Kubernetes Monitoring and Init Containers

Task 1:

1.3 Here are the main components:

Prometheus: This is the core component. It's a time-series database that collects metrics from monitored targets by scraping metrics HTTP endpoints on these targets.

Alertmanager: This component handles alerts sent by Prometheus server and takes care of deduplicating, grouping, and routing them to the correct receiver (like email, PagerDuty, etc.). It also silences and inhibition of alerts.

Node Exporter: This is a Prometheus exporter for hardware and OS metrics with pluggable metric collectors. It allows you to measure various machine resources such as memory, disk I/O, CPU, network, etc.

kube-state-metrics: This service listens to the Kubernetes API server and generates metrics about the state of the objects in the cluster (like deployments, pods, nodes, etc.).

Grafana: A visualization tool that provides charts, graphs, and alerts for the web when connected to supported data sources (like Prometheus). It allows you to create dashboards for your data.

Prometheus Operator: This component simplifies the deployment and configuration of Prometheus, Alertmanager, and related monitoring components. It defines custom resources to manage the lifecycle of these components.

1.4 Install Helm Charts:

```
helm repo add prometheus-community https://prometheus-community.github.io/helm-
charts
helm repo update
helm install kube-prometheus-stack prometheus-community/kube-prometheus-stack -
-version 57.2.0 --set-string kubePrometheusStack.appVersion=v0.72.0
```

```
NAME: kube-prometheus-stack
LAST DEPLOYED: Tue May  7 18:50:48 2024
NAMESPACE: default
STATUS: deployed
REVISION: 1
NOTES:
kube-prometheus-stack has been installed. Check its status by running:
  kubectl --namespace default get pods -l "release=kube-prometheus-stack"

Visit https://github.com/prometheus-operator/kube-prometheus for instructions
```

```
on how to create & configure Alertmanager and Prometheus instances using the
Operator.
```

1.5 Output of `kubectl get po,sts,svc,pvc,cm`:

```
PS D:\Innopolis\3\2\devops\S24-core-course-labs\k8s> kubectl get
po,sts,svc,pvc,cm
NAME                                                     READY   STATUS
RESTARTS   AGE
pod/alertmanager-kube-prometheus-stack-alertmanager-0    2/2     Running
0          58m
pod/app-javascript-helm-0                                1/1     Running
0          26m
pod/app-javascript-helm-1                                1/1     Running
0          20m
pod/app-python-helm-0                                    1/1     Running
0          8m2s
pod/app-python-helm-1                                    1/1     Running
0          8m2s
pod/kube-prometheus-stack-grafana-7664d8545c-whmd8       3/3     Running
0          58m
pod/kube-prometheus-stack-kube-state-metrics-5c6549bfd5-hh8zk   1/1     Running
0          58m
pod/kube-prometheus-stack-operator-76bf64f57d-5hwn6      1/1     Running
0          58m
pod/kube-prometheus-stack-prometheus-node-exporter-rqr84 1/1     Running
0          58m
pod/post-install-sleep-job-hm27p                         0/1
Completed   0          26m
pod/pre-install-sleep-job-x468n                          0/1
Completed   0          26m
pod/prometheus-kube-prometheus-stack-prometheus-0        2/2     Running
0          58m
pod/python-post-install-sleep-job-xlztt                  0/1
Completed   0          8m2s
pod/python-pre-install-sleep-job-k2l9f                   0/1
Completed   0          8m2s

NAME                                                         READY   AGE
statefulset.apps/alertmanager-kube-prometheus-stack-alertmanager   1/1     58m
statefulset.apps/app-javascript-helm                         2/2     26m
statefulset.apps/app-python-helm                             2/2     8m2s
statefulset.apps/prometheus-kube-prometheus-stack-prometheus 1/1     58m

NAME                                                 TYPE
CLUSTER-IP       EXTERNAL-IP   PORT(S)                    AGE
service/alertmanager-operated                        ClusterIP      None
<none>        9093/TCP,9094/TCP,9094/UDP   147m
service/app-javascript-helm                          LoadBalancer
10.107.91.255    <pending>     5000:31114/TCP             26m
```

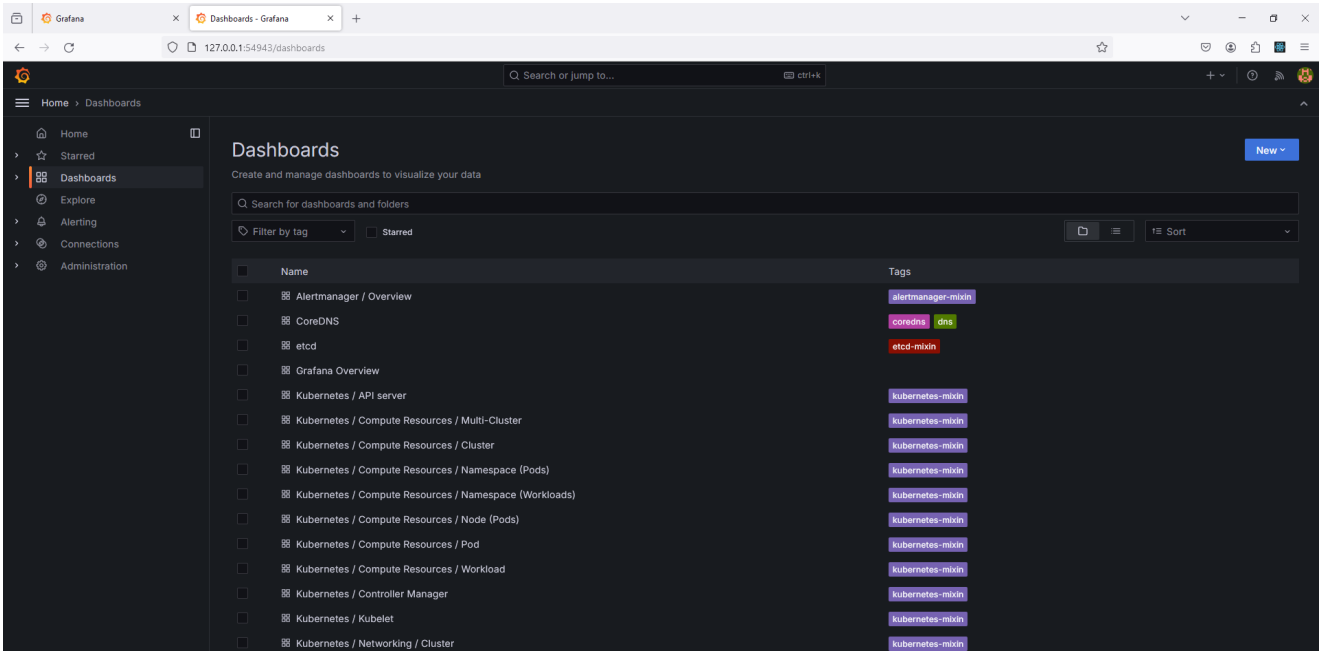
```
service/app-python-helm                                    LoadBalancer
10.100.220.173   <pending>     5000:32311/TCP              8m2s
service/kube-prometheus-stack-alertmanager                 ClusterIP
10.105.232.221   <none>        9093/TCP,8080/TCP           58m
service/kube-prometheus-stack-grafana                      ClusterIP
10.108.49.243    <none>        80/TCP                      58m
service/kube-prometheus-stack-kube-state-metrics           ClusterIP
10.98.146.11     <none>        8080/TCP                    58m
service/kube-prometheus-stack-operator                     ClusterIP
10.99.10.36      <none>        443/TCP                     58m
service/kube-prometheus-stack-prometheus                   ClusterIP
10.103.84.9      <none>        9090/TCP,8080/TCP           58m
service/kube-prometheus-stack-prometheus-node-exporter     ClusterIP
10.101.68.63     <none>        9100/TCP                    58m
service/kubernetes                                         ClusterIP
10.96.0.1        <none>        443/TCP                     158m
service/prometheus-operated                                ClusterIP      None
<none>        9090/TCP                    147m

NAME                                                                    DATA
AGE
configmap/app-javascript-helm-configmap                                 3
26m
configmap/app-python-helm-configmap                                     3
8m2s
configmap/kube-prometheus-stack-57.2-alertmanager-overview              1
150m
configmap/kube-prometheus-stack-57.2-apiserver                          1
150m
configmap/kube-prometheus-stack-57.2-cluster-total                      1
150m
configmap/kube-prometheus-stack-57.2-controller-manager                 1
150m
configmap/kube-prometheus-stack-57.2-etcd                               1
150m
configmap/kube-prometheus-stack-57.2-grafana-datasource                 1
150m
configmap/kube-prometheus-stack-57.2-grafana-overview                   1
150m
configmap/kube-prometheus-stack-57.2-k8s-coredns                        1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-cluster              1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-multicluster         1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-namespace            1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-node                 1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-pod                  1
150m
configmap/kube-prometheus-stack-57.2-k8s-resources-workload             1
150m
```

```
configmap/kube-prometheus-stack-57.2-k8s-resources-workloads-namespace   1
150m
configmap/kube-prometheus-stack-57.2-kubelet                             1
150m
configmap/kube-prometheus-stack-57.2-namespace-by-pod                    1
150m
configmap/kube-prometheus-stack-57.2-namespace-by-workload               1
150m
configmap/kube-prometheus-stack-57.2-node-cluster-rsrc-use               1
150m
configmap/kube-prometheus-stack-57.2-node-rsrc-use                       1
150m
configmap/kube-prometheus-stack-57.2-nodes                               1
150m
configmap/kube-prometheus-stack-57.2-nodes-darwin                        1
150m
configmap/kube-prometheus-stack-57.2-persistentvolumesusage              1
150m
configmap/kube-prometheus-stack-57.2-pod-total                           1
150m
configmap/kube-prometheus-stack-57.2-prometheus                          1
150m
configmap/kube-prometheus-stack-57.2-proxy                               1
150m
configmap/kube-prometheus-stack-57.2-scheduler                           1
150m
configmap/kube-prometheus-stack-57.2-workload-total                      1
150m
configmap/kube-prometheus-stack-57.2.0-grafana                           1
150m
configmap/kube-prometheus-stack-57.2.0-grafana-config-dashboards         1
150m
configmap/kube-prometheus-stack-alertmanager-overview                    1
58m
configmap/kube-prometheus-stack-apiserver                                1
58m
configmap/kube-prometheus-stack-cluster-total                            1
58m
configmap/kube-prometheus-stack-controller-manager                       1
58m
configmap/kube-prometheus-stack-etcd                                     1
58m
configmap/kube-prometheus-stack-grafana                                  1
58m
configmap/kube-prometheus-stack-grafana-config-dashboards                1
58m
configmap/kube-prometheus-stack-grafana-datasource                       1
58m
configmap/kube-prometheus-stack-grafana-overview                         1
58m
configmap/kube-prometheus-stack-k8s-coredns                              1
58m
configmap/kube-prometheus-stack-k8s-resources-cluster                    1
```

```
58m
configmap/kube-prometheus-stack-k8s-resources-multicluster              1
58m
configmap/kube-prometheus-stack-k8s-resources-namespace                 1
58m
configmap/kube-prometheus-stack-k8s-resources-node                      1
58m
configmap/kube-prometheus-stack-k8s-resources-pod                       1
58m
configmap/kube-prometheus-stack-k8s-resources-workload                  1
58m
configmap/kube-prometheus-stack-k8s-resources-workloads-namespace       1
58m
configmap/kube-prometheus-stack-kubelet                                 1
58m
configmap/kube-prometheus-stack-namespace-by-pod                        1
58m
configmap/kube-prometheus-stack-namespace-by-workload                   1
58m
configmap/kube-prometheus-stack-node-cluster-rsrc-use                   1
58m
configmap/kube-prometheus-stack-node-rsrc-use                           1
58m
configmap/kube-prometheus-stack-nodes                                   1
58m
configmap/kube-prometheus-stack-nodes-darwin                            1
58m
configmap/kube-prometheus-stack-persistentvolumesusage                  1
58m
configmap/kube-prometheus-stack-pod-total                               1
58m
configmap/kube-prometheus-stack-prometheus                              1
58m
configmap/kube-prometheus-stack-proxy                                   1
58m
configmap/kube-prometheus-stack-scheduler                               1
58m
configmap/kube-prometheus-stack-workload-total                          1
58m
configmap/kube-root-ca.crt                                              1
158m
configmap/prometheus-kube-prometheus-stack-57.2-prometheus-rulefiles-0  35
147m
configmap/prometheus-kube-prometheus-stack-prometheus-rulefiles-0       35
58m
```

1.6 Utilize Grafana Dashboards:

1. Access Grafana using `minikube service kube-prometheus-stack-grafana`.



1.7 [Explore existing dashboards] Answers:

1. Check CPU and Memory consumption of your StatefulSet.

- CPU Utilization: `21.9%`
- Memory Utilization: `243%`

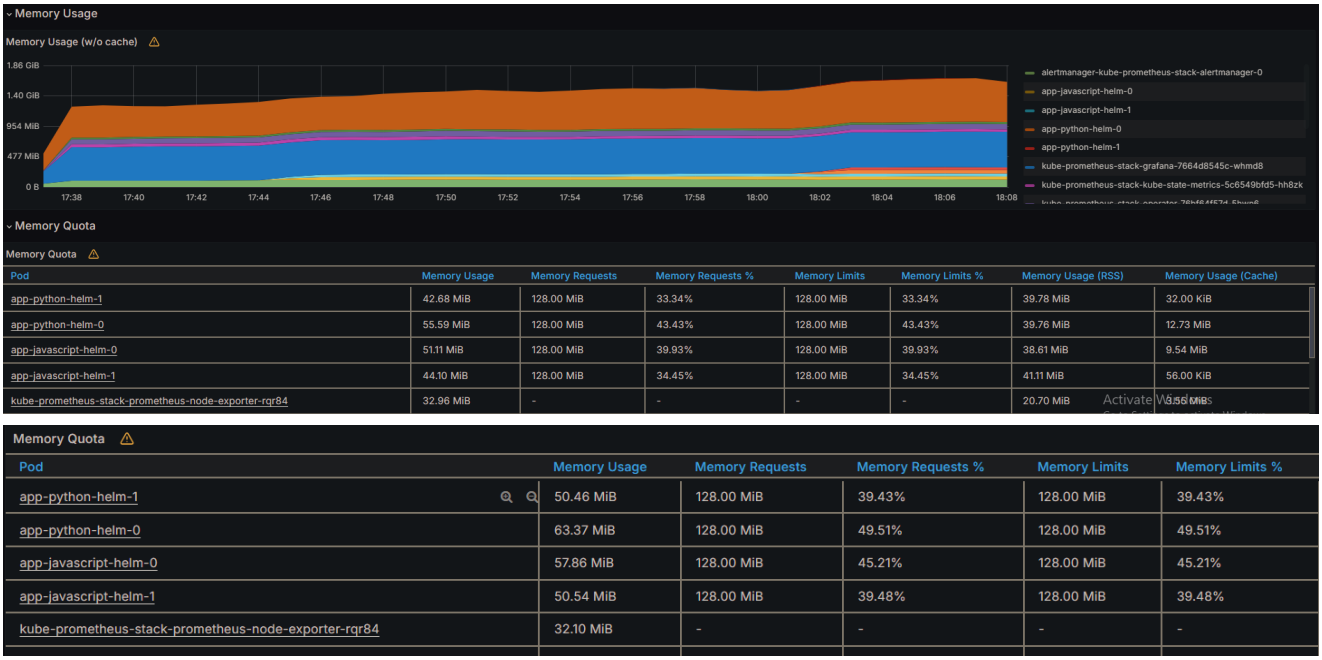
2. Identify Pods with higher and lower CPU usage in the default namespace.

- Highest among all the stateful statefulset: `kube-prometheus-stack-grafana-7664d8545c-whmd8`

- Highest among my apps: `app-python-helm-1`

Lowest: `app-javascript-helm-0`

3. Monitor node memory usage in percentage and megabytes.

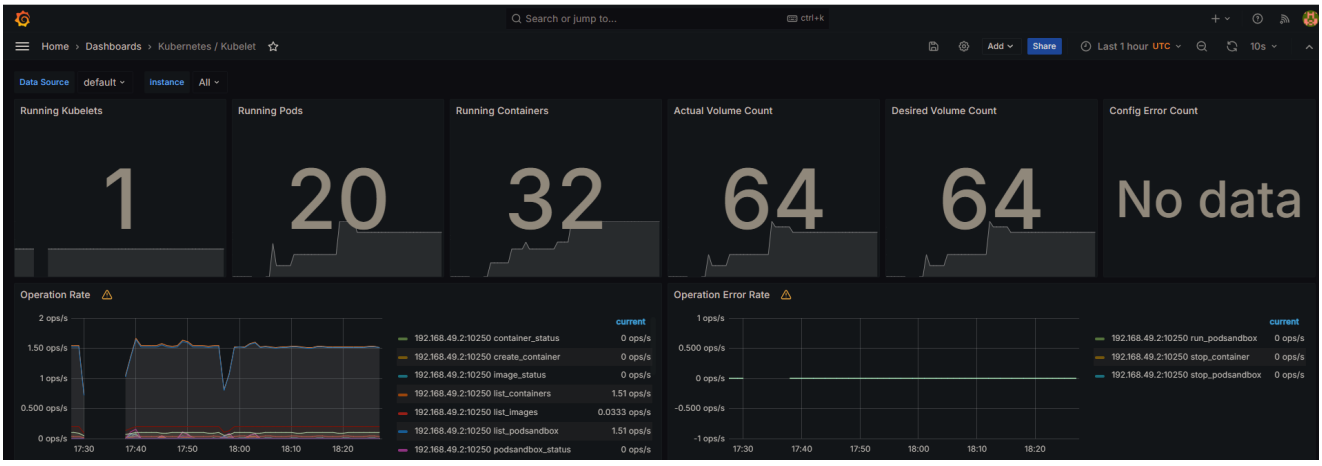


Memory Quota

Pod	Memory Usage	Memory Requests	Memory Requests %	Memory Limits	Memory Limits %
app-python-helm-1	50.46 MiB	128.00 MiB	39.43%	128.00 MiB	39.43%
app-python-helm-0	63.37 MiB	128.00 MiB	49.51%	128.00 MiB	49.51%
app-javascript-helm-0	57.86 MiB	128.00 MiB	45.21%	128.00 MiB	45.21%
app-javascript-helm-1	50.54 MiB	128.00 MiB	39.48%	128.00 MiB	39.48%
kube-prometheus-stack-prometheus-node-exporter-rqr84	32.10 MiB	-	-	-	-

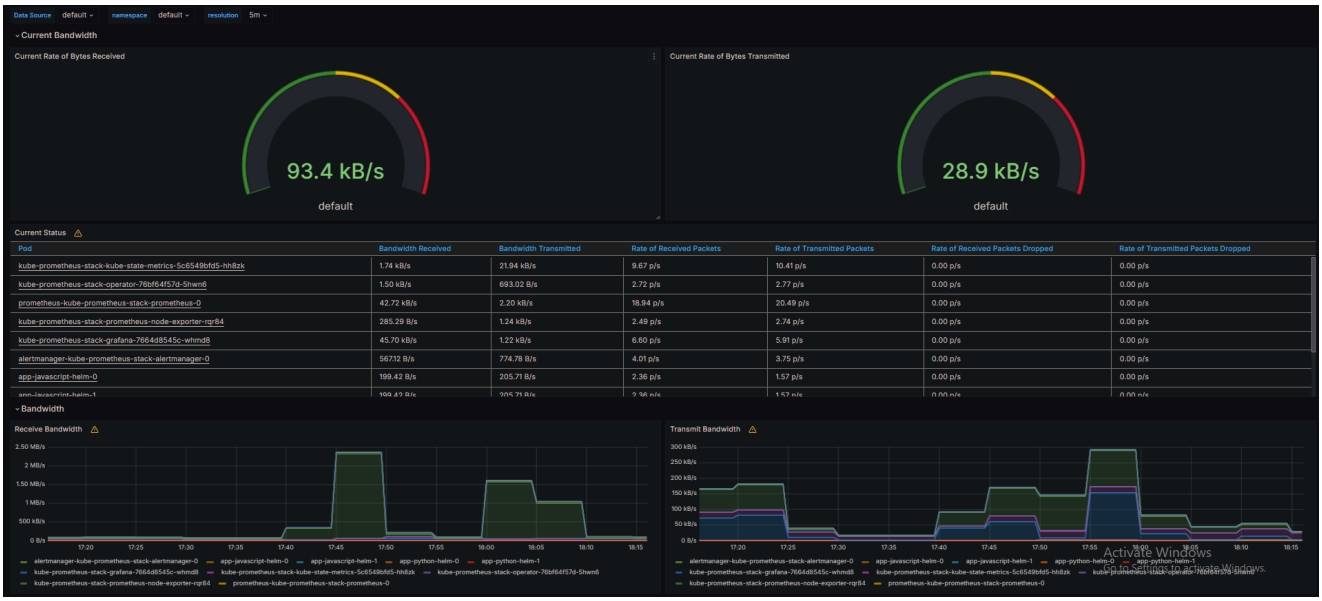
4. Count the number of pods and containers managed by the Kubelet service.

- Number of Running Pods: `20`
- Number of Running Containers: `32`



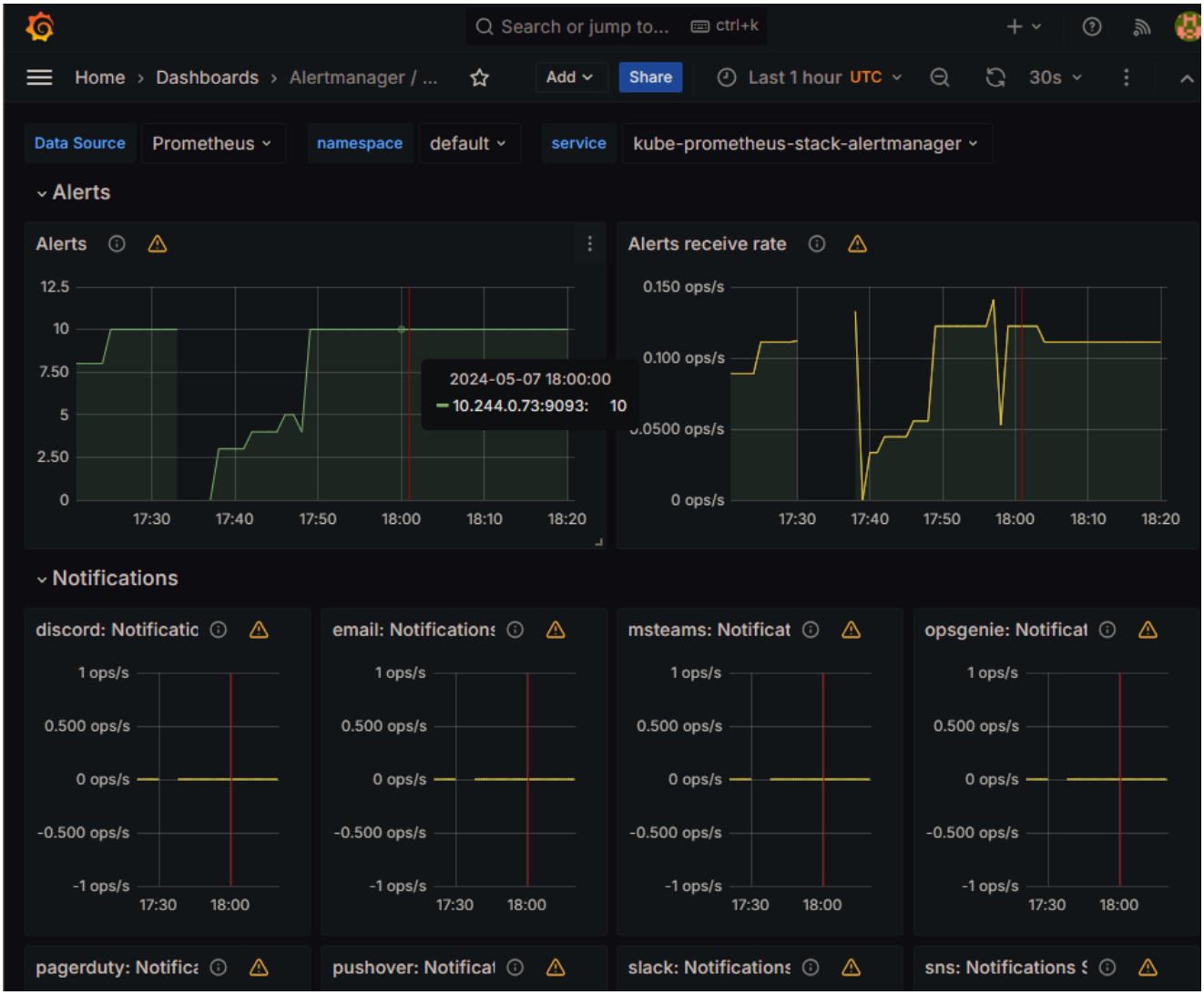
5. Evaluate network usage of Pods in the default namespace.

- Rate of Bytes Received: `93.4 kB/s`
- Rate of Bytes Sent: `28.9 kB/s`



6. Determine the number of active alerts; also check the Web UI with `minikube service monitoring-kube-prometheus-alertmanager`:

- Number of Active Alerts: `10`



Task 2: Init Containers

1. create a `pod.yaml` file:

```
apiVersion: v1
kind: Pod
metadata:
  name: demo
spec:
  volumes:
    - name: workdir
      emptyDir: {}
  initContainers:
    - name: init
      image: busybox
      command: ["sh", "-c", "wget -O /workdir/test.html http://example.com"]
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
  containers:
    - name: main
      image: busybox
      command: ["sleep", "infinity"]
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
```

2. Apply the pod:

```
kubectl apply -f pod.yaml
pod/demo created
```

3. Exec into the pod and check the file:

```
kubectl exec demo -- cat /workdir/test.html
Defaulted container "main" out of: main, init (init)
<!doctype html>
<html>
<head>
    <title>Example Domain</title>

    <meta charset="utf-8" />
    <meta http-equiv="Content-type" content="text/html; charset=utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1" />
    <style type="text/css">
    body {
        background-color: #f0f0f2;
        margin: 0;
        padding: 0;
```

```
        font-family: -apple-system, system-ui, BlinkMacSystemFont, "Segoe UI",
"Open Sans", "Helvetica Neue", Helvetica, Arial, sans-serif;

    }
    div {
        width: 600px;
        margin: 5em auto;
        padding: 2em;
        background-color: #fdfdff;
        border-radius: 0.5em;
        box-shadow: 2px 3px 7px 2px rgba(0,0,0,0.02);
    }
    a:link, a:visited {
        color: #38488f;
        text-decoration: none;
    }
    @media (max-width: 700px) {
        div {
            margin: 0 auto;
            width: auto;
        }
    }
    </style>
</head>

<body>
<div>
    <h1>Example Domain</h1>
    <p>This domain is for use in illustrative examples in documents. You may
use this
    domain in literature without prior coordination or asking for permission.
</p>
    <p><a href="https://www.iana.org/domains/example">More information...</a>
</p>
</div>
</body>
</html>
```

4. Proof of success.

```
PS D:\Innopolis\3\2\devops\S24-core-course-labs\k8s> kubectl apply -f pod.yaml
pod/demo created
PS D:\Innopolis\3\2\devops\S24-core-course-labs\k8s> kubectl exec demo -- cat /workdir/test.html
Defaulted container "main" out of: main, init (init)
<!doctype html>
<html>
<head>
    <title>Example Domain</title>

    <meta charset="utf-8" />
    <meta http-equiv="Content-type" content="text/html; charset=utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1" />
    <style type="text/css">
    body {
        background-color: #f0f0f2;
        margin: 0;
        padding: 0;
        font-family: -apple-system, system-ui, BlinkMacSystemFont, "Segoe UI", "Open Sans", "Helvetic
 Neue", Helvetica, Arial, sans-serif;

    }
    div {
        width: 600px;
        margin: 5em auto;
        padding: 2em;
        background-color: #fdfdff;
        border-radius: 0.5em;
        box-shadow: 2px 3px 7px 2px rgba(0,0,0,0.02);
    }
    a:link, a:visited {
        color: #38488f;
        text-decoration: none;
    }
    @media (max-width: 700px) {
        div {
            margin: 0 auto;
            width: auto;
        }
    }
    </style>
</head>

<body>
```

Bonus Task: App Metrics & Multiple Init Containers

1. App Metrics: Fetch metrics from your app and provide proof.

```
kubectl exec app-python-helm-0 -- curl localhost:5000/metrics
```

```
# HELP python_gc_objects_collected_total Objects collected during gc
# TYPE python_gc_objects_collected_total counter
python_gc_objects_collected_total{generation="0"} 113.0
python_gc_objects_collected_total{generation="1"} 295.0
python_gc_objects_collected_total{generation="2"} 0.0
# HELP python_gc_objects_uncollectable_total Uncollectable objects found during
GC
# TYPE python_gc_objects_uncollectable_total counter
python_gc_objects_uncollectable_total{generation="0"} 0.0
python_gc_objects_uncollectable_total{generation="1"} 0.0
python_gc_objects_uncollectable_total{generation="2"} 0.0
```

```
# HELP python_gc_collections_total Number of times this generation was
collected
# TYPE python_gc_collections_total counter
python_gc_collections_total{generation="0"} 78.0
python_gc_collections_total{generation="1"} 7.0
python_gc_collections_total{generation="2"} 0.0
# HELP python_info Python platform information
# TYPE python_info gauge
python_info{implementation="CPython",major="3",minor="9",patchlevel="18",versio
n="3.9.18"} 1.0
# HELP process_virtual_memory_bytes Virtual memory size in bytes.
# TYPE process_virtual_memory_bytes gauge
process_virtual_memory_bytes 1.11476736e+08
# HELP process_resident_memory_bytes Resident memory size in bytes.
# TYPE process_resident_memory_bytes gauge
process_resident_memory_bytes 3.129344e+07
# HELP process_start_time_seconds Start time of the process since unix epoch in
seconds.
# TYPE process_start_time_seconds gauge
process_start_time_seconds 1.71511186019e+09
# HELP process_cpu_seconds_total Total user and system CPU time spent in
seconds.
# TYPE process_cpu_seconds_total counter
process_cpu_seconds_total 0.55
# HELP process_open_fds Number of open file descriptors.
# TYPE process_open_fds gauge
process_open_fds 6.0
# HELP process_max_fds Maximum number of open file descriptors.
# TYPE process_max_fds gauge
process_max_fds 1.048576e+06
# HELP flask_http_request_duration_seconds Flask HTTP request duration in
seconds
# TYPE flask_http_request_duration_seconds histogram
flask_http_request_duration_seconds_bucket{le="0.005",method="GET",path="/",sta
tus="200"} 1.0
flask_http_request_duration_seconds_bucket{le="0.01",method="GET",path="/",stat
us="200"} 1.0
flask_http_request_duration_seconds_bucket{le="0.025",method="GET",path="/",sta
tus="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.05",method="GET",path="/",stat
us="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.075",method="GET",path="/",sta
tus="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.1",method="GET",path="/",statu
s="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.25",method="GET",path="/",stat
us="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.5",method="GET",path="/",statu
s="200"} 2.0
flask_http_request_duration_seconds_bucket{le="0.75",method="GET",path="/",stat
us="200"} 2.0
flask_http_request_duration_seconds_bucket{le="1.0",method="GET",path="/",statu
s="200"} 2.0
```

```
flask_http_request_duration_seconds_bucket{le="2.5",method="GET",path="/",statu
s="200"} 2.0
flask_http_request_duration_seconds_bucket{le="5.0",method="GET",path="/",statu
s="200"} 2.0
flask_http_request_duration_seconds_bucket{le="7.5",method="GET",path="/",statu
s="200"} 2.0
flask_http_request_duration_seconds_bucket{le="10.0",method="GET",path="/",stat
us="200"} 2.0
flask_http_request_duration_seconds_bucket{le="+Inf",method="GET",path="/",stat
us="200"} 2.0
flask_http_request_duration_seconds_count{method="GET",path="/",status="200"}
2.0
flask_http_request_duration_seconds_sum{method="GET",path="/",status="200"}
0.018572942999526276
flask_http_request_duration_seconds_bucket{le="0.005",method="GET",path="/favic
on.ico",status="500"} 0.0
flask_http_request_duration_seconds_bucket{le="0.01",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.025",method="GET",path="/favic
on.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.05",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.075",method="GET",path="/favic
on.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.1",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.25",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.5",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="0.75",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="1.0",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="2.5",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="5.0",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="7.5",method="GET",path="/favicon
.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="10.0",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_bucket{le="+Inf",method="GET",path="/favico
n.ico",status="500"} 1.0
flask_http_request_duration_seconds_count{method="GET",path="/favicon.ico",stat
us="500"} 1.0
flask_http_request_duration_seconds_sum{method="GET",path="/favicon.ico",status
="500"} 0.00521483500051545
# HELP flask_http_request_duration_seconds_created Flask HTTP request duration
in seconds
# TYPE flask_http_request_duration_seconds_created gauge
flask_http_request_duration_seconds_created{method="GET",path="/",status="200"}
1.7151118657837467e+09
```

```
flask_http_request_duration_seconds_created{method="GET",path="/favicon.ico",st
atus="500"} 1.7151118658553383e+09
# HELP flask_http_request_total Total number of HTTP requests
# TYPE flask_http_request_total counter
flask_http_request_total{method="GET",status="200"} 2.0
flask_http_request_total{method="GET",status="500"} 1.0
# HELP flask_http_request_created Total number of HTTP requests
# TYPE flask_http_request_created gauge
flask_http_request_created{method="GET",status="200"} 1.7151118657844675e+09
flask_http_request_created{method="GET",status="500"} 1.7151118658554273e+09
# HELP flask_exporter_info Information about the Prometheus Flask exporter
# TYPE flask_exporter_info gauge
flask_exporter_info{version="0.0.9"} 1.0
```

2. Multiple Init Containers: Add another init container to the pod.

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: multi-demo
spec:
  volumes:
    - name: workdir
      emptyDir: {}
  initContainers:
    - name: init1
      image: busybox
      command: ["sh", "-c", 'echo "Init 1" > /workdir/test.txt']
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
    - name: init2
      image: busybox
      command: ["sh", "-c", 'echo "Init 2" >> /workdir/test.txt']
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
    - name: init3
      image: busybox
      command: ["sh", "-c", 'echo "Init 3" >> /workdir/test.txt']
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
  containers:
    - name: main
      image: busybox
      command: ["sleep", "infinity"]
      volumeMounts:
        - name: workdir
          mountPath: "/workdir"
```

3. Apply the pod:

```
kubectl apply -f multi-pod.yaml
pod/multi-demo created
```

4. Exec into the pod and check the file:

```
kubectl exec multi-demo -- cat /workdir/test.txt
Init 1
Init 2
Init 3
```