10th Week

열번째 뵙겠습니다 ?!

▷ 잠시만 기다렸다가 30분 되면 시작하겠습니다~^^

▷ 이제 고지가 눈 앞에 있습니다~

- 끝까지 달려봅시다~~~!!!

▷ Camera는 가급적 켜 주시면 대단히 감사하겠습니다 !!!

- 너무 부끄러우면 Snap Camera를 사용하시는 것 까지는~ ^^

▷ 오늘 수업 자료는 아래 링크에서 다운로드 받으실 수 있어요.

- https://github.com/whatwant-school/kubernetes

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지난 수업 기억 나시나요?

https://kahoot.it/

///

Kubernetes

Resource Management

Status

```
remote ❯ kubectl get nodes -o wide

NAME      STATUS   ROLES                  AGE   VERSION   INTERNAL-IP       EXTERNAL-IP   OS-IMAGE             KERNEL-VERSION      CONTAINER-RUNTIME
master    Ready    control-plane,master   46d   v1.22.5   192.168.100.200   <none>        Ubuntu 20.04.4 LTS   5.4.0-100-generic   containerd://1.5.8
worker1   Ready    <none>                 46d   v1.22.5   192.168.100.201   <none>        Ubuntu 20.04.4 LTS   5.4.0-100-generic   containerd://1.5.8
worker2   Ready    <none>                 46d   v1.22.5   192.168.100.202   <none>        Ubuntu 20.04.4 LTS   5.4.0-100-generic   containerd://1.5.8

remote ❯ kubectl describe nodes master

...
Capacity:
  cpu:                2
  ephemeral-storage:  25155844Ki
  hugepages-2Mi:      0
  memory:             2030728Ki
  pods:               110
Allocatable:
  cpu:                1800m
  ephemeral-storage:  23183625793
  hugepages-2Mi:      0
  memory:             1404040Ki
  pods:               110
...
Non-terminated Pods:          (13 in total)
  Namespace                   Name                                       CPU Requests  CPU Limits  Memory Requests  Memory Limits  Age
  ---------                   ----                                       ------------  ----------  ---------------  -------------  ---
  kube-system                 calico-kube-controllers-5788f6558-c4dmn    30m (1%)      1 (55%)     64M (4%)         256M (17%)     11d
  kube-system                 calico-node-jtspn                          150m (8%)     300m (16%)  64M (4%)         500M (34%)     46d
...
Allocated resources:
  (Total limits may be over 100 percent, i.e., overcommitted.)
  Resource           Requests         Limits
  --------           --------         ------
  cpu                1100m (61%)      1500m (83%)
  memory             559001600 (38%)  1578231040 (109%)
  ephemeral-storage  0 (0%)           0 (0%)
  hugepages-2Mi      0 (0%)           0 (0%)
Events:              <none>
```

Units

- CPU : **ms** (밀리 세컨드), 1000ms = 1 vCore (가상 CPU 코어)

  . 1 = 1000ms, 0.5 = 500ms

- Memory : **Mi** (MiB, 메비바이트), 1 MiB = 1024 KiB

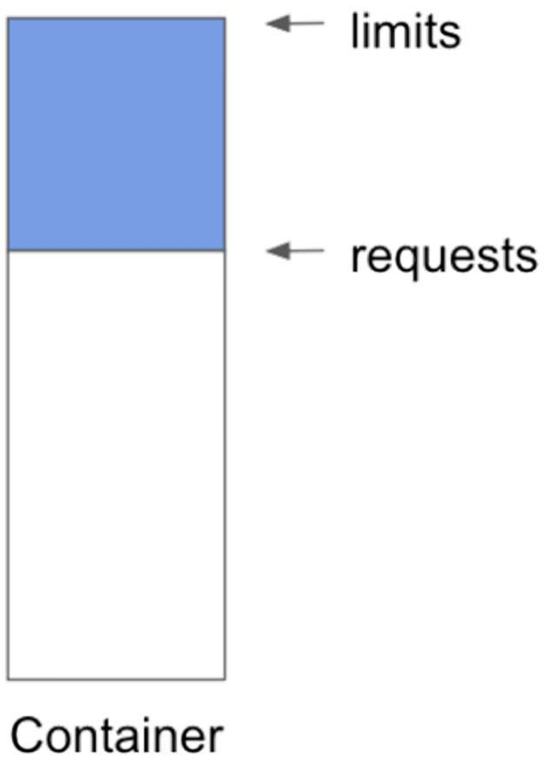
바이트 크기 v • d • e • h					
SI 접두어		전통적 용법		이진 접두어	
기호(이름)	값	기호	값	기호(이름)	V값
kB (킬로바이트)	$1000^1 = 10^3$	KB	$1024^1 = 2^{10}$	KiB (키비바이트)	2^{10}
MB (메가바이트)	$1000^2 = 10^6$	MB	$1024^2 = 2^{20}$	MiB (**메비바이트**)	2^{20}
GB (기가바이트)	$1000^3 = 10^9$	GB	$1024^3 = 2^{30}$	GiB (기비바이트)	2^{30}
TB (테라바이트)	$1000^4 = 10^{12}$	TB	$1024^4 = 2^{40}$	TiB (테비바이트)	2^{40}
PB (페타바이트)	$1000^5 = 10^{15}$	PB	$1024^5 = 2^{50}$	PiB (페비바이트)	2^{50}
EB (엑사바이트)	$1000^6 = 10^{18}$	EB	$1024^6 = 2^{60}$	EiB (엑스비바이트)	2^{60}
ZB (제타바이트)	$1000^7 = 10^{21}$	ZB	$1024^7 = 2^{70}$	ZiB (제비바이트)	2^{70}
YB (요타바이트)	$1000^8 = 10^{24}$	YB	$1024^8 = 2^{80}$	YiB (요비바이트)	2^{80}

※ 참고 : https://ko.wikipedia.org/wiki/메비바이트

Requests & Limits

- **requests** : container가 생성될 때 요청하는 리소스

- **limits** : container가 생성되고 CPU/Memory가 더 필요한 경우 추가로 더 사용할 수 있는 리소스



※ 참고 : https://bcho.tistory.com/1291

///

Example - requests

- dd : 파일을 변환하고 복사하는 것이 주 목적인 유닉스 및 유닉스 계열 운영 체제용 명령 줄 유틸리티

- /dev/zero : 읽기를 위해 가능한 많은 널 문자(ASCII NUL, 0x00)를 제공하는 유닉스 계열 운영 체제의 특수 파일

- /dev/null : 기록 대상이 되는 모든 데이터를 버리지만 쓰기 작업은 성공했다고 보고하는 장치 파일

pod-requests.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: requests

spec:
  containers:
  - image: busybox
    command: ["dd", "if=/dev/zero", "of=/dev/null"]

    name: dd

    resources:
      requests:
        cpu: 200m
        memory: 10Mi
```

CPU를 100% 사용하는 예제

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/requests/pod-requests.yaml

pod/requests created


remote ❯ kubectl exec -it requests -- top

Mem: 1166988K used, 89596K free, 2060K shrd, 41788K buff, 692296K cached
CPU: 12.2% usr 39.3% sys  0.0% nic 48.1% idle  0.1% io  0.0% irq  0.1% sirq
Load average: 1.14 1.13 1.09 4/394 17
  PID  PPID USER     STAT   VSZ %VSZ CPU %CPU COMMAND
    1     0 root     R     1312  0.1   1 50.3 dd if /dev/zero of /dev/null
    8     0 root     R     1320  0.1   0  0.0 top
```

일부러 vCPU=2 환경에서 실행했다.
dd = 최대 CPU 소비, but 1 thread
실행환경 2 cpu, ∴ 50%
→ requests cpu 200m, but use 1000m

※ 참고 : https://ko.wikipedia.org/wiki/Dd_(유닉스)

※ 참고 : https://ko.wikipedia.org/wiki//dev/zero

※ 참고 : https://ko.wikipedia.org/wiki/널_장치

Example - limits

- requests를 설정하지 않으면, limits 값으로 requests 값 설정됨

- 실행환경 2 cpu, limits cpu 200m → ∴ 10%

pod-limits.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: limits

spec:
  containers:
  - image: busybox
    command: ["dd", "if=/dev/zero", "of=/dev/null"]

    name: dd

    resources:
      limits:
        cpu: 200m
        memory: 10Mi
```

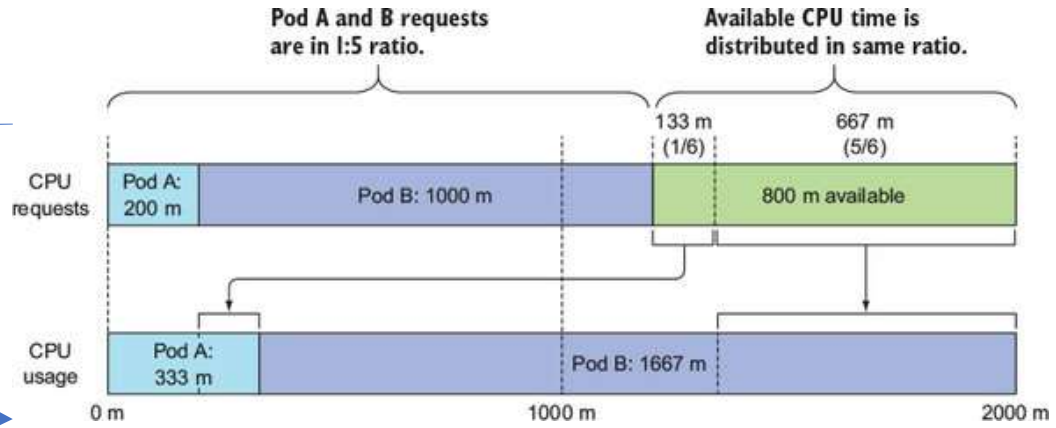
```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/limits/pod-limits.yaml

pod/limits created


remote ❯ kubectl exec -it requests -- top

Mem: 1172240K used, 84344K free, 2076K shrd, 42848K buff, 693392K cached
CPU:  2.5% usr  8.4% sys  0.0% nic 88.8% idle  0.0% io  0.0% irq  0.0% sirq
Load average: 0.60 1.00 1.07 2/399 14
  PID  PPID USER     STAT   VSZ %VSZ CPU %CPU COMMAND
    1     0 root     R     1312  0.1   0  9.9 dd if /dev/zero of /dev/null
    7     0 root     R     1320  0.1   1  0.0 top
```

///

CPU time sharing

이렇게 요청했지만,

실제로는 전체 CPU를 비율만큼 사용한다.



※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/60

///

containers always see the node's memory/cpu, not the container's

- **cpu.cfs_period_us** : CPU 자원을 정기적으로 할당 받을 주기(microsecond 단위)

  . 파라미터의 max 1 second, min 1,000 microsecond

- **cpu.cfs_quota_us** : 모든 task들이 한 주기(period) 동안 실행할 수 있는 총 시간(microsecond 단위)

  . 예를 들어, 매 1초당 0.2초 동안 단일 CPU에 액세스할 수 있어야 하는 경우 cpu.cfs_quota_us=200,000, cpu.cfs_period_us=1,000,000

  . 예를 들어, 두 개의 CPU를 완전히 활용(2 core) 한다면 cpu.cfs_quota_us=200,000(200ms), cpu.cfs_period_us=100,000(100ms)

  . cpu.cfs_quota_us의 값을 -1로 설정하면, CPU 시간 제한을 설정하지 않는다는 의미이며, 이는 root cgroup을 제외한 모든 cgroup의 기본 값임

```
remote ❯ kubectl exec -it limits -- cat /sys/fs/cgroup/cpu/cpu.cfs_period_us
100000    100,000 = 100ms

remote ❯ kubectl exec -it limits -- cat /sys/fs/cgroup/cpu/cpu.cfs_quota_us
20000     20,000 = 20ms
```

```
| CPU 사용률 = cpu.cfs_quota_us / cpu.cfs_period_us * 100
           = 20,000 / 100,000 * 100
           = 20%
           → vCPU 1개의 20% 성능까지 사용
```

※ 참고 : https://velog.io/@jrlee/cgroup-subsystem-CPU

///

QoS (Quality of Service) – 1/2

- **BestEffort** : 최하위 우선순위

  . requests/limits 지정하지 않은 pod

  . 가장 먼저 종료

  . 메모리가 충분하면 최대 메모리 사용

- **Burstable**

  . BestEffort/Guaranteed에 해당하지 않는 Pod

  . requests ~ limits 범위의 리소스 얻음

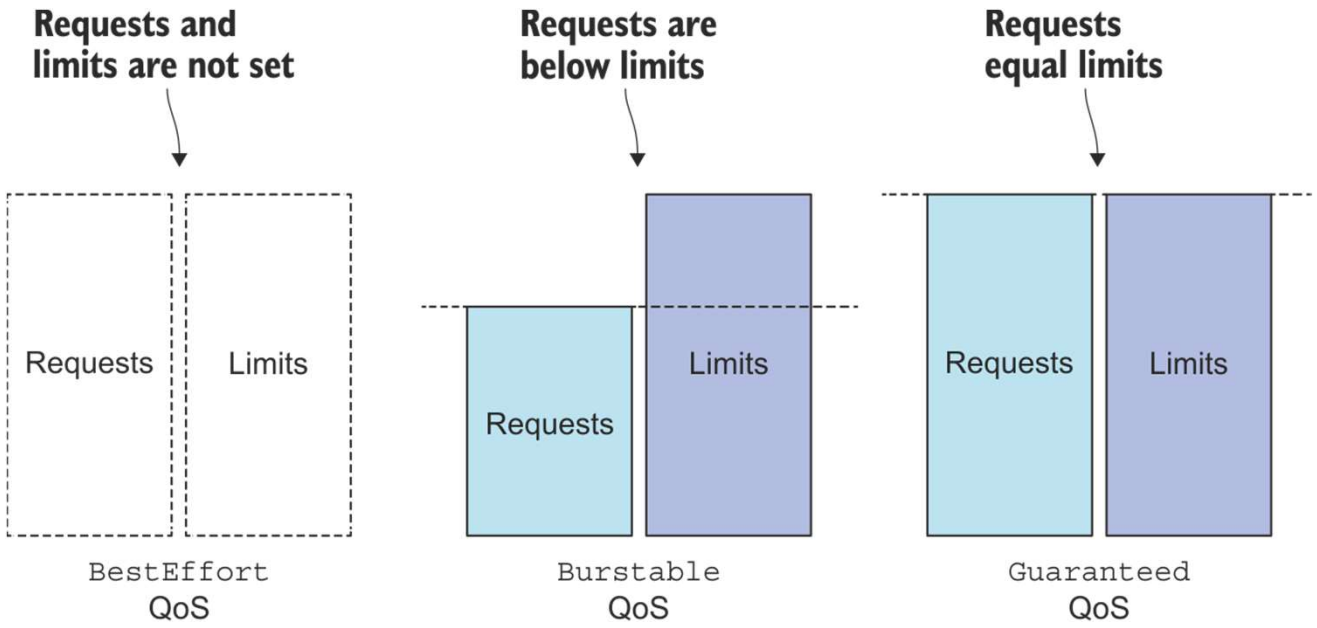
- **Guaranteed** : 최상위 우선순위

  . 3가지 조건 충족되어야 함

  ① requests/limits 모두 설정

  ② 각 container에 모두 설정

  ③ requests == limits



※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/133

QoS (Quality of Service) – 2/2

- 2개 container를 갖고 있는 경우, 각 container QoS에 따른 Pod의 QoS 결과

Table 14.1 The QoS class of a single-container pod based on resource requests and limits

CPU requests vs. limits	Memory requests vs. limits	Container QoS class
None set	None set	`BestEffort`
None set	Requests < Limits	`Burstable`
None set	Requests = Limits	`Burstable`
Requests < Limits	None set	`Burstable`
Requests < Limits	Requests < Limits	`Burstable`
Requests < Limits	Requests = Limits	`Burstable`
Requests = Limits	Requests = Limits	`Guaranteed`

Table 14.2 A Pod's QoS class derived from the classes of its containers

Container 1 QoS class	Container 2 QoS class	Pod's QoS class
`BestEffort`	`BestEffort`	`BestEffort`
`BestEffort`	`Burstable`	`Burstable`
`BestEffort`	`Guaranteed`	`Burstable`
`Burstable`	`Burstable`	`Burstable`
`Burstable`	`Guaranteed`	`Burstable`
`Guaranteed`	`Guaranteed`	`Guaranteed`

※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/133

which process gets killed when memory is low

- QoS 클래스에 따라 해당 프로세스 종료

- 동일하면? → OOM Score (Out of Memory)

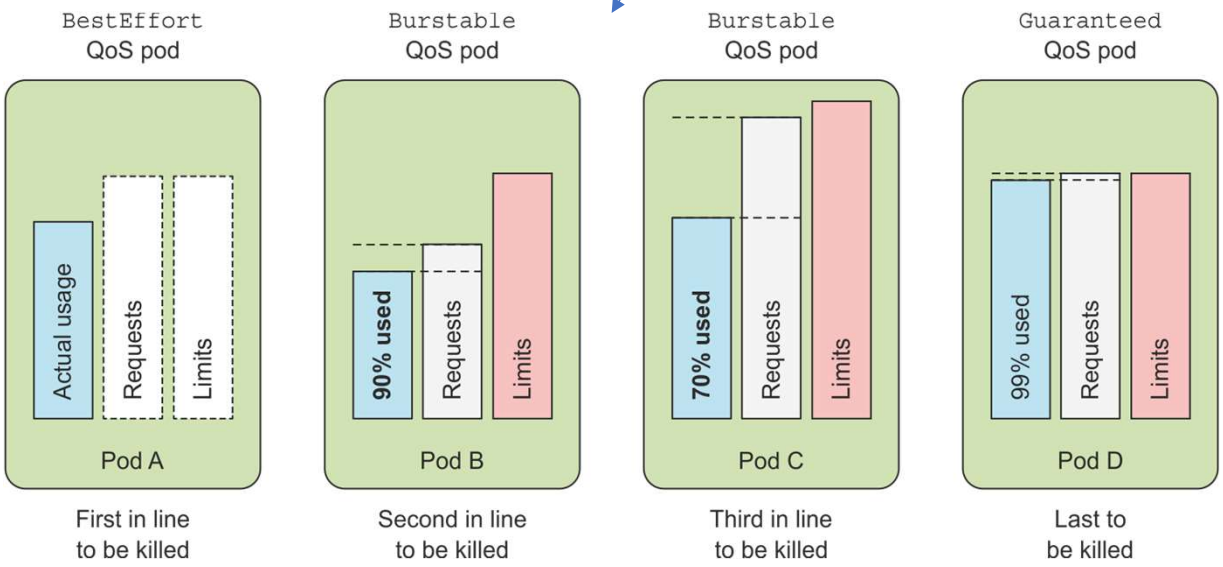
  . 아래 2가지 기준을 QoS 클래스를 기반으로 한 고정된 OOM Score 조정

  ① 프로세스가 소비하는 가용 메모리 비율

  ② requests Memory

Requests 대비하여
사용하는 비율이 높은 Pod가 먼저 종료

4개의 Pod에 대해서
어떤 것부터
프로세스 종료되는지 설명

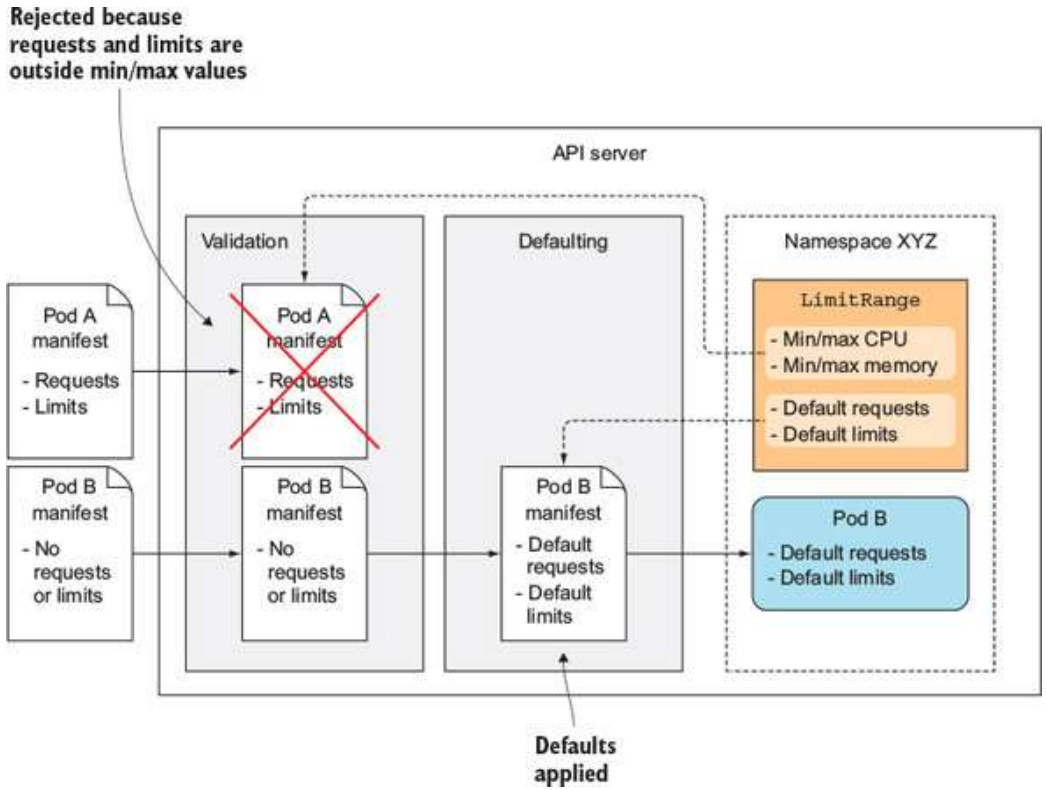


※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/151

///

LimitRange

- Namespace 단위로 리소스에 대한 min/max/default 값 설정



정해 놓은 min/max 값을 벗어난 요청은 거절

따로 명시하지 않아도 default 값 기본 적용

※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/162

Example - LimitRange 1/2

limitrange.yaml

```yaml
apiVersion: v1
kind: LimitRange
metadata:
  name: limitrange

spec:
  limits:
  - type: Pod
    min:
      cpu: 50m
      memory: 5Mi
    max:
      cpu: 1
      memory: 1Gi

  - type: Container
    defaultRequest:
      cpu: 100m
      memory: 10Mi
    default:
      cpu: 200m
      memory: 100Mi
    min:
      cpu: 50m
      memory: 5Mi
    max:
      cpu: 1
      memory: 1Gi
    maxLimitRequestRatio:
      cpu: 4
      memory: 10

  - type: PersistentVolumeClaim
    min:
      storage: 1Gi
    max:
      storage: 10Gi
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create namespace limitrange-test

namespace/limitrange-test created


remote ❯ kubectl create --namespace limitrange-test -f 08-week/limitrange/limitrange.yaml

limitrange/limitrange created


remote ❯ kubectl describe --namespace limitrange-test limitranges limitrange

Name:                  limitrange
Namespace:             limitrange-test
Type                   Resource  Min  Max   Default Request  Default Limit  Max Limit/Request Ratio
----                   --------  ---  ---   ---------------  -------------  -----------------------
Pod                    cpu       50m  1     -                -              -
Pod                    memory    5Mi  1Gi   -                -              -
Container              cpu       50m  1     100m             200m           4
Container              memory    5Mi  1Gi   10Mi             100Mi          10
PersistentVolumeClaim  storage   1Gi  10Gi  -                -              -
```

Example - LimitRange 2/2

- LimitRange가 설정된 namespace에 Pod를 생성하면 resource가 어떻게 설정될지 알아보자.

pod-nolimit.yaml

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nolimit

spec:
  containers:
  - name: main
    image: busybox
    command: ["dd", "if=/dev/zero", "of=/dev/null"]
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create --namespace limitrange-test -f 08-week/limitrange/pod-nolimit.yaml

pod/nolimit created


remote ❯ kubectl exec -it --namespace limitrange-test nolimit -- top

Mem: 1158312K used, 98272K free, 2076K shrd, 47104K buff, 672428K cached
CPU:  2.7% usr  6.9% sys  0.0% nic 90.0% idle  0.0% io  0.0% irq  0.2% sirq
Load average: 0.44 0.31 0.28 3/383 24
  PID  PPID USER     STAT   VSZ %VSZ CPU %CPU COMMAND
    1     0 root     R     1312  0.1   0  9.9 dd if /dev/zero of /dev/null
   16     0 root     R     1320  0.1   0  0.0 top


remote ❯ kubectl describe --namespace limitrange-test pods nolimit

...
    Limits:
      cpu:     200m
      memory:  100Mi
    Requests:
      cpu:        100m
      memory:     10Mi
...
```

Limits 값이 200인데
2 cpu 이니까, 10 ???

///

ResourceQuota

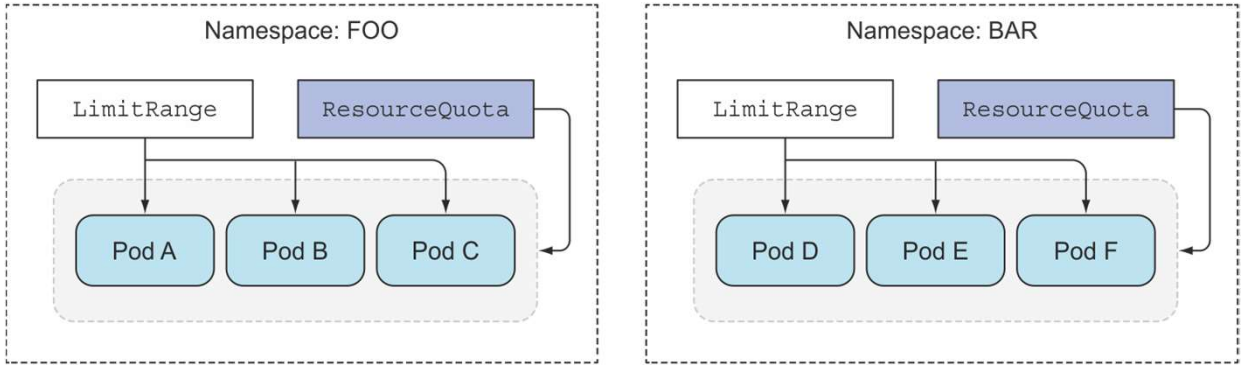
resourcequota.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: quota-all

spec:
  scopes:
  - BestEffort
  - NotTerminating

  hard:
    requests.cpu: 400m
    requests.memory: 200Mi
    limits.cpu: 600m
    limits.memory: 500Mi

    requests.storage: 500Gi
    standard.storageclass.storage.k8s.io/requests.storage: 1Ti
    ssd.storageclass.storage.k8s.io/requests.storage: 300Gi
    ssd.storageclass.storage.k8s.io/persistentvolumeclaims: 2
    pods: 10
    replicationcontrollers: 5
    secrets: 10
    configmaps: 10
    persistentvolumeclaims: 5
    services: 5
    services.loadbalancers: 1
    services.nodeports: 2
```

※ 참고 : https://livebook.manning.com/book/kubernetes-in-action/chapter-14/198

- API 서버에 --enable-admission-plugins= 플래그 인수로 ResourceQuota가 있는 경우 활성화
- 각 Namespace에서 동작. 관리자는 각 네임스페이스에 대해 하나의 리소스 쿼터를 생성
- Namespace에 쿼터가 활성화된 경우 사용자는 CPU, MEMORY값에 request, limit을 지정해야 함
- 리소스 요구사항이 없는 Pod를 기본값으로 설정하려면, LimitRange admission controller를 사용하

※ 참고 : https://velog.io/@idnnbi/kubernetes-Resource-Quotas



///

Break

///

Kubernetes

Monitoring

metrics

```
remote ❯ kubectl get componentstatuses

Warning: v1 ComponentStatus is deprecated in v1.19+
NAME                 STATUS    MESSAGE                         ERROR
controller-manager   Healthy   ok
scheduler            Healthy   ok
etcd-0               Healthy   {"health":"true","reason":""}


remote ❯ kubectl get --namespace kube-system pods ¦ grep metrics

kubernetes-metrics-scraper-6d49f96c97-9clml   1/1     Running   7 (5h34m ago)    12d
metrics-server-6978dd689f-dgst9               1/1     Running   25 (5h34m ago)   46d


remote ❯ kubectl top nodes

NAME      CPU(cores)   CPU%   MEMORY(bytes)   MEMORY%
master    139m         7%     1282Mi          93%
worker1   60m          3%     691Mi           79%
worker2   259m         13%    619Mi           71%


remote ❯ kubectl top pods -A

NAMESPACE         NAME                                       CPU(cores)   MEMORY(bytes)
ingress-nginx     ingress-nginx-controller-778574f59b-pw25s  1m           95Mi
...
limitrange-test   nolimit                                    201m         1Mi
metallb-system    controller-7dcc8764f4-565sc                1m           11Mi
metallb-system    speaker-87zsg                              3m           18Mi
metallb-system    speaker-m4rg4                              4m           20Mi
metallb-system    speaker-xr847                              4m           21Mi
```

[별첨] ComponentStatus – 오류 해결

- `kubectl get componentstatuses` 결과가 정상적으로 나오지 않는 경우 아래와 같이 조치를 취하면 된다.

```
master ❯ sudo nano /etc/kubernetes/manifests/kube-controller-manager.yaml


master ❯ sudo nano /etc/kubernetes/manifests/kube-scheduler.yaml
```

```
...
 #- --port=0
...
```

2개 파일 모두 `--port` 구문을 주석 처리하면 된다

master node에서 진행해야 한다.

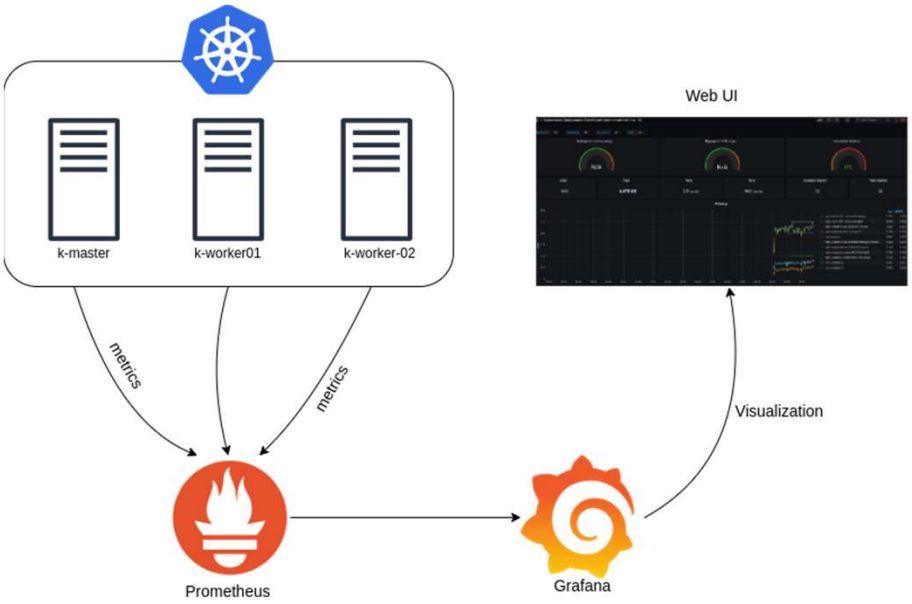
```
remote ❯ kubectl get componentstatuses

Warning: v1 ComponentStatus is deprecated in v1.19+
NAME                 STATUS    MESSAGE                         ERROR
controller-manager   Healthy   ok
scheduler            Healthy   ok
etcd-0               Healthy   {"health":"true","reason":""}
```

///

Prometheus & Grafana

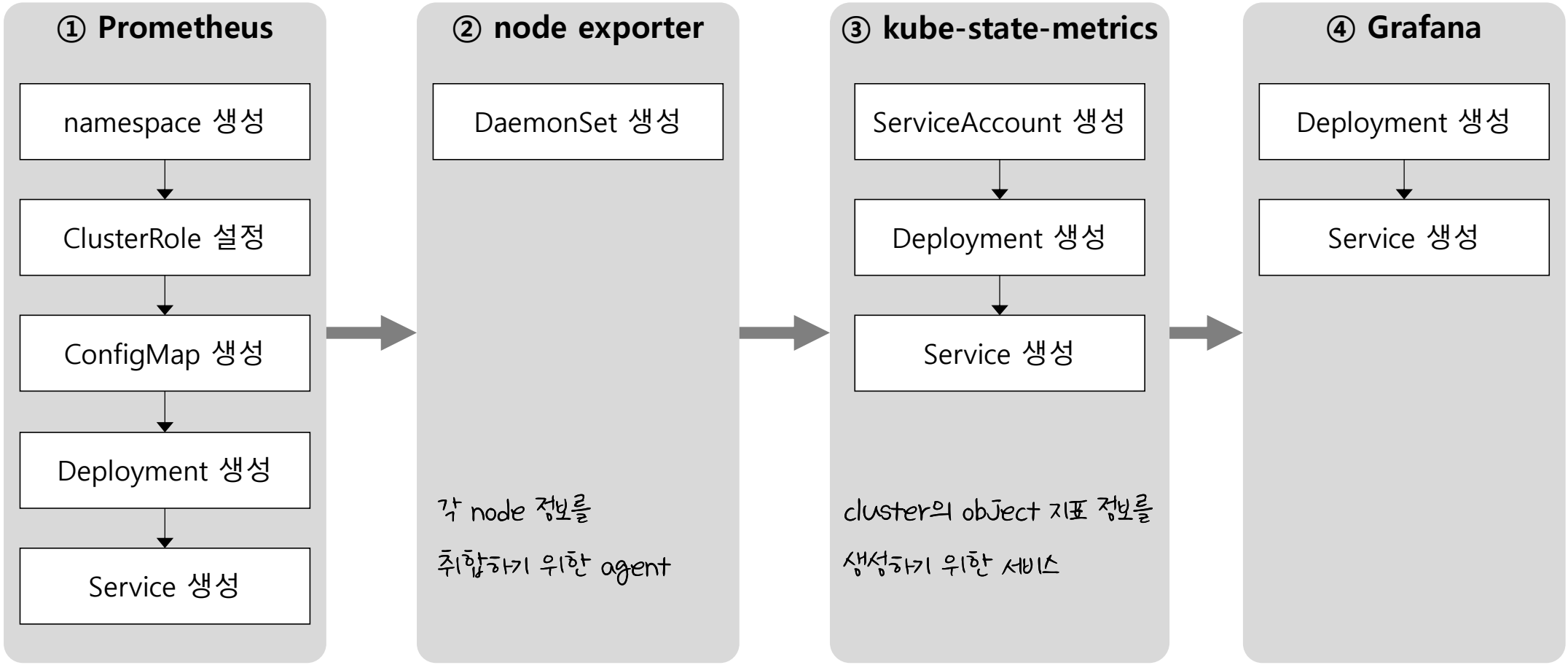
Prometheus

- SoundCloud社에서 만든 오픈소스 모니터링 툴
- go언어로 만들어졌으며, 지금은 독립된 오픈소스 프로젝트로 개발
- Kubernetes 환경에서 모니터링 하기 원하는 리소스로부터 metric을 수집하고 해당 metric을 이용해서 모니터링하는 기능을 제공
- 이상 증세가 발생했을 때 slack이나 여타 다른 webhook을 이용해서 알림을 주는 등 다양한 기능을 제공



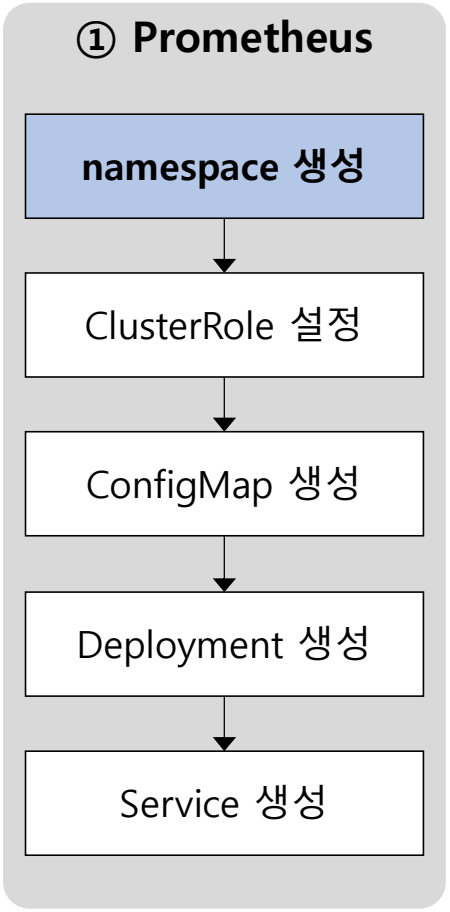
※ 참고 : https://velog.io/@pingping95/Kubernetes-Prometheus-Grafana-모니터링-설치-KVM

Workflow - Overview



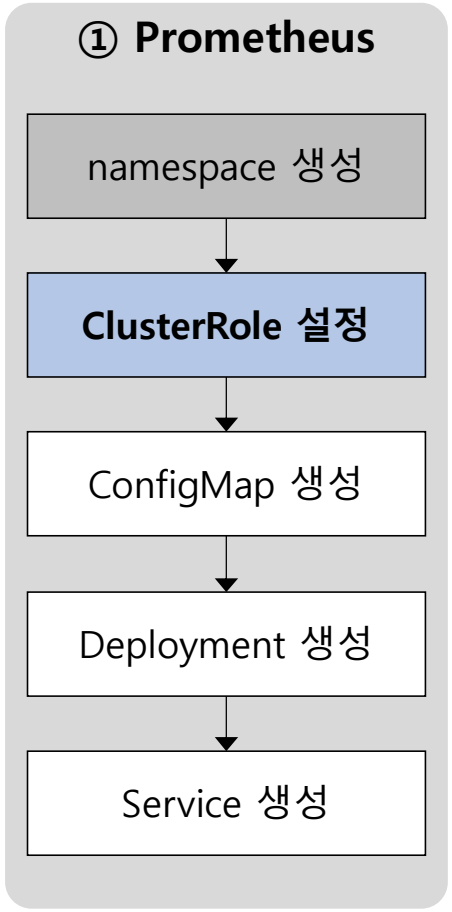
///

Workflow - ① Prometheus




```
remote ❯ kubectl create namespace monitoring

namespace/monitoring created
```

Workflow - ① Prometheus



01-clusterrole.yaml

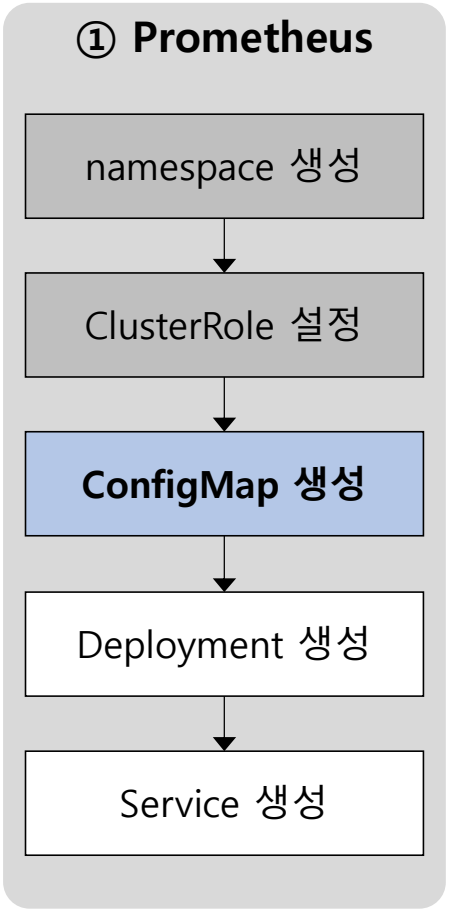
```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: prometheus

rules:
  - apiGroups: [""]
    resources: ["nodes", "nodes/proxy", "services", "endpoints", "pods" ]
    verbs: ["get", "list", "watch"]

  - apiGroups: ["extensions"]
    resources: ["ingresses"]
    verbs: ["get", "list", "watch"]

  - nonResourceURLs: ["/metrics"]
    verbs: ["get"]
```

02-clusterrolebinding.yaml

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: prometheus

roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: prometheus

subjects:
  - kind: ServiceAccount
    name: default
    namespace: monitoring
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/monitoring/01-clusterrole.yaml

clusterrole.rbac.authorization.k8s.io/prometheus created


remote ❯ kubectl create -f 08-week/monitoring/02-clusterrolebinding.yaml

clusterrolebinding.rbac.authorization.k8s.io/prometheus created
```

Workflow - ① Prometheus



03-configmap.yaml

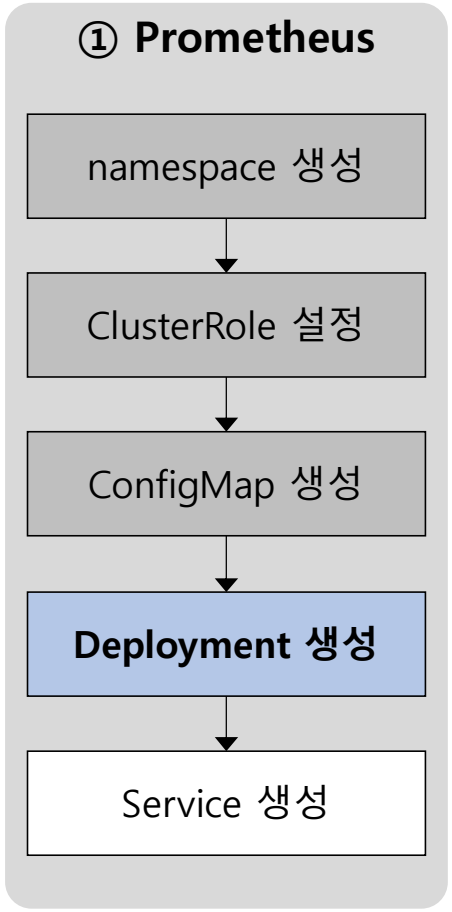
```
apiVersion: v1
kind: ConfigMap
metadata:
  name: prometheus-server-conf
  labels:
    name: prometheus-server-conf
  namespace: monitoring

data:
  prometheus.rules: |-
    groups:
    - name: container memory alert
      rules:
      - alert: container memory usage rate is very high( > 55%)
...

  prometheus.yml: |-
    global:
      scrape_interval: 5s
      evaluation_interval: 5s
...
```

Metric에 대한 Alarm 조건

Metric의 종류, 수집 주기

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/monitoring/03-configmap.yaml

configmap/prometheus-server-conf created
```

Workflow - ① Prometheus

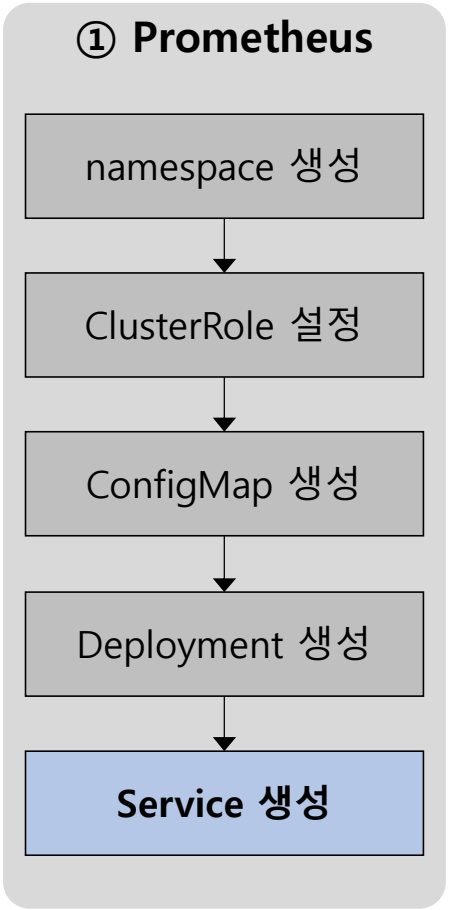


04-deployment.yaml

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: prometheus-deployment
  namespace: monitoring

spec:
  replicas: 1

  selector:
    matchLabels:
      app: prometheus-server

  template:
    metadata:
      labels:
        app: prometheus-server

    spec:
      containers:
        - name: prometheus
          image: prom/prometheus:latest
          args:
            - "--config.file=/etc/prometheus/prometheus.yml"
            - "--storage.tsdb.path=/prometheus/"

          ports:
            - containerPort: 9090

          volumeMounts:
            - name: prometheus-config-volume
              mountPath: /etc/prometheus/
            - name: prometheus-storage-volume
              mountPath: /prometheus/

      volumes:
        - name: prometheus-config-volume
          configMap:
            defaultMode: 420
            name: prometheus-server-conf

        - name: prometheus-storage-volume
          emptyDir: {}
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/monitoring/04-deployment.yaml

deployment.apps/prometheus-deployment created
```

Workflow - ① Prometheus



05-service.yaml

```yaml
apiVersion: v1
kind: Service
metadata:
  name: prometheus
  namespace: monitoring

  annotations:
      prometheus.io/scrape: 'true'
      prometheus.io/port:    '9090'

spec:
  type: LoadBalancer

  ports:
    - name: http
      port: 80
      protocol: TCP
      targetPort: 9090

  selector:
    app: prometheus-server
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/monitoring/05-service.yaml

service/prometheus created
```

///

Workflow - ② node exporter

② node exporter

DaemonSet 생성

06-daemonset.yaml

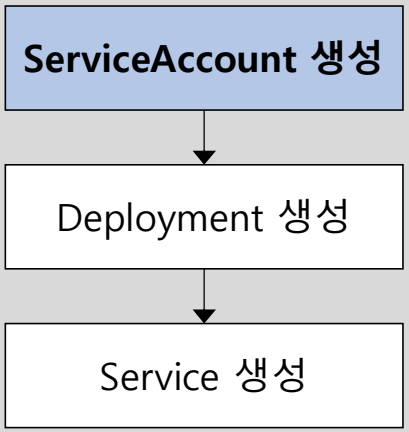
```yaml
apiVersion: apps/v1
kind: DaemonSet
metadata:
  name: node-exporter
  labels:
    k8s-app: node-exporter
  namespace: monitoring

spec:
  selector:
    matchLabels:
      k8s-app: node-exporter

  template:
    metadata:
      labels:
        k8s-app: node-exporter

    spec:
      containers:
      - image: prom/node-exporter
        name: node-exporter
```

```
remote ❯ git clone https://github.com/whatwant-school/advanced-kubernetes.git
remote ❯ cd advanced-kubernetes

remote ❯ kubectl create -f 08-week/monitoring/06-daemonset.yaml

daemonset.apps/node-exporter created
```

///

Workflow - ③ kube-state-metrics

③ kube-state-metrics



08-serviceaccount.yaml

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: kube-state-metrics
  namespace: kube-system
```

10-clusterrolebinding.yaml

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: kube-state-metrics

roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: kube-state-metrics
subjects:
- kind: ServiceAccount
  name: kube-state-metrics
  namespace: kube-system
```

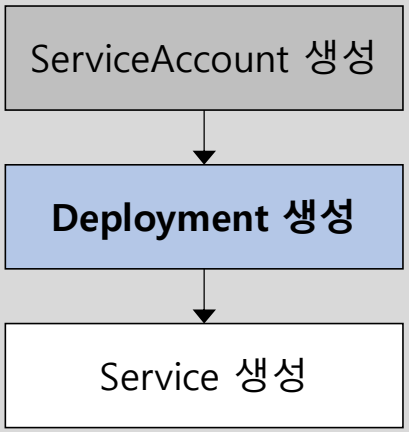
09-clusterrole.yaml

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: kube-state-metrics

rules:
- apiGroups: [""]
  resources: ["configmaps", "secrets", "nodes", "pods", "services", ...]
  verbs: ["list","watch"]

- apiGroups: ["extensions"]
  resources: ["daemonsets", "deployments", "replicasets", "ingresses"]
  verbs: ["list", "watch"]

- apiGroups: ["apps"]
  resources: ["statefulsets", "daemonsets", "deployments", "replicasets"]
  verbs: ["list", "watch"]

- apiGroups: ["batch"]
...
```

```
remote ❯ kubectl create -f 08-week/monitoring/08-serviceaccount.yaml
serviceaccount/kube-state-metrics created

remote ❯ kubectl create -f 08-week/monitoring/09-clusterrole.yaml
clusterrole.rbac.authorization.k8s.io/kube-state-metrics created

remote ❯ kubectl create -f 08-week/monitoring/10-clusterrolebinding.yaml
clusterrolebinding.rbac.authorization.k8s.io/kube-state-metrics created
```

Workflow - ③ kube-state-metrics

③ kube-state-metrics



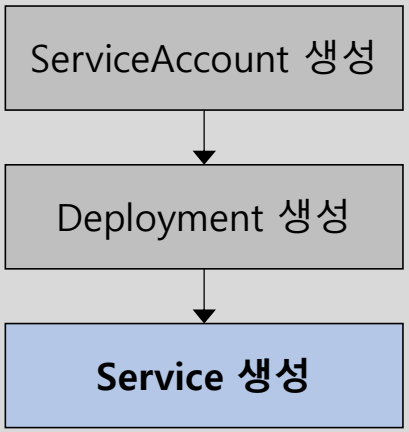
11-deployment.yaml

```yaml
apiVersion: apps/v1
kind: Deployment

metadata:
  name: kube-state-metrics
  labels:
    app: kube-state-metrics
  namespace: kube-system

spec:
  replicas: 1

  selector:
    matchLabels:
      app: kube-state-metrics

  template:
    metadata:
      labels:
        app: kube-state-metrics

    spec:
      containers:
      - image: quay.io/coreos/kube-state-metrics:v1.8.0
        name: kube-state-metrics
        ports:
        - containerPort: 8080
          name: http-metrics
        - containerPort: 8081
          name: telemetry

        livenessProbe:
          httpGet:
            path: /healthz
            port: 8080
          initialDelaySeconds: 5
          timeoutSeconds: 5

        readinessProbe:
          httpGet:
            path: /
            port: 8081
          initialDelaySeconds: 5
          timeoutSeconds: 5

      nodeSelector:
        kubernetes.io/os: linux

      serviceAccountName: kube-state-metrics
```

```
remote ❯ kubectl create -f 08-week/monitoring/11-deployment.yaml

deployment.apps/kube-state-metrics created
```

Workflow - ③ kube-state-metrics

③ kube-state-metrics



12-service.yaml

```yaml
apiVersion: v1
kind: Service

metadata:
  name: kube-state-metrics
  labels:
    app: kube-state-metrics
  namespace: kube-system

spec:
  clusterIP: None

  ports:
  - name: http-metrics
    port: 8080
    targetPort: http-metrics

  - name: telemetry
    port: 8081
    targetPort: telemetry

  selector:
    app: kube-state-metrics
```

Headless Service로 생성

```
remote ❯ kubectl create -f 08-week/monitoring/12-service.yaml

service/kube-state-metrics created
```

///

Workflow - ④ Grafana

④ Grafana

Deployment 생성

↓

Service 생성

13-deployment.yaml

```yaml
apiVersion: apps/v1
kind: Deployment

metadata:
  name: grafana
  namespace: monitoring

spec:
  replicas: 1

  selector:
    matchLabels:
      app: grafana

  template:
    metadata:
      name: grafana
      labels:
        app: grafana

    spec:
      containers:
      - name: grafana
        image: grafana/grafana:latest
        ports:
        - name: grafana
          containerPort: 3000

        env:
        - name: GF_SERVER_HTTP_PORT
          value: "3000"
        - name: GF_AUTH_BASIC_ENABLED
          value: "false"
        - name: GF_AUTH_ANONYMOUS_ENABLED
          value: "true"
        - name: GF_AUTH_ANONYMOUS_ORG_ROLE
          value: Admin
        - name: GF_SERVER_ROOT_URL
          value: /
```

```
remote ❯ kubectl create -f 08-week/monitoring/13-deployment.yaml

deployment.apps/grafana created
```

Workflow - ④ Grafana

④ Grafana

Deployment 생성

↓

Service 생성

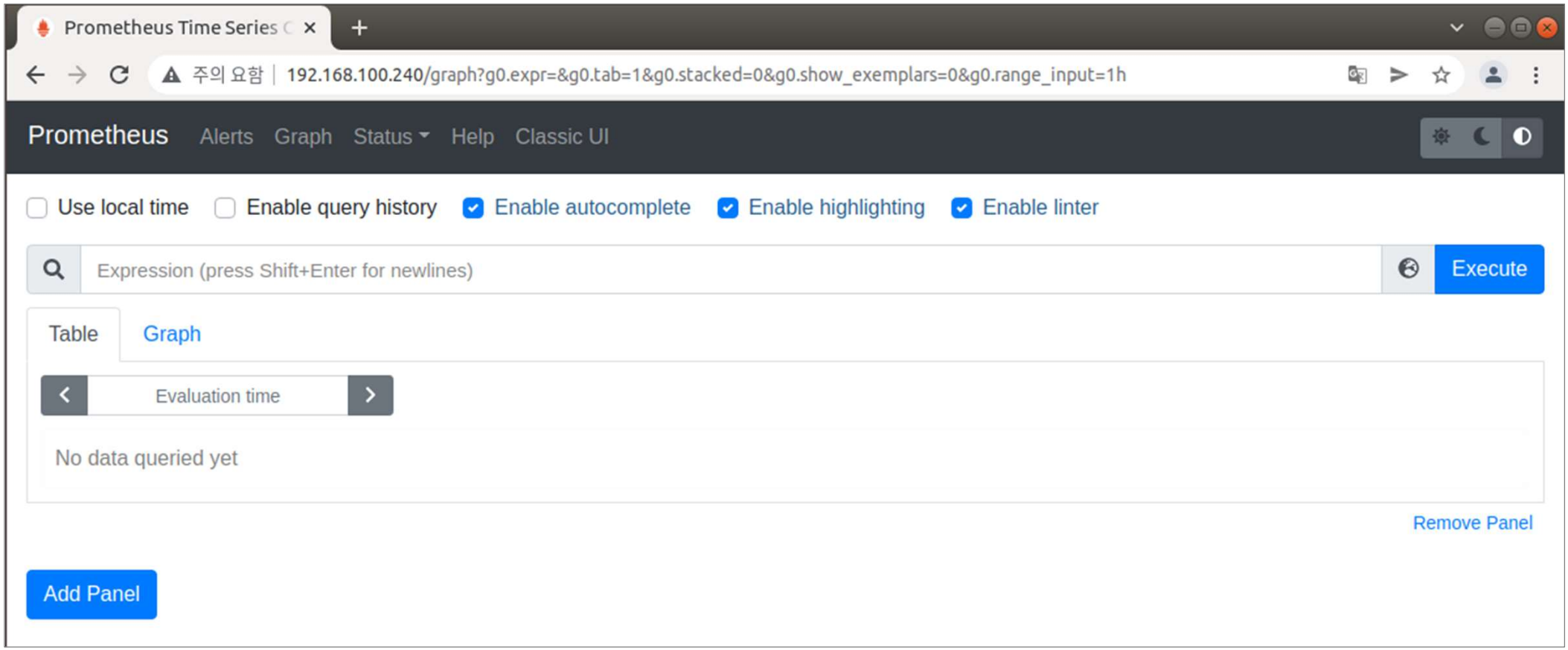
14-service.yaml

```yaml
apiVersion: v1
kind: Service
metadata:
  name: grafana
  annotations:
      prometheus.io/scrape: 'true'
      prometheus.io/port:    '3000'
  namespace: monitoring

spec:
  type: LoadBalancer

  ports:
    - name: http
      port: 80
      protocol: TCP
      targetPort: 3000

  selector:
    app: grafana
```

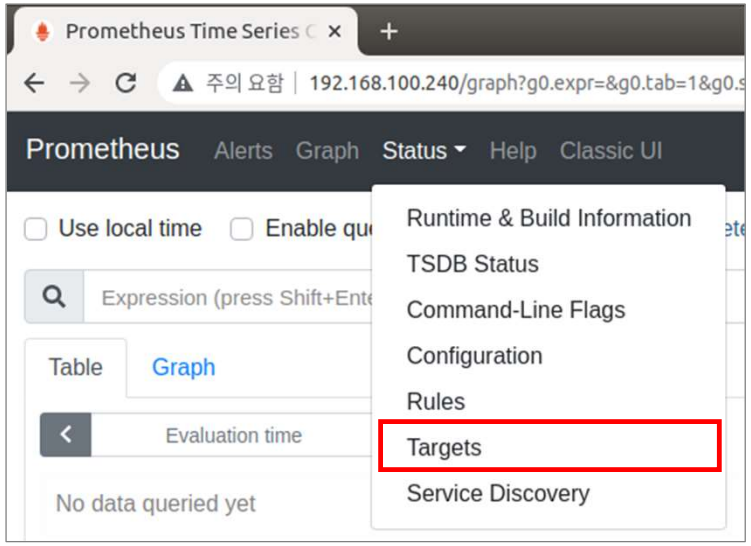
```
remote ❯ kubectl create -f 08-week/monitoring/14-service.yaml

service/grafana created


remote ❯ kubectl get services --namespace monitoring

NAME         TYPE           CLUSTER-IP     EXTERNAL-IP      PORT(S)          AGE
grafana      LoadBalancer   10.233.33.18   192.168.100.241  80:30119/TCP     48s
prometheus   LoadBalancer   10.233.50.69   192.168.100.240  80:31407/TCP     132m
```

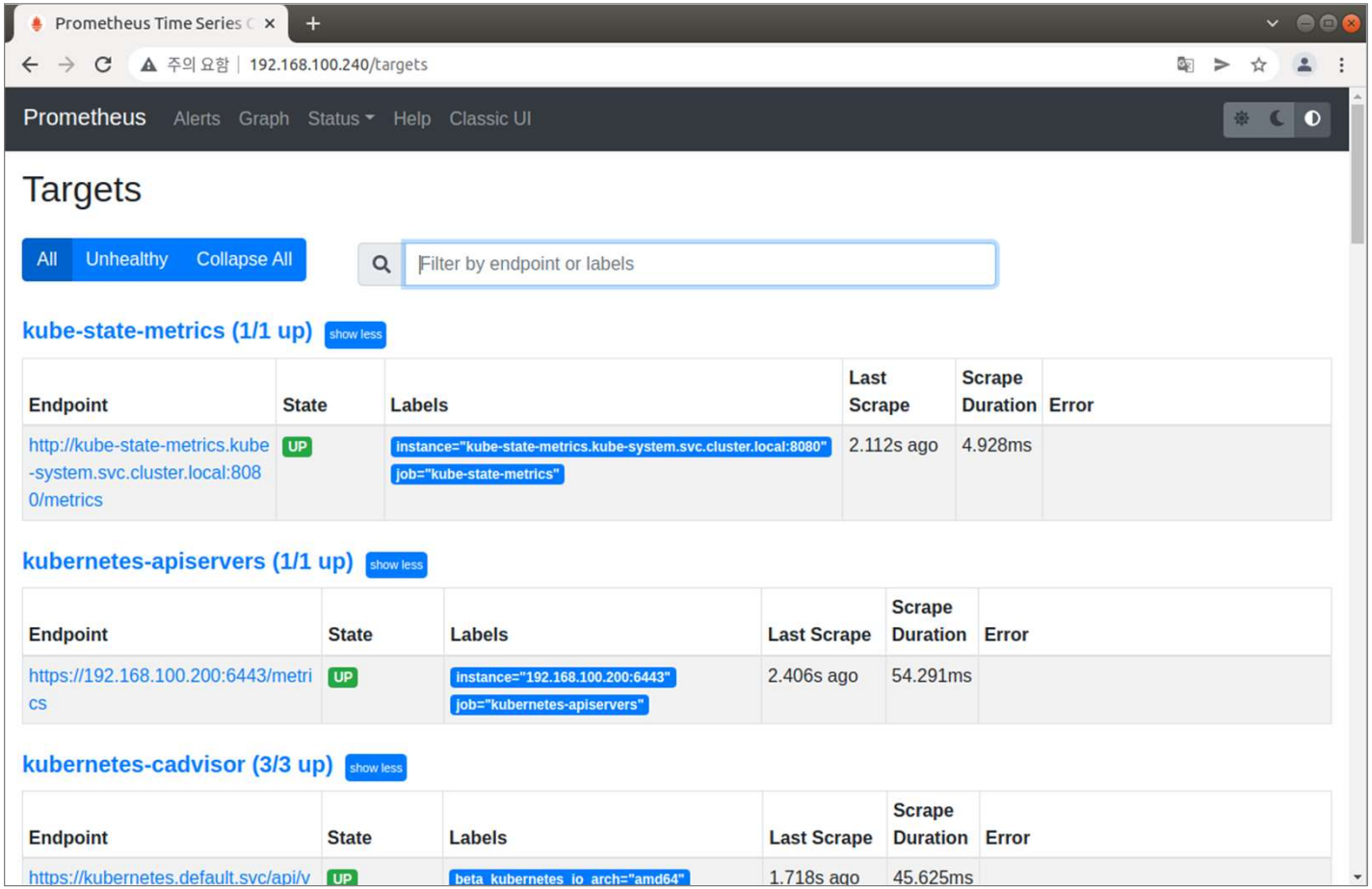
///

Prometheus


Prometheus Time Series
주의 요함 | 192.168.100.240/graph?g0.expr=&g0.tab=1&g0.stacked=0&g0.show_exemplars=0&g0.range_input=1h
Prometheus
Alerts
Graph
Status
Help
Classic UI
Use local time
Enable query history
Enable autocomplete
Enable highlighting
Enable linter
Expression (press Shift+Enter for newlines)
Execute
Table
Graph
Evaluation time
No data queried yet
Remove Panel
Add Panel

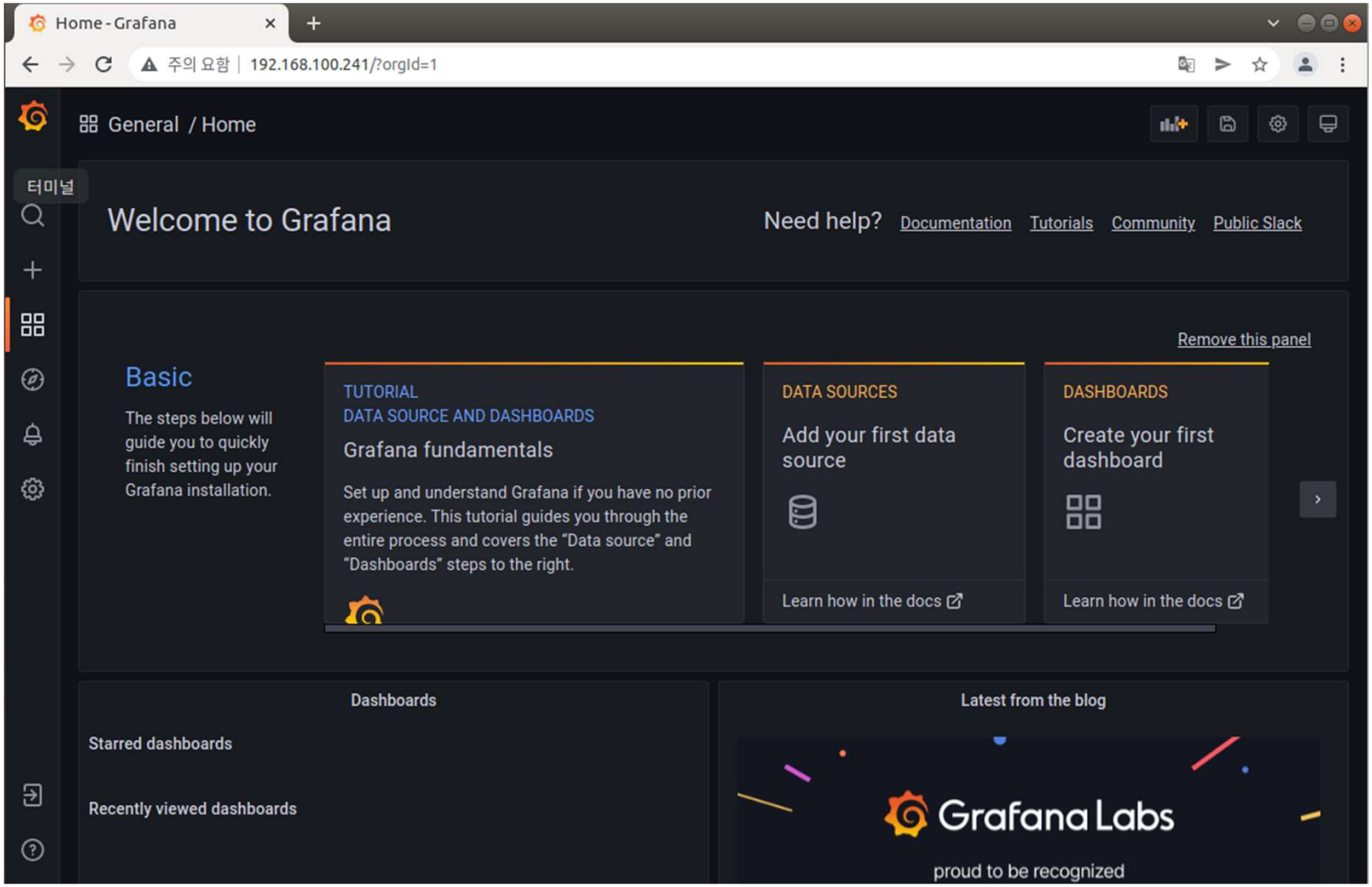
Prometheus : status - Targets



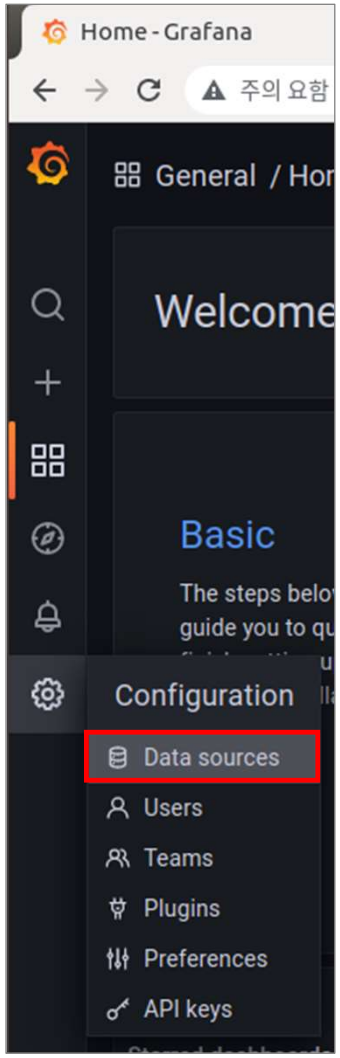


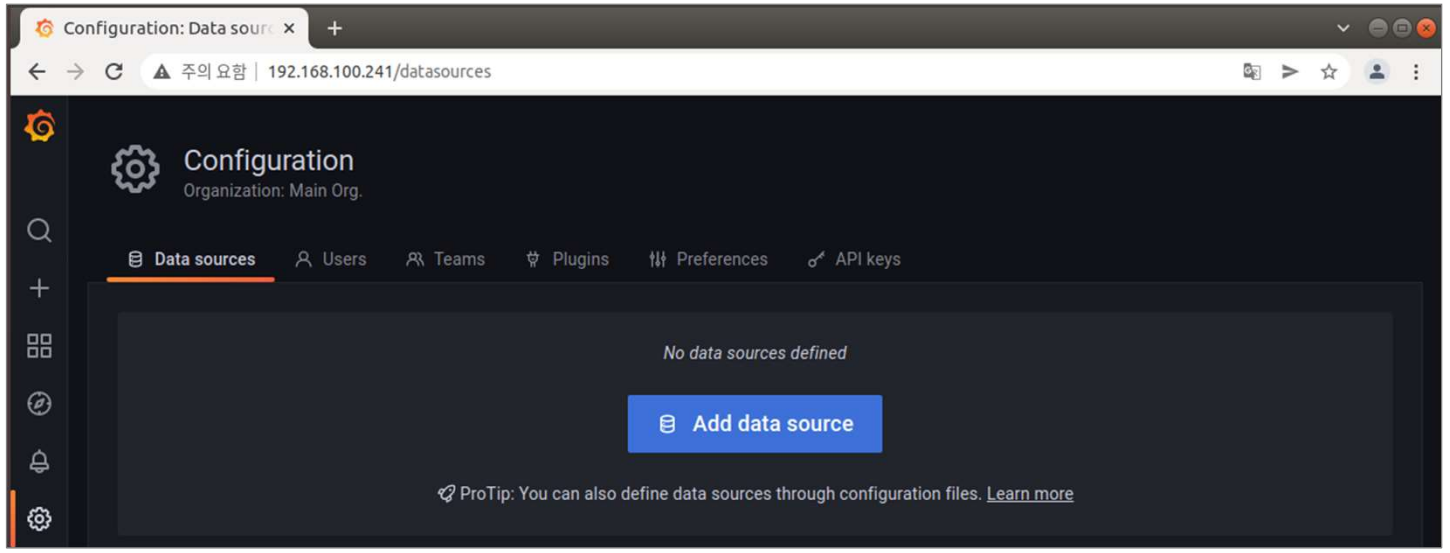
///

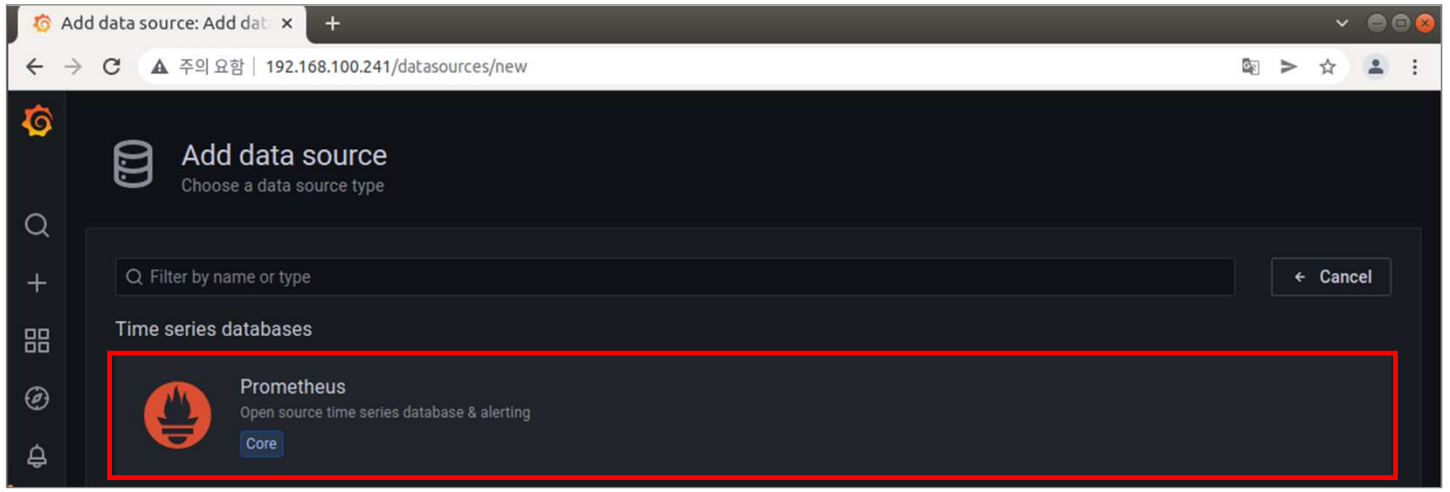
Grafana


Home - Grafana
주의 요함 | 192.168.100.241/?orgId=1
General / Home
터미널
Welcome to Grafana
Need help? Documentation Tutorials Community Public Slack
Remove this panel
Basic
The steps below will guide you to quickly finish setting up your Grafana installation.
TUTORIAL
DATA SOURCE AND DASHBOARDS
Grafana fundamentals
Set up and understand Grafana if you have no prior experience. This tutorial guides you through the entire process and covers the "Data source" and "Dashboards" steps to the right.
DATA SOURCES
Add your first data source
Learn how in the docs
DASHBOARDS
Create your first dashboard
Learn how in the docs
Dashboards
Starred dashboards
Recently viewed dashboards
Latest from the blog
Grafana Labs
proud to be recognized

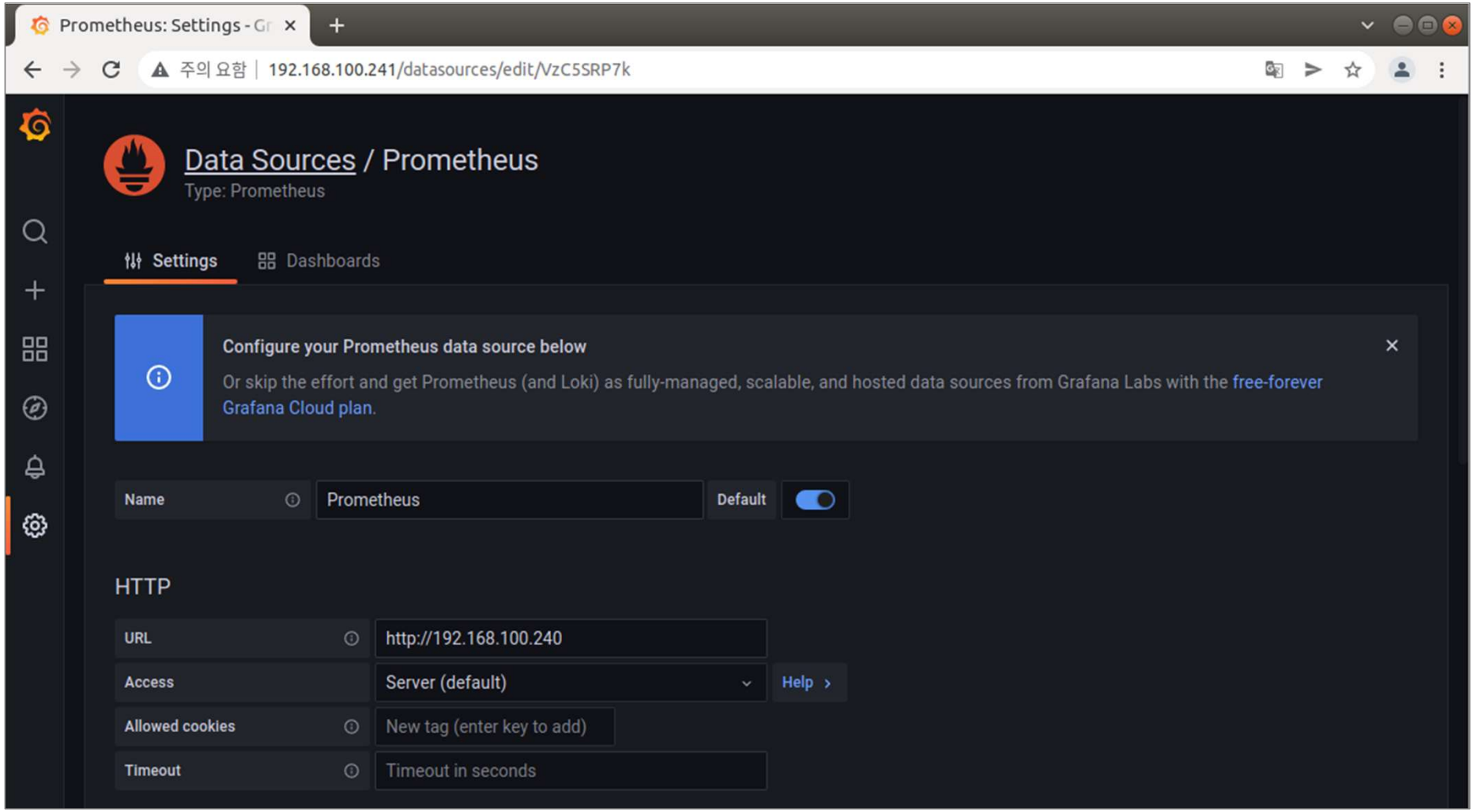
Grafana : Configuration - Data sources - 1/2



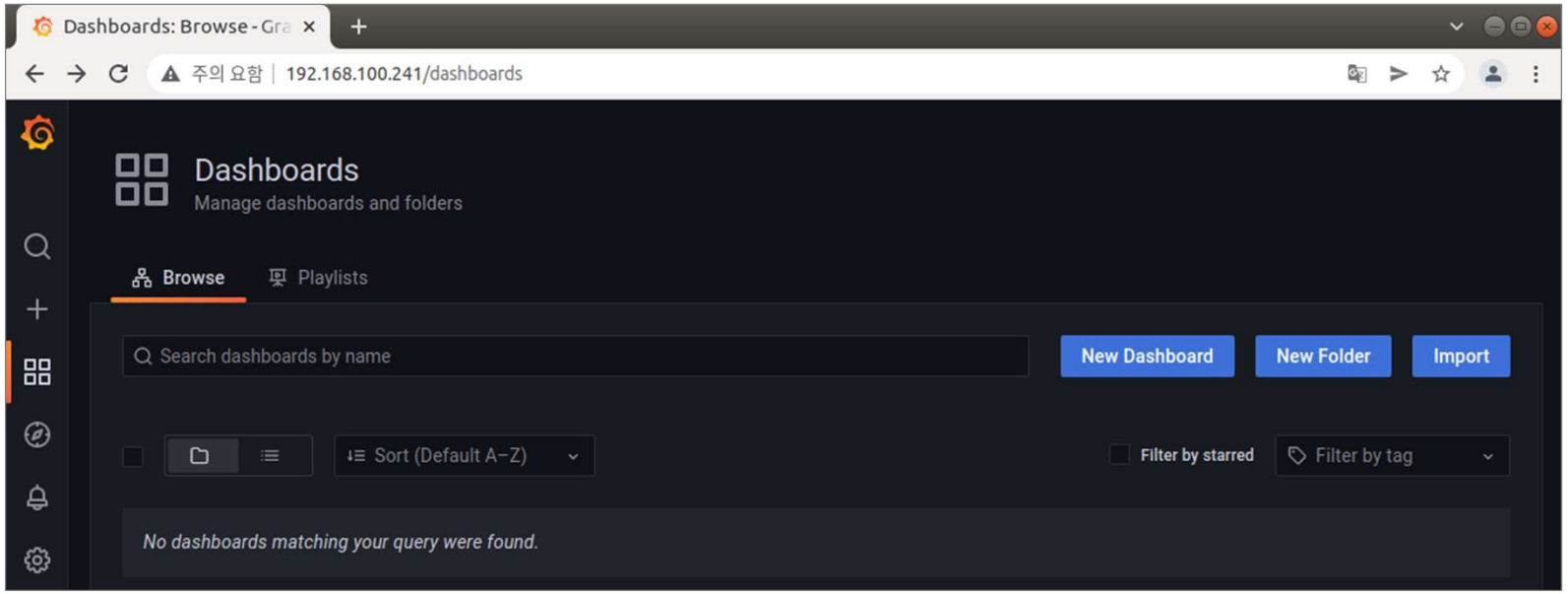


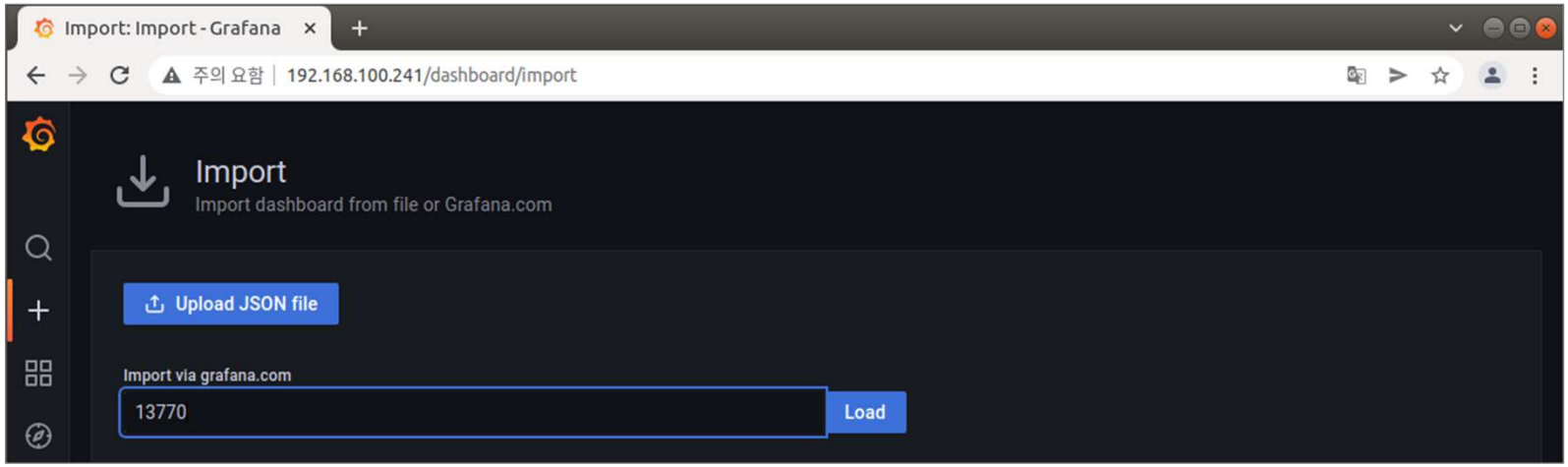


Grafana : Configuration - Data sources - 2/2

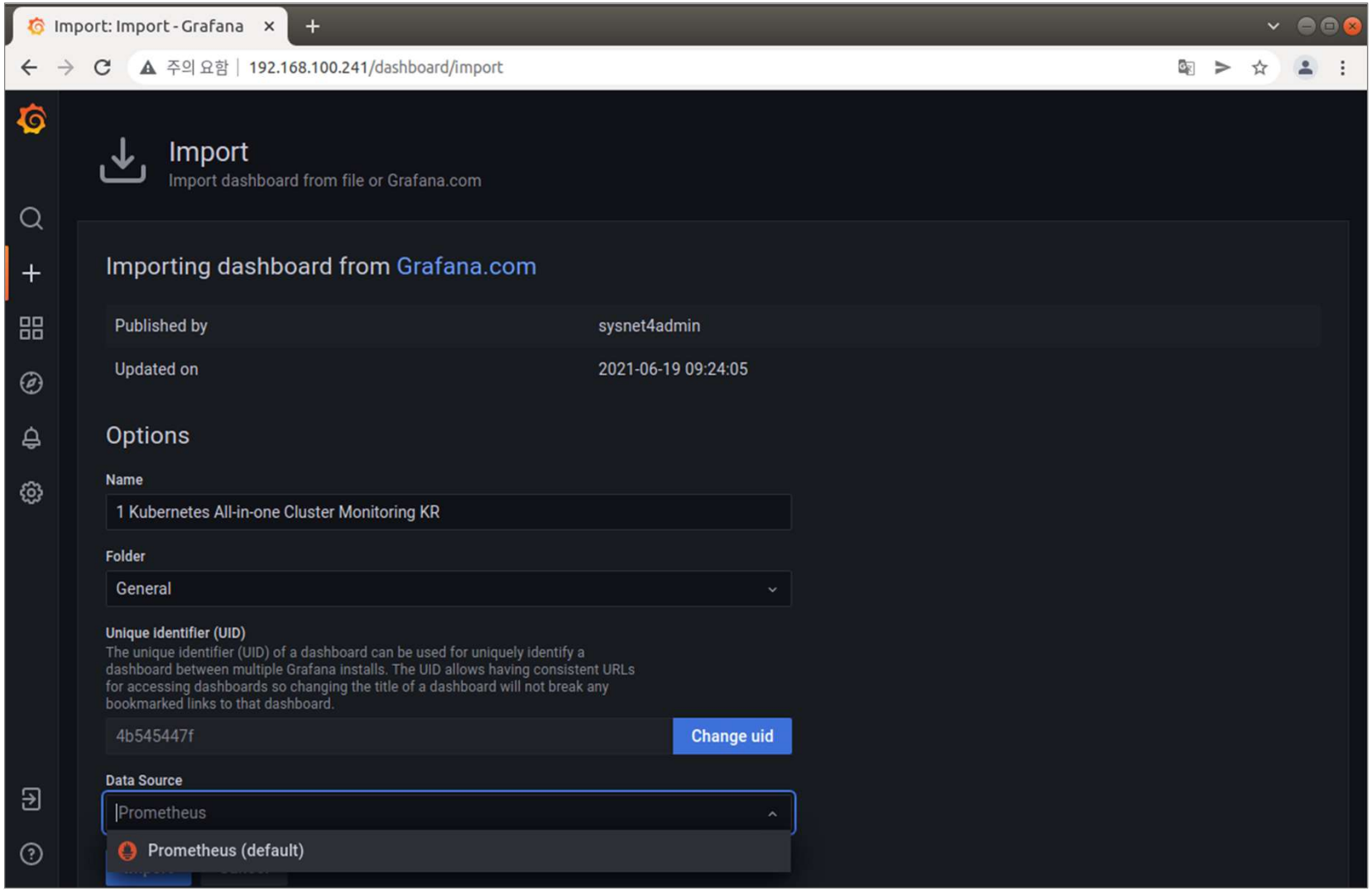


Grafana : Dashboard - Import - 1/2

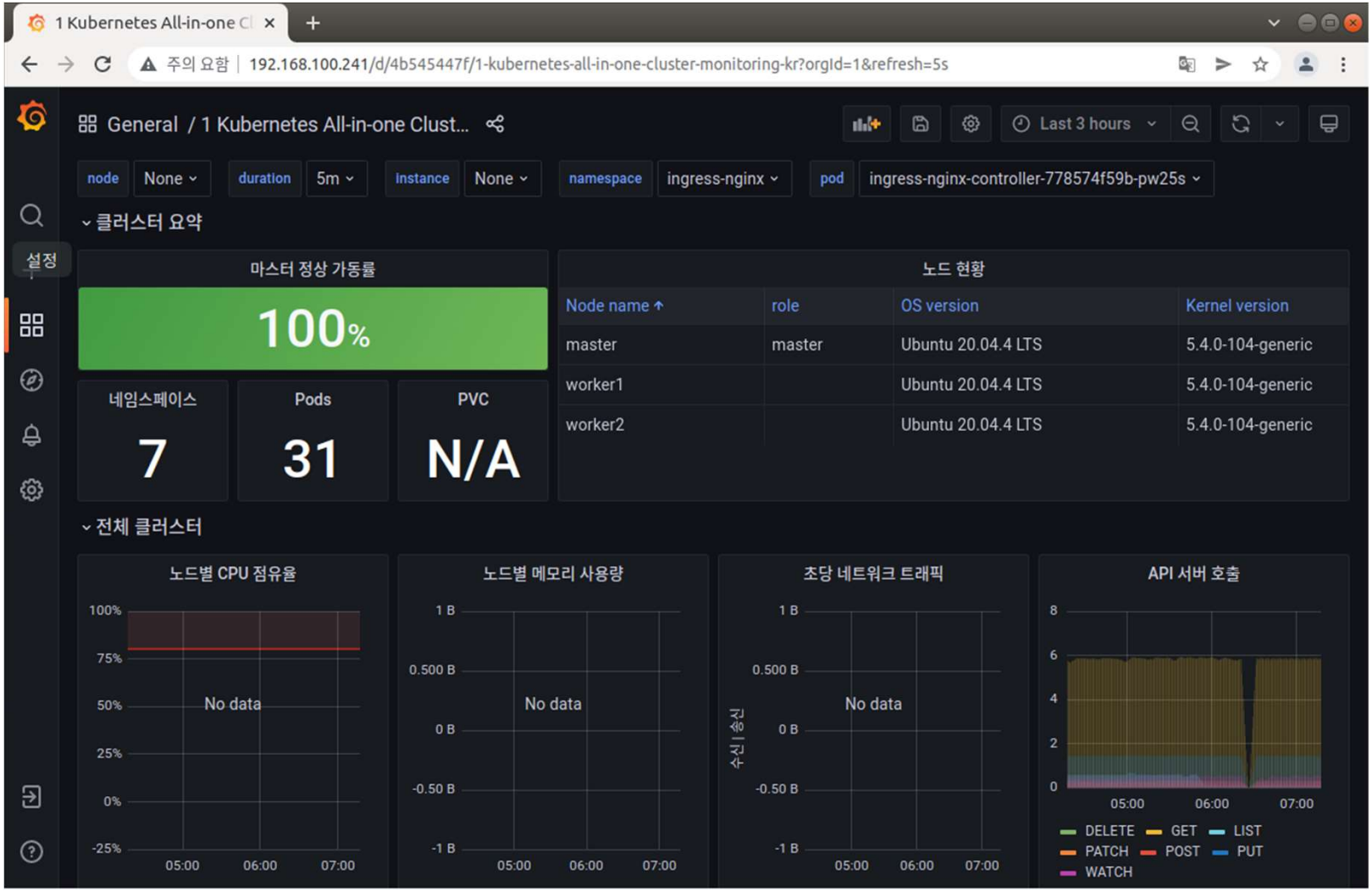




Grafana : Dashboard - Import - 2/2



Grafana : Dashboard



///

Kubernetes

PodSecurityPolicy

PodSecurityPolicy is ...

- Pod의 Security 관련 항목들을 제어하는 cluster-레벨의 리소스

- K8s v1.21 deprecated / v1.25 removed

Control Aspect	Field Names
특권을 가진(privileged) 컨테이너의 실행	`privileged`
호스트 네임스페이스의 사용	`hostPID` , `hostIPC`
호스트 네트워킹과 포트의 사용	`hostNetwork` , `hostPorts`
볼륨 유형의 사용	`volumes`
호스트 파일시스템의 사용	`allowedHostPaths`
특정 FlexVolume 드라이버의 허용	`allowedFlexVolumes`
파드 볼륨을 소유한 FSGroup 할당	`fsGroup`
읽기 전용 루트 파일시스템 사용 필요	`readOnlyRootFilesystem`
컨테이너의 사용자 및 그룹 ID	`runAsUser` , `runAsGroup` , `supplementalGroups`
루트 특권으로의 에스컬레이션 제한	`allowPrivilegeEscalation` , `defaultAllowPrivilegeEscalation`
리눅스 기능	`defaultAddCapabilities` , `requiredDropCapabilities` , `allowedCapabilities`
컨테이너의 SELinux 컨텍스트	`seLinux`
컨테이너에 허용된 Proc 마운트 유형	`allowedProcMountTypes`
컨테이너가 사용하는 AppArmor 프로파일	어노테이션
컨테이너가 사용하는 seccomp 프로파일	어노테이션
컨테이너가 사용하는 sysctl 프로파일	`forbiddenSysctls` , `allowedUnsafeSysctls`

※ 참고 : https://kubernetes.io/ko/docs/concepts/policy/pod-security-policy/

K8s：PodSecurityPolicy Hands-On

PodSecurityPolicy Create

PodSecurityPolicy Admission Controller를 활성화 해야 하는데,
활성화 되었을 때 PodSecurityPolicy 리소스가 없을 경우 Pod 생성 및 업데이트 할 때 정상적으로 동작하지 않을 수 있다.
즉, PodSecurityPolicy Admission Controller 활성화 하기 전에 PodSecurityPolicy를 1개 이상 미리 등록해 놓는 것이 좋다.

podsecuritypolicy.yaml

```yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy

metadata:
  name: privileged
  annotations:
    seccomp.security.alpha.kubernetes.io/allowedProfileNames: '*'

spec:
  privileged: true
  allowPrivilegeEscalation: true
  allowedCapabilities:
  - '*'
  volumes:
  - '*'
  hostNetwork: true
  hostPorts:
  - min: 0
    max: 65535
  hostIPC: true
  hostPID: true
  runAsUser:
    rule: 'RunAsAny'
  seLinux:
    rule: 'RunAsAny'
  supplementalGroups:
    rule: 'RunAsAny'
  fsGroup:
    rule: 'RunAsAny'
```

```
remote ❯ cd advanced-kubernetes/inbox/psp

remote ❯ kubectl create -f ./podsecuritypolicy.yaml

remote ❯ kubectl get podsecuritypolicies -o wide
```

ClusterRole / ClusterRoleBinding Create

대부분 RBAC 권한 체계를 사용하고 있을 것이고,
그렇다면, 정책 사용 권한을 부여하기 위해 ClusterRole / ClusterRoleBinding 리소스를 생성해 놓자 !

clusterrole.yaml

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole

metadata:
  name: privileged-psp

rules:
- apiGroups: ['policy']
  resources: ['podsecuritypolicies']
  verbs:     ['use']
  resourceNames:
  - privileged
```

clusterrolebinding.yaml

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding

metadata:
  name: privileged-psp-system-authenticated

roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: privileged-psp

subjects:
  - kind: Group
    apiGroup: rbac.authorization.k8s.io
    name: system:authenticated
```

```
remote ❯ cd advanced-kubernetes/inbox/psp

remote ❯ kubectl create -f ./clusterrole.yaml

remote ❯ kubectl create -f ./clusterrolebinding.yaml

remote ❯ kubectl get clusterroles -o wide

remote ❯ kubectl get clusterrolebindings -o wide
```

PodSecurityPolicy Admission Controller Enable - 1/2

Admission Controller 중에서 'PodSecurityPolicy'를 추가해줘야 한다(enable).
master node로 접속해서 YAML 파일을 수정하고 반영해주자 !

```
remote ❯ ssh vagrant@192.168.100.200

master ❯ cd /etc/kubernetes/manifests/

master ❯ sudo nano ./kube-apiserver.yaml
```

```
...
spec:
  containers:
  - command:
    - kube-apiserver
    - --advertise-address=192.168.100.200
    - --allow-privileged=true
    - --anonymous-auth=True
    - --apiserver-count=1
    - --authorization-mode=Node,RBAC
    - --bind-address=0.0.0.0
    - --client-ca-file=/etc/kubernetes/ssl/ca.crt
    - --default-not-ready-toleration-seconds=300
    - --default-unreachable-toleration-seconds=300
    - --enable-admission-plugins=NodeRestriction,PodSecurityPolicy
    - --enable-aggregator-routing=False
    - --enable-bootstrap-token-auth=true
    - --endpoint-reconciler-type=lease
...
```

PodSecurityPolicy Admission Controller Enable - 2/2

```
master ❯ sudo kubectl apply -f kube-apiserver.yaml

master ❯ kubectl describe pod --namespace kube-system kube-apiserver-master

Name:                 kube-apiserver-master
Namespace:            kube-system
...
Containers:
  kube-apiserver:
    Container ID:  docker://4c7d91c3358b4e770b0d3ddc5e3a742ebfd28c775d897ab3062afb9c24b9bbe7
    Image:         k8s.gcr.io/kube-apiserver:v1.20.7
    Image ID:      docker-pullable://k8s.gcr.io/kube-apiserver@sha256:5ab3d676c426bfb272fb7605e6978b90d5676913636a6105688862849961386f
    Port:          <none>
    Host Port:     <none>
    Command:
      kube-apiserver
      --advertise-address=192.168.100.200
      --allow-privileged=true
      --anonymous-auth=True
      --apiserver-count=1
      --authorization-mode=Node,RBAC
      --bind-address=0.0.0.0
      --client-ca-file=/etc/kubernetes/ssl/ca.crt
      --default-not-ready-toleration-seconds=300
      --default-unreachable-toleration-seconds=300
      --enable-admission-plugins=NodeRestriction,PodSecurityPolicy
      --enable-aggregator-routing=False
      --enable-bootstrap-token-auth=true
...
```

Privileged Example - 1/2

privileged 정책이 잘 적용이 되는지 확인 해 보자

pod-non-privileged.yaml

```yaml
apiVersion: v1
kind: Pod

metadata:
  name: pod-non-privileged

spec:
  containers:
  - name: main
    image: alpine
    command: ["/bin/sleep", "999999"]
```

pod-privileged.yaml

```yaml
apiVersion: v1
kind: Pod

metadata:
  name: pod-privileged

spec:
  containers:
  - name: main
    image: alpine
    command: ["/bin/sleep", "999999"]

    securityContext:
      privileged: true
```

```
remote ❯ cd advanced-kubernetes/inbox/psp

remote ❯ kubectl create -f ./pod-non-privileged.yaml

remote ❯ kubectl create -f ./pod-privileged.yaml
```

Privileged Example - 2/2

`privileged: true` 적용한 경우, host의 내역까지 모두 나오고 있는 것을 볼 수 있다.

```
remote ❯ kubectl exec -it pod-non-privileged -- ls /dev

core            null            shm             termination-log
fd              ptmx            stderr          tty
full            pts             stdin           urandom
mqueue          random          stdout          zero
```

```
remote ❯ kubectl exec -it pod-privileged -- ls /dev

autofs          sda2            tty41           ttyS28
bsg             sda3            tty42           ttyS29
btrfs-control   sg0             tty43           ttyS3
bus             sg1             tty44           ttyS30
core            shm             tty45           ttyS31
cpu             snapshot        tty46           ttyS4
cpu_dma_latency snd             tty47           ttyS5
cuse            sr0             tty48           ttyS6
dm-0            stderr          tty49           ttyS7
dri             stdin           tty5            ttyS8
ecryptfs        stdout          tty50           ttyS9
fb0             termination-log tty51           ttyprintk
fd              tty             tty52           udmabuf
full            tty0            tty53           uhid
fuse            tty1            tty54           uinput
hidraw0         tty10           tty55           urandom
hpet            tty11           tty56           userio
hwrng           tty12           tty57           vboxguest
i2c-0           tty13           tty58           vboxuser
input           tty14           tty59           vcs
kmsg            tty15           tty6            vcs1
lightnvm        tty16           tty60           vcs2
loop-control    tty17           tty61           vcs3
...
```