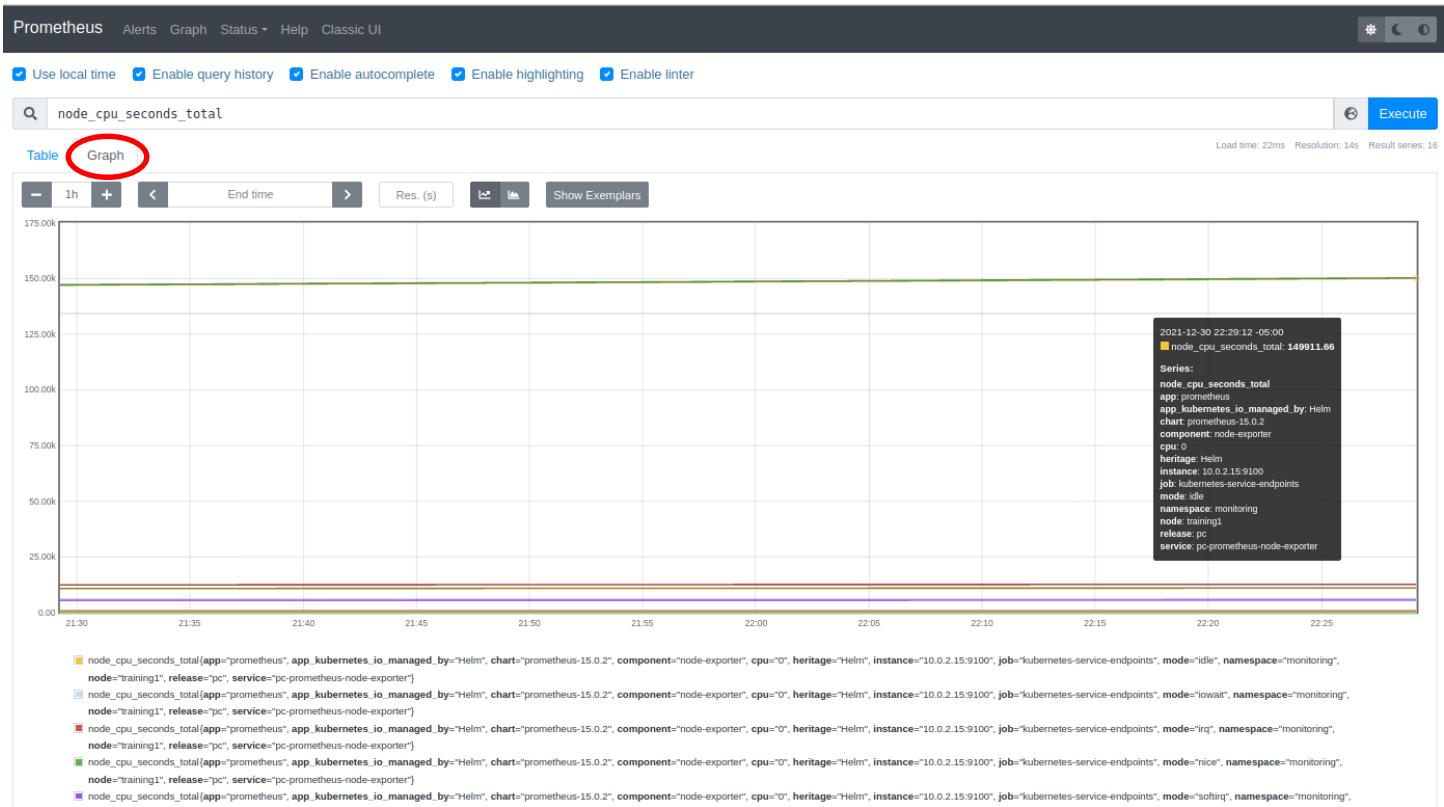
The screenshot shows the Prometheus search interface. A search query 'con' has been entered into the search bar. A dropdown menu appears, listing several metrics: container_blkio_device_usage_total, container_cpu_load_average_10s, container_cpu_system_seconds_total, container_cpu_usage_seconds_total, container_cpu_usage_seconds_total, container_file_descriptors, container_fs_inodes_free, container_fs_inodes_total, container_fs_io_current, and container_fs_time_seconds_total. To the right of the dropdown, a tooltip provides a detailed description of each metric: 'Blkio Device bytes usage' (counter), 'gauge', 'counter', 'counter', 'past query', 'counter', 'gauge', 'gauge', 'gauge', and 'counter'.

- 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.

The screenshot shows the Prometheus search interface after executing the query 'node_cpu_seconds_total'. The results are displayed in a table format. The table has two columns: 'Evaluation time' and 'Result'. The 'Evaluation time' column shows the timestamp '2023-06-12T14:45:00Z'. The 'Result' column displays multiple rows of data, each representing a different node and its CPU usage. The data includes fields such as app, kubernetes.io.managed_by, chart, component, cpu, heritage, instance, mode, namespace, node, release, service, and value. The 'Execute' button, which was highlighted with a red circle, is visible at the top right of the search bar.

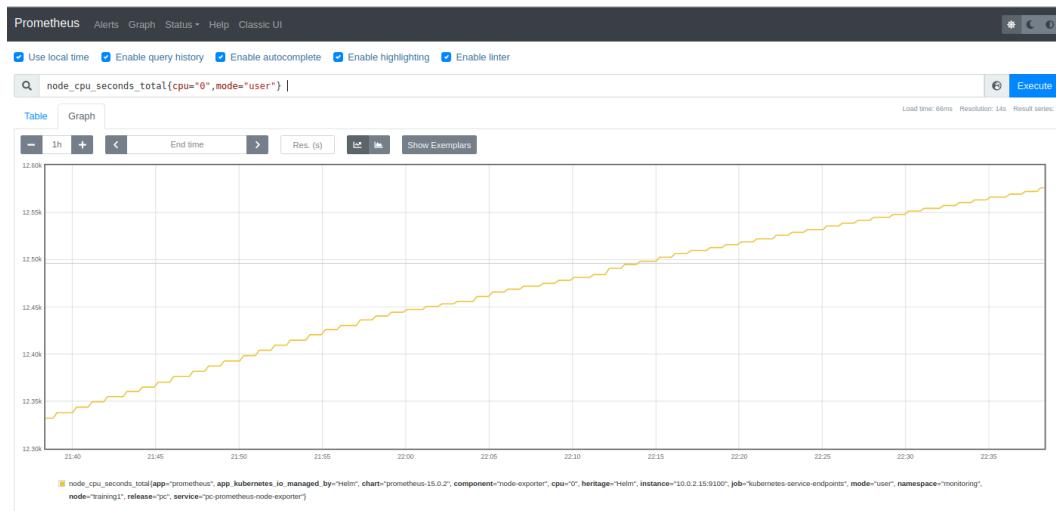
Evaluation time	Result
2023-06-12T14:45:00Z	node_cpu_seconds_total{app="prometheus", app_kubernetes_io_managed_by="Helm", chart="prometheus-15.0.2", component="node-exporter", cpu="0", heritage="Helm", instance="10.0.2.15:9100", job="kubernetes-service-endpoints", mode="idle", namespace="monitoring", node="training1", release="pc", service="pc-prometheus-node-exporter"} 149642.6
	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"} 137.21
	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", node="training1", release="pc", service="pc-prometheus-node-exporter"} 0
	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", node="training1", release="pc", service="pc-prometheus-node-exporter"} 80.2
	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"} 503.56
	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", node="training1", release="pc", service="pc-prometheus-node-exporter"} 0

- 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"}
```



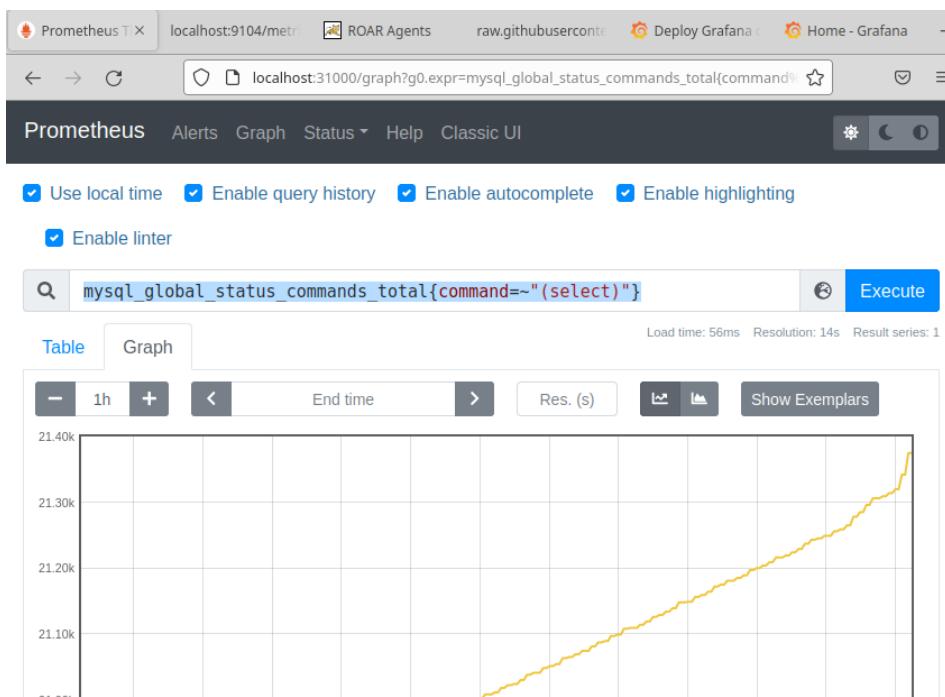
7. So far we have used counters in our queries - a value that increases (or can be reset to 0) as indicated by the "total" in the name. However, there are other kinds of time series such as "gauges" where values can go up or down. Let's see an example of one of those. Change your query to the expression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

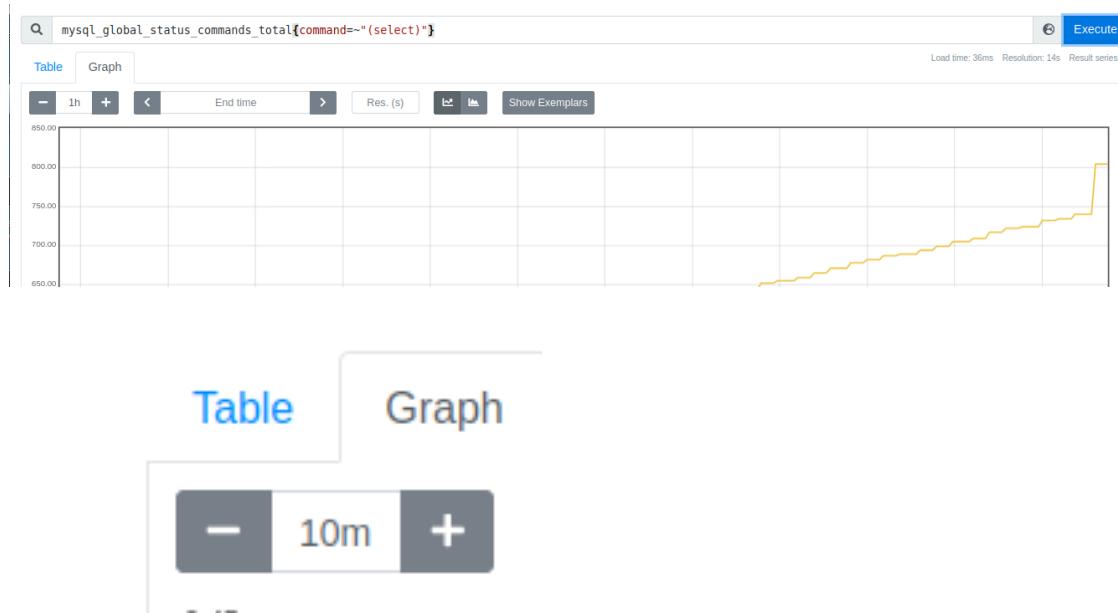
mysql_global_status_commands_total{command=~"(select)"}



9. 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 this in a terminal 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.)

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

10. 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. (Note that you can type in this field too.)



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 which 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
```

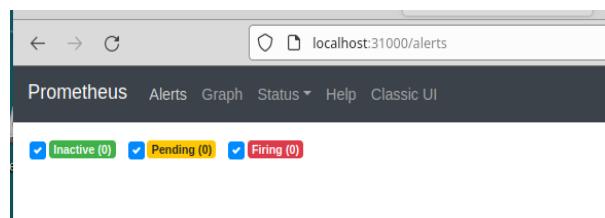
- After clicking on the Execute button to refresh, you will probably see an empty query result on the page. This is because we are targeting a certain threshold of data and that threshold hasn't been hit in the time range of the query (5 minutes). To have some data to look at, let's run our program to 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.

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

3. 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.



4. 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.



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

```
$ cd ~/prom-start/extra
```

```
$ cat ps-cm-with-rules.yaml | grep -A20 alerting_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: |-
15     groups:
16       - name: demo alerts
17         rules:
18           - alert: Cluster Memory Usage
19             expr: sum(container_memory_working_set_bytes{id="/"})/
sum(machine_memory_bytes()) * 100 > 90
20             for: 5m
21             labels:
22               severity: page
23             annotations:
24               summary: Cluster Memory Usage > 90%
25             - alert: Cluster CPU Usage
26               expr: sum(rate(container_cpu_usage_seconds_total{id="/"})
[5m]) / sum(machine_cpu_cores{}) * 100 > 90
27             for: 5m
28             labels:
29               severity: page
30             annotations:
31               summary: "Cluster CPU Usage > 90%"
32             description: "Cluster CPU Usage on host
{{$labels.instance}} : (current value: {{ $value }})."
33             - alert: Pod Memory usage
34               expr: sum(container_memory_working_set_bytes{image!
...

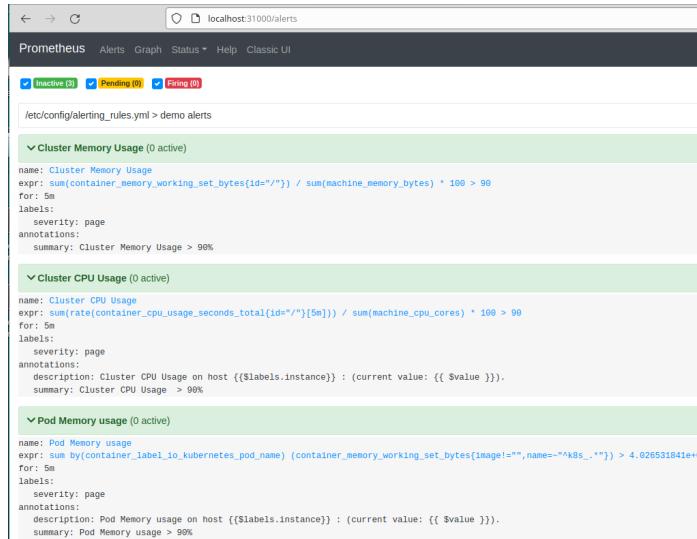
```

- 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

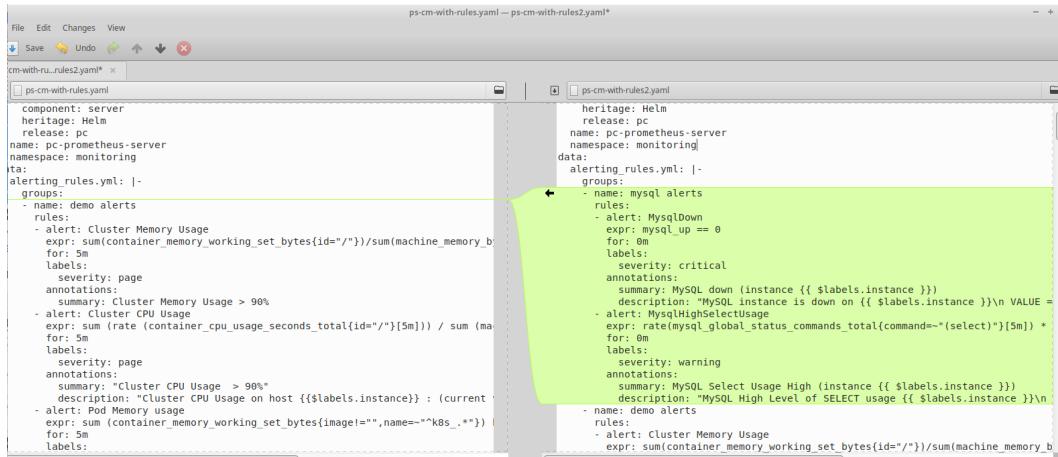
Alert Description	Status
> Cluster Memory Usage (0 active)	Inactive
> Cluster CPU Usage (0 active)	Inactive
> Pod Memory usage (0 active)	Inactive

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.



7. 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 definitions listed:

- /etc/config/alerting_rules.yml > demo alerts**: Contains three items: Cluster Memory Usage (0 active), Cluster CPU Usage (0 active), and Pod Memory usage (0 active).
- /etc/config/alerting_rules.yml > mysql alerts**: Contains two items: MysqlDown (0 active) and MysqlHighSelectUsage (0 active).

At the top, there are filters for Inactive (5), Pending (0), and Firing (0). A checkbox for "Show annotations" is checked. The status for both alert groups is "inactive".

- 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.

```
$ ~/prom-start/extra/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 firing status.

Configuration (from /etc/config/alerting_rules.yml):

```

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 }})

```

Firing Details:

Labels	State	Active Since	Value
alarmname=MysqlHighSelectUsage,command=select,instance=mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104,job=mysql,severity=warning	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, with 'Alerts' selected. A 'New Silence' button is in the top right. Below the tabs, there are 'Filter' and 'Group' buttons, and a search bar with placeholder text 'Custom matcher, e.g. env="production"'. To the right of the search bar are buttons for 'Receiver: All', 'Silenced', and 'Inhibited'. A '+' button and a 'Silence' button are also present. Below the search bar, a link '+ Expand all groups' is shown. Under the 'Not grouped' section, there is 1 alert. The alert details are as follows:

- Timestamp: 2022-01-09T19:19:47.065Z
- Info: + Info
- Source: [Source](#)
- Silence: [Silence](#)
- Alertname: "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 checkboxes for Use local time, Enable query history, Enable autocomplete, Enable highlighting, and Enable linter. A search bar contains the query `rate(mysql_global_status_commands_total{command=~"(select)"}[5m]) * 100 > 35`. To the right of the search bar are 'Execute' and 'Remove Panel' buttons. Below the search bar, there are 'Table' and 'Graph' tabs, with 'Graph' selected. A 'Evaluation time' dropdown shows '< >'. The results table shows one row with the following data:

(command="select", instance="mysql-exporter-prometheus-mysql-exporter.monitoring.svc.cluster.local:9104", job="mysql")	61.851851851851855
--	--------------------

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.

[Source](#) [Silence](#)

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

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.

Silence Edit Expire

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 is "admin". The password will be the one that was echoed to your screen at the end of the "start-mini.sh" or "install-apps.sh" command.

The screenshot shows the Grafana home page with a dark theme. At the top, there's a search bar and a navigation bar with links to Documentation, Tutorials, Community, and Public Slack. Below the header, there are three main sections: 'Basic' (with steps for setting up Grafana), 'TUTORIAL DATA SOURCE AND DASHBOARDS Grafana fundamentals' (with a link to learn more), and 'DATA SOURCES Add your first data source' (with a link to learn more). On the right, there's a section for 'DASHBOARDS Create your first dashboard' (with a link to learn more). Below these sections, there are two cards: 'Dashboards' (listing 'Starred dashboards' and 'Recently viewed dashboards') and 'Latest from the blog' (listing two posts by Jan 06: 'Joining a company in its hypergrowth phase comes with its own challenges... Looking back, I'm extremely thankful for the support I've received from Day 1' and 'Building an effective remote-first team during the pandemic').

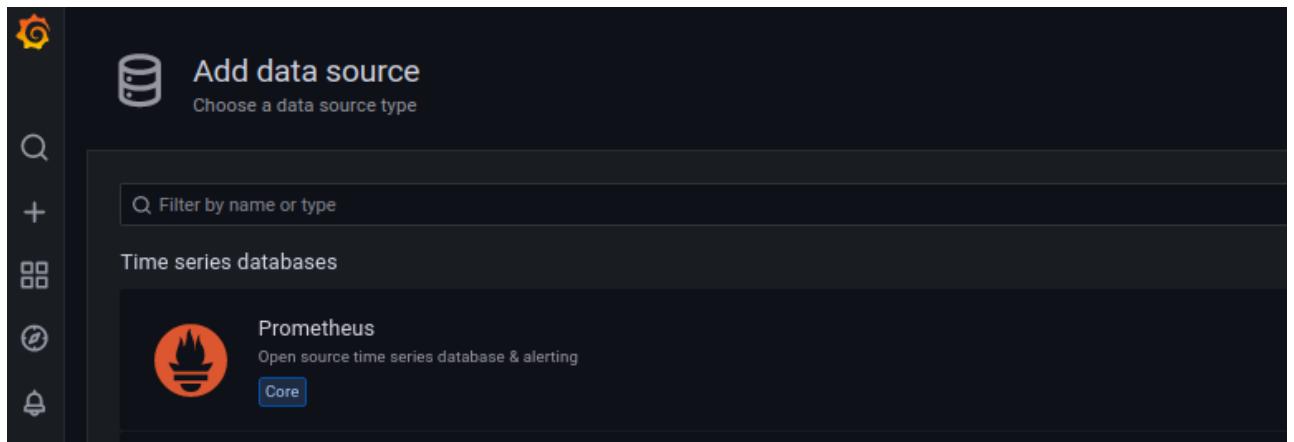
- Let's first add our Prometheus instance as a Data Source. Hover over or click on the "gear icon" on the side and select "Data Sources". Then click on the blue button for "Add data source".

The first screenshot shows the Grafana configuration interface with a sidebar containing 'Configuration', 'Data sources', 'Users', 'Teams', 'Plugins', and 'Preferences'. The 'Data sources' tab is highlighted. The main content area shows a list of data sources with a 'Create new' button. The second screenshot shows the same interface, but the 'Data sources' tab is selected in the main content area, and the message 'No data sources defined' is displayed. A blue 'Add data source' button is prominently featured at the bottom of the list.

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

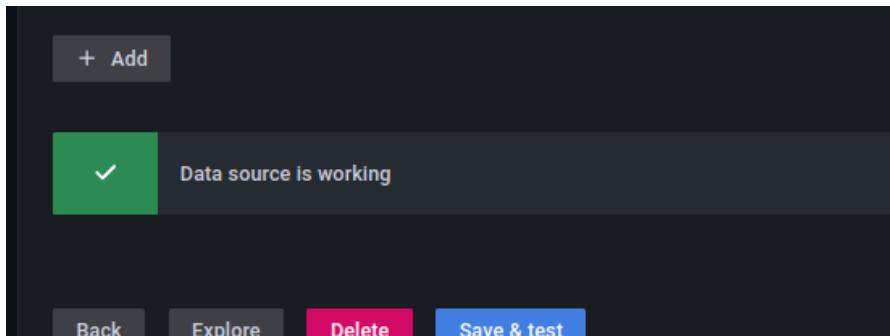
<http://prom-start-prometheus-server.monitoring.svc.cluster.local:80>

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

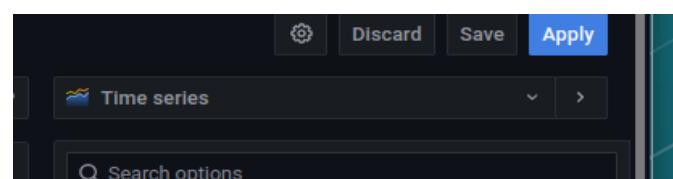
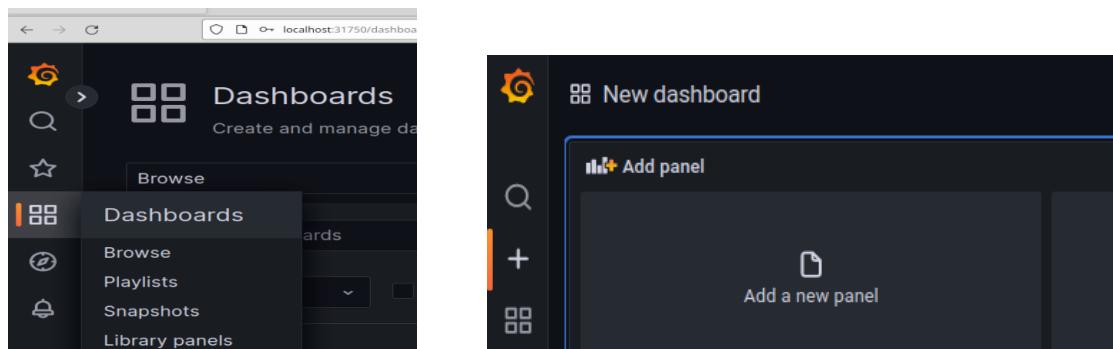


A screenshot of the 'Data Sources / Prometheus' configuration page in Grafana. The title is 'Data Sources / Prometheus' with a Prometheus icon, and it specifies 'Type: Prometheus'. The page has tabs for 'Settings' (which is active) and 'Dashboards'. In the 'Settings' tab, there is a table with a single row: 'Name' is set to 'Prometheus', there is a 'Default' switch which is turned on, and a 'Toggle' switch which is also turned on. Below this is a 'HTTP' section with three fields: 'URL' is 'rometheus-server.monitoring.svc.cluster.local:80', 'Access' is 'Server (default)', and 'Allowed cookies' is 'New tag (enter key to add)'. The URL field has a help icon and a 'Help >' link.

A screenshot of the 'Exemplars' configuration page in Grafana. The title is 'Exemplars'. There is a '+ Add' button. At the bottom are four buttons: 'Back', 'Explore', 'Delete', and 'Save & test' (which is highlighted in pink). The 'Delete' button is also pink.



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



- In the Metric section under "Builder", start typing "node" and then pick a sample metric, such as "node_disk_io_time_seconds_total". Then click on the "Run queries" button up and to the right of the "Metric" field and then click on "Apply" in the upper right corner. You should see a new chart.

New dashboard / Edit Panel

Panel Title

No data

Query 1 Transform 0 Alert 0

Data source Prom... MD = auto = 52Query inspector

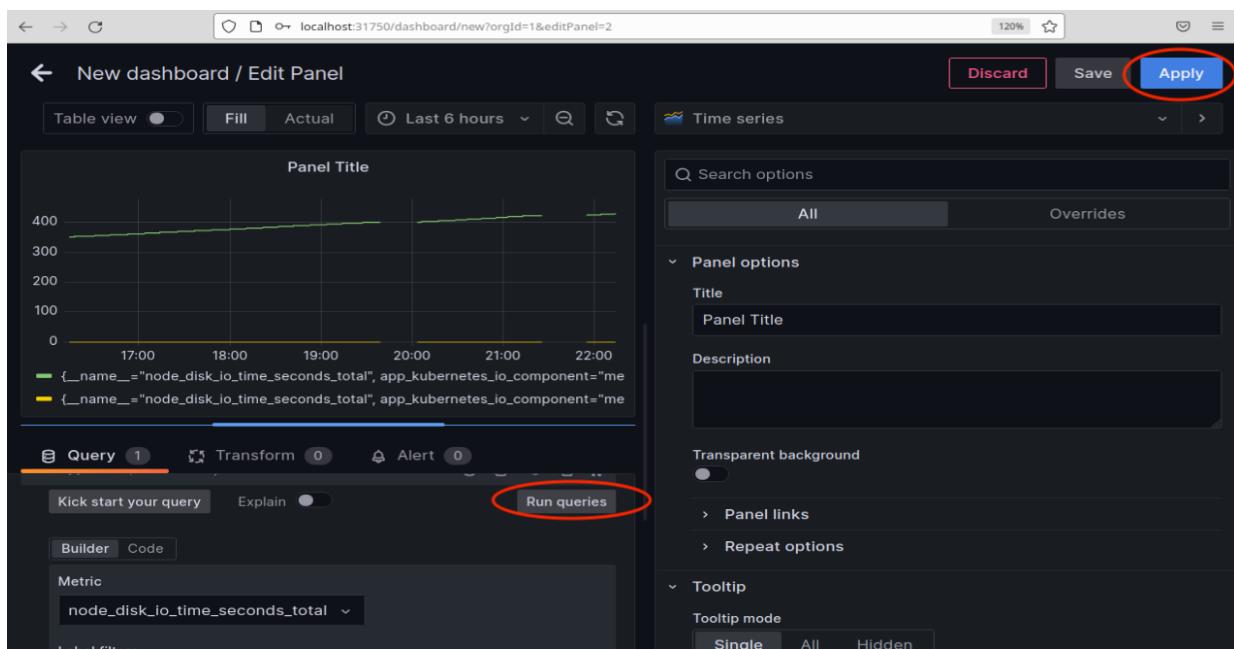
(Prometheus)

Kick start your query Explain Run queries

Builder Code

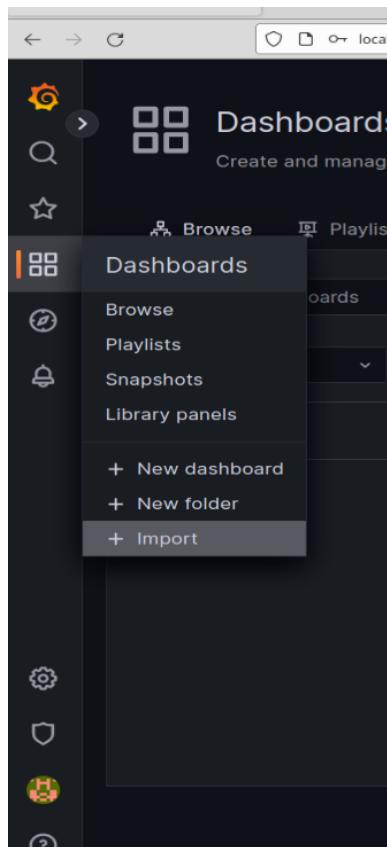
Metric

node_disk_io_time_seconds_total





6. 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. Back on the main page, click on the "four squares" icon on the left side, then select "Dashboards" then "Import". (You can save or discard the previous one if prompted.)

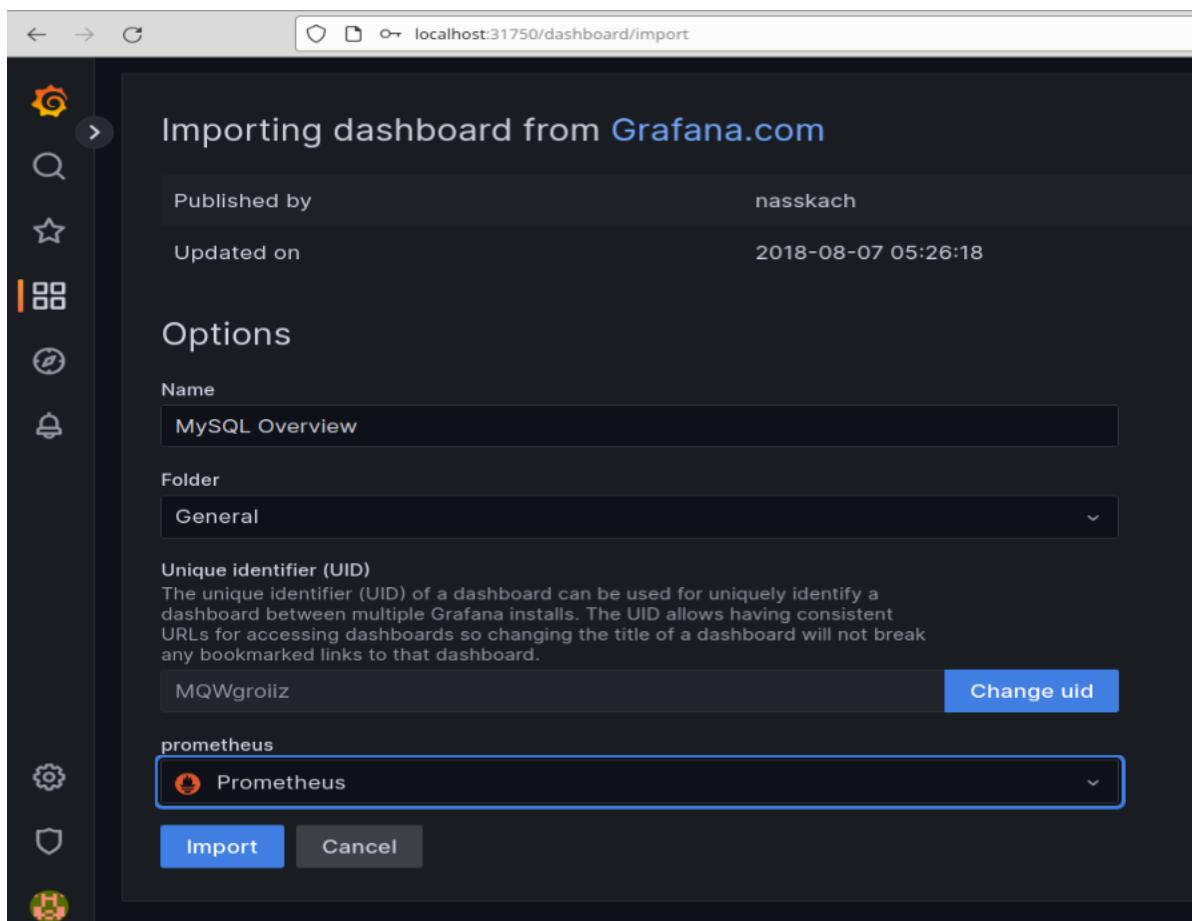


7. In the field that says "Grafana.com dashboard URL or ID", enter the location below and click the blue "Load" button.

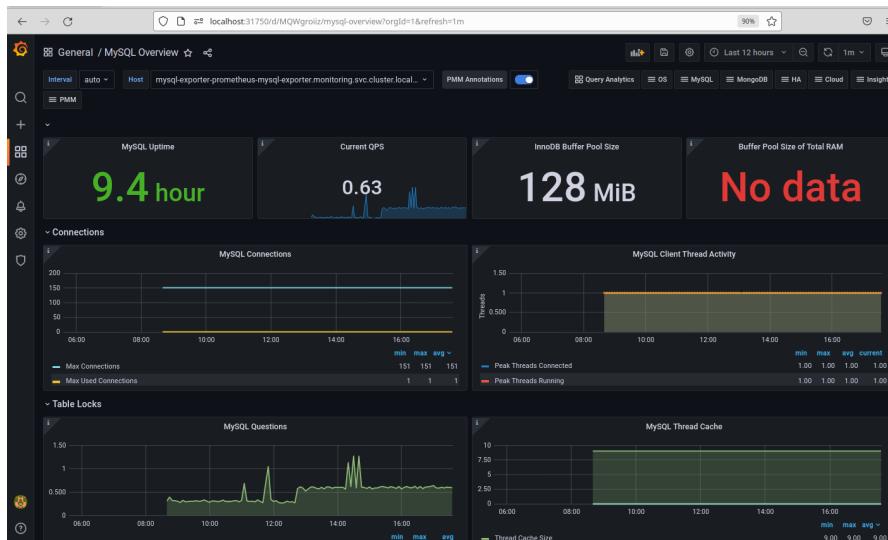
<https://grafana.com/grafana/dashboards/7362>

The screenshot shows the Grafana 'Dashboards / Import dashboard' page. At the top, there's a header with icons for back, forward, search, and refresh, followed by the URL 'localhost:31750/dashboard/import'. Below the header, the title 'Dashboards / Import dashboard' is displayed, with a sub-instruction 'Import dashboard from file or Grafana.com'. A large central area features a dashed box with an upward arrow icon and the text 'Upload dashboard JSON file', followed by the instruction 'Drag and drop here or click to browse'. Below this, it says 'Accepted file types: .json, .txt'. At the bottom of this section is a button labeled 'Import via grafana.com' with the URL 'http://grafana.com/grafana/dashboards/7362' entered into a text input field, and a blue 'Load' button to its right. On the left side of the page is a sidebar with icons for gear (settings), magnifying glass (search), star (favorites), square grid (dashboards), clock (alarms), and bell (notifications). The user 'admin' is logged in, as shown in the sidebar menu which includes options like 'Sign out', 'Change password', 'Notification history', and 'Profile'. The overall theme is dark.

8. 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.

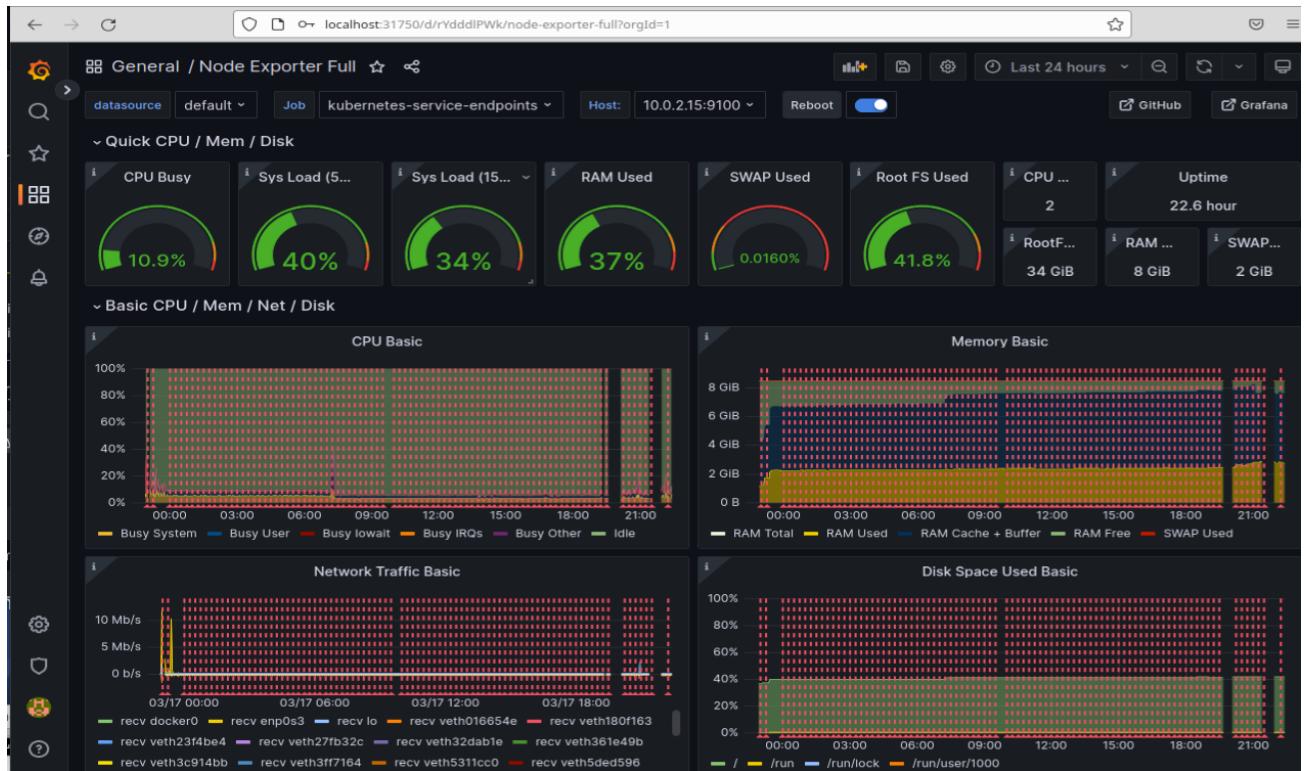


9. At this point, you should see a populated dashboard with a number of panels looking at the mysql exporter data from our system through Prometheus. You can scroll around and explore if you want.



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. (Here again, you'll need to select the Prometheus data source as we did before.)

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



END OF LAB