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Advanced Distributed Systems

Lecture 04-Prometheus and Grafana

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Agenda

- Monitoring
- Prometheus
- Grafana
- Prometheus and Grafana on Kubernetes cluster

Monitoring

Monitoring

- Monitoring is one of the fundamental tasks in any system.
- It helps to detect problems and take action, or simply to know the current state of our systems.
- It helps to reduce (or even eliminate) downtime.
- It detects problems, and solves them before they impact users.

Monitoring

Monitoring helps us to:

- Expose Important **metrics (data)** over time
- Provide a way to configure **rules**, e.g (Cpu usage <80%)
- Send **alerts** (email) when rules are broken
- Provide **visualization/graphing**

Monitoring tools: Sensu, Prometheus, Nagios

Prometheus

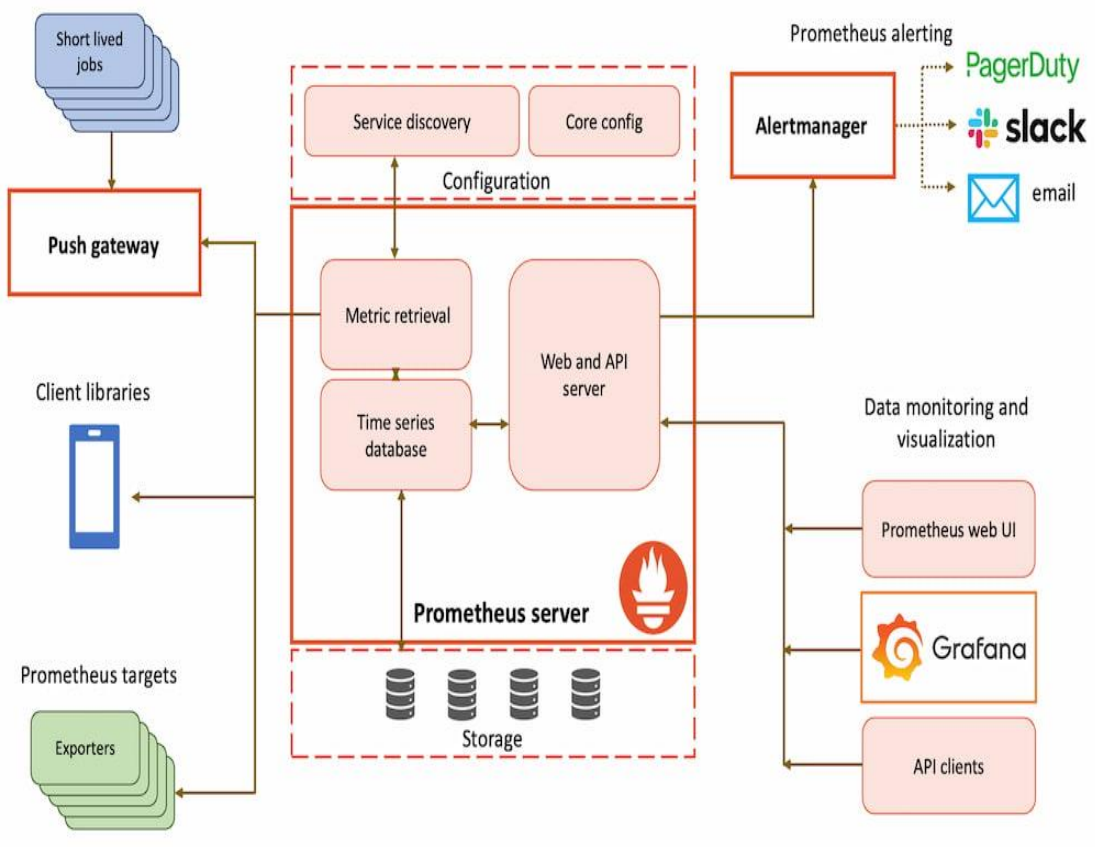
Prometheus

- An open source monitoring and alerting system.
- Written in Go, fully published in 2015.
- An in-memory dimensional time series database.
- A custom query language.
- Designed to scrape metrics from application instances periodically based on service discovery.
- A data scraper that pulls metrics data over HTTP periodically at a configured interval.
- A time-series database to store all the metrics data.
- A simple user interface where you can visualize, query, and monitor all the metrics.

Prometheus Architecture

Prometheus server

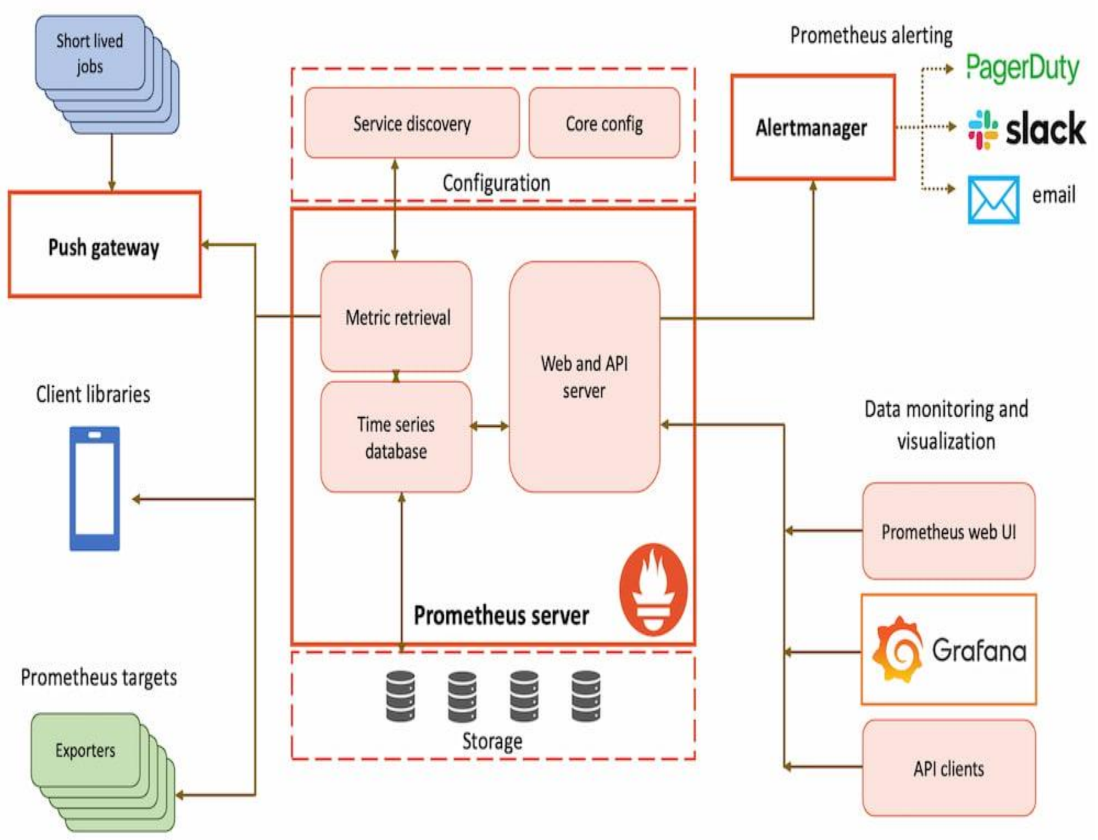
- This is the heart of the system.
- It collects the metrics at regular intervals from multiple nodes and stores them locally.
- Prometheus primarily utilizes an HTTP endpoint to scrape metric data from applications. The metrics are either scraped by
    - the Prometheus server directly or
    - a push gateway for short-lived, instrumented jobs.



Prometheus Architecture

Client libraries

- Client libraries enable developers to add Prometheus instrumentation to their code.
- This instrumentation helps define and expose application metrics for each application language.
- Prometheus offers official libraries that are compatible with Ruby, Go, Python, Java/JVM, Haskell, Common Lisp, Dart, Erlang, C#/.NET, PHP, Perl, and Rust.

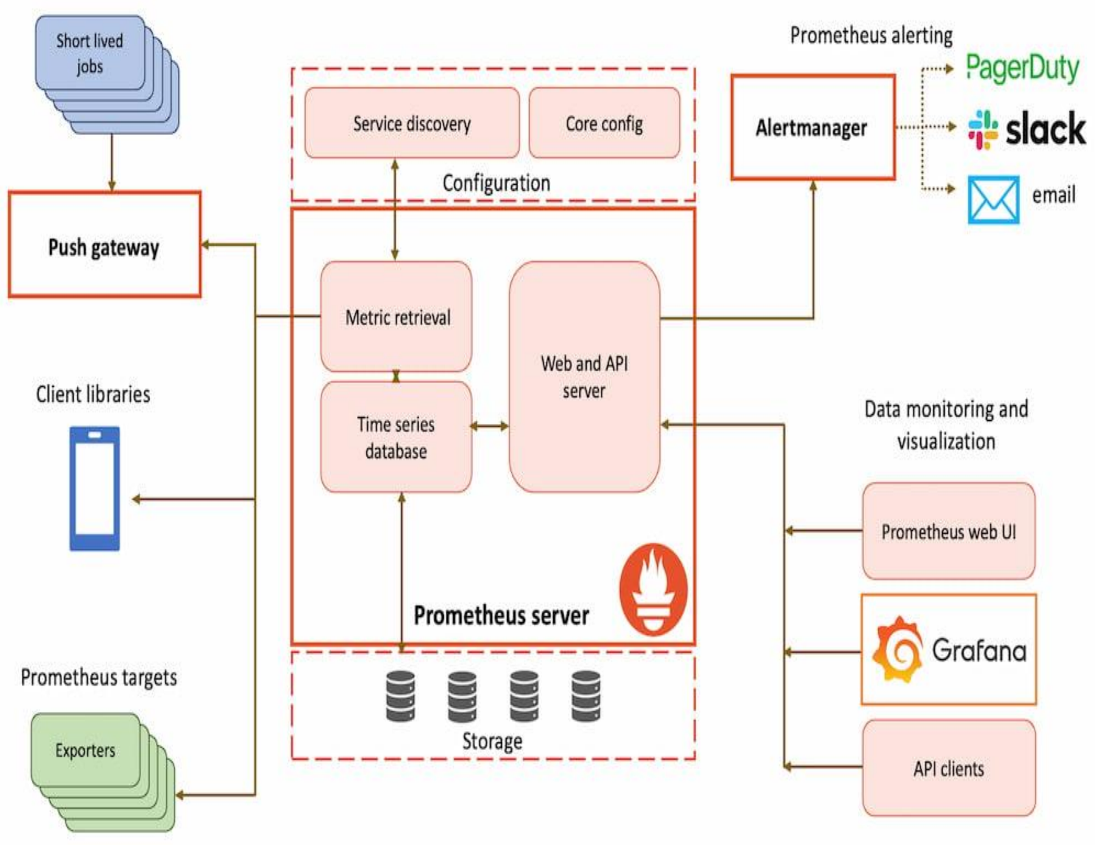


Prometheus Architecture

Exporter

- It refers to a separate software component or module that collects specific metrics from a system, service, or application.

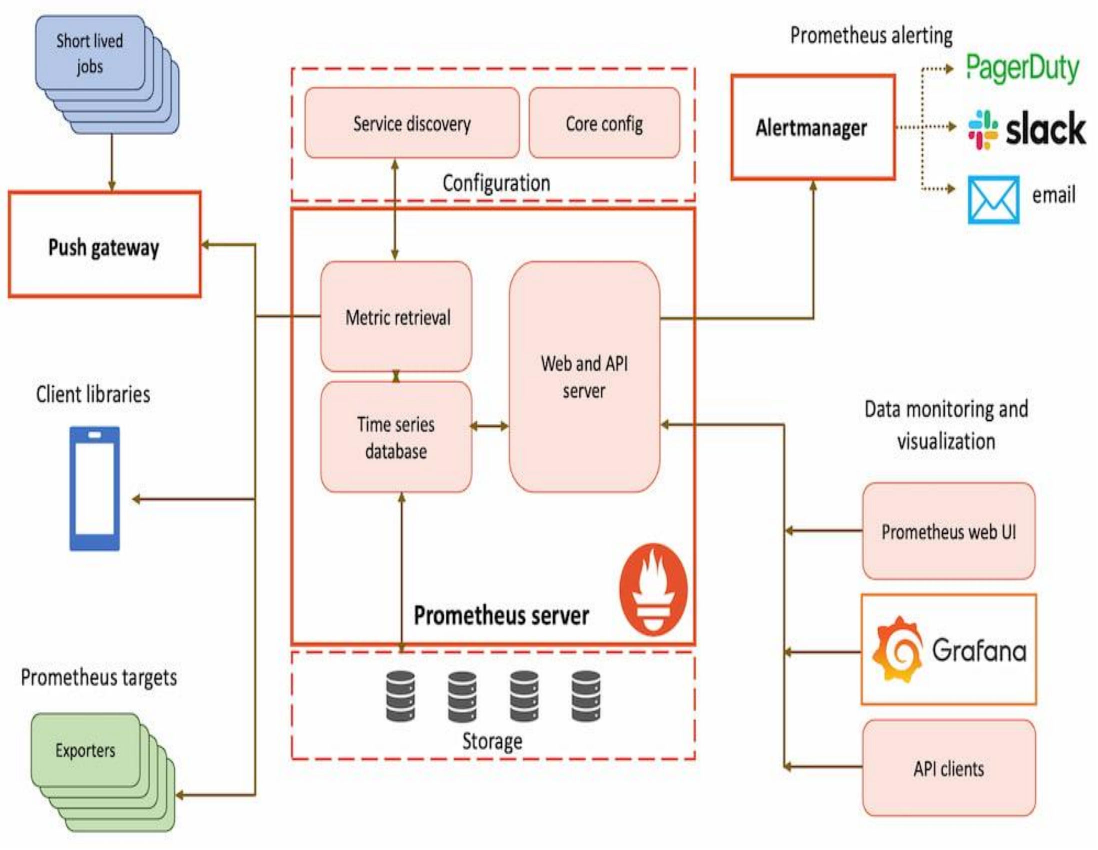
- It acts as bridges between Prometheus and the target, translating the data from those systems into a format that Prometheus can understand and collect.



Prometheus Architecture

Service discovery

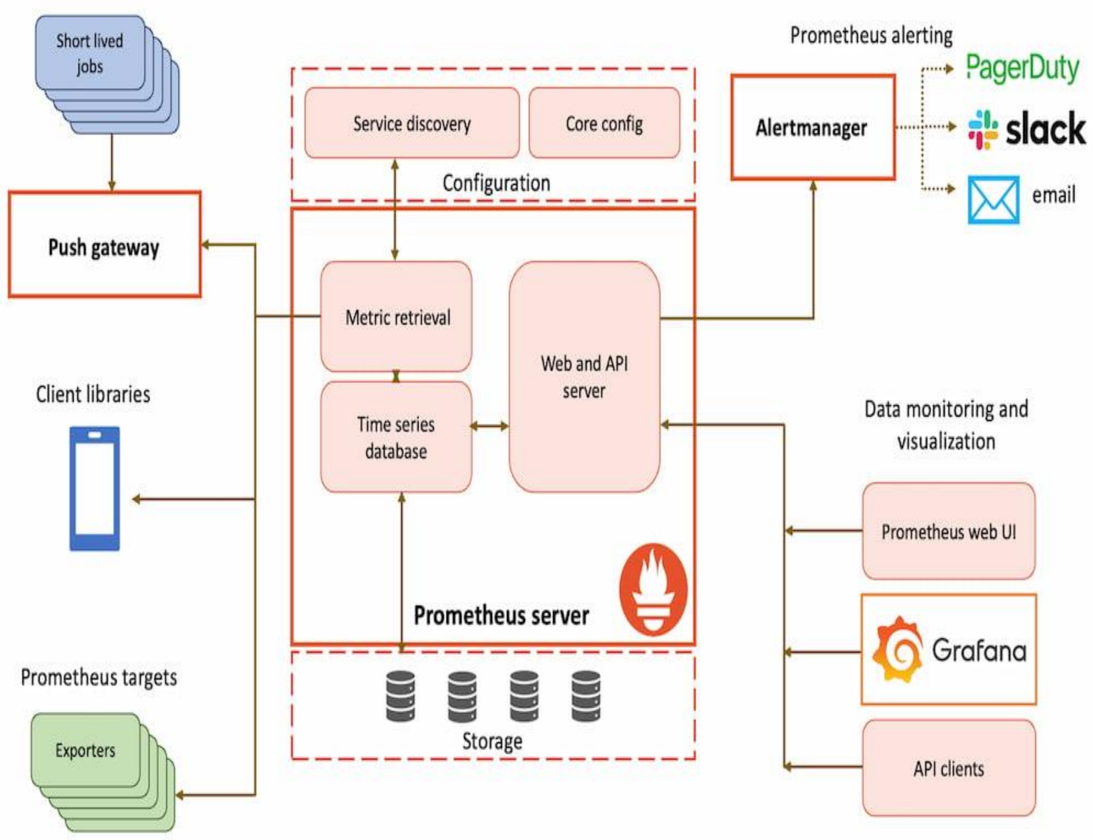
- Target discovery via static configuration or service discovery



Prometheus Architecture

Visualization

- Prometheus comes with its own user interface to check on the configuration, nodes and graphs.
- It is compatible with Grafana, a leading open source visualization application, so that Prometheus data is available for viewing inside Grafana.
- It also exposes an API, so in case you are interested in writing your own clients.



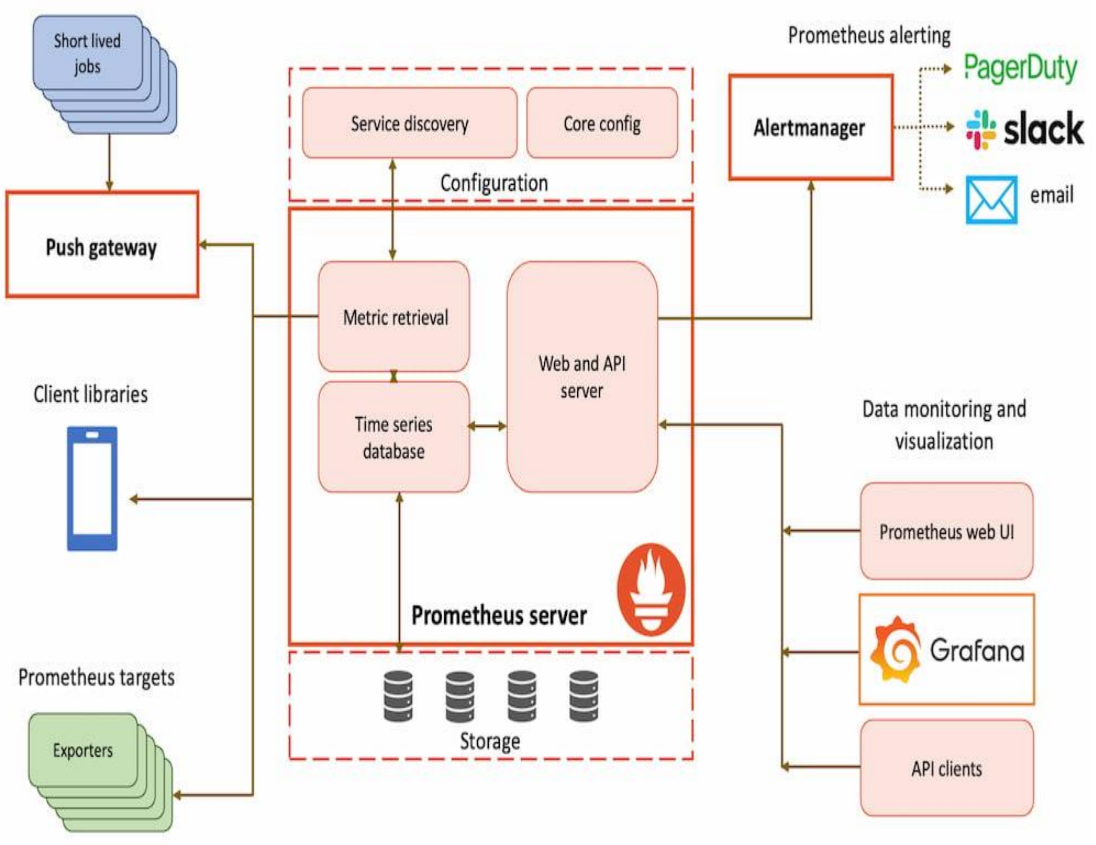
Prometheus Architecture

Alert manager

- AlertManager is a single binary which handles alerts sent by Prometheus server and notifies end user through E-mail, Slack or other tools.

Example (custom rules):

- The server is not running
- Average response time greater than 500ms
- The server's memory usage is greater than 95%.
- Number of 404 errors are greater than 10% of all requests.



What Prometheus monitors

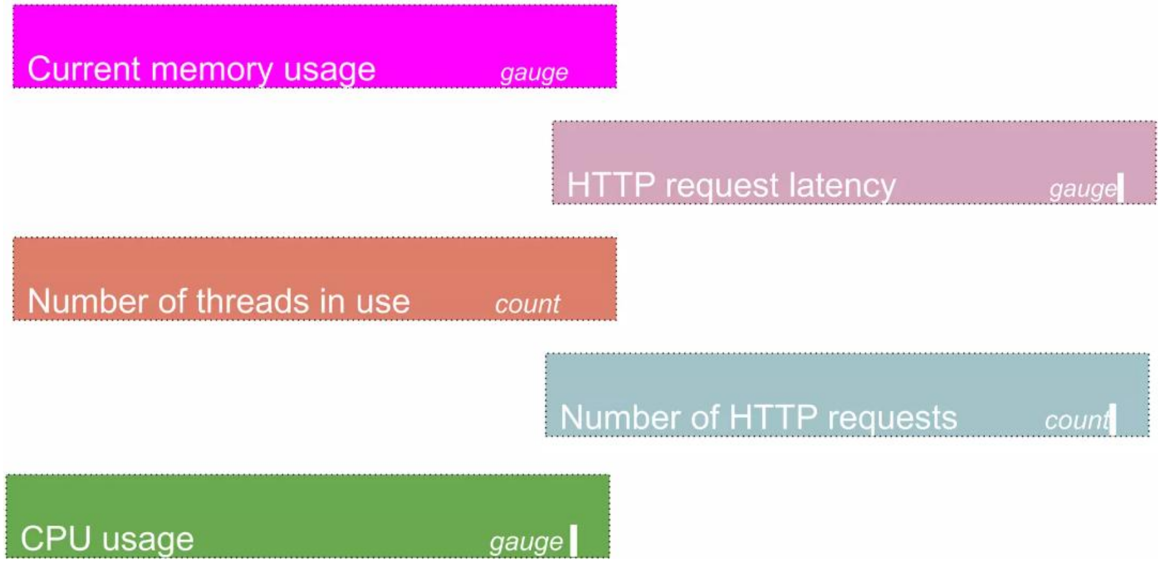
- Linux / windows servers (CPU status, memory, Disk space …)
- Apache server (On/Off status…)
- Single application (Exceptions, Requests count, client latency…)
- Service like database (status, Query Performance…)

Metrics

Metrics: all data as time series that Prometheus can scrape it and stores it in his database.

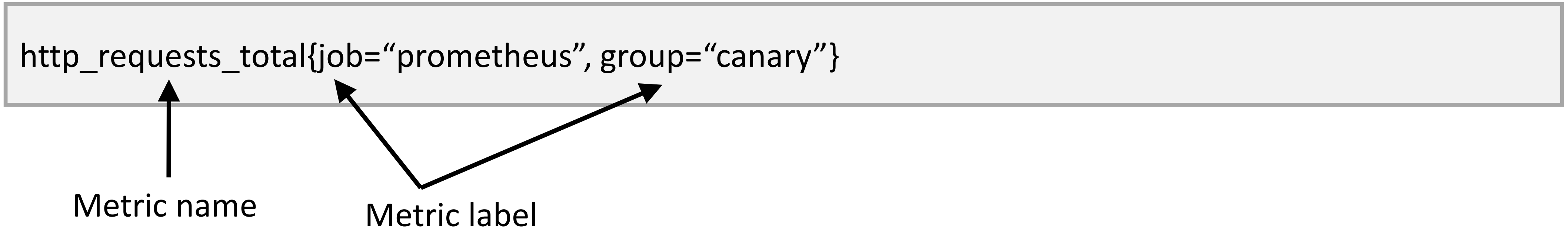
Metrics has two metadata lines: Help and Type

- **Help**: description of what the metrics is.
- **Type**: we have 3 metrics types:
  - Count: how many times x happened?
  - Gauge: what is the current value of x now?
  - Histogram; How long or how big?



Prometheus query

- Prometheus provides a functional query language called PromQL (Prometheus Query Language) that lets the user select and aggregate time series data in real time.
- The result of an expression can either be shown as a graph, viewed as tabular data in Prometheus's expression browser, or consumed by external systems via the HTTP API.



```
http_requests_total{job=“prometheus”, group=“canary”}
```

Prometheus query

Example Queries:

- http_requests_total:

  Return all time series with the metric

- http_requests_total{job="apiserver", handler="/api/comments"}:

  Return all time series with the metric http_requests_total and the given job and handler labels:

- Http_requests_total{status!~"4.."}:

  Query all HTTP status codes expect 4xx ones.

- Rate(Http_requests_total[5m])[30m:]:

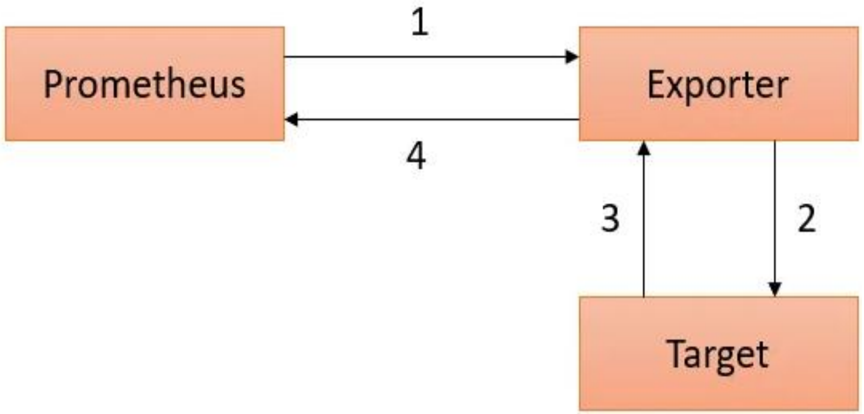
  Returns the 5-minutes rate of the Http_requests_total metric for the past 30 min.

You can find more example here:
https://prometheus.io/docs/prometheus/latest/querying/examples/

Target endpoints and Exporter

In order to monitor anything with Prometheus, you need an exporter – a process that exposes metrics for Prometheus to harvest.

1. Prometheus initiates requests with parameters.
2. Probe to targets. The exporter subsequently starts the scrape after getting Prometheus' GET requests.
3. Return status code.
4. Return Prometheus metrics. Once the exporter is done with scraping, it will return the result in Prometheus metric format.



Target endpoints and Exporter

- **Global:**

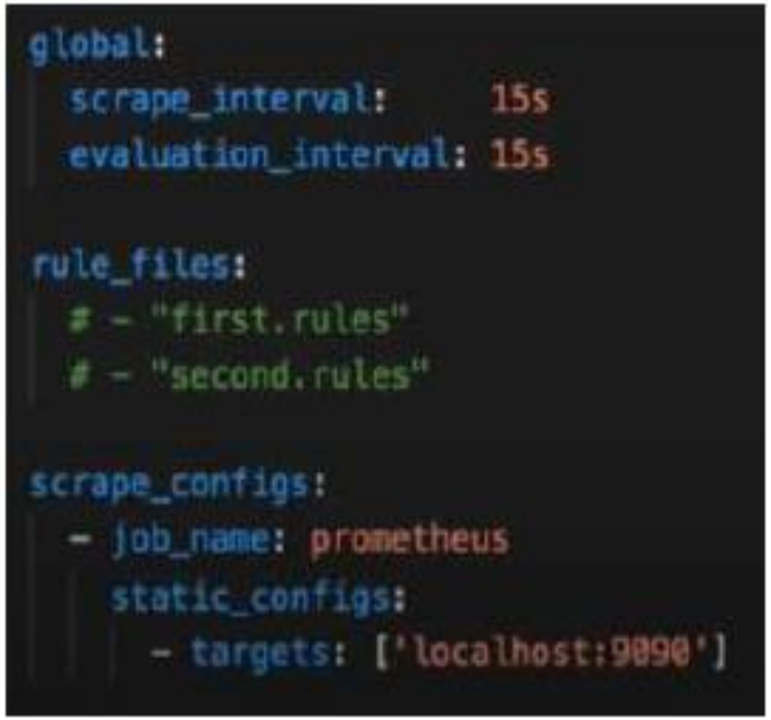
  How often Prometheus will scrape its targets

- **Rule_files:**

  Rules for aggregating metric values or creating alerts when condition met

- **Scrape_configs:**

  What resources Prometheus monitors



```yaml
global:
  scrape_interval:     15s
  evaluation_interval: 15s

rule_files:
  # - "first.rules"
  # - "second.rules"

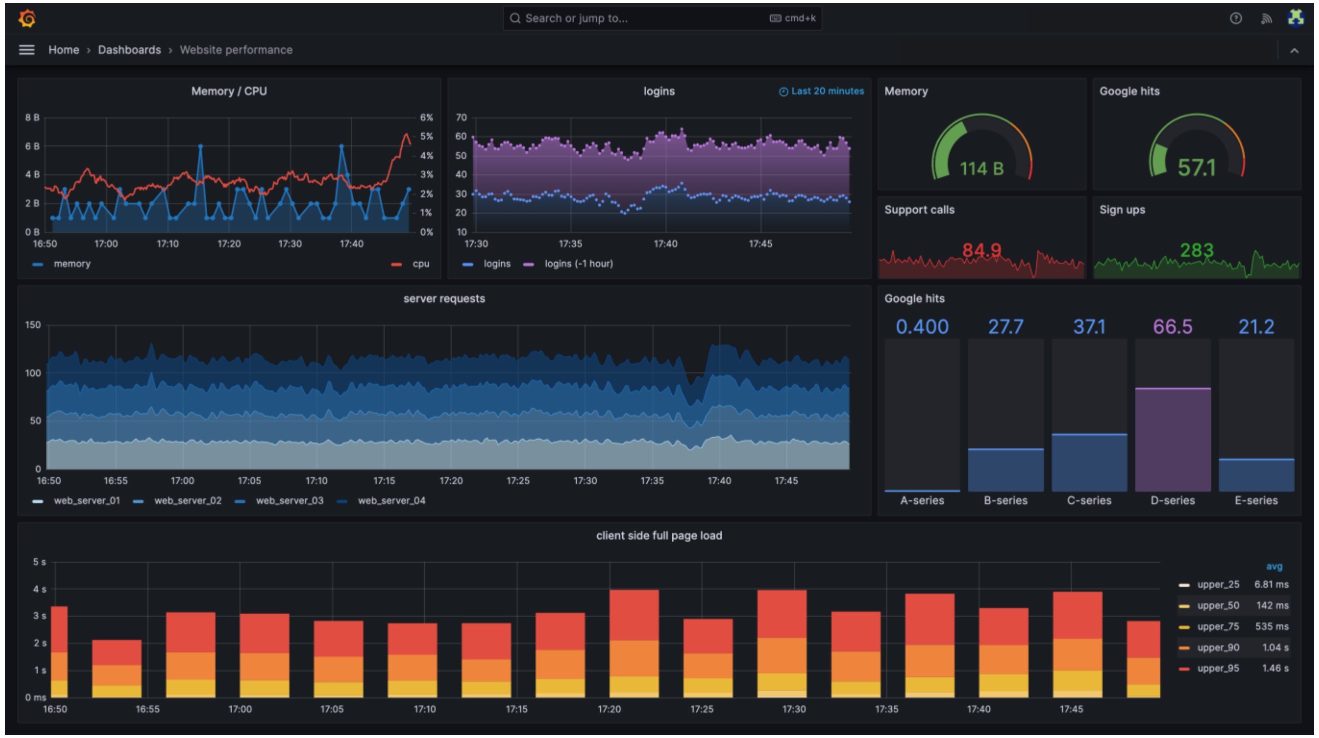
scrape_configs:
  - job_name: prometheus
    static_configs:
      - targets: ['localhost:9090']
```

prometheus.yml

Grafana

Grafana

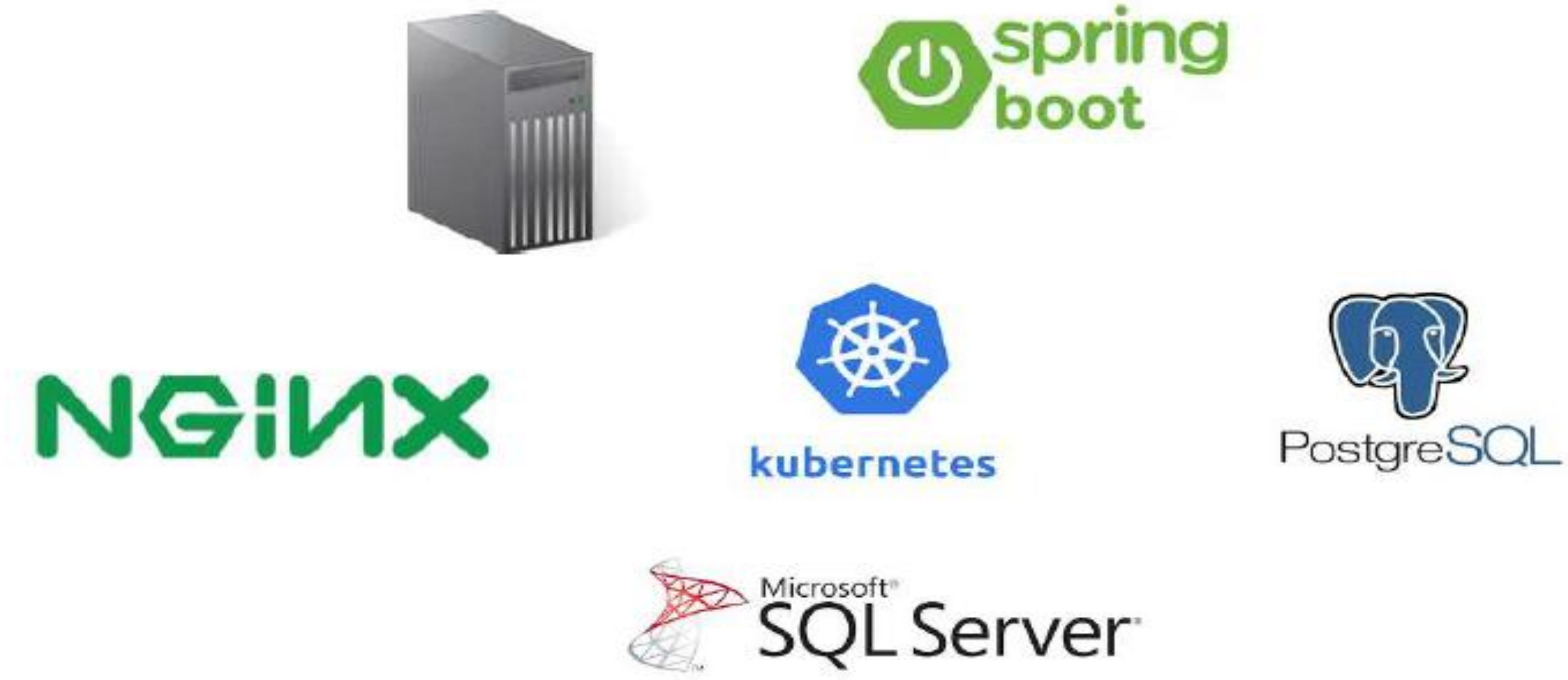
- Grafana Is the open source analytics & monitoring solution for every database.
- Grafana allows you to bring data from various data sources like Elasticsearch, Prometheus, Graphite, InfluxDB etc, and visualize them with beautiful graphs.



Grafana features

- Create graphs easily
- Visualize data in different ways
- Show graphs for different time periods
- Create dashboard to be viewed by others
- Allows us to easily make changes

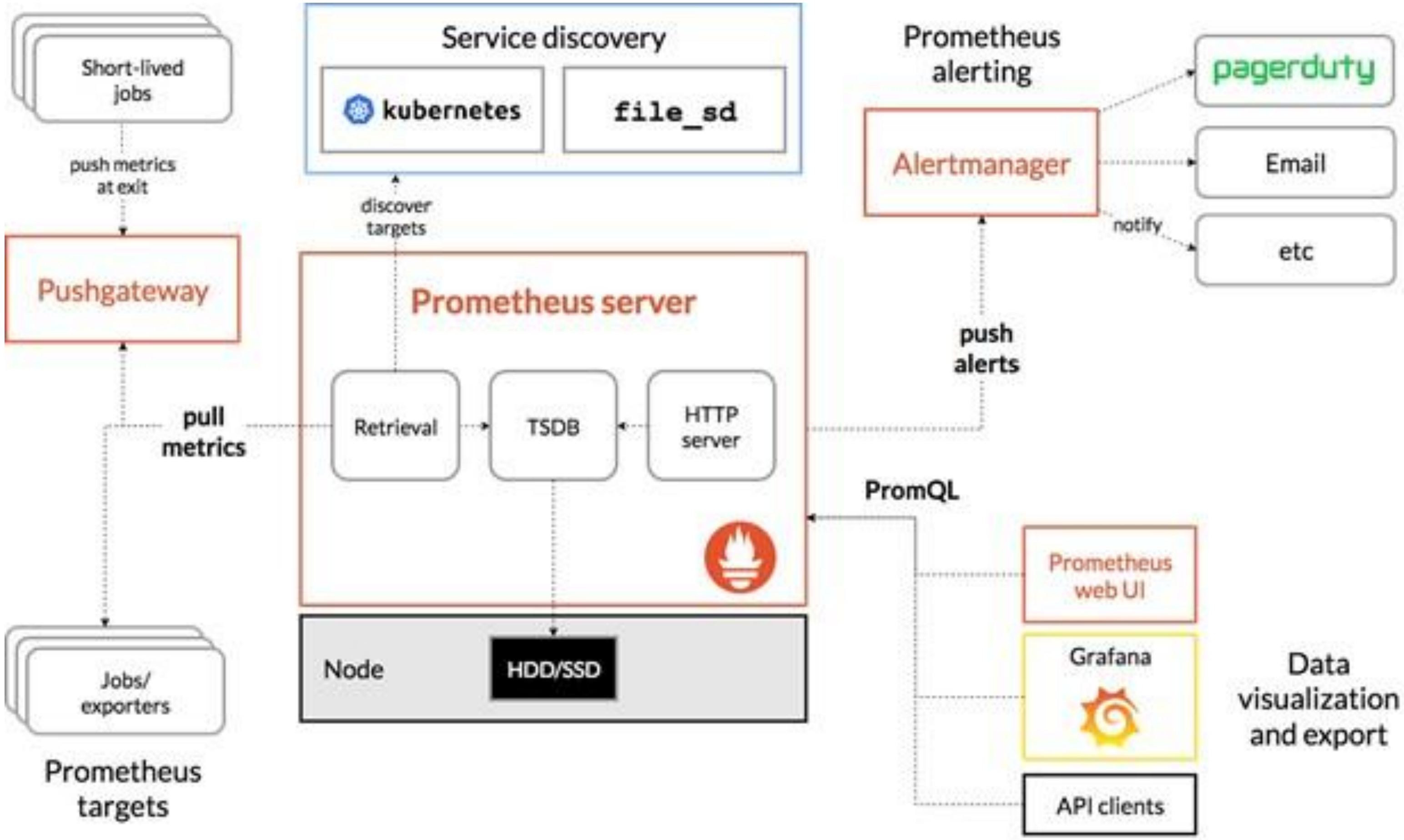
Prometheus and Grafana use cases



We monitor all this targets using Prometheus and Grafana

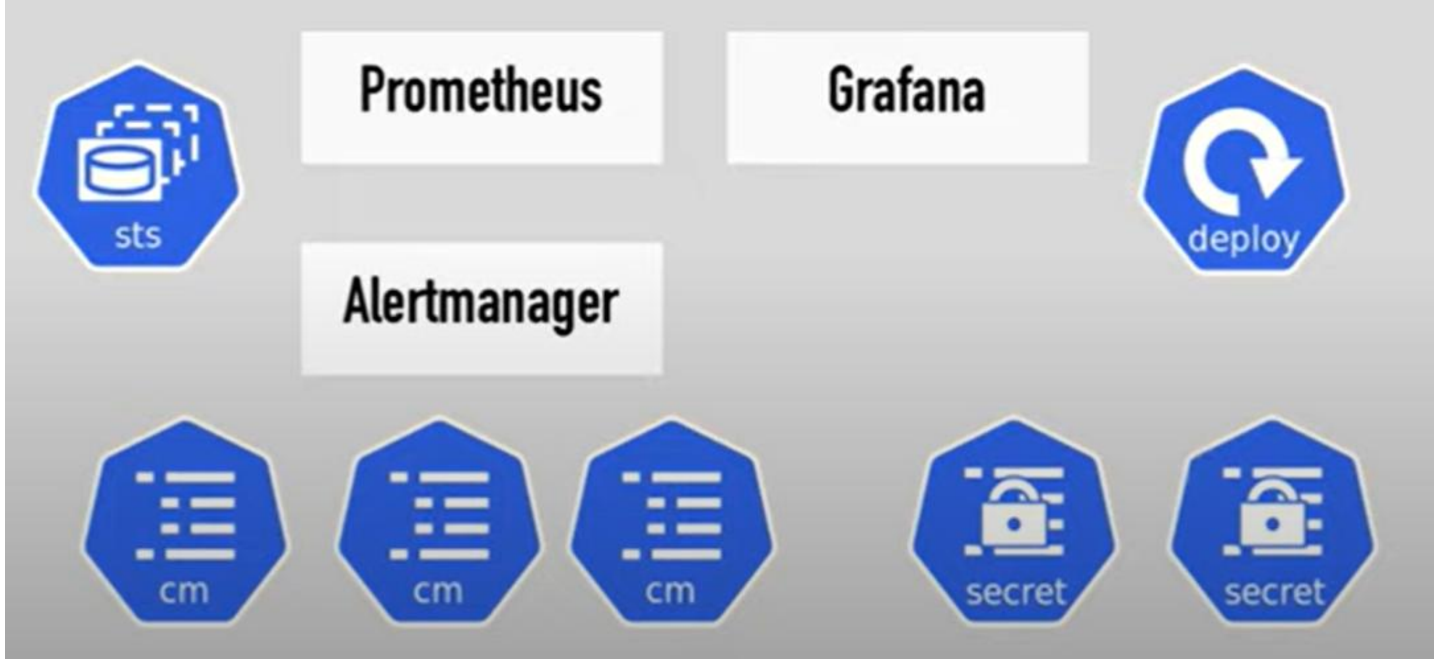
Prometheus and Grafana on Kubernetes cluster

Prometheus and Grafana for Kubernetes



Deploy Prometheus and Grafana on Kubernetes

1. Creating all configuration YAML files and execute them in right order because of dependences



Deploy Prometheus and Grafana on Kubernetes

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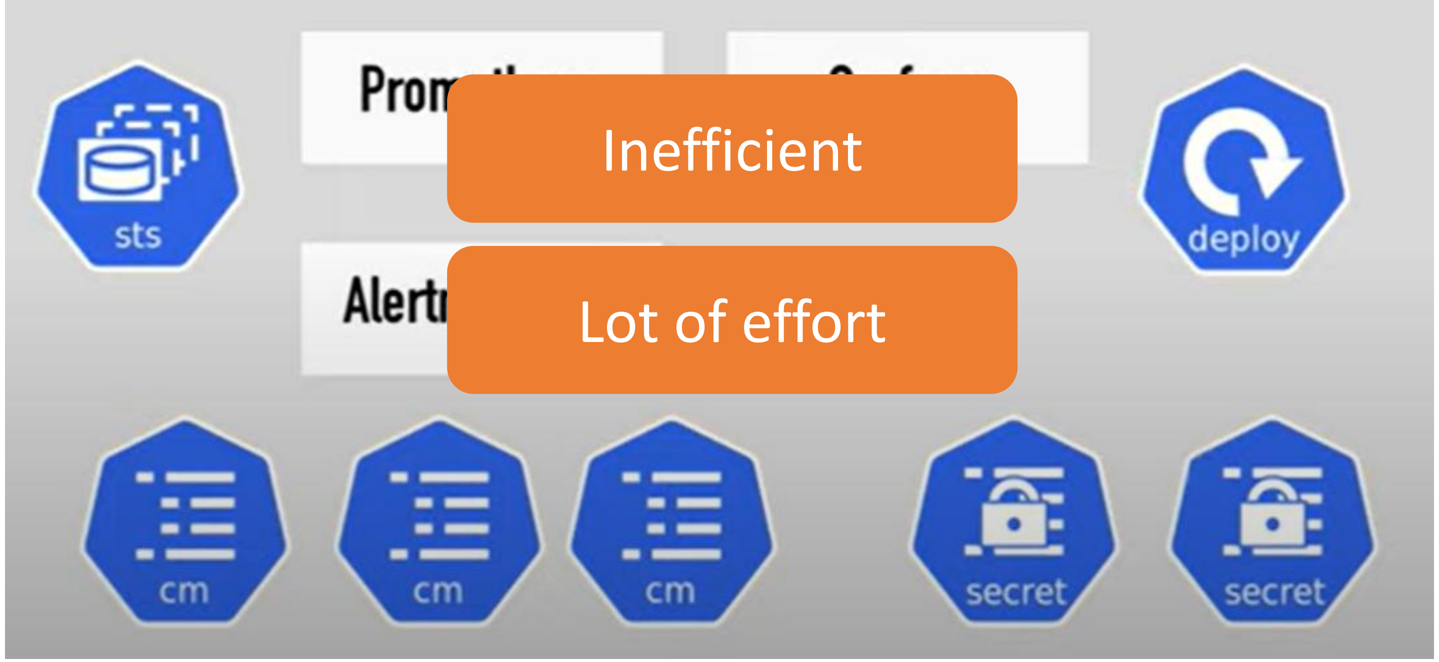


Inefficient

Lot of effort

Deploy Prometheus and Grafana on Kubernetes

2. Using operators
   - Manages all Prometheus component
   - Consider all the Prometheus stack as one unit
   - You do not need to manually manage all these components
   - Find Prometheus operator
   - Deploy in the k8s cluster using the configuration files of the operator

Deploy Prometheus and Grafana on Kubernetes

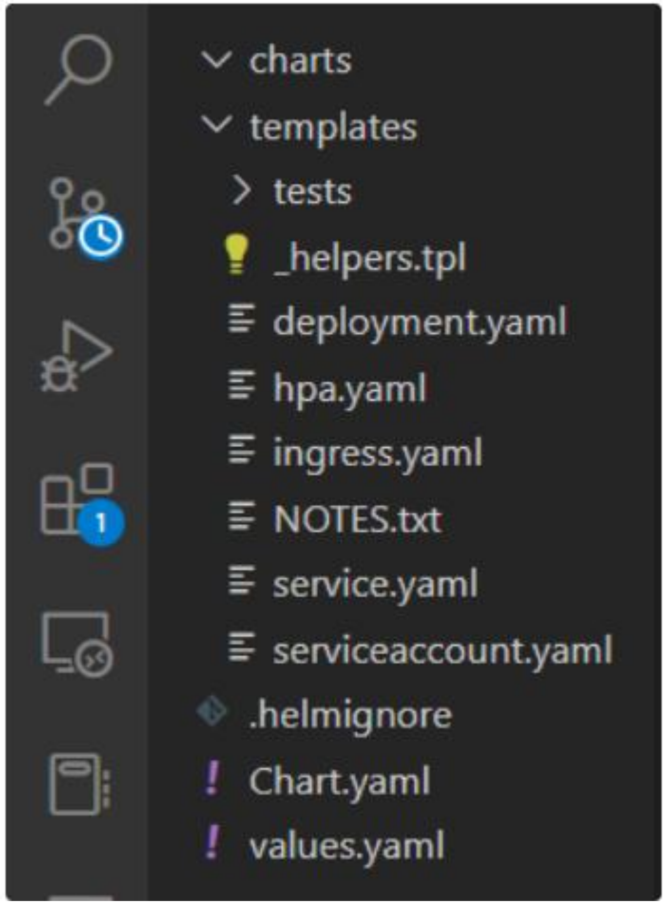
3. Using helm chart to deploy the operator
   - Helm is popularly known as the package manager for Kubernetes.
   - Helm helps to configure and install any application to Kubernetes.
   - It bundles a Kubernetes application into a package known as a Helm Chart.
   - Helm Charts helps in defining, installing, and upgrading the most complex Kubernetes application
   - Go or Ansible scripts are an alternative of Helm
   - Helm: initiate setup
   - Operator: manage setup

Using helm chart to Deploy Prometheus

- Install Helm on Linux

```
snap install helm --classic
```

- Chart Folder contains the chart dependencies for the downloaded Helm Chart.
- Chart.yaml contains the meta-information about the downloaded Helm Chart such as name, description version number, and list of dependencies.
- Template Folder contains all the configuration YAML files you are deploying to the Kubernetes Cluster with the Helm Chart. These files are the Deployments, Services, ConfigMaps, and Secrets configurations YAML files.
- Values.yaml configure and set all the values for the configurations of YAML files. The configuration YAML files read their values from this file.



```
charts
templates
  tests
  _helpers.tpl
  deployment.yaml
  hpa.yaml
  ingress.yaml
  NOTES.txt
  service.yaml
  serviceaccount.yaml
.helmignore
Chart.yaml
values.yaml
```

Using helm chart to Deploy Prometheus

- Update the helm repository

```
helm repo update
```

- Add Repositories. Add the following helm repositories by the commands below.

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

- Update Helm Repositories

```
helm repo update
```

Using helm chart to Deploy Prometheus

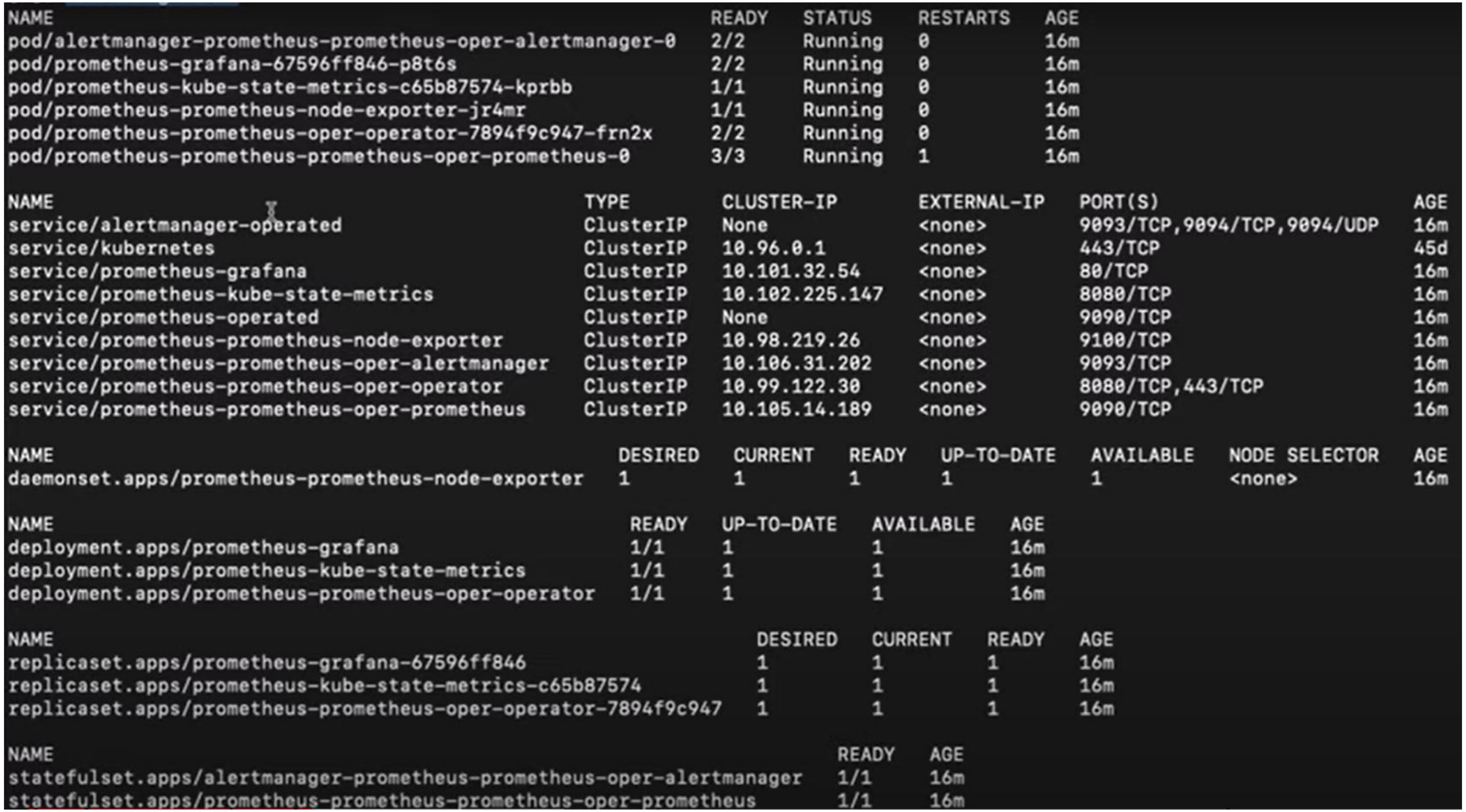
- Install Prometheus Kubernetes

```
helm install prometheus prometheus-community/kube-prometheus-stack
```

- Get all the deployed Kubernetes resources for the Prometheus Kubernetes application

```
kubectl get all
```

Using helm chart to Deploy Prometheus



```
NAME                                                       READY   STATUS    RESTARTS   AGE
pod/alertmanager-prometheus-prometheus-oper-alertmanager-0   2/2     Running   0          16m
pod/prometheus-grafana-67596ff846-p8t6s                      2/2     Running   0          16m
pod/prometheus-kube-state-metrics-c65b87574-kprbb            1/1     Running   0          16m
pod/prometheus-prometheus-node-exporter-jr4mr                1/1     Running   0          16m
pod/prometheus-prometheus-oper-operator-7894f9c947-frn2x     2/2     Running   0          16m
pod/prometheus-prometheus-prometheus-oper-prometheus-0       3/3     Running   1          16m

NAME                                              TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)                      AGE
service/alertmanager-operated                     ClusterIP   None             <none>        9093/TCP,9094/TCP,9094/UDP   16m
service/kubernetes                                ClusterIP   10.96.0.1        <none>        443/TCP                      45d
service/prometheus-grafana                        ClusterIP   10.101.32.54     <none>        80/TCP                       16m
service/prometheus-kube-state-metrics             ClusterIP   10.102.225.147   <none>        8080/TCP                     16m
service/prometheus-operated                       ClusterIP   None             <none>        9090/TCP                     16m
service/prometheus-prometheus-node-exporter       ClusterIP   10.98.219.26     <none>        9100/TCP                     16m
service/prometheus-prometheus-oper-alertmanager   ClusterIP   10.106.31.202    <none>        9093/TCP                     16m
service/prometheus-prometheus-oper-operator       ClusterIP   10.99.122.30     <none>        8080/TCP,443/TCP             16m
service/prometheus-prometheus-oper-prometheus     ClusterIP   10.105.14.189    <none>        9090/TCP                     16m

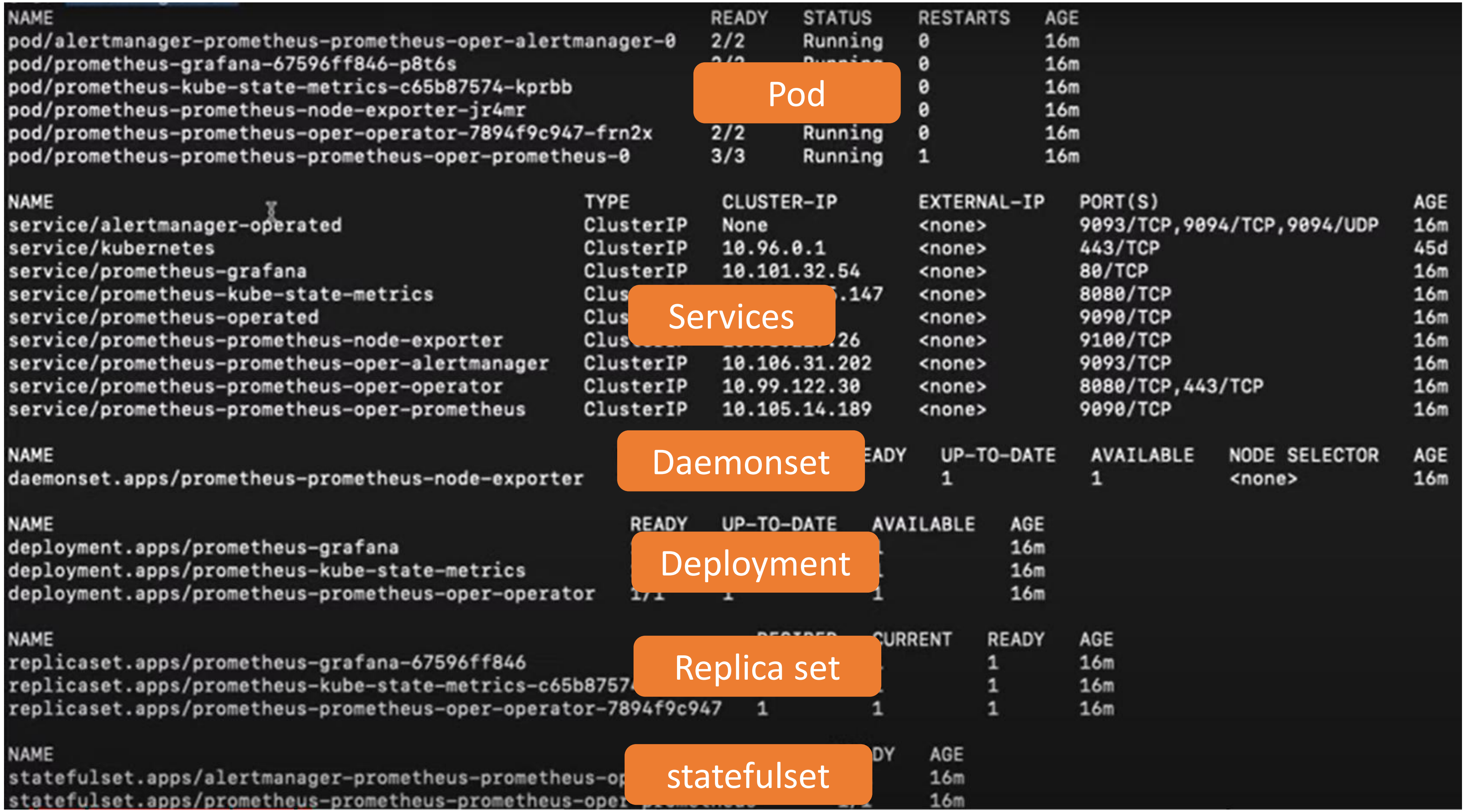
NAME                                                 DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR   AGE
daemonset.apps/prometheus-prometheus-node-exporter   1         1         1       1            1           <none>          16m

NAME                                                  READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/prometheus-grafana                    1/1     1            1           16m
deployment.apps/prometheus-kube-state-metrics         1/1     1            1           16m
deployment.apps/prometheus-prometheus-oper-operator   1/1     1            1           16m

NAME                                                             DESIRED   CURRENT   READY   AGE
replicaset.apps/prometheus-grafana-67596ff846                    1         1         1       16m
replicaset.apps/prometheus-kube-state-metrics-c65b87574          1         1         1       16m
replicaset.apps/prometheus-prometheus-oper-operator-7894f9c947   1         1         1       16m

NAME                                                                   READY   AGE
statefulset.apps/alertmanager-prometheus-prometheus-oper-alertmanager   1/1     16m
statefulset.apps/prometheus-prometheus-prometheus-oper-prometheus       1/1     16m
```

Using helm chart to Deploy Prometheus



```
NAME                                                   READY   STATUS    RESTARTS   AGE
pod/alertmanager-prometheus-prometheus-oper-alertmanager-0   2/2     Running   0          16m
pod/prometheus-grafana-67596ff846-p8t6s                                          0          16m
pod/prometheus-kube-state-metrics-c65b87574-kprbb                                0          16m
pod/prometheus-prometheus-node-exporter-jr4mr                                    0          16m
pod/prometheus-prometheus-oper-operator-7894f9c947-frn2x     2/2     Running   0          16m
pod/prometheus-prometheus-oper-prometheus-0                  3/3     Running   1          16m

NAME                                            TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)                      AGE
service/alertmanager-operated                   ClusterIP   None            <none>        9093/TCP,9094/TCP,9094/UDP   16m
service/kubernetes                              ClusterIP   10.96.0.1       <none>        443/TCP                      45d
service/prometheus-grafana                      ClusterIP   10.101.32.54    <none>        80/TCP                       16m
service/prometheus-kube-state-metrics           Clus              .147      <none>        8080/TCP                     16m
service/prometheus-operated                     Clus                        <none>        9090/TCP                     16m
service/prometheus-prometheus-node-exporter     Clus               26       <none>        9100/TCP                     16m
service/prometheus-prometheus-oper-alertmanager ClusterIP   10.106.31.202   <none>        9093/TCP                     16m
service/prometheus-prometheus-oper-operator     ClusterIP   10.99.122.30    <none>        8080/TCP,443/TCP             16m
service/prometheus-prometheus-oper-prometheus   ClusterIP   10.105.14.189   <none>        9090/TCP                     16m

NAME                                                                  EADY   UP-TO-DATE   AVAILABLE   NODE SELECTOR   AGE
daemonset.apps/prometheus-prometheus-node-exporter                              1            1           <none>          16m

NAME                                               READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/prometheus-grafana                                                   16m
deployment.apps/prometheus-kube-state-metrics                                        16m
deployment.apps/prometheus-prometheus-oper-operator                         1           16m

NAME                                                                    CURRENT   READY   AGE
replicaset.apps/prometheus-grafana-67596ff846                                     1       16m
replicaset.apps/prometheus-kube-state-metrics-c65b8757                            1       16m
replicaset.apps/prometheus-prometheus-oper-operator-7894f9c947   1      1         1       16m

NAME                                                              DY   AGE
statefulset.apps/alertmanager-prometheus-prometheus-op                 16m
statefulset.apps/prometheus-prometheus-prometheus-oper                 16m
```

Pod

Services

Daemonset

Deployment

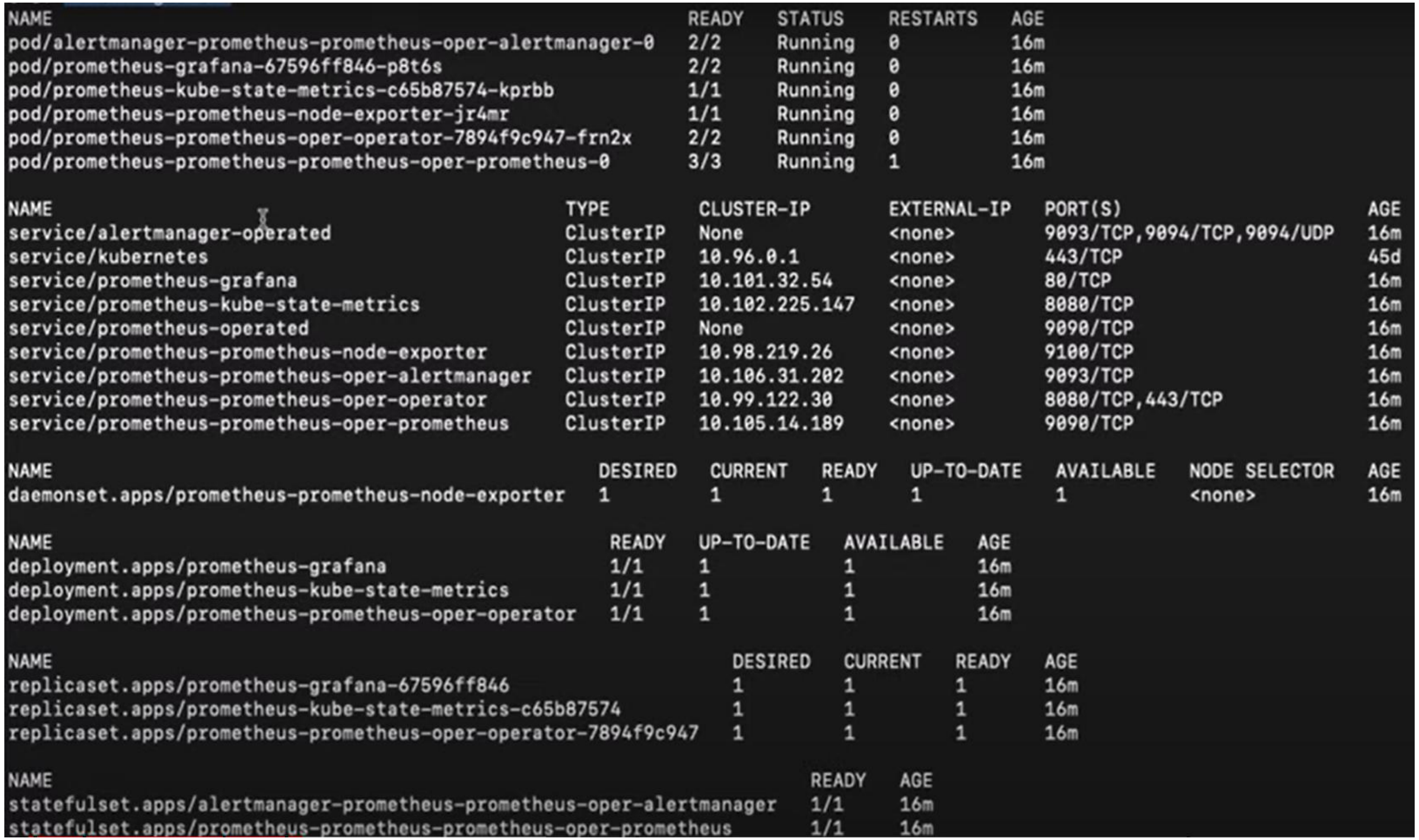
Replica set

statefulset

Using helm chart to Deploy Prometheus

Statefulsets

1. Core Prometheus server managed by operator
2. Alertmanager



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NAME                                                     READY   STATUS    RESTARTS   AGE
pod/alertmanager-prometheus-prometheus-oper-alertmanager-0   2/2     Running   0          16m
pod/prometheus-grafana-67596ff846-p8t6s                   2/2     Running   0          16m
pod/prometheus-kube-state-metrics-c65b87574-kprbb         1/1     Running   0          16m
pod/prometheus-prometheus-node-exporter-jr4mr             1/1     Running   0          16m
pod/prometheus-prometheus-oper-operator-7894f9c947-frn2x  2/2     Running   0          16m
pod/prometheus-prometheus-prometheus-oper-prometheus-0    3/3     Running   1          16m

NAME                                          TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)                      AGE
service/alertmanager-operated                 ClusterIP   None             <none>        9093/TCP,9094/TCP,9094/UDP   16m
service/kubernetes                            ClusterIP   10.96.0.1        <none>        443/TCP                      45d
service/prometheus-grafana                    ClusterIP   10.101.32.54     <none>        80/TCP                       16m
service/prometheus-kube-state-metrics         ClusterIP   10.102.225.147   <none>        8080/TCP                     16m
service/prometheus-operated                   ClusterIP   None             <none>        9090/TCP                     16m
service/prometheus-prometheus-node-exporter   ClusterIP   10.98.219.26     <none>        9100/TCP                     16m
service/prometheus-prometheus-oper-alertmanager ClusterIP 10.106.31.202    <none>        9093/TCP                     16m
service/prometheus-prometheus-oper-operator   ClusterIP   10.99.122.30     <none>        8080/TCP,443/TCP             16m
service/prometheus-prometheus-oper-prometheus ClusterIP   10.105.14.189    <none>        9090/TCP                     16m

NAME                                                 DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR   AGE
daemonset.apps/prometheus-prometheus-node-exporter   1         1         1       1            1           <none>          16m

NAME                                                  READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/prometheus-grafana                    1/1     1            1           16m
deployment.apps/prometheus-kube-state-metrics         1/1     1            1           16m
deployment.apps/prometheus-prometheus-oper-operator   1/1     1            1           16m

NAME                                                             DESIRED   CURRENT   READY   AGE
replicaset.apps/prometheus-grafana-67596ff846                    1         1         1       16m
replicaset.apps/prometheus-kube-state-metrics-c65b87574          1         1         1       16m
replicaset.apps/prometheus-prometheus-oper-operator-7894f9c947   1         1         1       16m

NAME                                                                    READY   AGE
statefulset.apps/alertmanager-prometheus-prometheus-oper-alertmanager   1/1     16m
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```

Using helm chart to Deploy Prometheus

Statefulsets

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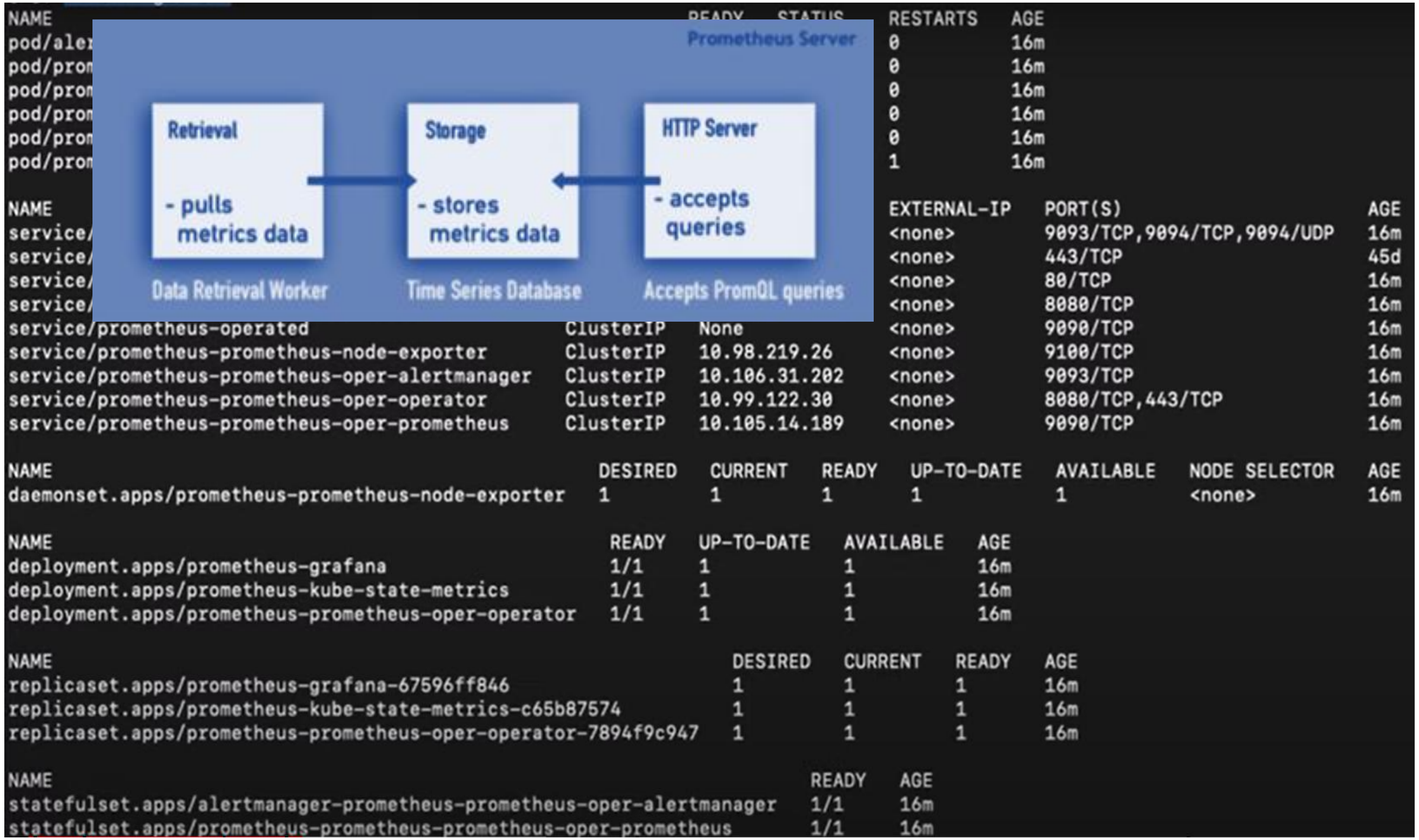
2. Alertmanager



```
NAME                                                    READY   STATUS      RESTARTS   AGE
pod/aler                                                                    0          16m
pod/prom                                                                    0          16m
pod/prom                                                                    0          16m
pod/prom                                                                    0          16m
pod/prom                                                                    0          16m
pod/prom                                                                    1          16m

NAME                                                                        EXTERNAL-IP   PORT(S)                       AGE
service/                                                                    <none>        9093/TCP,9094/TCP,9094/UDP    16m
service/                                                                    <none>        443/TCP                       45d
service/                                                                    <none>        80/TCP                        16m
service/                                                                    <none>        8080/TCP                      16m
service/prometheus-operated                          ClusterIP   None           <none>        9090/TCP                      16m
service/prometheus-prometheus-node-exporter          ClusterIP   10.98.219.26   <none>        9100/TCP                      16m
service/prometheus-prometheus-oper-alertmanager      ClusterIP   10.106.31.202  <none>        9093/TCP                      16m
service/prometheus-prometheus-oper-operator          ClusterIP   10.99.122.30   <none>        8080/TCP,443/TCP              16m
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deployment.apps/prometheus-kube-state-metrics           1/1     1            1           16m
deployment.apps/prometheus-prometheus-oper-operator     1/1     1            1           16m

NAME                                                          DESIRED   CURRENT   READY   AGE
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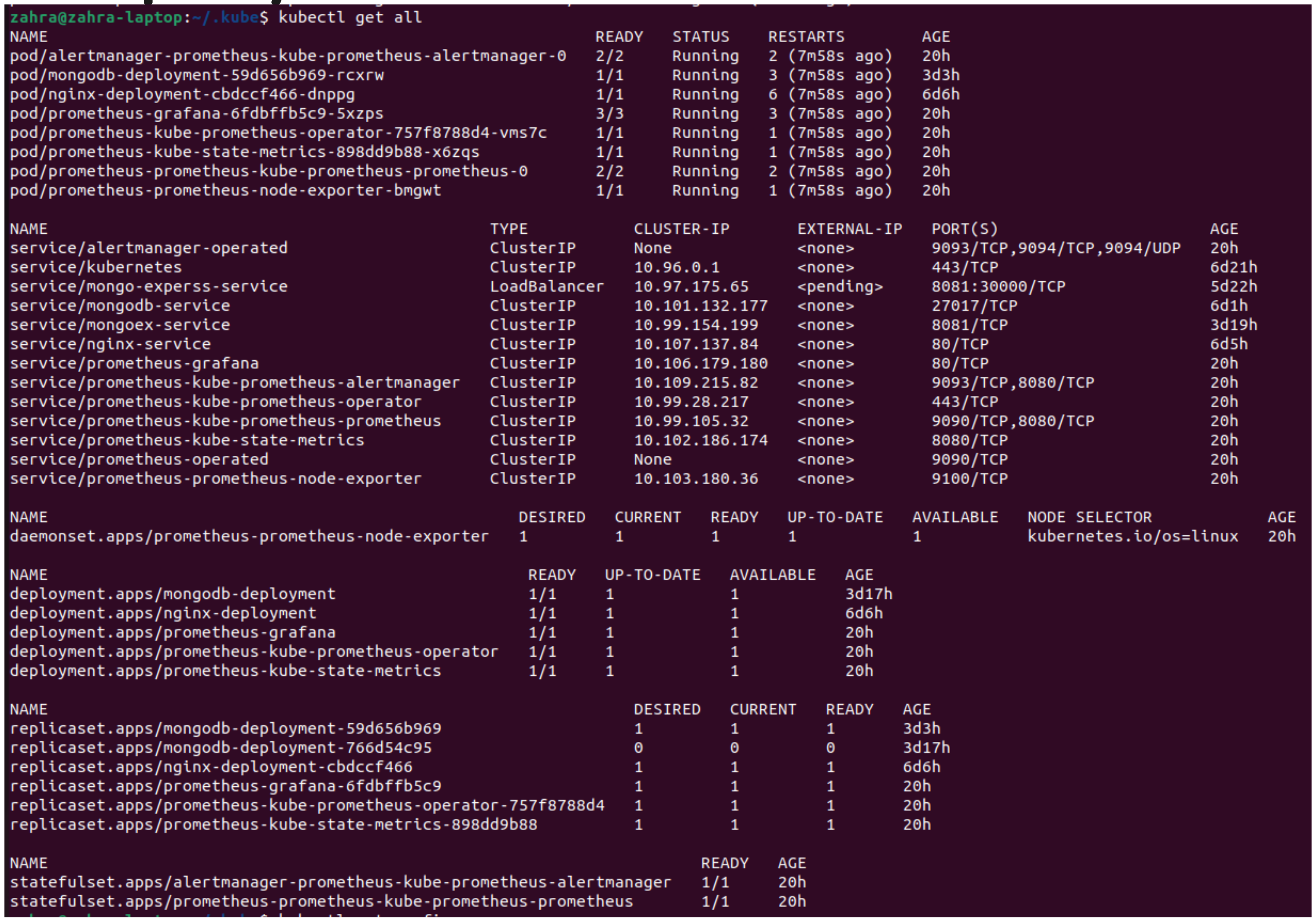
replicaset.apps/prometheus-kube-state-metrics-c65b87574       1         1         1       16m
replicaset.apps/prometheus-prometheus-oper-operator-7894f9c947 1        1         1       16m

NAME                                                                   READY   AGE
statefulset.apps/alertmanager-prometheus-prometheus-oper-alertmanager  1/1     16m
statefulset.apps/prometheus-prometheus-prometheus-oper-prometheus      1/1     16m
```

Using helm chart to Deploy Prometheus

Deployments

1. Prometheus operator
   - Created Prometheus and Alertmanager statefulset
2. Grafana
3. Kube state metrics
   - Own helm chart
   - Dependency of helm chart
   - Monitor the health of K8s component



```
zahra@zahra-laptop:~/.kube$ kubectl get all
NAME                                                    READY   STATUS    RESTARTS       AGE
pod/alertmanager-prometheus-kube-prometheus-alertmanager-0   2/2     Running   2 (7m58s ago)   20h
pod/mongodb-deployment-59d656b969-rcxrw                 1/1     Running   3 (7m58s ago)   3d3h
pod/nginx-deployment-cbdccf466-dnppg                    1/1     Running   6 (7m58s ago)   6d6h
pod/prometheus-grafana-6fdbffb5c9-5xzps                 3/3     Running   3 (7m58s ago)   20h
pod/prometheus-kube-prometheus-operator-757f8788d4-vms7c   1/1     Running   1 (7m58s ago)   20h
pod/prometheus-kube-state-metrics-898dd9b88-x6zqs       1/1     Running   1 (7m58s ago)   20h
pod/prometheus-prometheus-kube-prometheus-prometheus-0   2/2     Running   2 (7m58s ago)   20h
pod/prometheus-prometheus-node-exporter-bmgwt           1/1     Running   1 (7m58s ago)   20h

NAME                                          TYPE           CLUSTER-IP       EXTERNAL-IP   PORT(S)                      AGE
service/alertmanager-operated                 ClusterIP      None             <none>        9093/TCP,9094/TCP,9094/UDP   20h
service/kubernetes                            ClusterIP      10.96.0.1        <none>        443/TCP                      6d21h
service/mongo-experss-service                 LoadBalancer   10.97.175.65     <pending>     8081:30000/TCP               5d22h
service/mongodb-service                       ClusterIP      10.101.132.177   <none>        27017/TCP                    6d1h
service/mongoex-service                       ClusterIP      10.99.154.199    <none>        8081/TCP                     3d19h
service/nginx-service                         ClusterIP      10.107.137.84    <none>        80/TCP                       6d5h
service/prometheus-grafana                    ClusterIP      10.106.179.180   <none>        80/TCP                       20h
service/prometheus-kube-prometheus-alertmanager   ClusterIP      10.109.215.82    <none>        9093/TCP,8080/TCP            20h
service/prometheus-kube-prometheus-operator   ClusterIP      10.99.28.217     <none>        443/TCP                      20h
service/prometheus-kube-prometheus-prometheus   ClusterIP      10.99.105.32     <none>        9090/TCP,8080/TCP            20h
service/prometheus-kube-state-metrics         ClusterIP      10.102.186.174   <none>        8080/TCP                     20h
service/prometheus-operated                   ClusterIP      None             <none>        9090/TCP                     20h
service/prometheus-prometheus-node-exporter   ClusterIP      10.103.180.36    <none>        9100/TCP                     20h

NAME                                                 DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR            AGE
daemonset.apps/prometheus-prometheus-node-exporter   1         1         1       1            1           kubernetes.io/os=linux   20h

NAME                                                  READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mongodb-deployment                    1/1     1            1           3d17h
deployment.apps/nginx-deployment                      1/1     1            1           6d6h
deployment.apps/prometheus-grafana                    1/1     1            1           20h
deployment.apps/prometheus-kube-prometheus-operator   1/1     1            1           20h
deployment.apps/prometheus-kube-state-metrics         1/1     1            1           20h

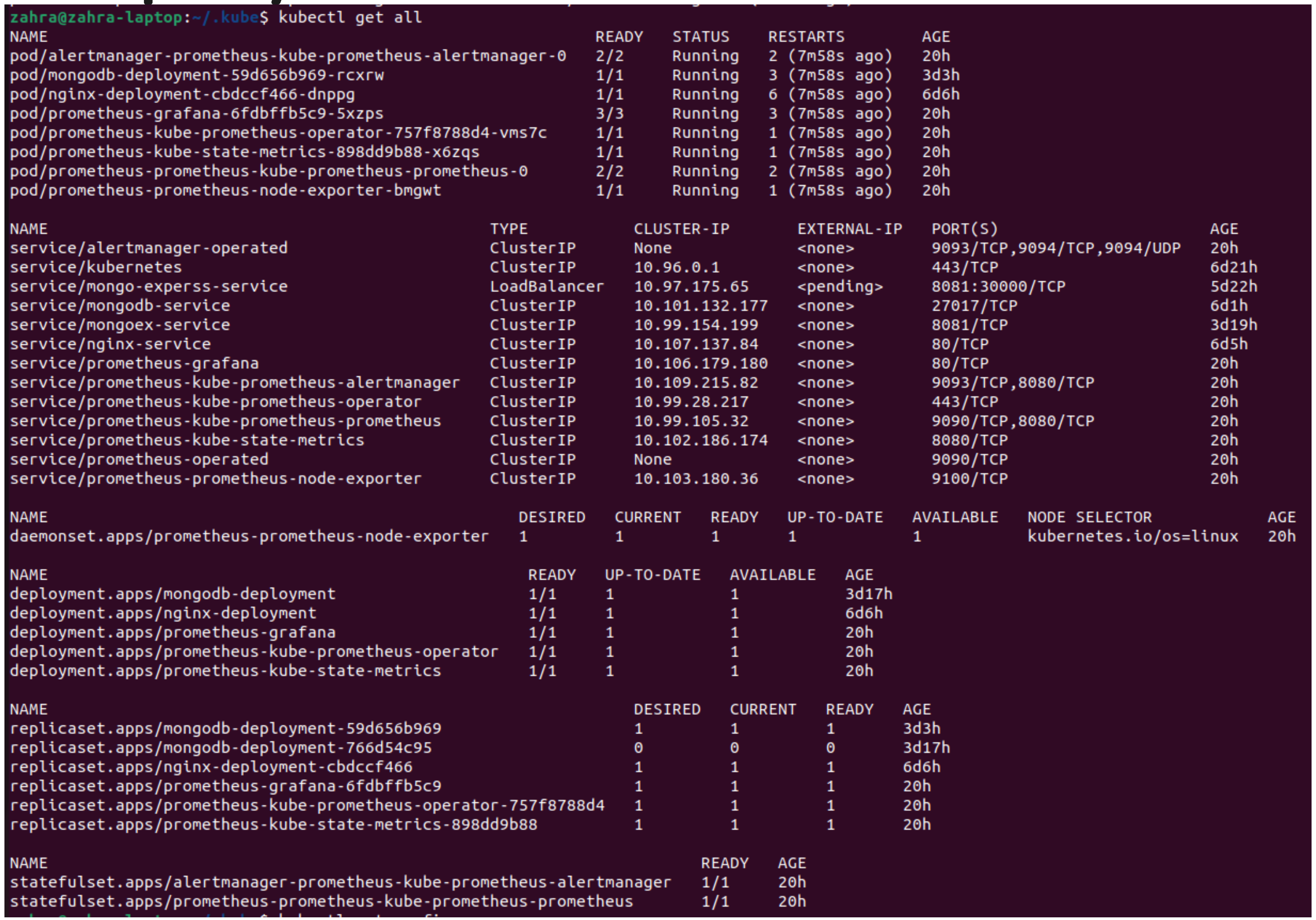
NAME                                                             DESIRED   CURRENT   READY   AGE
replicaset.apps/mongodb-deployment-59d656b969                    1         1         1       3d3h
replicaset.apps/mongodb-deployment-766d54c95                     0         0         0       3d17h
replicaset.apps/nginx-deployment-cbdccf466                       1         1         1       6d6h
replicaset.apps/prometheus-grafana-6fdbffb5c9                    1         1         1       20h
replicaset.apps/prometheus-kube-prometheus-operator-757f8788d4   1         1         1       20h
replicaset.apps/prometheus-kube-state-metrics-898dd9b88          1         1         1       20h

NAME                                                                   READY   AGE
statefulset.apps/alertmanager-prometheus-kube-prometheus-alertmanager   1/1     20h
statefulset.apps/prometheus-prometheus-kube-prometheus-prometheus      1/1     20h
```

Using helm chart to Deploy Prometheus

Replicaset

- Created by deployment



```
zahra@zahra-laptop:~/.kube$ kubectl get all
NAME                                                  READY   STATUS    RESTARTS       AGE
pod/alertmanager-prometheus-kube-prometheus-alertmanager-0   2/2     Running   2 (7m58s ago)   20h
pod/mongodb-deployment-59d656b969-rcxrw               1/1     Running   3 (7m58s ago)   3d3h
pod/nginx-deployment-cbdccf466-dnppg                  1/1     Running   6 (7m58s ago)   6d6h
pod/prometheus-grafana-6fdbffb5c9-5xzps               3/3     Running   3 (7m58s ago)   20h
pod/prometheus-kube-prometheus-operator-757f8788d4-vms7c   1/1     Running   1 (7m58s ago)   20h
pod/prometheus-kube-state-metrics-898dd9b88-x6zqs     1/1     Running   1 (7m58s ago)   20h
pod/prometheus-prometheus-kube-prometheus-prometheus-0   2/2     Running   2 (7m58s ago)   20h
pod/prometheus-prometheus-node-exporter-bmgwt         1/1     Running   1 (7m58s ago)   20h

NAME                                               TYPE           CLUSTER-IP       EXTERNAL-IP   PORT(S)                        AGE
service/alertmanager-operated                      ClusterIP      None             <none>        9093/TCP,9094/TCP,9094/UDP     20h
service/kubernetes                                 ClusterIP      10.96.0.1        <none>        443/TCP                        6d21h
service/mongo-experss-service                      LoadBalancer   10.97.175.65     <pending>     8081:30000/TCP                 5d22h
service/mongodb-service                            ClusterIP      10.101.132.177   <none>        27017/TCP                      6d1h
service/mongoex-service                            ClusterIP      10.99.154.199    <none>        8081/TCP                       3d19h
service/nginx-service                              ClusterIP      10.107.137.84    <none>        80/TCP                         6d5h
service/prometheus-grafana                         ClusterIP      10.106.179.180   <none>        80/TCP                         20h
service/prometheus-kube-prometheus-alertmanager    ClusterIP      10.109.215.82    <none>        9093/TCP,8080/TCP              20h
service/prometheus-kube-prometheus-operator        ClusterIP      10.99.28.217     <none>        443/TCP                        20h
service/prometheus-kube-prometheus-prometheus      ClusterIP      10.99.105.32     <none>        9090/TCP,8080/TCP              20h
service/prometheus-kube-state-metrics              ClusterIP      10.102.186.174   <none>        8080/TCP                       20h
service/prometheus-operated                        ClusterIP      None             <none>        9090/TCP                       20h
service/prometheus-prometheus-node-exporter        ClusterIP      10.103.180.36    <none>        9100/TCP                       20h

NAME                                                 DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR            AGE
daemonset.apps/prometheus-prometheus-node-exporter   1         1         1       1            1           kubernetes.io/os=linux   20h

NAME                                                  READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mongodb-deployment                    1/1     1            1           3d17h
deployment.apps/nginx-deployment                      1/1     1            1           6d6h
deployment.apps/prometheus-grafana                    1/1     1            1           20h
deployment.apps/prometheus-kube-prometheus-operator   1/1     1            1           20h
deployment.apps/prometheus-kube-state-metrics         1/1     1            1           20h

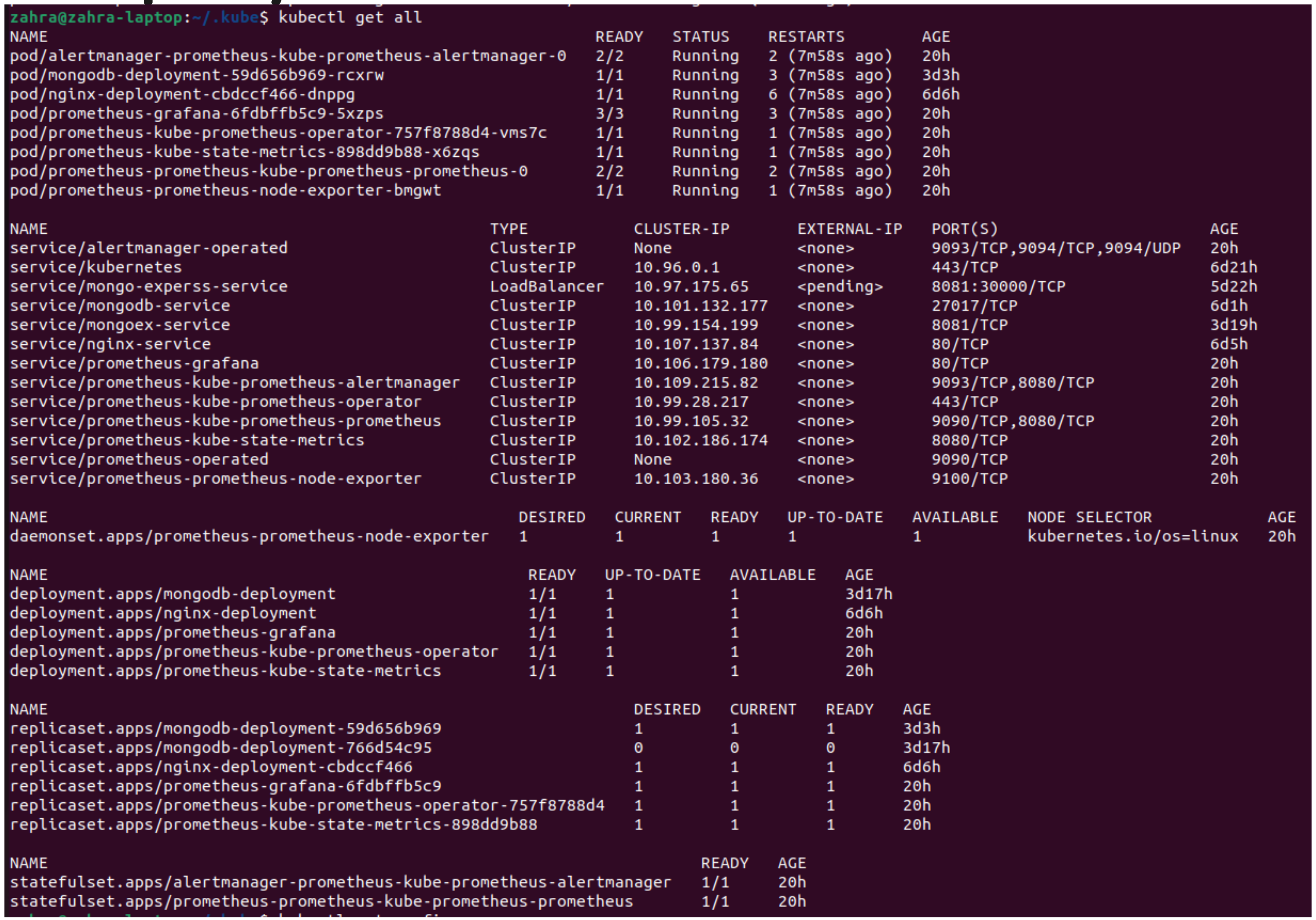
NAME                                                             DESIRED   CURRENT   READY   AGE
replicaset.apps/mongodb-deployment-59d656b969                    1         1         1       3d3h
replicaset.apps/mongodb-deployment-766d54c95                     0         0         0       3d17h
replicaset.apps/nginx-deployment-cbdccf466                       1         1         1       6d6h
replicaset.apps/prometheus-grafana-6fdbffb5c9                    1         1         1       20h
replicaset.apps/prometheus-kube-prometheus-operator-757f8788d4   1         1         1       20h
replicaset.apps/prometheus-kube-state-metrics-898dd9b88          1         1         1       20h

NAME                                                                   READY   AGE
statefulset.apps/alertmanager-prometheus-kube-prometheus-alertmanager   1/1     20h
statefulset.apps/prometheus-prometheus-kube-prometheus-prometheus       1/1     20h
```

Using helm chart to Deploy Prometheus

Daemonset

- Node exporter daemonset runs on every node
- Connected to the server
- Translates worker node metrics(CPU usage, load on server) to Prometheus metrics



```
zahra@zahra-laptop:~/.kube$ kubectl get all
NAME                                                         READY   STATUS    RESTARTS        AGE
pod/alertmanager-prometheus-kube-prometheus-alertmanager-0   2/2     Running   2 (7m58s ago)   20h
pod/mongodb-deployment-59d656b969-rcxrw                      1/1     Running   3 (7m58s ago)   3d3h
pod/nginx-deployment-cbdccf466-dnppg                         1/1     Running   6 (7m58s ago)   6d6h
pod/prometheus-grafana-6fdbffb5c9-5xzps                      3/3     Running   3 (7m58s ago)   20h
pod/prometheus-kube-prometheus-operator-757f8788d4-vms7c     1/1     Running   1 (7m58s ago)   20h
pod/prometheus-kube-state-metrics-898dd9b88-x6zqs            1/1     Running   1 (7m58s ago)   20h
pod/prometheus-prometheus-kube-prometheus-prometheus-0       2/2     Running   2 (7m58s ago)   20h
pod/prometheus-prometheus-node-exporter-bmgwt                1/1     Running   1 (7m58s ago)   20h

NAME                                              TYPE           CLUSTER-IP       EXTERNAL-IP   PORT(S)                      AGE
service/alertmanager-operated                     ClusterIP      None             <none>        9093/TCP,9094/TCP,9094/UDP   20h
service/kubernetes                                ClusterIP      10.96.0.1        <none>        443/TCP                      6d21h
service/mongo-experss-service                     LoadBalancer   10.97.175.65     <pending>     8081:30000/TCP               5d22h
service/mongodb-service                           ClusterIP      10.101.132.177   <none>        27017/TCP                    6d1h
service/mongoex-service                           ClusterIP      10.99.154.199    <none>        8081/TCP                     3d19h
service/nginx-service                             ClusterIP      10.107.137.84    <none>        80/TCP                       6d5h
service/prometheus-grafana                        ClusterIP      10.106.179.180   <none>        80/TCP                       20h
service/prometheus-kube-prometheus-alertmanager   ClusterIP      10.109.215.82    <none>        9093/TCP,8080/TCP            20h
service/prometheus-kube-prometheus-operator       ClusterIP      10.99.28.217     <none>        443/TCP                      20h
service/prometheus-kube-prometheus-prometheus     ClusterIP      10.99.105.32     <none>        9090/TCP,8080/TCP            20h
service/prometheus-kube-state-metrics             ClusterIP      10.102.186.174   <none>        8080/TCP                     20h
service/prometheus-operated                       ClusterIP      None             <none>        9090/TCP                     20h
service/prometheus-prometheus-node-exporter       ClusterIP      10.103.180.36    <none>        9100/TCP                     20h

NAME                                                 DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR            AGE
daemonset.apps/prometheus-prometheus-node-exporter   1         1         1       1            1           kubernetes.io/os=linux   20h

NAME                                                  READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mongodb-deployment                    1/1     1            1           3d17h
deployment.apps/nginx-deployment                      1/1     1            1           6d6h
deployment.apps/prometheus-grafana                    1/1     1            1           20h
deployment.apps/prometheus-kube-prometheus-operator   1/1     1            1           20h
deployment.apps/prometheus-kube-state-metrics         1/1     1            1           20h

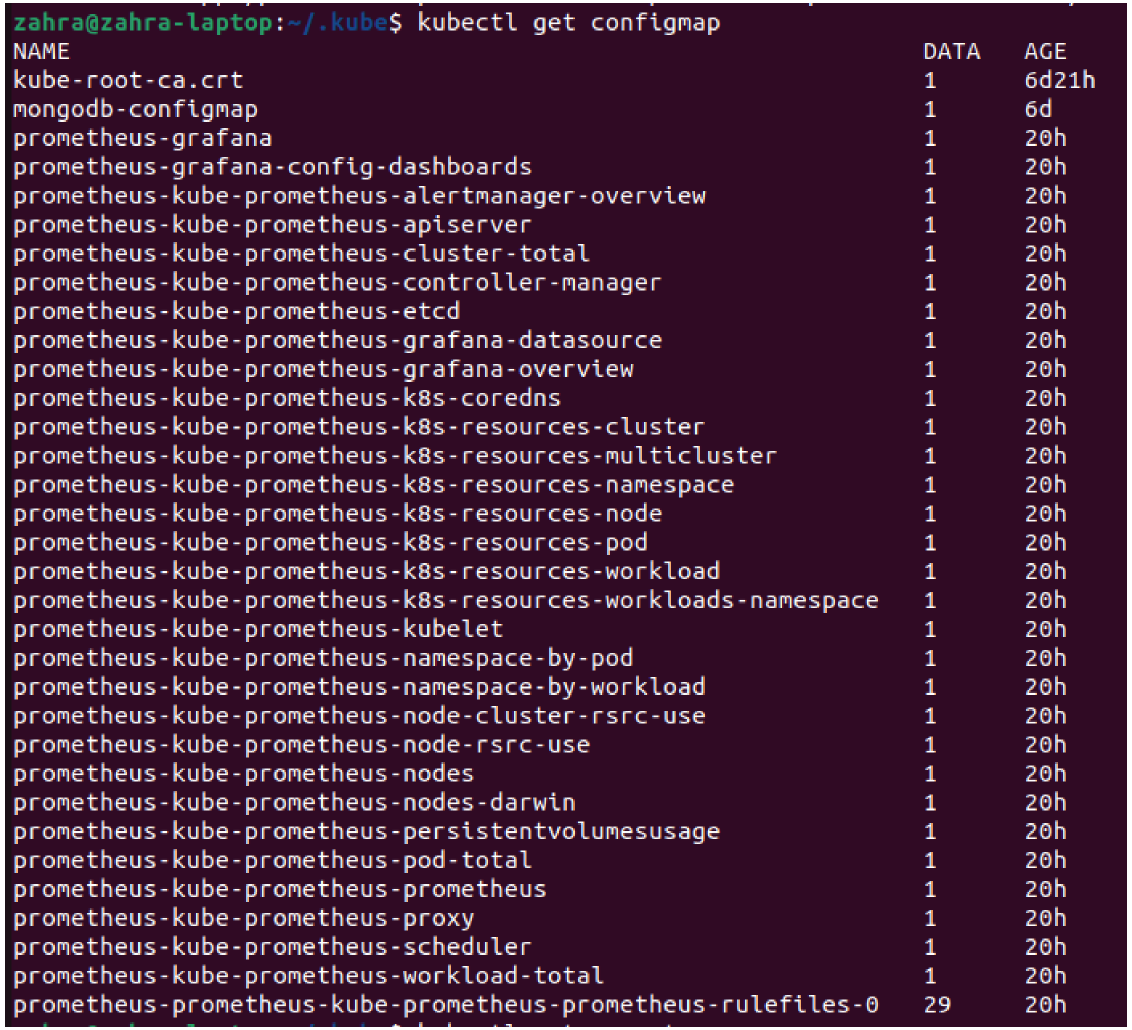
NAME                                                        DESIRED   CURRENT   READY   AGE
replicaset.apps/mongodb-deployment-59d656b969               1         1         1       3d3h
replicaset.apps/mongodb-deployment-766d54c95                0         0         0       3d17h
replicaset.apps/nginx-deployment-cbdccf466                  1         1         1       6d6h
replicaset.apps/prometheus-grafana-6fdbffb5c9               1         1         1       20h
replicaset.apps/prometheus-kube-prometheus-operator-757f8788d4   1         1         1       20h
replicaset.apps/prometheus-kube-state-metrics-898dd9b88     1         1         1       20h

NAME                                                                READY   AGE
statefulset.apps/alertmanager-prometheus-kube-prometheus-alertmanager   1/1     20h
statefulset.apps/prometheus-prometheus-kube-prometheus-prometheus       1/1     20h
```

Using helm chart to Deploy Prometheus

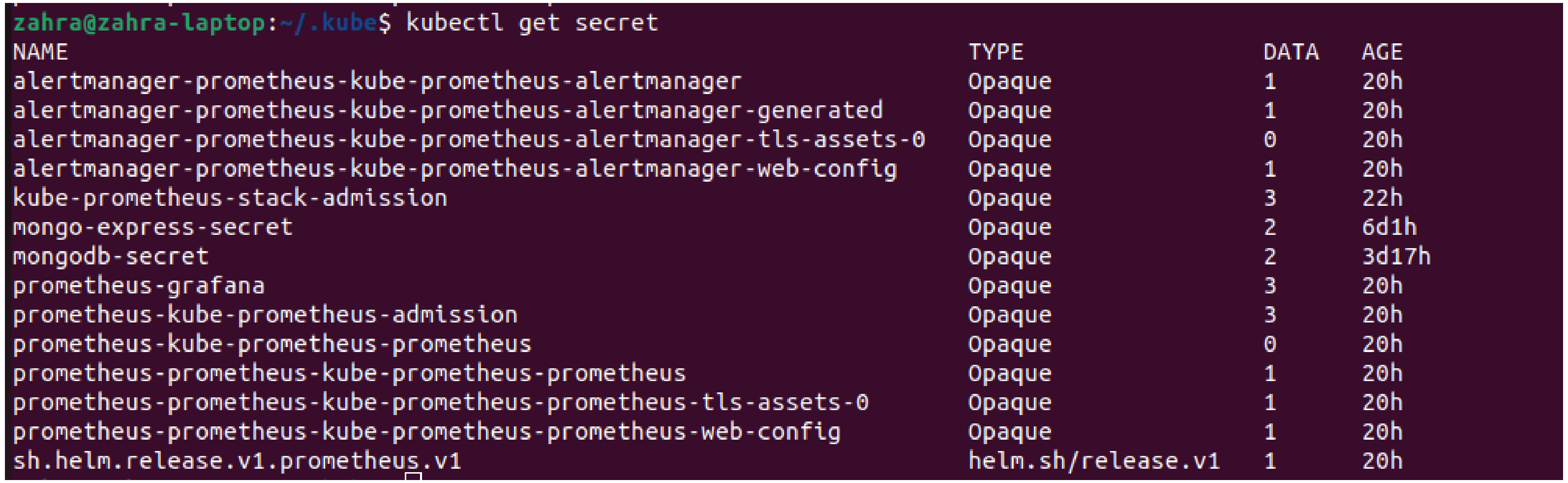
Configmap

- Configuration for different parts
  - Managing by operator
  - Containing the information for connecting to default metrics



```
zahra@zahra-laptop:~/.kube$ kubectl get configmap
NAME                                                           DATA   AGE
kube-root-ca.crt                                               1      6d21h
mongodb-configmap                                              1      6d
prometheus-grafana                                             1      20h
prometheus-grafana-config-dashboards                           1      20h
prometheus-kube-prometheus-alertmanager-overview               1      20h
prometheus-kube-prometheus-apiserver                           1      20h
prometheus-kube-prometheus-cluster-total                       1      20h
prometheus-kube-prometheus-controller-manager                  1      20h
prometheus-kube-prometheus-etcd                                1      20h
prometheus-kube-prometheus-grafana-datasource                  1      20h
prometheus-kube-prometheus-grafana-overview                    1      20h
prometheus-kube-prometheus-k8s-coredns                         1      20h
prometheus-kube-prometheus-k8s-resources-cluster               1      20h
prometheus-kube-prometheus-k8s-resources-multicluster          1      20h
prometheus-kube-prometheus-k8s-resources-namespace             1      20h
prometheus-kube-prometheus-k8s-resources-node                  1      20h
prometheus-kube-prometheus-k8s-resources-pod                   1      20h
prometheus-kube-prometheus-k8s-resources-workload              1      20h
prometheus-kube-prometheus-k8s-resources-workloads-namespace   1      20h
prometheus-kube-prometheus-kubelet                             1      20h
prometheus-kube-prometheus-namespace-by-pod                    1      20h
prometheus-kube-prometheus-namespace-by-workload               1      20h
prometheus-kube-prometheus-node-cluster-rsrc-use               1      20h
prometheus-kube-prometheus-node-rsrc-use                       1      20h
prometheus-kube-prometheus-nodes                               1      20h
prometheus-kube-prometheus-nodes-darwin                        1      20h
prometheus-kube-prometheus-persistentvolumesusage              1      20h
prometheus-kube-prometheus-pod-total                           1      20h
prometheus-kube-prometheus-prometheus                          1      20h
prometheus-kube-prometheus-proxy                               1      20h
prometheus-kube-prometheus-scheduler                           1      20h
prometheus-kube-prometheus-workload-total                      1      20h
prometheus-prometheus-kube-prometheus-prometheus-rulefiles-0   29     20h
```

Using helm chart to Deploy Prometheus



```
zahra@zahra-laptop:~/.kube$ kubectl get secret
NAME                                                                TYPE                 DATA   AGE
alertmanager-prometheus-kube-prometheus-alertmanager                Opaque               1      20h
alertmanager-prometheus-kube-prometheus-alertmanager-generated      Opaque               1      20h
alertmanager-prometheus-kube-prometheus-alertmanager-tls-assets-0   Opaque               0      20h
alertmanager-prometheus-kube-prometheus-alertmanager-web-config     Opaque               1      20h
kube-prometheus-stack-admission                                     Opaque               3      22h
mongo-express-secret                                                Opaque               2      6d1h
mongodb-secret                                                      Opaque               2      3d17h
prometheus-grafana                                                  Opaque               3      20h
prometheus-kube-prometheus-admission                                Opaque               3      20h
prometheus-kube-prometheus-prometheus                               Opaque               0      20h
prometheus-prometheus-kube-prometheus-prometheus                    Opaque               1      20h
prometheus-prometheus-kube-prometheus-prometheus-tls-assets-0       Opaque               1      20h
prometheus-prometheus-kube-prometheus-prometheus-web-config         Opaque               1      20h
sh.helm.release.v1.prometheus.v1                                    helm.sh/release.v1   1      20h
```

Secrets

- For Grafana
- For Prometheus
- For operator

Including

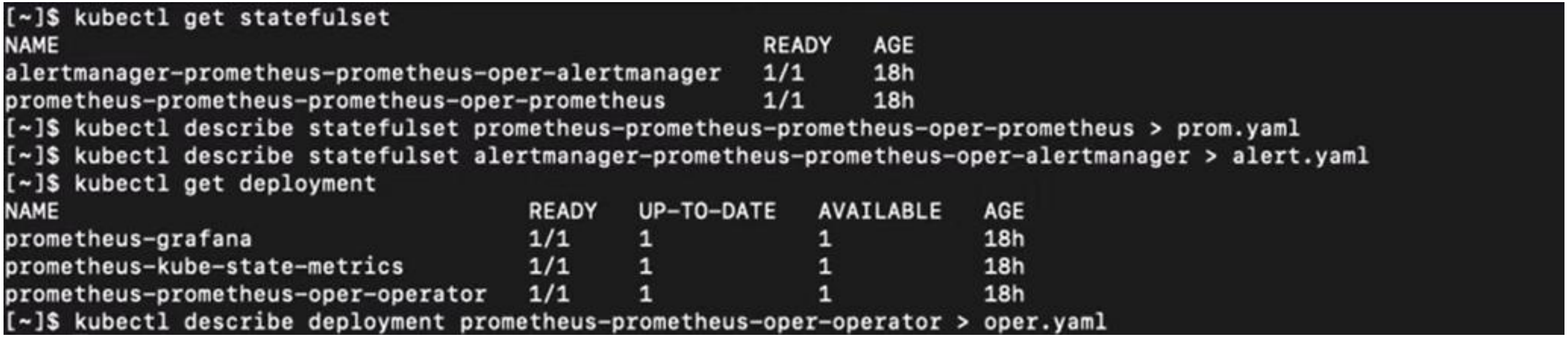
- Certificates
- Username and passwords

Using helm chart to Deploy Prometheus

What is inside

- Prometheus?
- Alertmanager?
- Operator?

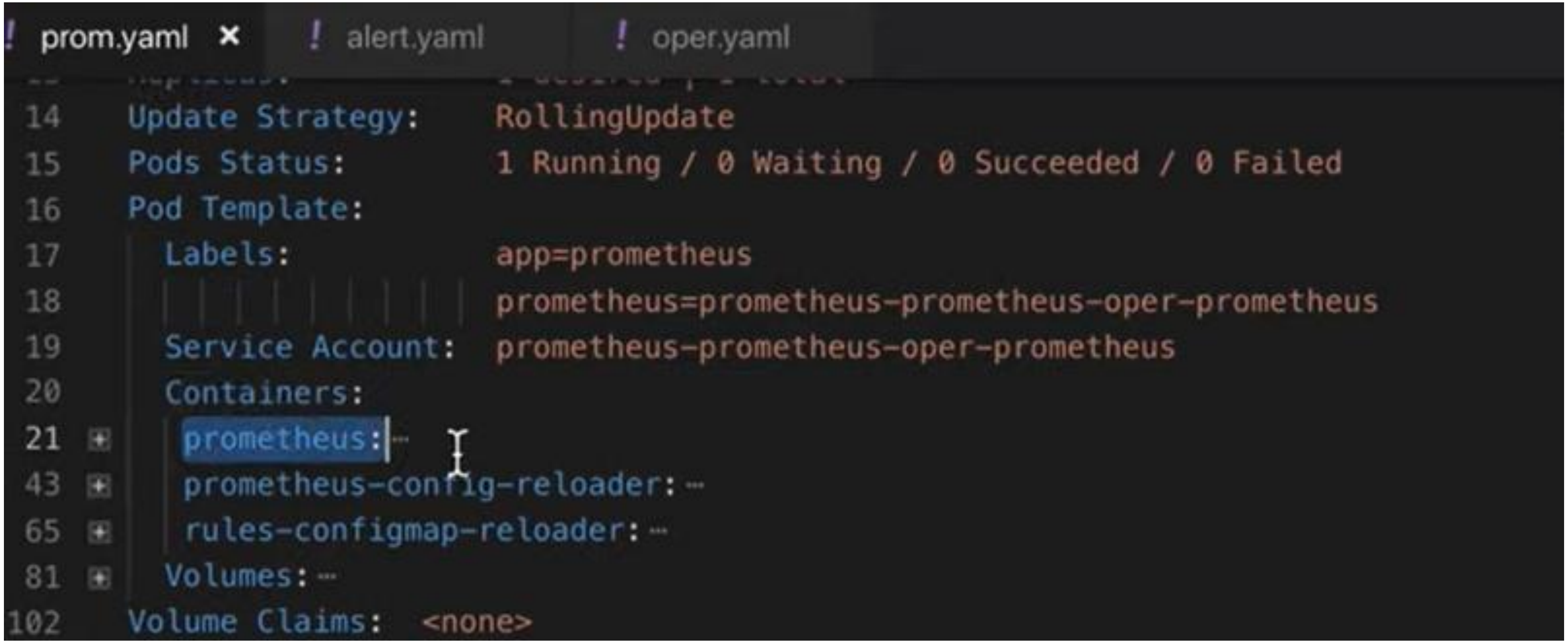
Kubctl describe component-type component-name



```
[~]$ kubectl get statefulset
NAME                                                   READY   AGE
alertmanager-prometheus-prometheus-oper-alertmanager   1/1     18h
prometheus-prometheus-prometheus-oper-prometheus       1/1     18h
[~]$ kubectl describe statefulset prometheus-prometheus-prometheus-oper-prometheus > prom.yaml
[~]$ kubectl describe statefulset alertmanager-prometheus-prometheus-oper-alertmanager > alert.yaml
[~]$ kubectl get deployment
NAME                                  READY   UP-TO-DATE   AVAILABLE   AGE
prometheus-grafana                    1/1     1            1           18h
prometheus-kube-state-metrics         1/1     1            1           18h
prometheus-prometheus-oper-operator   1/1     1            1           18h
[~]$ kubectl describe deployment prometheus-prometheus-oper-operator > oper.yaml
```

Using helm chart to Deploy Prometheus

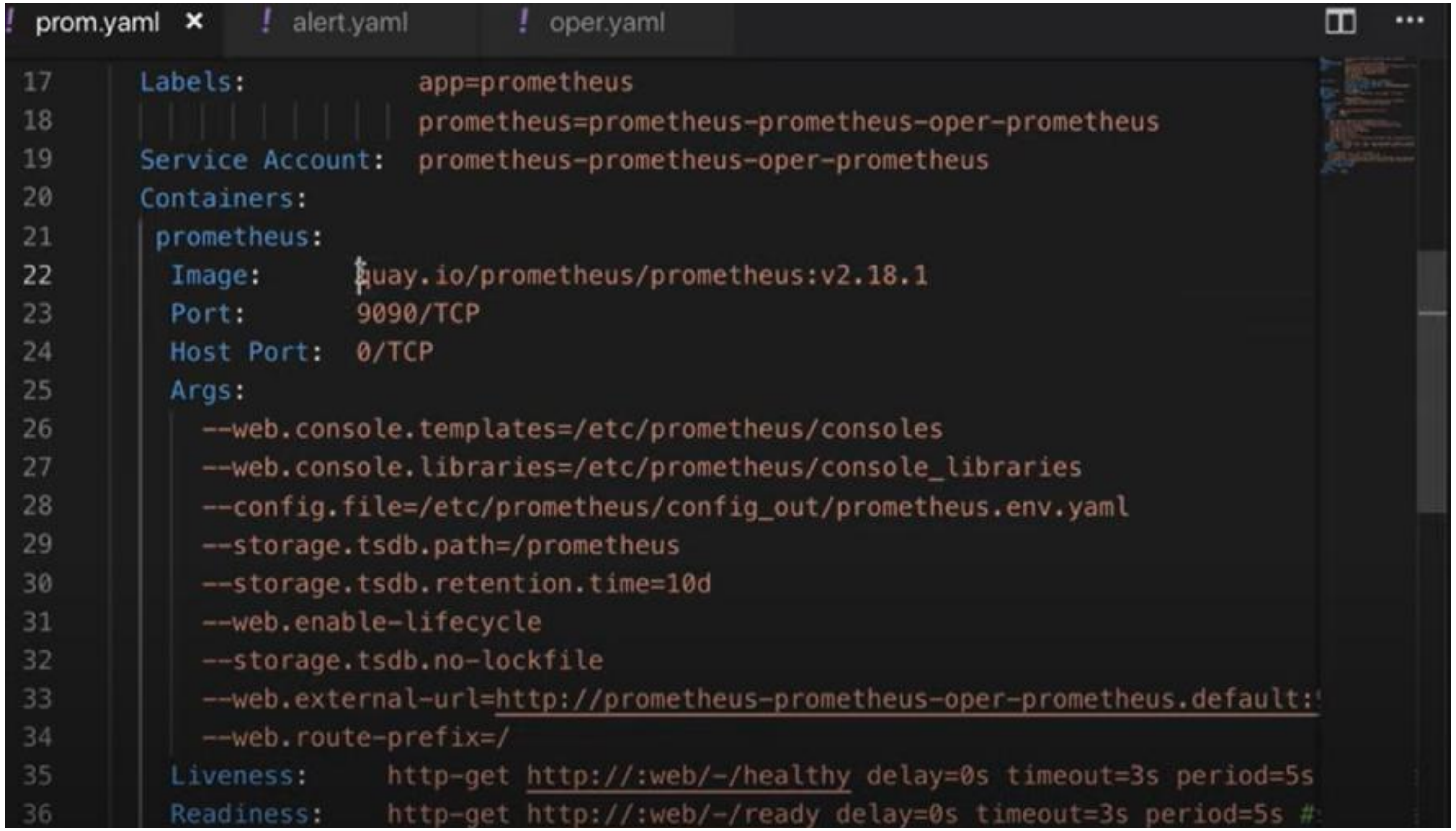
What is inside Prometheus Yaml file?



```
Replicas:             1 desired | 1 total
Update Strategy:    RollingUpdate
Pods Status:        1 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:           app=prometheus
                    prometheus=prometheus-prometheus-oper-prometheus
  Service Account:  prometheus-prometheus-oper-prometheus
  Containers:
   prometheus:⋯
   prometheus-config-reloader:⋯
   rules-configmap-reloader:⋯
  Volumes:⋯
Volume Claims:  <none>
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

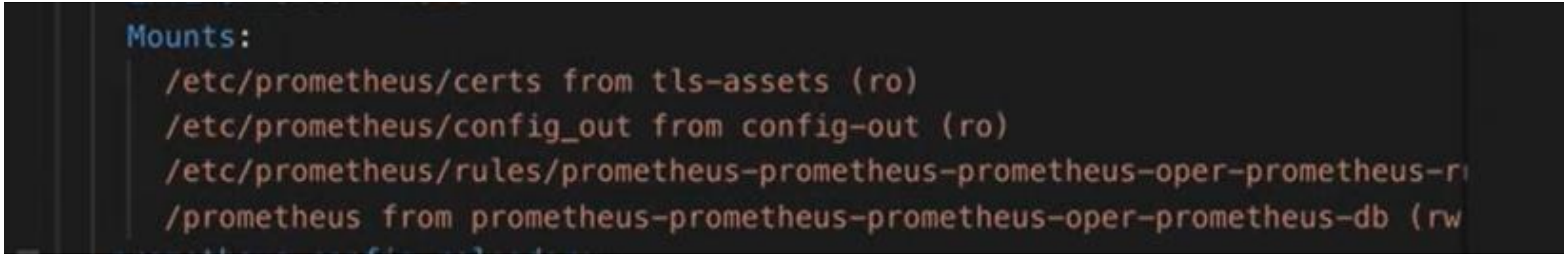


```
Labels:           app=prometheus
                  prometheus=prometheus-prometheus-oper-prometheus
Service Account:  prometheus-prometheus-oper-prometheus
Containers:
 prometheus:
  Image:        quay.io/prometheus/prometheus:v2.18.1
  Port:         9090/TCP
  Host Port:    0/TCP
  Args:
    --web.console.templates=/etc/prometheus/consoles
    --web.console.libraries=/etc/prometheus/console_libraries
    --config.file=/etc/prometheus/config_out/prometheus.env.yaml
    --storage.tsdb.path=/prometheus
    --storage.tsdb.retention.time=10d
    --web.enable-lifecycle
    --storage.tsdb.no-lockfile
    --web.external-url=http://prometheus-prometheus-oper-prometheus.default:
    --web.route-prefix=/
  Liveness:     http-get http://:web/-/healthy delay=0s timeout=3s period=5s
  Readiness:    http-get http://:web/-/ready delay=0s timeout=3s period=5s #
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

- Mount: Prometheus gets all the configuration data
  - Configuration file defines what end point to scrape. It has all the addresses of all the applications that they expose this metric endpoint.
  - Rules file define different rules (alerting rules, etc)



```
Mounts:
  /etc/prometheus/certs from tls-assets (ro)
  /etc/prometheus/config_out from config-out (ro)
  /etc/prometheus/rules/prometheus-prometheus-prometheus-oper-prometheus-r
  /prometheus from prometheus-prometheus-prometheus-oper-prometheus-db (rw
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

```
prometheus-config-reloader: --
rules-configmap-reloader:   --
```

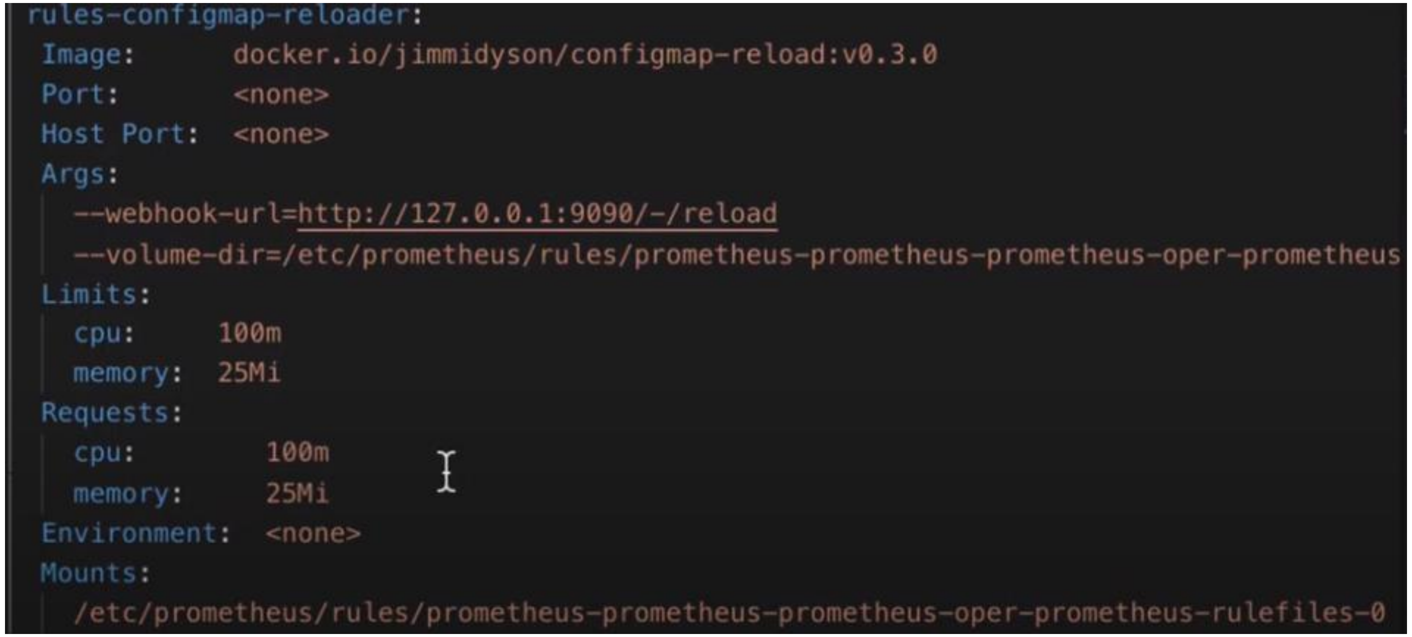
They help to reload the main container of Prometheus when there is some changes in the configuration.

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

The rules-configmap-reloader: shows all the rules

Mount: shows the pass for the rule file



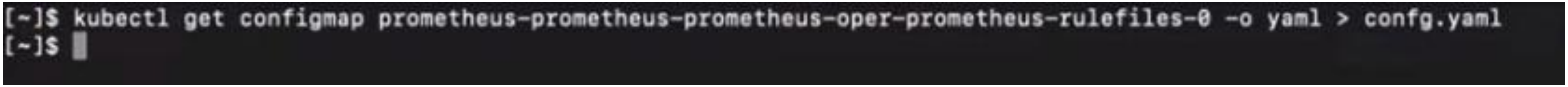
```
rules-configmap-reloader:
  Image:       docker.io/jimmidyson/configmap-reload:v0.3.0
  Port:        <none>
  Host Port:   <none>
  Args:
    --webhook-url=http://127.0.0.1:9090/-/reload
    --volume-dir=/etc/prometheus/rules/prometheus-prometheus-prometheus-oper-prometheus
  Limits:
    cpu:     100m
    memory:  25Mi
  Requests:
    cpu:        100m
    memory:     25Mi
  Environment:  <none>
  Mounts:
    /etc/prometheus/rules/prometheus-prometheus-prometheus-oper-prometheus-rulefiles-0
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

The rules-configmap-reloader: shows all the rules

Mount: shows the pass for the rule file

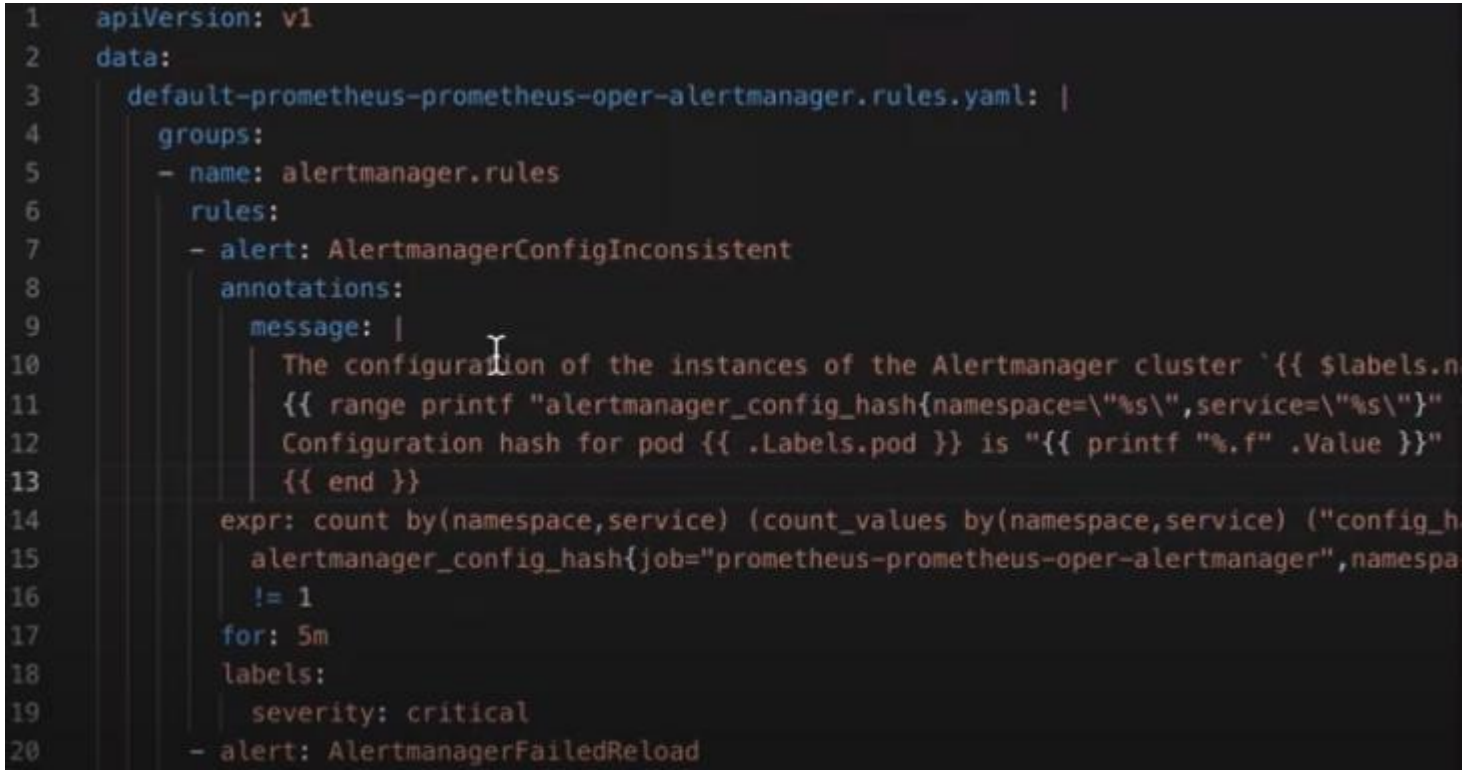


```
[~]$ kubectl get configmap prometheus-prometheus-prometheus-oper-prometheus-rulefiles-0 -o yaml > confg.yaml
[~]$
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

- rules file

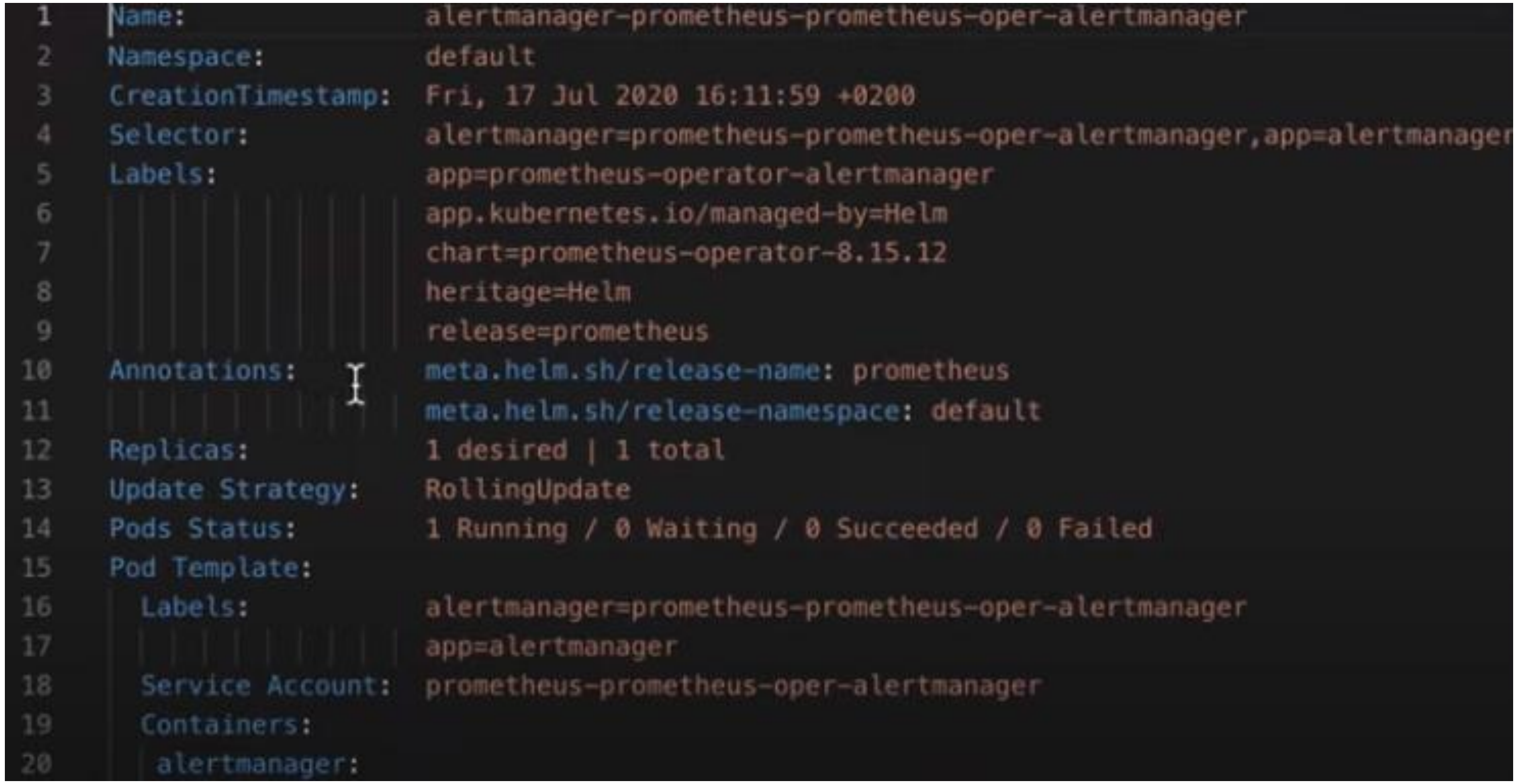


```
apiVersion: v1
data:
  default-prometheus-prometheus-oper-alertmanager.rules.yaml: |
    groups:
    - name: alertmanager.rules
      rules:
      - alert: AlertmanagerConfigInconsistent
        annotations:
          message: |
            The configuration of the instances of the Alertmanager cluster `{{ $labels.n
            {{ range printf "alertmanager_config_hash{namespace=\"%s\",service=\"%s\"}"
            Configuration hash for pod {{ .Labels.pod }} is "{{ printf "%.f" .Value }}"
            {{ end }}
        expr: count by(namespace,service) (count_values by(namespace,service) ("config_h
          alertmanager_config_hash{job="prometheus-prometheus-oper-alertmanager",namespa
          != 1
        for: 5m
        labels:
          severity: critical
      - alert: AlertmanagerFailedReload
```

Using helm chart to Deploy Prometheus

What is inside Prometheus Yaml file?

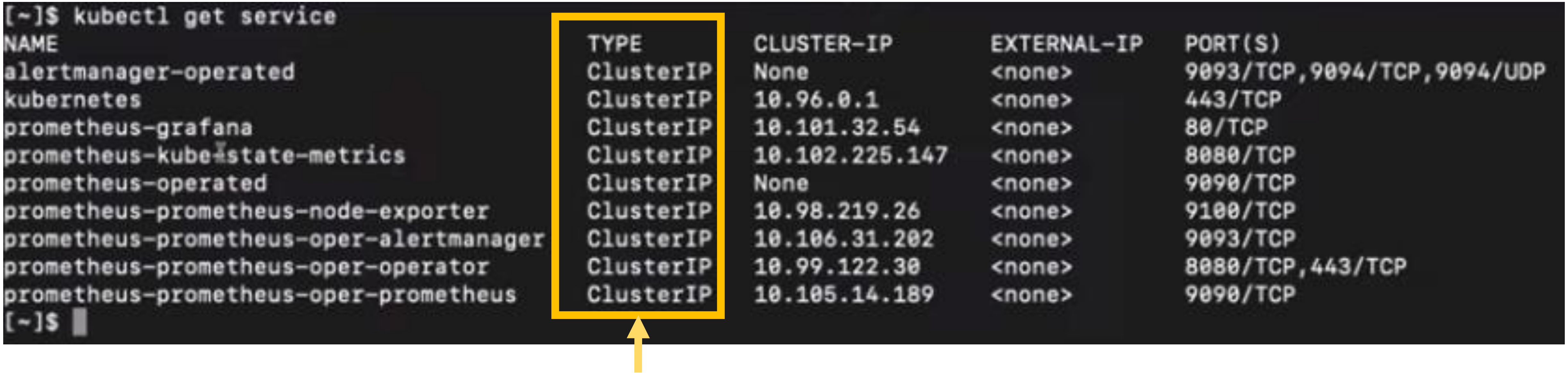
- Alert manager



```
Name:                 alertmanager-prometheus-prometheus-oper-alertmanager
Namespace:            default
CreationTimestamp:    Fri, 17 Jul 2020 16:11:59 +0200
Selector:             alertmanager=prometheus-prometheus-oper-alertmanager,app=alertmanager
Labels:               app=prometheus-operator-alertmanager
                      app.kubernetes.io/managed-by=Helm
                      chart=prometheus-operator-8.15.12
                      heritage=Helm
                      release=prometheus
Annotations:          meta.helm.sh/release-name: prometheus
                      meta.helm.sh/release-namespace: default
Replicas:             1 desired | 1 total
Update Strategy:      RollingUpdate
Pods Status:          1 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:             alertmanager=prometheus-prometheus-oper-alertmanager
                      app=alertmanager
  Service Account:    prometheus-prometheus-oper-alertmanager
  Containers:
   alertmanager:
```

Accessing Grafana

Grafana is UI providing data visualization for Prometheus data



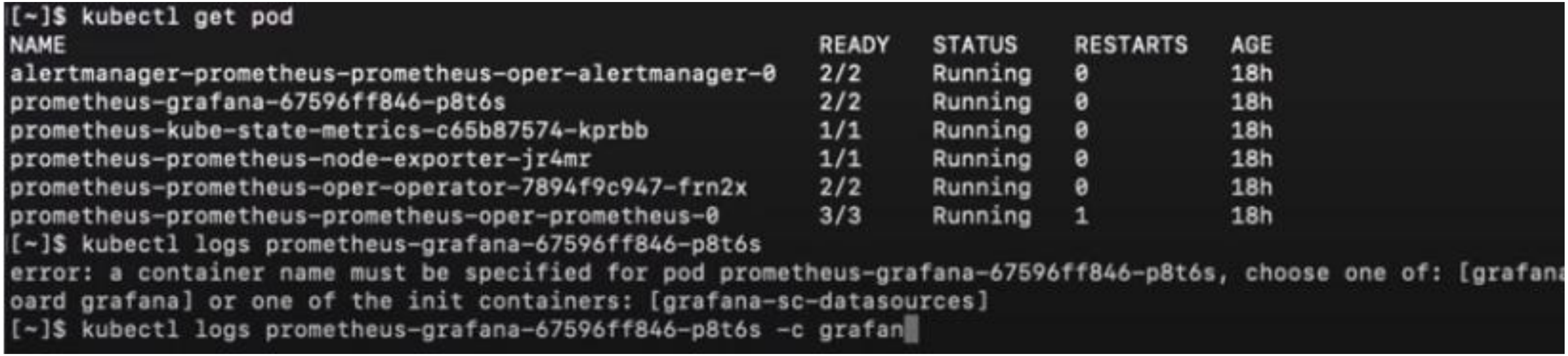
```
[~]$ kubectl get service
NAME                                       TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)
alertmanager-operated                      ClusterIP   None             <none>        9093/TCP,9094/TCP,9094/UDP
kubernetes                                 ClusterIP   10.96.0.1        <none>        443/TCP
prometheus-grafana                         ClusterIP   10.101.32.54     <none>        80/TCP
prometheus-kube-state-metrics              ClusterIP   10.102.225.147   <none>        8080/TCP
prometheus-operated                        ClusterIP   None             <none>        9090/TCP
prometheus-prometheus-node-exporter        ClusterIP   10.98.219.26     <none>        9100/TCP
prometheus-prometheus-oper-alertmanager    ClusterIP   10.106.31.202    <none>        9093/TCP
prometheus-prometheus-oper-operator        ClusterIP   10.99.122.30     <none>        8080/TCP,443/TCP
prometheus-prometheus-oper-prometheus      ClusterIP   10.105.14.189    <none>        9090/TCP
[~]$
```

Internal service

Accessing Grafana

Access Grafana through port forward:

1. Get Grafana pod logs

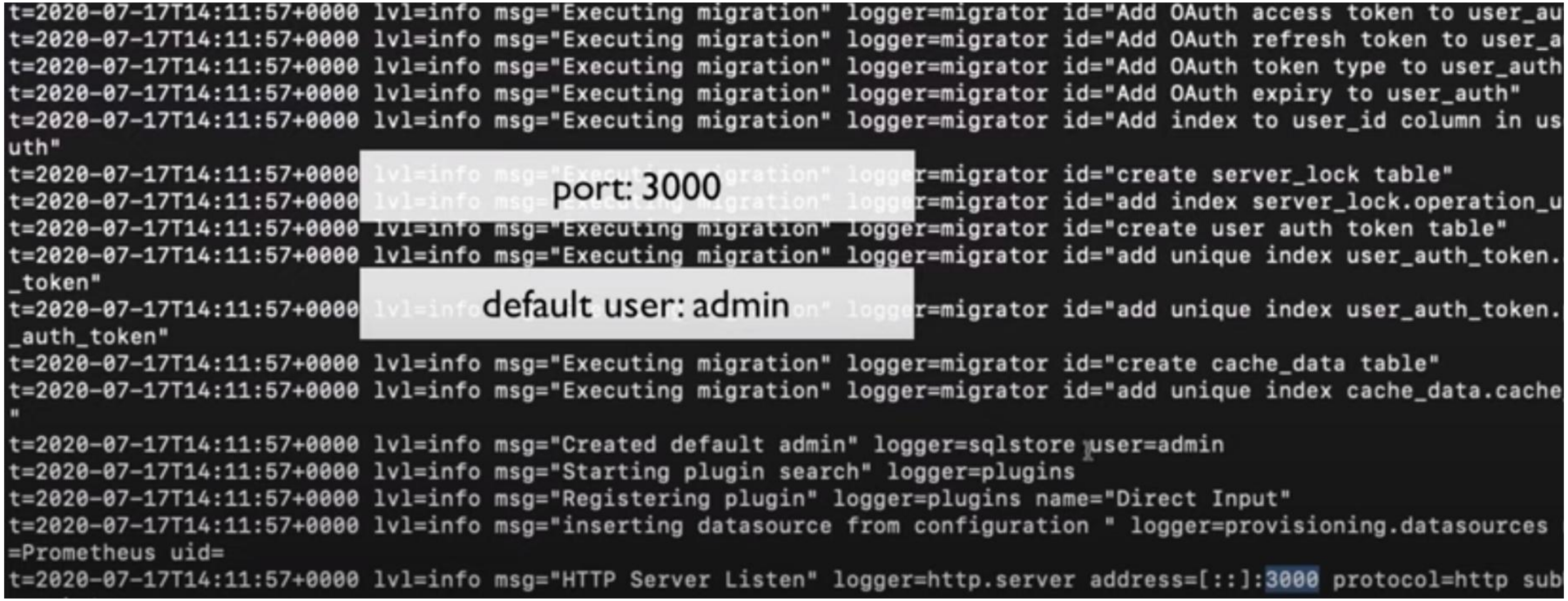


```
[~]$ kubectl get pod
NAME                                                    READY   STATUS    RESTARTS   AGE
alertmanager-prometheus-prometheus-oper-alertmanager-0  2/2     Running   0          18h
prometheus-grafana-67596ff846-p8t6s                     2/2     Running   0          18h
prometheus-kube-state-metrics-c65b87574-kprbb           1/1     Running   0          18h
prometheus-prometheus-node-exporter-jr4mr               1/1     Running   0          18h
prometheus-prometheus-oper-operator-7894f9c947-frn2x    2/2     Running   0          18h
prometheus-prometheus-prometheus-oper-prometheus-0      3/3     Running   1          18h
[~]$ kubectl logs prometheus-grafana-67596ff846-p8t6s
error: a container name must be specified for pod prometheus-grafana-67596ff846-p8t6s, choose one of: [grafana
oard grafana] or one of the init containers: [grafana-sc-datasources]
[~]$ kubectl logs prometheus-grafana-67596ff846-p8t6s -c grafan
```

Accessing Grafana

Getting Grafana port and username

- Username: admin
- password: prom-operator(https://github.com/helm/charts/tree/master/stable/prometheus-operator)



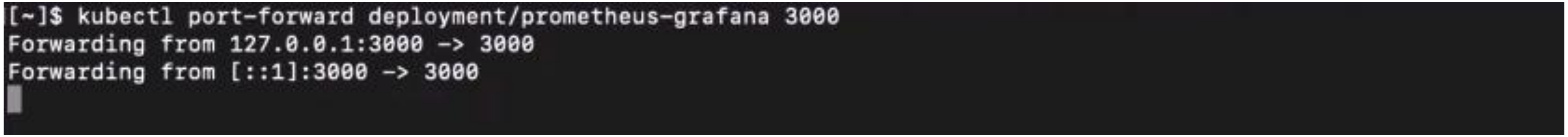
```
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="Add OAuth access token to user_au
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="Add OAuth refresh token to user_a
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="Add OAuth token type to user_auth
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="Add OAuth expiry to user_auth"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="Add index to user_id column in us
uth"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="create server_lock table"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="add index server_lock.operation_u
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="create user auth token table"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="add unique index user_auth_token.
_token"
t=2020-07-17T14:11:57+0000 lvl=info                         on" logger=migrator id="add unique index user_auth_token.
_auth_token"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="create cache_data table"
t=2020-07-17T14:11:57+0000 lvl=info msg="Executing migration" logger=migrator id="add unique index cache_data.cache
"
t=2020-07-17T14:11:57+0000 lvl=info msg="Created default admin" logger=sqlstore user=admin
t=2020-07-17T14:11:57+0000 lvl=info msg="Starting plugin search" logger=plugins
t=2020-07-17T14:11:57+0000 lvl=info msg="Registering plugin" logger=plugins name="Direct Input"
t=2020-07-17T14:11:57+0000 lvl=info msg="inserting datasource from configuration " logger=provisioning.datasources
=Prometheus uid=
t=2020-07-17T14:11:57+0000 lvl=info msg="HTTP Server Listen" logger=http.server address=[::]:3000 protocol=http sub
```

port: 3000

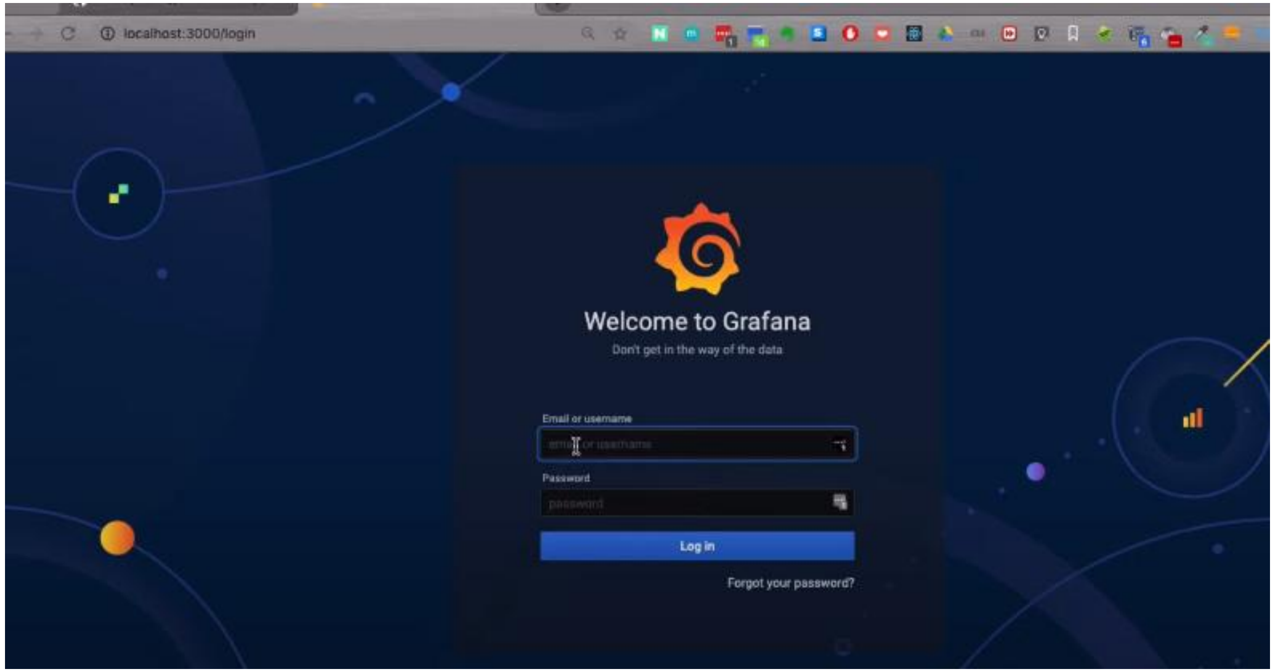
default user: admin

Accessing Grafana

Opening the port 3000



```
[~]$ kubectl port-forward deployment/prometheus-grafana 3000
Forwarding from 127.0.0.1:3000 -> 3000
Forwarding from [::1]:3000 -> 3000
```

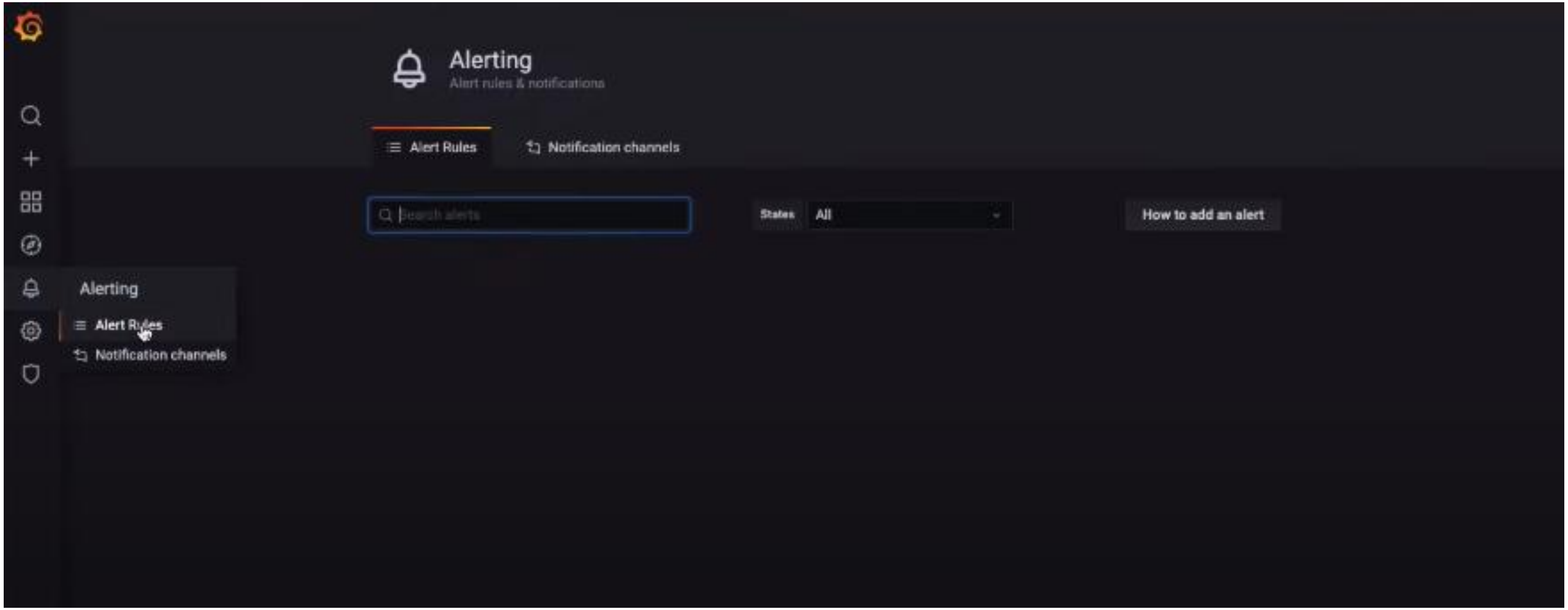


Welcome to Grafana

Don't get in the way of the data

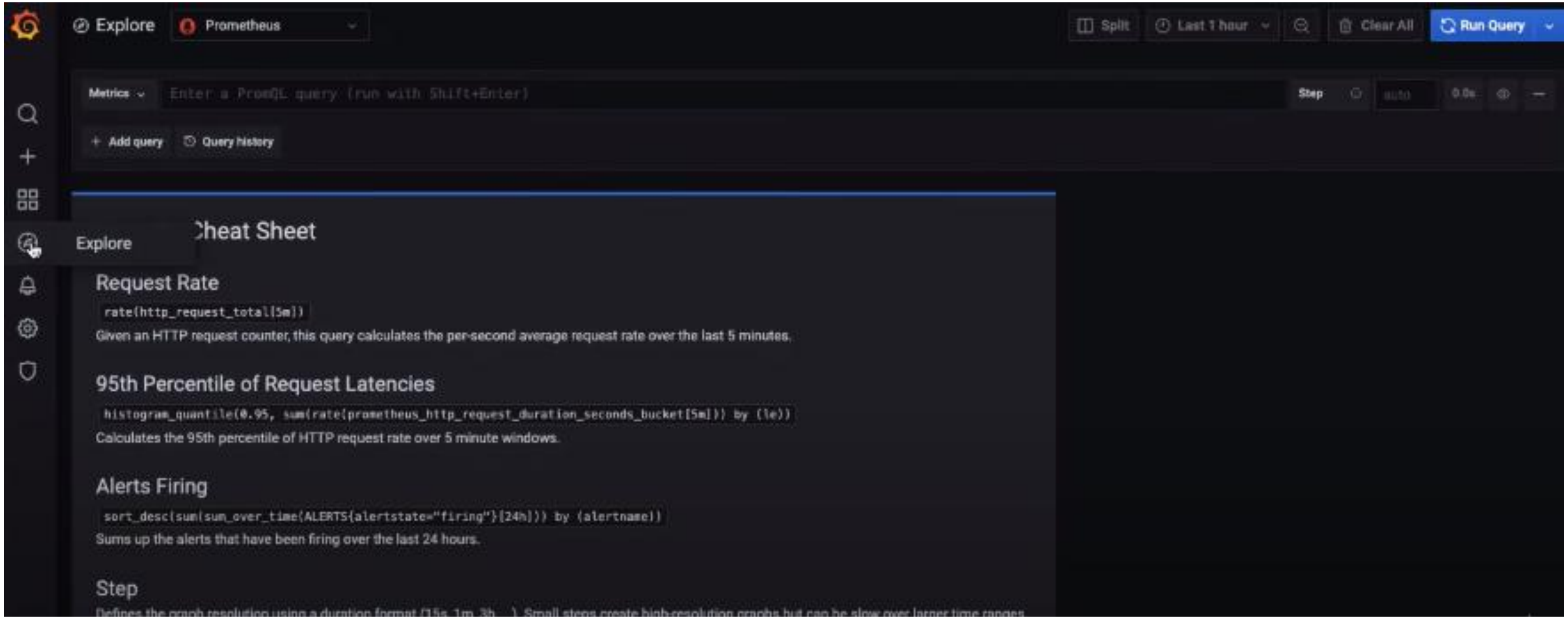
Grafana UI

Alert rules: shows the different alert rules



Grafana UI

PromQL: is the query language to create the data from Prometheus



Cheat Sheet

Request Rate

```
rate(http_request_total[5m])
```

Given an HTTP request counter, this query calculates the per-second average request rate over the last 5 minutes.

95th Percentile of Request Latencies

```
histogram_quantile(0.95, sum(rate(prometheus_http_request_duration_seconds_bucket[5m])) by (le))
```

Calculates the 95th percentile of HTTP request rate over 5 minute windows.

Alerts Firing

```
sort_desc(sum(sum_over_time(ALERTS{alertstate="firing"}[24h])) by (alertname))
```

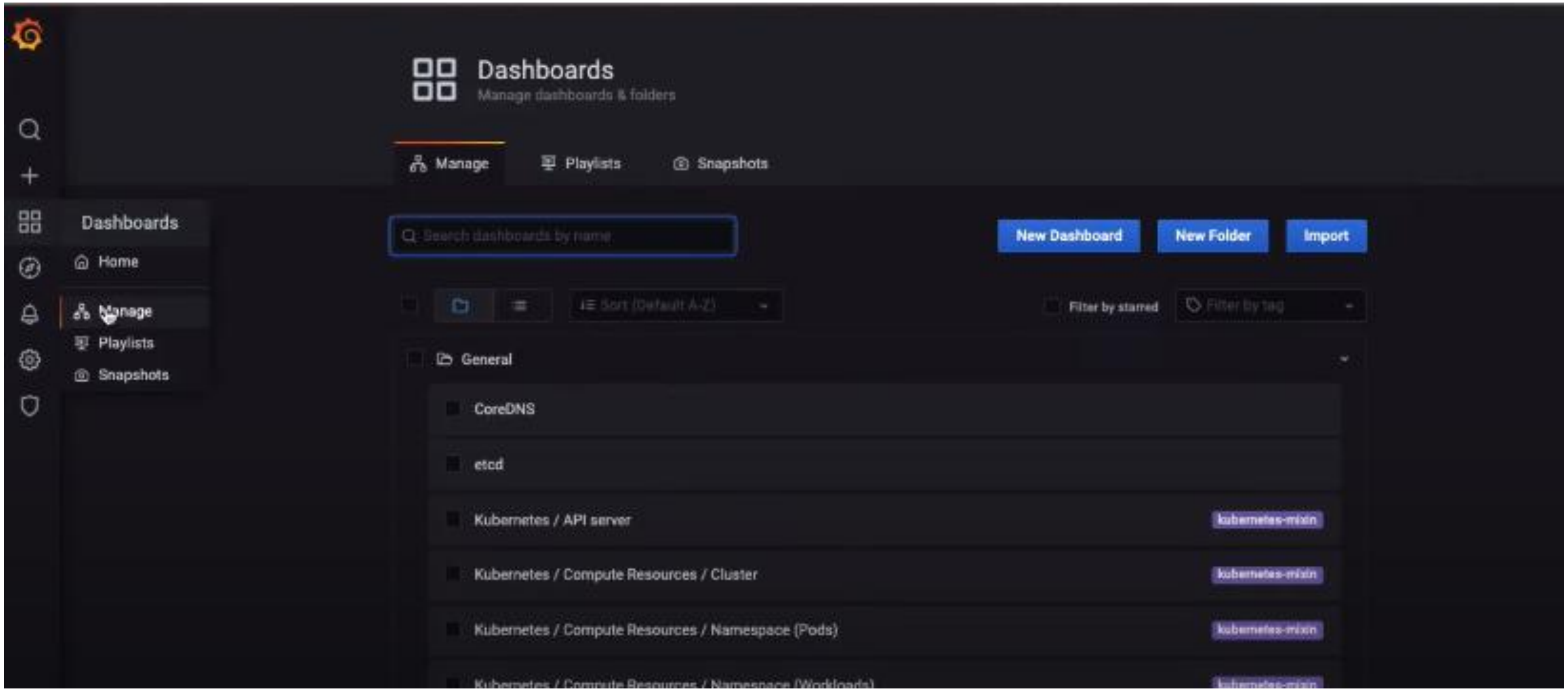
Sums up the alerts that have been firing over the last 24 hours.

Step

Defines the graph resolution using a duration format (15s, 1m, 3h, ...). Small steps create high-resolution graphs but can be slow over larger time ranges.

Grafana UI

Dashboard: shows the data that Prometheus is already collecting.



General

CoreDNS

etcd

Kubernetes / API server kubernetes-mixin

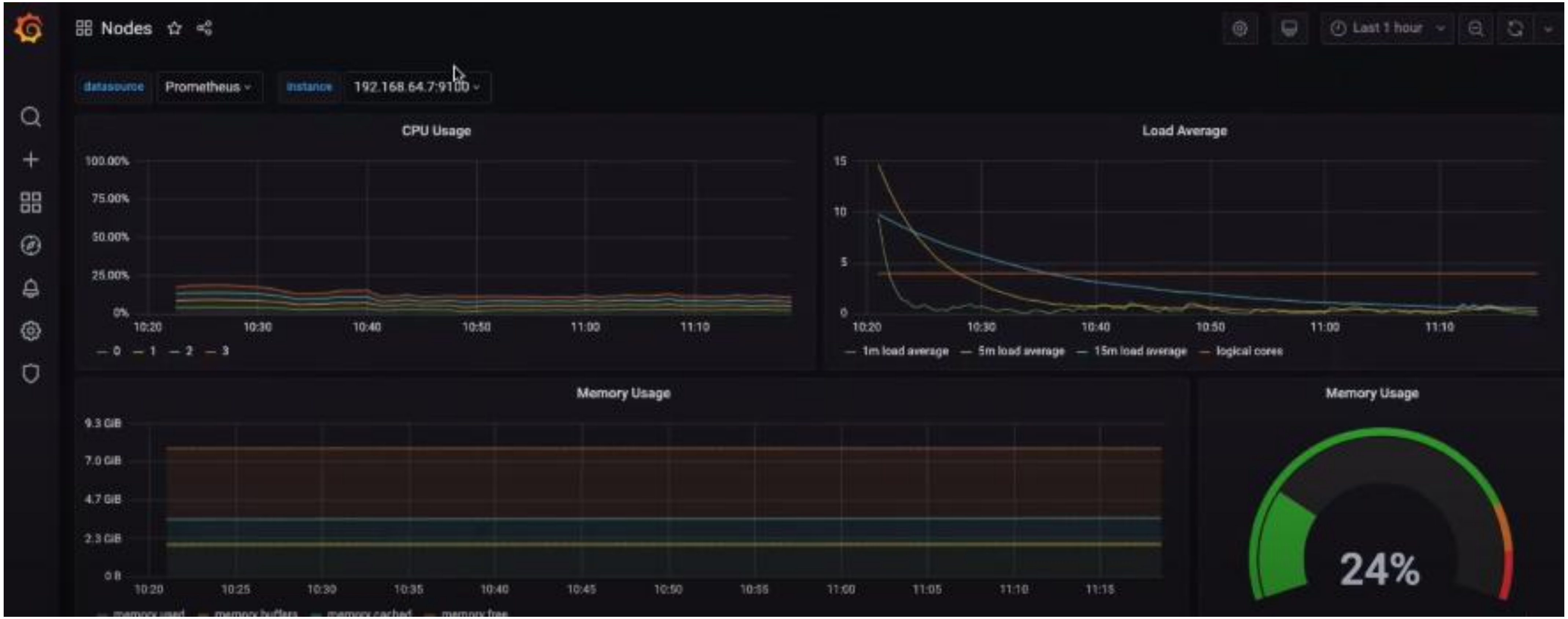
Kubernetes / Compute Resources / Cluster kubernetes-mixin

Kubernetes / Compute Resources / Namespace (Pods) kubernetes-mixin

Kubernetes / Compute Resources / Namespace (Workloads) kubernetes-mixin

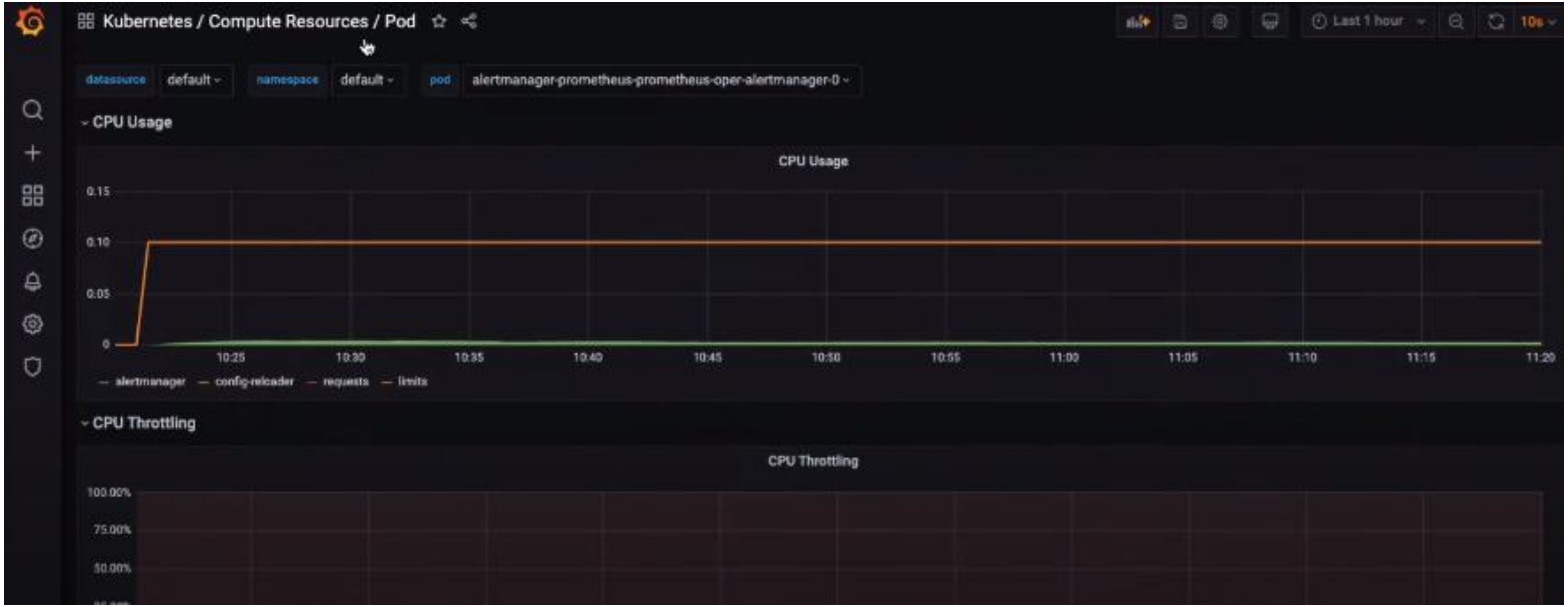
Grafana UI

Node exporter: shows the information about the nodes.



Grafana UI

Pod: shows the information about the pods.



Kubernetes / Compute Resources / Pod

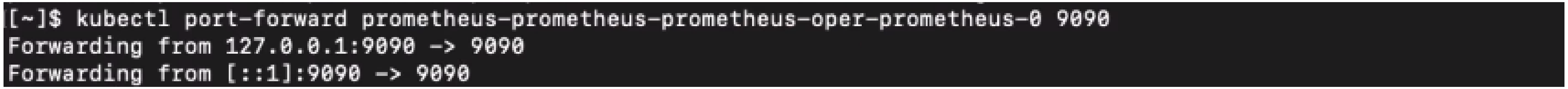
datasource default

namespace default

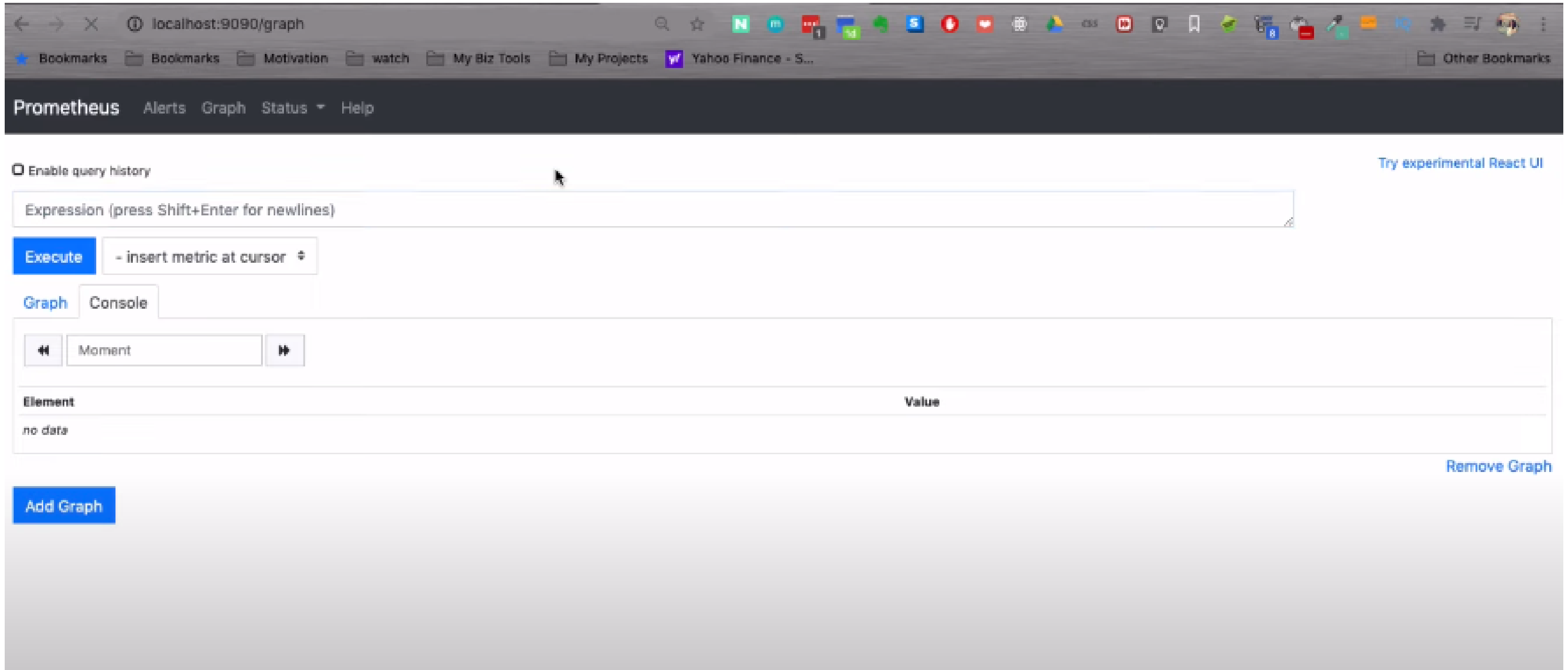
pod alertmanager-prometheus-prometheus-oper-alertmanager-0

Access Prometheus UI

Access the Prometheus using port forward.



```
[~]$ kubectl port-forward prometheus-prometheus-prometheus-oper-prometheus-0 9090
Forwarding from 127.0.0.1:9090 -> 9090
Forwarding from [::1]:9090 -> 9090
```



localhost:9090/graph

References

- https://prometheus.io/docs/introduction/overview/
- https://grafana.com/
- https://helm.sh/docs/

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innsbruck

Thank you for your attention☺

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