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## CKS Simulator Kubernetes 1.19

<https://killer.sh>

### Pre Setup

Once you've gained access to your terminal it might be wise to spend ~1 minute to setup your environment. Set these:

```
alias k=kubectl

export do="--dry-run=client -o yaml" # like short for dry output. use whatever you like
```

### vim

To make `vim` use 2 spaces for a tab edit `~/.vimrc` to contain:

```
set tabstop=2
set expandtab
set shiftwidth=2
```

More setup suggestions are in the tips section of the CKS Simulator.

## Question 0 | Instructions

You should avoid using deprecated `kubect1` commands as these might not work in the exam.

There are three Kubernetes clusters and 7 nodes in total:

- cluster1-master1
- cluster1-worker1
- cluster1-worker2
- cluster2-master1
- cluster2-worker1
- cluster3-master1
- cluster3-worker1

### Rules

You're only allowed to have one other browser tab open with

- <https://kubernetes.io/docs>
- <https://github.com/kubernetes>
- <https://kubernetes.io/blog>
- <https://github.com/aquasecurity/trivy>
- <https://docs.sysdig.com>
- <https://falco.org/docs>
- <https://gitlab.com/apparmor/apparmor/-/wikis/Documentation>

### Notes

You have a notepad (top right) where you can store plain text. This is useful to store questions you skipped and might try again at the end.

### Difficulty

This simulator is more difficult than the real certification. We think this gives you a greater learning effect and also confidence to score in the real exam. Most of the simulator scenarios require good amount of work and can be considered "hard". In the real exam you will also face these "hard" scenarios, just less often.

### SSH Access

As the `k8s@terminal` user you can connect via `ssh` to every node, like `ssh cluster1-master1`. Using `kubect1` as root user on a master node you can connect to the api-server of just that cluster.

### File system

User `k8s@terminal` has root permissions using `sudo` should you face permission issues. Whenever you're asked to write or edit something in `/opt/course/...` it should be done so in your main terminal and not on any of the master or worker nodes.

### K8s contexts

Using `kubect1` from `k8s@terminal` you can reach the api-servers of all available clusters through different pre-configured contexts. The command to switch to the correct Kubernetes context will be listed on top of every question when needed.

### Ctrl/Cmd-F Search

Do not use the browser search via `Ctrl-F` or `Cmd-F` beause this will render the brower terminal unusuable. If this happened you can simply reload your browser page.

## Question 1 | Contexts

Task weight: 1%

You have access to multiple clusters from your main terminal through `kubect1` contexts. Write all context names into `/opt/course/1/contexts`, one per line.

From the kubeconfig extract the certificate of user `restricted@infra-prod` and write it decoded to `/opt/course/1/cert`.

### Answer:

Maybe the fastest way is just to run:

```
k config get-contexts # copy by hand

k config get-contexts -o name
```

Or using `jsonpath`:

```
k config view -o jsonpath="{.contexts[*].name}"
k config view -o jsonpath="{.contexts[*].name}" | tr " " "\n" # new lines
k config view -o jsonpath="{.contexts[*].name}" | tr " " "\n" > /opt/course/1/contexts
```

The content could then look like:

```
# /opt/course/1/contexts
gianna@infra-prod
infra-prod
restricted@infra-prod
workload-prod
workload-stage
```

For the certificate we could just run

```
k config view --raw
```

And copy it manually. Or we do:

```
k config view --raw -ojsonpath="{.users[2].user.client-certificate-data}" | base64 -d > /opt/course/1/cert
```

Or even:

```
k config view --raw -ojsonpath="{.users[?(.name == 'restricted@infra-prod')].user.client-certificate-data}" | base64 -d > /opt/course/1/cert
```

```
# /opt/course/1/cert
-----BEGIN CERTIFICATE-----
MIIDHZCCAgEgAwIBAgIQN5Qe/Rj/PhaqckEI23LPnjANBgkqhkiG9w0BAQsFADAV
MRMwEQYDVQQDEwprdwJlcm5ldGVzMB4XDTIwMDkyNjIwNTUwN0xMDkyNjIw
NTUwN0wKJkETMBEGA1UEChMkcmlvZDh3R1ZDETMDEGA1UEAxMKcmVzdHJpY3R1
ZDCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAL/Jaf/QQdi j y JTWIDi j
qa5p4oAh+xDBX3jR9R0G5DkmPU/FgXjxej3rTWHJbuxg7qjTuqQbf9Fb2AHcvtwH
guJc120DUDE+nvtap+hCe80LHZwH7BGFwWscgInZ0Zw2IATK/YdqyQL50KpQpFkx
iAknVZmPa2DTZ8FoyRESboFSTZj6y+JVA7ot0pM09jnxswsta19GZLeqioqFFGY6
YB0/Dg4DDsbkhqfuwJVT6Ur3ELsktZIMTRS5By4Xz18798eBiFAHvgJGq1TTwuPM
Eh8fwywgYba1L8DSHeFre1LBKgc iwUKjr1l01nnuc1vhkX1peV1J3xr f6o2KkyMc
1Y0CAwEAAANWMFQWdgYDVR0PAAQH/BAQDAGwMBMGA1udJQQMMAoGCCSGAQUBwMC
MAwGA1udEwEB/wQCMAAwHwYDVROjBBgwFoAUPr spZiWR7YMN8vT5DF3s/Lvp xPQw
DQYJKoZIhvcNAQELBQADggEBAIDq0Zt77gXI1s+uw46zBw4mIWga1BL12QqCuwmV
kd86eH5bd0Fctw1b6vGdcKpDfccHh8Z6z2LjjLu6Uo iGudIJaALhbyNjiXxi/7cf
M7sqNOxpxQ5X5hyvOBYD1w7d/EzPHV/lcbXPUDYFHNqBYS842LWST1PQioDpupXp
FFUQPXsenNXDa4TbmaRvnK2jka0yXcqdiXuIteZZovp/IgnkfmX2Ld4/Q+X1nscf
CftwbjRa/0w/3EW/ghQ7xtc7bgcOHJeso iTZPCZ+dfkuUfH6d1qxgj6Jwt0HtyEf
QTQSc66BdMLnw5DMObs41XDo2YE6LvMrysDxm/S7img5YZU=
-----END CERTIFICATE-----
```

## Question 2 | Runtime Security with Falco

Task weight: 4%

Use context: `kubect1 config use-context workload-prod`

Falco is installed with default configuration on node `cluster1-worker1`. Connect using `ssh cluster1-worker1`. Use it to:

- Find a *Pod* running image `nginx` which creates unwanted package management processes inside its container.
- Find a *Pod* running image `httpd` which modifies `/etc/passwd`.

Save the Falco logs for case 1 under `/opt/course/2/falco.log` in format `[time][container-id][container-name][user-name]`. No other information should be in any line. Collect the logs for at least 30 seconds.

Afterwards remove the threads (both 1 and 2) by scaling the replicas of the *Deployments* that control the offending *Pods* down to 0.

Answer:

[Falco](#), the open-source cloud-native runtime security project, is the de facto Kubernetes threat detection engine.

**NOTE:** Other tools you might have to be familiar with are [sysdig](#) or [tracee](#)

### Use Falco as service

First we can investigate Falco config a little:

```
→ ssh cluster1-worker1

→ root@cluster1-worker1:~# service falco status
• falco.service - LSB: Falco syscall activity monitoring agent
  Loaded: loaded (/etc/init.d/falco; generated)
  Active: active (running) since Sat 2020-10-10 06:36:15 UTC; 2h 1min ago
  ...

→ root@cluster1-worker1:~# cd /etc/falco

→ root@cluster1-worker1:/etc/falco# ls
falco.yaml  falco_rules.local.yaml  falco_rules.yaml  k8s_audit_rules.yaml  rules.available  rules.d
```

This is the default configuration, if we look into `falco.yaml` we can see:

```
# /etc/falco/falco.yaml

...
# Where security notifications should go.
# Multiple outputs can be enabled.

syslog_output:
  enabled: true
...
```

This means that Falco is writing into syslog, hence we can do:

```
→ root@cluster1-worker1:~# cat /var/log/syslog | grep falco
Oct  9 21:46:55 ubuntu-bionic falco: Falco version 0.26.1 (driver version
2aa88dcf6243982697811df4c1b484bcbe9488a2)
Oct  9 21:46:55 ubuntu-bionic falco: Falco initialized with configuration file /etc/falco/falco.yaml
...
```

Yep, something going on in there. Let's investigate the first offending *Pod*:

```
→ root@cluster1-worker1:~# cat /var/log/syslog | grep falco | grep nginx | grep process
Oct  9 23:14:49 ubuntu-bionic falco: 23:14:49.070029616: Error Package management process launched in
container (user=root user_loginuid=-1 command=apk container_id=b51765aeafcb
container_name=k8s_nginx_webapi-6b797d5b65-7mxz7_team-blue_a0221829-d3ee-4c72-bfac-496a16e1c3fc_0
image=nginx:1.19.2-alpine)
...
```

And for the second *Pod*:

```
→ root@cluster1-worker1:~# cat /var/log/syslog | grep falco | grep httpd | grep passwd
Oct  9 23:26:19 ubuntu-bionic falco: 23:26:19.950348409: Error File below /etc opened for writing
(user=root user_loginuid=-1 command=sed -i $d /etc/passwd parent=sh pcmdline=sh -c echo hacker >>
/etc/passwd; sed -i '$d' /etc/passwd; true file=/etc/passwdJPAmIk program=sed gparent=<NA> ggparent=<NA>
gggparent=<NA> container_id=d9ce1e213996 image=httpd)

→ root@cluster1-worker1:~# docker ps | grep d9ce1e213996
d9ce1e213996          35ab485181ce          "httpd-foreground"    3 minutes ago        Up
3 minutes            k8s_httpd_rating-service-5c54c948c9-fnv2_team-purple_02083909-c6f5-
4f87-bab3-fae9de2fc55a_0
```

Use Falco from command line

We can also use Falco directly from command line, even if the service is disabled, like this:

```
→ root@cluster1-worker1:~# service falco stop

→ root@cluster1-worker1:~# falco
Sat Dec  5 19:58:29 2020: Falco version 0.26.1 (driver version 2aa88dcf6243982697811df4c1b484bcbe9488a2)
Sat Dec  5 19:58:29 2020: Falco initialized with configuration file /etc/falco/falco.yaml
Sat Dec  5 19:58:29 2020: Loading rules from file /etc/falco/falco_rules.yaml:
Sat Dec  5 19:58:29 2020: Loading rules from file /etc/falco/falco_rules.local.yaml:
Sat Dec  5 19:58:30 2020: Loading rules from file /etc/falco/k8s_audit_rules.yaml:
Sat Dec  5 19:58:30 2020: Starting internal webserver, listening on port 8765

19:58:34.436913858: Error Package management process launched in container (user=root user_loginuid=-1
command=apk container_id=fd6a98d42973 container_name=k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-
60fb-43e5-af89-3b8a579614ef_0 image=nginx:1.19.2-alpine)
...
```

We can see that rule files are loaded and logs printed afterwards.

Create logs in correct format

The task requires us to store logs for "unwanted package management processes" in format `[time][container-id][container-name][user-name]`. The output from `falco` shows entries for "Error Package management process launched" in a default format. Let's find the proper file that contains the rule and change it:

```
→ root@cluster1-worker1:~# cd /etc/falco/

→ root@cluster1-worker1:/etc/falco# grep -r "Package management process launched" .
./falco_rules.yaml:  Package management process launched in container (user=%user.name
user_loginuid=%user.loginuid

→ root@cluster1-worker1:/etc/falco# cp falco_rules.yaml falco_rules.yaml_ori

→ root@cluster1-worker1:/etc/falco# vim falco_rules.yaml
```

Find the rule which should look like this:

```
# Container is supposed to be immutable. Package management should be done in building the image.
- rule: Launch Package Management Process in Container
  desc: Package management process ran inside container
  condition: >
    spawned_process
    and container
    and user.name != "_apt"
    and package_mgmt_procs
    and not package_mgmt_ancestor_procs
    and not user_known_package_manager_in_container
  output: >
    Package management process launched in container (user=%user.name user_loginuid=%user.loginuid
    command=%proc.cmdline container_id=%container.id container_name=%container.name
image=%container.image.repository:%container.image.tag)
  priority: ERROR
  tags: [process, mitre_persistence]
```

And change it into the required format:

```
# Container is supposed to be immutable. Package management should be done in building the image.
- rule: Launch Package Management Process in Container
  desc: Package management process ran inside container
  condition: >
    spawned_process
    and container
    and user.name != "_apt"
    and package_mgmt_procs
    and not package_mgmt_ancestor_procs
    and not user_known_package_manager_in_container
  output: >
    Package management process launched in container [%evt.time][%container.id][%container.name][%user.name]
  priority: ERROR
  tags: [process, mitre_persistence]
```

For all available fields we can check <https://falco.org/docs/rules/supported-fields>, which should be allowed to open during the exam.

Next we check the logs in our adjusted format:

```
→ root@cluster1-worker1:/etc/falco# falco | grep "Package management"

20:23:14.395725592: Error Package management process launched in container [20:23:14.395725592]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:19.566382518: Error Package management process launched in container [20:23:19.566382518]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:24.502379334: Error Package management process launched in container [20:23:24.502379334]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:29.802281942: Error Package management process launched in container [20:23:29.802281942]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:34.560697766: Error Package management process launched in container [20:23:34.560697766]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:39.840817808: Error Package management process launched in container [20:23:39.840817808]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:44.409411640: Error Package management process launched in container [20:23:44.409411640]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:49.588266119: Error Package management process launched in container [20:23:49.588266119]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
20:23:54.487145960: Error Package management process launched in container [20:23:54.487145960]
[fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
```

This looks much better. Copy&paste the output into file `/opt/course/2/falco.log` on your main terminal. The content should be cleaned like this:

```
# /opt/course/2/falco.log
[20:23:14.395725592][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:19.566382518][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:24.502379334][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:29.802281942][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:34.560697766][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:39.840817808][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:44.409411640][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:49.588266119][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
[20:23:54.487145960][fd6a98d42973][k8s_nginx_webapi-5fcb69b746-gtx8q_team-blue_d5e9178c-60fb-43e5-af89-3b8a579614ef_0][root]
```

For a few entries it should be fast to just clean it up manually. If there are larger amounts of entries we could do:

```
cat /opt/course/2/falco.log.dirty | cut -d" " -f 9 > /opt/course/2/falco.log
```

The tool `cut` will split input into fields using space as the delimiter (`-d""`). We then only select the 9th field using `-f 9`.

Local falco rules

There is also file `/etc/falco/falco_rules.local.yaml` in which we can override existing default rules. This is a much cleaner solution for production. Choose the faster way for you in the exam if nothing is specified in the task.

Eliminate offending Pods

The logs from before should allow us to find and "eliminate" the offending *Pods*:

```
→ k get pod -A | grep webapi
team-blue          webapi-6b797d5b65-7mxz7                1/1      Running

→ k -n team-blue scale deploy webapi --replicas 0
deployment.apps/webapi scaled

→ k get pod -A | grep rating-service
team-purple        rating-service-5c54c948c9-fnv2         1/1      Running

→ k -n team-purple scale deploy rating-service --replicas 0
deployment.apps/rating-service scaled
```

Job done.

Question 3 | Apiserver Security

Task weight: 3%

Use context: `kubect1 config use-context workload-prod`

You received a list from the DevSecOps team which performed a security investigation of the k8s cluster1 (`workload-prod`). The list states the following about the apiserver setup:

- 1. Anonymous access is allowed
- 2. It's accessible on insecure port 8080
- 3. it's accessible through a NodePort *Service*

Change the apiserver setup so that:

- 1. No anonymous access is allowed
- 2. It's only accessible over HTTPS (disable insecure access)
- 3. It's only accessible through a ClusterIP *Service*

Answer:

In order to modify the parameters for the apiserver, we first ssh into the master node and check which parameters the apiserver process is running with:

```
→ ssh cluster1-master1

→ root@cluster1-master1:~# ps aux | grep kube-apiserver
root      7477  2.2 31.2 1163772 314932 ?        Ssl  18:47   0:33 kube-apiserver --advertise-
address=192.168.100.11 --allow-privileged=true --anonymous-auth=true --authorization-mode=Node,RBAC --
client-ca-file=/etc/kubernetes/pki/ca.crt --enable-admission-plugins=NodeRestriction --enable-bootstrap-
token-auth=true --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt --etcd-
certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-
client.key --etcd-servers=https://127.0.0.1:2379 --insecure-port=8080 --kubelet-client-
certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt --kubelet-client-
key=/etc/kubernetes/pki/apiserver-kubelet-client.key --kubelet-preferred-address-
types=InternalIP,ExternalIP,Hostname --kubernetes-service-node-port=31000
...
```

We may notice the following arguments:

```
--anonymous-auth=true
--insecure-port=8080
--kubernetes-service-node-port=31000
```

We can also check the *Service* and see its of type NodePort:

```
→ root@cluster1-master1:~# kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
kubernetes   NodePort    10.96.0.1    <none>        443:31000/TCP    5d2h
```

The apiserver runs as a static *Pod*, so we can edit the manifest. But before we do this we also create a copy in case we mess things up:

```
→ root@cluster1-master1:~# cp /etc/kubernetes/manifests/kube-apiserver.yaml ~/3_kube-apiserver.yaml

→ root@cluster1-master1:~# vim /etc/kubernetes/manifests/kube-apiserver.yaml
```

We should remove the unsecure settings:

```
# /etc/kubernetes/manifests/kube-apiserver.yaml
apiVersion: v1
kind: Pod
metadata:
  annotations:
    kubeadm.kubernetes.io/kube-apiserver.advertise-address.endpoint: 192.168.100.11:6443
  creationTimestamp: null
  labels:
    component: kube-apiserver
    tier: control-plane
  name: kube-apiserver
  namespace: kube-system
spec:
  containers:
  - command:
    - kube-apiserver
    - --advertise-address=192.168.100.11
    - --allow-privileged=true
    # - --anonymous-auth=true # delete or set to false
    - --authorization-mode=Node,RBAC
    - --client-ca-file=/etc/kubernetes/pki/ca.crt
    - --enable-admission-plugins=NodeRestriction
    - --enable-bootstrap-token-auth=true
    - --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
    - --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
    - --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-client.key
    - --etcd-servers=https://127.0.0.1:2379
    # - --insecure-port=8080 # delete or set to 0
    - --kubelet-client-certificate=/etc/kubernetes/pki/apiserver-kubelet-client.crt
    - --kubelet-client-key=/etc/kubernetes/pki/apiserver-kubelet-client.key
    - --kubelet-preferred-address-types=InternalIP,ExternalIP,Hostname
    # - --kubernetes-service-node-port=31000 # delete or set to 0
    - --proxy-client-cert-file=/etc/kubernetes/pki/front-proxy-client.crt
    - --proxy-client-key-file=/etc/kubernetes/pki/front-proxy-client.key
    ...
```

Once the changes are made, give the apiserver some time to start up again. Check the apiserver's *Pod* status and the process parameters:

```
→ root@cluster1-master1:~# kubectl -n kube-system get pod | grep apiserver
kube-apiserver-cluster1-master1          1/1      Running      0          38s

→ root@cluster1-master1:~# ps aux | grep kube-apiserver | grep anonymous-auth

→ root@cluster1-master1:~# ps aux | grep kube-apiserver | grep insecure-port

→ root@cluster1-master1:~# ps aux | grep kube-apiserver | grep node-port
```

The apiserver got restarted without the unsecure settings. However, the *Service* `kubernetes` will still be of type NodePort:

```
→ root@cluster1-master1:~# kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
kubernetes   NodePort    10.96.0.1    <none>        443:31000/TCP    5d3h
```

We need to delete the *Service* for the changes to take effect:

```
→ root@cluster1-master1:~# kubectl delete svc kubernetes
service "kubernetes" deleted
```

After a few seconds:

```
→ root@cluster1-master1:~# kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)  AGE
kubernetes   ClusterIP   10.96.0.1    <none>        443/TCP  6s
```

This should satisfy the DevSecOps team.

## Question 4 | Pod Security Policies

Task weight: 8%

Use context: `kubectl config use-context workload-prod`

There is *Deployment* `docker-log-hacker` in *Namespace* `team-red` which mounts `/var/lib/docker` as a `hostPath` volume on the *Node* where its running. This means that the *Pods* can for example read all Docker container logs which are running on the same *Node*.

You're asked to forbid this behavior by:

1. Enabling Admission Plugin `PodSecurityPolicy` in the apiserver
2. Creating a *PodSecurityPolicy* named `psp-mount` which allows `hostPath` volumes only for directory `/tmp`
3. Creating a *ClusterRole* named `psp-mount` which allows to use the new *PSP*
4. Creating a *RoleBinding* named `psp-mount` in *Namespace* `team-red` which binds the new *ClusterRole* to all *ServiceAccounts* in the *Namespace* `team-red`

Restart the *Pod* of *Deployment* `docker-log-hacker` afterwards to verify new creation is prevented.

*PSPs* can affect the whole cluster. Should you encounter issues you can always disable the Admission Plugin again.

Answer:

Investigate

First of all, let's inspect what a *Pod* of *Deployment* `docker-log-hacker` is capable of:

```
→ k -n team-red get pod | grep hacker
docker-log-hacker-79cd6c58d5-2g4zv      1/1      Running    0          88s

→ k -n team-red describe pod docker-log-hacker-79cd6c58d5-2g4zv
Name:          docker-log-hacker-79cd6c58d5-2g4zv
Namespace:     team-red
Priority:       0
Node:          cluster1-worker1/192.168.100.12
Start Time:    Mon, 28 Sep 2020 09:17:44 +0000
Labels:        app=docker-log-hacker
               pod-template-hash=79cd6c58d5
Annotations:   <none>
Status:        Running
IP:            10.44.0.19
IPs:
  IP:          10.44.0.19
Controlled By: ReplicaSet/docker-log-hacker-79cd6c58d5
Containers:
  bash:
  ...
  Command:
    sh
    -c
    while true; do sleep 1d; done
  ...
  Mounts:
    /dockerlogs from dockerlogs (rw)
    /var/run/secrets/kubernetes.io/serviceaccount from default-token-9c2wf (ro)
  ...
Volumes:
  dockerlogs:
    Type:      HostPath (bare host directory volume)
    Path:      /var/lib/docker
  ...
```

We see it mounts `/var/lib/docker` from the *Node* where it's running on, what does this mean?

```
→ k -n team-red exec -it docker-log-hacker-79cd6c58d5-2g4zv -- sh

→ # cd /dockerlogs/containers/

→ /dockerlogs/containers # ls
025c21a3e9f466550d15d06620318dc2a4dc5bd09562b3e30169fde56162f6ba
092cb84e4cb17f537aa50a78f6e3d0737b90d78ff49c03aa88547daf66359dd
17f00b3e25313b05c1f642831f25e388852664699d8a5be26315cb14642016de
...

→ /dockerlogs/containers # cd 47ac9c0a75aff011e865ebfb7b1695bddc891fccf59e6eafddb06032d44c6d5b/

→ /dockerlogs/containers/47ac9c0a75aff011e865ebfb7b1695bddc891fccf59e6eafddb06032d44c6d5b # head
47ac9c0a75aff011e865e
bfb7b1695bddc891fccf59e6eafddb06032d44c6d5b-json.log

{"log":"Mon Sep 28 08:55:14 UTC 2020\n","stream":"stdout","time":"2020-09-28T08:55:14.431789056Z"}
{"log":"uid=0(root) gid=0(root)
groups=0(root),1(bin),2(daemon),3(sys),4(adm),6(disk),10(wheel),11(floppy),20(dialout),26(tape),27(video)\n
","stream":"stdout","time":"2020-09-28T08:55:14.441553845Z"}
{"log":"","stream":"stdout","time":"2020-09-28T08:55:14.442354173Z"}
{"log":"Mon Sep 28 08:55:15 UTC 2020\n","stream":"stdout","time":"2020-09-28T08:55:15.446719832Z"}
...
```

We can see that this *Pod* can access Docker logs from all containers running on the same *Node*. Something that should be prevented unless necessary.

Enable Admission Plugin for *PodSecurityPolicy*

We enable the Admission Plugin and create a config backup in case we misconfigure something:

```
→ ssh cluster1-master1

→ root@cluster1-master1:~# cp /etc/kubernetes/manifests/kube-apiserver.yaml ~/4_kube-apiserver.yaml

→ root@cluster1-master1:~# vim /etc/kubernetes/manifests/kube-apiserver.yaml

# /etc/kubernetes/manifests/kube-apiserver.yaml
apiVersion: v1
kind: Pod
metadata:
  annotations:
    kubeadm.kubernetes.io/kube-apiserver.advertise-address.endpoint: 192.168.100.11:6443
  creationTimestamp: null
  labels:
    component: kube-apiserver
    tier: control-plane
  name: kube-apiserver
  namespace: kube-system
spec:
  containers:
  - command:
    - kube-apiserver
    - --advertise-address=192.168.100.11
    - --allow-privileged=true
```

```
- --anonymous-auth=true
- --authorization-mode=Node,RBAC
- --client-ca-file=/etc/kubernetes/pki/ca.crt
- --enable-admission-plugins=NodeRestriction,PodSecurityPolicy      # change
- --enable-bootstrap-token-auth=true
- --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
...
```

Existing *PodSecurityPolicy*

Enabling the *PSP* admission plugin without authorizing any policies would prevent any *Pods* from being created in the cluster. That's why there is already an existing *PSP* `default-allow-all` which allows everything and all *Namespaces* except `team-red` use it via a *RoleBinding*:

```
→ k get psp
NAME                PRIV  CAPS  SELINUX  RUNASUSER  ...
default-allow-all  true  *     RunAsAny RunAsAny    ...

→ k get rolebinding -A | grep psp-access
default                psp-access ... ClusterRole/psp-access
kube-public            psp-access ... ClusterRole/psp-access
kube-system            psp-access ... ClusterRole/psp-access
kubernetes-dashboard  psp-access ... ClusterRole/psp-access
team-blue              psp-access ... ClusterRole/psp-access
team-green             psp-access ... ClusterRole/psp-access
team-purple            psp-access ... ClusterRole/psp-access
team-yellow           psp-access ... ClusterRole/psp-access
```

Create new *PodSecurityPolicy*

Next we create the new *PSP* with the task requirements by copying an example from the k8s docs and altering it:

```
vim 4_psp.yaml
```

```
# 4_psp.yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: psp-mount
spec:
  privileged: true
  selinux:
    rule: RunAsAny
  supplementalGroups:
    rule: RunAsAny
  runAsUser:
    rule: RunAsAny
  fsGroup:
    rule: RunAsAny
  volumes:
  - '*'
  allowedHostPaths:
    - pathPrefix: "/tmp"      # task requirement
      # task requirement
```

```
k -f 4_psp.yaml create
```

So far the *PSP* has no effect because we gave no RBAC permission for any *Pods-ServiceAccounts* to use it yet. So we do:

```
k -n team-red create clusterrole psp-mount --verb=use \
--resource=podsecuritypolicies --resource-name=psp-mount
```

Which will create a *ClusterRole* like:

```
# kubectl -n team-red create clusterrole psp-mount --verb=use --resource=podsecuritypolicies --resource-
name=psp-mount
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  creationTimestamp: null
  name: psp-mount
rules:
- apiGroups:
  - policy
  resourceNames:
  - psp-mount
  resources:
  - podsecuritypolicies
  verbs:
  - use
```

And for the *RoleBinding*:

```
k -n team-red create rolebinding psp-mount --clusterrole=psp-mount --group system:serviceaccounts
```

Which will create:

```
# kubectl -n team-red create rolebinding psp-mount --clusterrole=psp-mount --group system:serviceaccounts
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  creationTimestamp: null
  name: psp-mount
  namespace: team-red
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: psp-mount
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: Group
  name: system:serviceaccounts
```

Test new PSP

We restart the *Deployment* and check the status:

```
→ k -n team-red rollout restart deploy docker-log-hacker
deployment.apps/docker-log-hacker restarted

→ k -n team-red describe deploy docker-log-hacker
Name:                docker-log-hacker
Namespace:           team-red
```



```
...
Replicas:          1 desired | 0 updated | 0 total | 0 available | 2 unavailable
...
Pod Template:
  Labels:           app=docker-log-hacker
  Annotations:      kubect1.kubernetes.io/restartedAt: 2020-09-28T11:08:18Z
  Containers:
    bash:
      ...
  Volumes:
    dockerlogs:
      Type:          HostPath (bare host directory volume)
      Path:          /var/lib/docker
      HostPathType:
Conditions:
  Type           Status  Reason
  ----           -
  Available      False   MinimumReplicasUnavailable
  ReplicaFailure  True    FailedCreate
```

We see FailedCreate and checking for *Events* shows more information about why:

```
→ k -n team-red get events --sort-by='{.metadata.creationTimestamp}'

docker-log-hacker-6bdfbf8546-" is forbidden: PodSecurityPolicy: unable to admit pod:
[spec.volumes[0].hostPath.pathPrefix: Invalid value: "/var/lib/docker": is not allowed to be used]
```

Beautiful, the *PSP* seems to work. To verify further we can change the *Deployment*:

```
k -n team-red edit deploy docker-log-hacker
```

```
# kubectl -n team-red edit deploy docker-log-hacker
apiVersion: apps/v1
kind: Deployment
metadata:
...
spec:
...
  template:
    metadata:
...
    spec:
      containers:
      - command:
        - sh
        - -c
        - while true; do sleep 1d; done
        image: bash
...
      volumeMounts:
      - mountPath: /dockerlogs
        name: dockerlogs
...
      volumes:
      - hostPath:
        path: /tmp
        type: "" # change
```

And we should see it running:

```
→ k -n team-red get pod -l app=docker-log-hacker
NAME                                READY   STATUS    RESTARTS   AGE
docker-log-hacker-5674dbccc9-51c6q  1/1     Running   0           20s
```

When a *Pod* has been allowed to be created by a *PSP*, then this is shown via an annotation:

```
→ k -n team-red describe pod -l app=docker-log-hacker
...
Annotations:  kubernetes.io/psp: psp-mount
...
```

*PodSecurityPolicies* can be hard to come around at first, but once done they're a powerful part in the security tool box.

## Question 5 | CIS Benchmark

Task weight: 3%

Use context: `kubect1 config use-context infra-prod`

You're ask to evaluate specific settings of cluster2 against the CIS Benchmark recommendations. Use the tool `kube-bench` which is already installed on the nodes.

Connect using `ssh cluster2-master1` and `ssh cluster2-worker1`.

On the master node ensure (correct if necessary) that the CIS recommendations are set for:

- 1. The `--profiling` argument of the kube-controller-manager
- 2. The ownership of directory `/var/lib/etcd`

On the worker node ensure (correct if necessary) that the CIS recommendations are set for:

- 3. The permissions of the kubelet configuration `/var/lib/kubelet/config.yaml`
- 4. The `--client-ca-file` argument of the kubelet

Answer:

### Number 1

First we ssh into the master node run `kube-bench` against the master components:

```
→ ssh cluster2-master1

→ root@cluster2-master1:~# kube-bench master
...
== Summary ==
41 checks PASS
13 checks FAIL
11 checks WARN
0 checks INFO
```



We see some passes, fails and warnings. Let's check the required task (1) of the controller manager:

```
→ root@cluster2-master1:~# kube-bench master | grep kube-controller -A 3
1.3.1 Edit the Controller Manager pod specification file /etc/kubernetes/manifests/kube-controller-
manager.yaml
on the master node and set the --terminated-pod-gc-threshold to an appropriate threshold,
for example:
--terminated-pod-gc-threshold=10
--
1.3.2 Edit the Controller Manager pod specification file /etc/kubernetes/manifests/kube-controller-
manager.yaml
on the master node and set the below parameter.
--profiling=false

1.3.6 Edit the Controller Manager pod specification file /etc/kubernetes/manifests/kube-controller-
manager.yaml
on the master node and set the --feature-gates parameter to include RotateKubeletServerCertificate=true.
--feature-gates=RotateKubeletServerCertificate=true
```

There we see 1.3.2 which suggests to set `--profiling=false`, so we obey:

```
→ root@cluster2-master1:~# vim /etc/kubernetes/manifests/kube-controller-manager.yaml
```

Edit the corresponding line:

```
# /etc/kubernetes/manifests/kube-controller-manager.yaml
apiVersion: v1
kind: Pod
metadata:
  creationTimestamp: null
  labels:
    component: kube-controller-manager
    tier: control-plane
  name: kube-controller-manager
  namespace: kube-system
spec:
  containers:
  - command:
    - kube-controller-manager
    - --allocate-node-cidrs=true
    - --authentication-kubeconfig=/etc/kubernetes/controller-manager.conf
    - --authorization-kubeconfig=/etc/kubernetes/controller-manager.conf
    - --bind-address=127.0.0.1
    - --client-ca-file=/etc/kubernetes/pki/ca.crt
    - --cluster-cidr=10.244.0.0/16
    - --cluster-name=kubernetes
    - --cluster-signing-cert-file=/etc/kubernetes/pki/ca.crt
    - --cluster-signing-key-file=/etc/kubernetes/pki/ca.key
    - --controllers=*,bootstrapsigner,tokencleaner
    - --kubeconfig=/etc/kubernetes/controller-manager.conf
    - --leader-elect=true
    - --node-cidr-mask-size=24
    - --port=0
    - --requestheader-client-ca-file=/etc/kubernetes/pki/front-proxy-ca.crt
    - --root-ca-file=/etc/kubernetes/pki/ca.crt
    - --service-account-private-key-file=/etc/kubernetes/pki/sa.key
    - --service-cluster-ip-range=10.96.0.0/12
    - --use-service-account-credentials=true
    - --profiling=false          # add
  ...
```

We wait for the *Pod* to restart, then run `kube-bench` again to check if the problem was solved:

```
→ root@cluster2-master1:~# kube-bench master | grep kube-controller -A 3
1.3.1 Edit the Controller Manager pod specification file /etc/kubernetes/manifests/kube-controller-
manager.yaml
on the master node and set the --terminated-pod-gc-threshold to an appropriate threshold,
for example:
--terminated-pod-gc-threshold=10
--
1.3.6 Edit the Controller Manager pod specification file /etc/kubernetes/manifests/kube-controller-
manager.yaml
on the master node and set the --feature-gates parameter to include RotateKubeletServerCertificate=true.
--feature-gates=RotateKubeletServerCertificate=true
```

Problem solved and 1.3.2 is passing:

```
root@cluster2-master1:~# kube-bench master | grep 1.3.2
[PASS] 1.3.2 Ensure that the --profiling argument is set to false (Scored)
```

Number 2

Next task (2) is to check the ownership of directory `/var/lib/etcd`, so we first have a look:

```
→ root@cluster2-master1:~# ls -lh /var/lib | grep etcd
drwx----- 3 root      root      4.0K Sep 11 20:08 etcd
```

Looks like user root and group root. Also possible to check using:

```
→ root@cluster2-master1:~# stat -c %U:%G /var/lib/etcd
root:root
```

But what has `kube-bench` to say about this?

```
→ root@cluster2-master1:~# kube-bench master | grep "/var/lib/etcd" -B5

1.1.12 On the etcd server node, get the etcd data directory, passed as an argument --data-dir,
from the below command:
ps -ef | grep etcd
Run the below command (based on the etcd data directory found above).
For example, chown etcd:etcd /var/lib/etcd
```

To comply we run the following:

```
→ root@cluster2-master1:~# chown etcd:etcd /var/lib/etcd

→ root@cluster2-master1:~# ls -lh /var/lib | grep etcd
drwx----- 3 etcd      etcd      4.0K Sep 11 20:08 etcd
```

This looks better. We run `kube-bench` again, and make sure test 1.1.12. is passing.

```
→ root@cluster2-master1:~# kube-bench master | grep 1.1.12
[PASS] 1.1.12 Ensure that the etcd data directory ownership is set to etcd:etcd (Scored)
```

Done.

Number 3

To continue with number (3), we'll head to the worker node and ensure that the kubelet configuration file has the minimum necessary permissions as recommended:

```
→ ssh cluster2-worker1

→ root@cluster2-worker1:~# kube-bench node
...
== Summary ==
13 checks PASS
10 checks FAIL
2 checks WARN
0 checks INFO
```

Also here some passes, fails and warnings. We check the permission level of the kubelet config file:

```
→ root@cluster2-worker1:~# stat -c %a /var/lib/kubelet/config.yaml
777
```

777 is highly permissive access level and not recommended by the `kube-bench` guidelines:

```
→ root@cluster2-worker1:~# kube-bench node | grep /var/lib/kubelet/config.yaml -B2

2.2.10 Run the following command (using the config file location identified in the Audit step)
chmod 644 /var/lib/kubelet/config.yaml
```

We obey and set the recommended permissions:

```
→ root@cluster2-worker1:~# chmod 644 /var/lib/kubelet/config.yaml

→ root@cluster2-worker1:~# stat -c %a /var/lib/kubelet/config.yaml
644
```

And check if test 2.2.10 is passing:

```
→ root@cluster2-worker1:~# kube-bench node | grep 2.2.10
[PASS] 2.2.10 Ensure that the kubelet configuration file has permissions set to 644 or more restrictive
(Scored)
```

Number 4

Finally for number (4), let's check whether `--client-ca-file` argument for the kubelet is set properly according to `kube-bench` recommendations:

```
→ root@cluster2-worker1:~# kube-bench node | grep client-ca-file
[PASS] 2.1.4 Ensure that the --client-ca-file argument is set as appropriate (Scored)
2.2.7 Run the following command to modify the file permissions of the --client-ca-file
2.2.8 Run the following command to modify the ownership of the --client-ca-file .
```

This looks passing with 2.1.4. The other ones are about the file that the parameter points to and can be ignored here.

To further investigate we run the following command to locate the kubelet config file, and open it:

```
→ root@cluster2-worker1:~# ps -ef | grep kubelet
root      5157      1   2  20:28 ?           00:03:22 /usr/bin/kubelet --bootstrap-
kubeconfig=/etc/kubernetes/bootstrap-kubelet.conf --kubeconfig=/etc/kubernetes/kubelet.conf --
config=/var/lib/kubelet/config.yaml --network-plugin=cni --pod-infra-container-image=k8s.gcr.io/pause:3.2
root      19940 11901   0  22:38 pts/0    00:00:00 grep --color=auto kubelet

→ root@croot@cluster2-worker1:~# vim /var/lib/kubelet/config.yaml
```

```
# /var/lib/kubelet/config.yaml
apiVersion: kubelet.config.k8s.io/v1beta1
authentication:
  anonymous:
    enabled: false
  webhook:
    cacheTTL: 0s
    enabled: true
  x509:
    clientCAFile: /etc/kubernetes/pki/ca.crt
...
```

The `clientCAFile` points to the location of the certificate, which is correct.

Question 6 | Verify Platform Binaries

Task weight: 2%

(can be solved in any kubectl context)

There are four Kubernetes server binaries located at `/opt/course/6/binaries`. You're provided with the following verified sha512 values for these:

**kube-apiserver**  
f417c0555bc0167355589dd1afe23be9bf909bf98312b1025f12015d1b58a1c62c9908c0067a7764fa35efdac7016a9efa8711a44425dd6692906a7c283f032c

**kube-controller-manager**  
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33boa8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fbb726307d1608b44f38a60

**kube-proxy**  
52f9d8ad045f8eee1d689619ef8ceef2d86d50c75a6a332653240d7ba5b2a114aca056d9e513984ade24358c9662714973c1960c62a5cb37dd375631c8a614c6

**kubelet**  
4be40f2440619e990897cf956c32800dc96c2c983bf64519854a3309fa5aa21827991559f9c44595098e27e6f2ee4d64a3fdec6baba8a177881f20e3ec61e26c

Delete those binaries that don't match with the sha512 values above.

Answer:

We check the directory:

```
→ cd /opt/course/6/binaries

→ ls
kube-apiserver  kube-controller-manager  kube-proxy  kubelet
```

To generate the sha512 sum of a binary we do:

```
→ sha512sum kube-apiserver
f417c0555bc016735589dd1afe23be9bf909bf98312b1025f12015d1b58a1c62c9908c0067a7764fa35efdac7016a9efa8711a44425dd6692906a7c283f032c  kube-apiserver
```

Looking good, next:

```
→ sha512sum kube-controller-manager
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33b0a8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fb726307d1608b44f38a60  kube-controller-manager
```

Okay, next:

```
→ sha512sum kube-proxy
52f9d8ad045f8eee1d689619ef8ceef2d86d50c75a6a332653240d7ba5b2a114aca056d9e513984ade24358c9662714973c1960c62a5cb37dd375631c8a614c6  kube-proxy
```

Also good, and finally:

```
→ sha512sum kubelet
7b720598e6a3483b45c537b57d759e3e82bc5c53b3274f681792f62e941019cde3d51a7f9b55158abf3810d506146bc0aa7cf97b36f27f341028a54431b335be  kubelet
```

Catch! Binary **kubelet** has a different hash!

But did we actually compare everything properly before? Let's have a closer look at **kube-controller-manager** again:

```
→ sha512sum kube-controller-manager > compare

→ vim compare
```

Edit to only have the provided hash and the generated one in one line each:

```
# ./compare
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33b0a8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fb726307d1608b44f38a60
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33boa8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fb726307d1608b44f38a60
```

Looks right at a first glance, but if we do:

```
→ cat compare | uniq
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33b0a8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fb726307d1608b44f38a60
60100cc725e91fe1a949e1b2d0474237844b5862556e25c2c655a33boa8225855ec5ee22fa4927e6c46a60d43a7c4403a27268f96fb726307d1608b44f38a60
```

This shows they are different, by just one character actually.

To complete the task we do:

```
rm kubelet kube-controller-manager
```

## Question 7 | Open Policy Agent

Task weight: 6%

Use context: **kubect1 config use-context infra-prod**

The Open Policy Agent and Gatekeeper have been installed to, among other things, enforce blacklisting of certain image registries. Alter the existing constraint and/or template to also blacklist images from **very-bad-registry.com**.

Test it by creating a single *Pod* using image **very-bad-registry.com/image** in *Namespace default*, it shouldn't work.

You can also verify your changes by looking at the existing *Deployment untrusted* in *Namespace default*, it uses an image from the new untrusted source. The OPA constraint should throw violation messages for this one.

Answer:

We look at existing OPA constraints, these are implemeted using CRDs by Gatekeeper:

```
→ k get crd
NAME                                     CREATED AT
blacklistimages.constraints.gatekeeper.sh 2020-09-14T19:29:31Z
configs.config.gatekeeper.sh             2020-09-14T19:29:04Z
constraintpodstatuses.status.gatekeeper.sh 2020-09-14T19:29:05Z
constrainttemplatepodstatuses.status.gatekeeper.sh 2020-09-14T19:29:05Z
constrainttemplates.templates.gatekeeper.sh 2020-09-14T19:29:05Z
requiredlabels.constraints.gatekeeper.sh  2020-09-14T19:29:31Z
```

So we can do:

```
→ k get constraint
NAME                                                                                                     AGE
blacklistimages.constraints.gatekeeper.sh/pod-trusted-images      10m

NAME                                                                                                     AGE
requiredlabels.constraints.gatekeeper.sh/namespace-mandatory-labels 10m
```

and then look at the one that is probably about blacklisting images:

```
k edit blacklistimages pod-trusted-images
```

```
# kubectl edit blacklistimages pod-trusted-images
apiVersion: constraints.gatekeeper.sh/v1beta1
kind: BlacklistImages
metadata:
...
spec:
  match:
    kinds:
      - apiGroups:
          - ""
        kinds:
          - Pod
```

It looks like this constraint simply applies the template to all *Pods*, no arguments passed. So we edit the template:

```
k edit constrainttemplates blacklistimages
```

```
# kubectl edit constrainttemplates blacklistimages
apiVersion: templates.gatekeeper.sh/v1beta1
kind: ConstraintTemplate
metadata:
...
spec:
  crd:
    spec:
      names:
        kind: BlacklistImages
  targets:
  - rego: |
      package k8strustedimages

      images {
        image := input.review.object.spec.containers[_].image
        not startswith(image, "docker-fake.io/")
        not startswith(image, "google-gcr-fake.com/")
        not startswith(image, "very-bad-registry.com/") # ADD THIS LINE
      }

      violation[{"msg": msg}] {
        not images
        msg := "not trusted image!"
      }
    target: admission.k8s.gatekeeper.sh
```

We simply have to add another line. After editing we try to create a *Pod* of the bad image:

```
→ k run opa-test --image=very-bad-registry.com/image
Error from server ([denied by pod-trusted-images] not trusted image!): admission webhook
"validation.gatekeeper.sh" denied the request: [denied by pod-trusted-images] not trusted image!
```

Nice! After some time we can also see that *Pods* of the existing *Deployment* "untrusted" will be listed as violators:

```
→ k describe blacklistimages pod-trusted-images
...
Total Violations: 1
Violations:
  Enforcement Action: deny
  Kind:               Pod
  Message:            not trusted image!
  Name:               untrusted-68c4944d48-2hgt9
  Namespace:         default
  Events:             <none>
```

Great, OPA fights bad registries !

## Question 8 | Secure Kubernetes Dashboard

Task weight: 3%

Use context: `kubectl config use-context workload-prod`

The Kubernetes Dashboard is installed in *Namespace* `kubernetes-dashboard` and is configured to:

- 1. Allow users to "skip login"
- 2. Allow insecure access (HTTP without authentication)
- 3. Allow basic authentication
- 4. Allow access from outside the cluster

You are asked to make it more secure by:

- 1. Deny users to "skip login"
- 2. Deny insecure access, enforce HTTPS (self signed certificates are ok for now)
- 3. Add the `--auto-generate-certificates` argument
- 4. Enforce authentication using a token (with possibility to use RBAC)
- 5. Allow only cluster internal access

Answer:

Head to <https://github.com/kubernetes/dashboard/tree/master/docs> to find documentation about the dashboard.

First we have a look in *Namespace* `kubernetes-dashboard` :

```
→ k -n kubernetes-dashboard get pod,svc
NAME                                     READY   STATUS    RESTARTS   AGE
pod/dashboard-metrics-scraper-7b59f7d4df-fbpd9   1/1     Running   0           24m
pod/kubernetes-dashboard-6d8cd5dd84-w7wr2       1/1     Running   0           24m

NAME                                     TYPE          ...   PORT(S)                                     AGE
service/dashboard-metrics-scraper        ClusterIP     ...   8000/TCP                                    24m
service/kubernetes-dashboard             NodePort      ...   9090:32520/TCP,443:31206/TCP             24m
```

We can see one running *Pod* and a NodePort *Service* exposing it. Let's try to connect to it via a NodePort, we can use IP of any *Node*:  
(your port might be a different)

```
→ k get node -o wide
NAME                STATUS    ROLES    AGE   VERSION   INTERNAL-IP   ...
cluster1-master1    Ready    master   37m   v1.19.1   192.168.100.11 ...
cluster1-worker1    Ready    <none>   36m   v1.19.1   192.168.100.12 ...
cluster1-worker2    Ready    <none>   34m   v1.19.1   192.168.100.13 ...

→ curl http://192.168.100.11:32520
<!--
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You may obtain a copy of the License at

    http://www.apache.org/licenses/LICENSE-2.0
```

The dashboard is not secured because it allows unsecure HTTP access without authentication and is exposed externally. It's is loaded with a few parameter making it insecure, let's fix this.

First we create a backup in case we need to undo something:

```
k -n kubernetes-dashboard get deploy kubernetes-dashboard -oyaml > 8_deploy_kubernetes-dashboard.yaml
```

Then:

```
k -n kubernetes-dashboard edit deploy kubernetes-dashboard
```

The changes to make are :

```
template:
spec:
  containers:
  - args:
    - --namespace=kubernetes-dashboard
    - --authentication-mode=token          # change or delete, "token" is default
    - --auto-generate-certificates        # add
    #- --enable-skip-login=true            # delete or set to false
    #- --enable-insecure-login            # delete
    image: kubernetesui/dashboard:v2.0.3
    imagePullPolicy: Always
    name: kubernetes-dashboard
```

Next, we'll have to deal with the NodePort *Service*:

```
k -n kubernetes-dashboard get svc kubernetes-dashboard -o yaml > 8_svc_kubernetes-dashboard.yaml # backup

k -n kubernetes-dashboard edit svc kubernetes-dashboard
```

And make the following changes:

```
spec:
  clusterIP: 10.107.176.19
  externalTrafficPolicy: Cluster
  ports:
  - name: http
    nodePort: 32513 # delete
    port: 9090
    protocol: TCP
    targetPort: 9090
  - name: https
    nodePort: 32441 # delete
    port: 443
    protocol: TCP
    targetPort: 8443
  selector:
    k8s-app: kubernetes-dashboard
  sessionAffinity: None
  type: ClusterIP          # change or delete
status:
  loadBalancer: {}
```

Let's confirm the changes, we can do that even without having a browser:

```
→ k run tmp --image=nginx:1.19.2 --restart=Never --rm -it -- bash
If you don't see a command prompt, try pressing enter.
root@tmp:/# curl http://kubernetes-dashboard.kubernetes-dashboard:9090
curl: (7) Failed to connect to kubernetes-dashboard.kubernetes-dashboard port 9090: Connection refused

→ root@tmp:/# curl https://kubernetes-dashboard.kubernetes-dashboard
curl: (60) SSL certificate problem: self signed certificate
More details here: https://curl.haxx.se/docs/sslcerts.html

curl failed to verify the legitimacy of the server and therefore could not
establish a secure connection to it. To learn more about this situation and
how to fix it, please visit the web page mentioned above.

→ root@tmp:/# curl https://kubernetes-dashboard.kubernetes-dashboard -k
<!--
Copyright 2017 The Kubernetes Authors.
```

We see that insecure access is disabled and HTTPS works (using a self signed certificate for now). Let's also check the remote access:  
(your port might be a different)

```
→ curl http://192.168.100.11:32520
curl: (7) Failed to connect to 192.168.100.11 port 32520: Connection refused

→ k -n kubernetes-dashboard get svc
NAME                                TYPE           CLUSTER-IP      ...    PORT(S)
dashboard-metrics-scraper          ClusterIP       10.111.171.247   ...    8000/TCP
kubernetes-dashboard               ClusterIP       10.100.118.128   ...    9090/TCP,443/TCP
```

Much better.

## Question 9 | AppArmor Profile

Task weight: 3%

Use context: `kubect1 config use-context workload-prod`

Some containers need to run more secure and restricted. There is an existing AppArmor profile located at `/opt/course/9/profile` for this.

1. Install the AppArmor profile on *Node cluster1-worker1*. Connect using `ssh cluster1-worker1`.
2. Add label `security=apparmor` to the *Node*
3. Create a *Deployment* named `apparmor` in *Namespace default* with:
  - One replica of image `nginx:1.19.2`
  - NodeSelector for `security=apparmor`
  - Single container named `c1` with the AppArmor profile enabled

The *Pod* might not run properly with the profile enabled. Write the logs of the *Pod* into `/opt/course/9/logs` so another team can work on getting the application running.

Answer:

<https://kubernetes.io/docs/tutorials/clusters/apparmor>

### Part 1

First we have a look at the provided profile:

```
vim /opt/course/9/profile
```

```
# /opt/course/9/profile

#include <tunables/global>

profile very-secure flags=(attach_disconnected) {
    #include <abstractions/base>

    file,

    # Deny all file writes.
    deny /** w,
}
```

Very simple profile named `very-secure` which denies all file writes. Next we copy it onto the *Node*:

```
→ scp /opt/course/9/profile root@cluster1-worker1:~/
Warning: Permanently added the ECDSA host key for IP address '192.168.100.12' to the list of known hosts.
profile                                                    100% 161   329.9kB/s
00:00

→ ssh cluster1-worker1

→ root@cluster1-worker1:~# ls
profile
```

And install it:

```
→ root@cluster1-worker1:~# apparmor_parser -q ./profile
```

And verify it has been installed:

```
→ root@cluster1-worker1:~# apparmor_status
apparmor module is loaded.
17 profiles are loaded.
17 profiles are in enforce mode.
  /sbin/dhclient
  ...
  man_filter
  man_groff
  very-secure
0 profiles are in complain mode.
56 processes have profiles defined.
56 processes are in enforce mode.
  ...
0 processes are in complain mode.
0 processes are unconfined but have a profile defined.
```

There we see among many others the `very-secure` one, which is the name of the profile specified in `/opt/course/9/profile`.

### Part 2

We label the *Node*:

```
k label -h # show examples

k label node cluster1-worker1 security=apparmor
```

### Part 3

Now we can go ahead and create the *Deployment* which uses the profile.

```
k create deploy apparmor --image=nginx:1.19.2 $do > 9_deploy.yaml

vim 9_deploy.yaml
```

```
# 9_deploy.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  creationTimestamp: null
  labels:
    app: apparmor
    name: apparmor
    namespace: default
spec:
  replicas: 1
  selector:
    matchLabels:
      app: apparmor
  strategy: {}
  template:
    metadata:
      creationTimestamp: null
      labels:
        app: apparmor
      annotations:
        container.apparmor.security.beta.kubernetes.io/c1: localhost/very-secure # add
    spec:
      nodeSelector:
        security: apparmor # add
      containers:
      - image: nginx:1.19.2
        name: c1 # change
        resources: {}
```

```
k -f 9_deploy.yaml create
```

What the damage?

```
→ k get pod -owide | grep apparmor
apparmor-85c65645dc-w852p          0/1      CrashLoopBackOff   1          118s    10.44.0.18    cluster1-
worker1      <none>          <none>

→ k logs apparmor-85c65645dc-w852p
/docker-entrypoint.sh: No files found in /docker-entrypoint.d/, skipping configuration
/docker-entrypoint.sh: 13: /docker-entrypoint.sh: cannot create /dev/null: Permission denied
2020/09/26 18:14:11 [emerg] 1#1: mkdir() "/var/cache/nginx/client_temp" failed (13: Permission denied)
nginx: [emerg] mkdir() "/var/cache/nginx/client_temp" failed (13: Permission denied)
```

This looks alright, the *Pod* is running on **cluster1-worker1** because of the `nodeSelector`. The AppArmor profile simply denies all filesystem writes, but Nginx needs to write into some locations to run, hence the errors.

It looks like our profile is running but we can confirm this as well by inspecting the Docker container:

```
→ ssh cluster1-worker1

→ root@cluster1-worker1:~# docker ps -a | grep apparmor
41f014a9e7a8          7e4d58f0e5f3          "/docker-entrypoint..." About a minute ago
Exited (1) About a minute ago          k8s_c1_apparmor-85c65645dc-w852p_default_3e209d37-74ee-
43c5-8a5e-b61a683f068c_6
c79fe47d5a78          k8s.gcr.io/pause:3.2          "/pause"          7 minutes ago          Up
7 minutes          k8s_POD_apparmor-85c65645dc-w852p_default_3e209d37-74ee-
43c5-8a5e-b61a683f068c_0

→ root@cluster1-worker1:~# docker inspect 41f014a9e7a8 | grep -i profile
"AppArmorProfile": "very-secure",
```

We need to use `docker ps -a` to also show stopped containers. Then `docker inspect` shows that the container is using our AppArmor profile. Notice to be fast between `ps` and `inspect` as K8s will restart the *Pod* periodically when in error state.

To complete the task we write the logs into the required location:

```
k logs apparmor-85c65645dc-w852p > /opt/course/9/logs
```

Fixing the errors is the job of another team, lucky us.

## Question 10 | Container Runtime Sandbox gVisor

Task weight: 4%

Use context: `kubect1 config use-context workload-prod`

Team purple wants to run some of their workloads more secure. Worker node **cluster1-worker2** has container engine containerd already installed and its configured to support the `runc/gvisor` runtime.

The **cluster1-worker2** kubelet uses containerd instead of docker. Write the two arguments the kubelet has been configured with to use containerd into `/opt/course/10/arguments`.

Create a *RuntimeClass* named `gvisor` with handler `runc`.

Create a *Pod* that uses the *RuntimeClass*. The *Pod* should be in *Namespace* `team-purple`, named `gvisor-test` and of image `nginx:1.19.2`. Make sure the *Pod* runs on **cluster1-worker2**.

Write the `dmesg` output of the successfully started *Pod* into `/opt/course/10/gvisor-test-dmesg`.

Answer:

We check the nodes and can see that worker2 runs using containerd:

```
→ k get node -o wide
NAME              STATUS    ROLES    AGE   VERSION   ... CONTAINER-RUNTIME
cluster1-master1  Ready    master   9h    v1.19.1   ... docker://19.3.6
cluster1-worker1  Ready    <none>   9h    v1.19.1   ... docker://19.3.6
cluster1-worker2  Ready    <none>   9h    v1.19.1   ... containerd://1.3.3
```

First we ssh into the worker node and optionally check if containerd and runc are installed and configured as it as described in the task:

```
→ ssh cluster1-worker2
```



```
→ root@cluster1-worker2:~# runsc --version
runsc version release-20201130.0
spec: 1.0.1-dev

→ root@cluster1-worker2:~# service containerd status
• containerd.service - containerd container runtime
  Loaded: loaded (/lib/systemd/system/containerd.service; enabled; vendor preset: enabled)
  Active: active (running) since Thu 2020-09-03 15:58:22 UTC; 2min 36s ago
  ...

→ root@cluster1-worker2:~# cat /etc/containerd/config.toml
disabled_plugins = ["restart"]
[plugins.linux]
  shim_debug = true
[plugins.cri.containerd.runtimes.runsc]
  runtime_type = "io.containerd.runsc.v1"
```

Looking good. Next we check the arguments of the kubelet.

```
# defines how the kubelet is started
vim /etc/systemd/system/kubelet.service.d/10-kubeadm.conf
```

We see that it references file `/etc/default/kubelet`.

```
# /etc/default/kubelet
KUBELET_EXTRA_ARGS="--container-runtime remote --container-runtime-endpoint
unix:///run/containerd/containerd.sock"
```

And we write these into the required location on our main terminal:

```
# /opt/course/10/arguments
--container-runtime remote
--container-runtime-endpoint unix:///run/containerd/containerd.sock
```

For the next requirement it's best head to the k8s docs for *RuntimeClasses* <https://kubernetes.io/docs/concepts/containers/runtime-class>, steal an example and create the gvisor one:

```
vim 10_rtc.yaml
```

```
# 10_rtc.yaml
apiVersion: node.k8s.io/v1beta1
kind: RuntimeClass
metadata:
  name: gvisor
handler: runsc
```

```
k -f 10_rtc.yaml create
```

And the required *Pod*:

```
k -n team-purple run gvisor-test --image=nginx:1.19.2 $do > 10_pod.yaml
```

```
vim 10_pod.yaml
```

```
# 10_pod.yaml
apiVersion: v1
kind: Pod
metadata:
  creationTimestamp: null
  labels:
    run: gvisor-test
  name: gvisor-test
  namespace: team-purple
spec:
  nodeName: cluster1-worker2 # add
  runtimeClassName: gvisor   # add
  containers:
  - image: nginx:1.19.2
    name: gvisor-test
    resources: {}
  dnsPolicy: ClusterFirst
  restartPolicy: Always
status: {}
```

```
k -f 10_pod.yaml create
```

After creating the pod we should check if its running and if it uses the gvisor sandbox:

```
→ k -n team-purple get pod gvisor-test
NAME          READY   STATUS    RESTARTS   AGE
gvisor-test   1/1     Running   0           30s

→ k -n team-purple exec gvisor-test -- dmesg
[ 0.000000] Starting gvisor...
[ 0.417740] Checking naughty and nice process list...
[ 0.623721] Waiting for children...
[ 0.902192] Gathering forks...
[ 1.258087] Committing treasure map to memory...
[ 1.653149] Generating random numbers by fair dice roll...
[ 1.918386] Creating cloned children...
[ 2.137450] Digging up root...
[ 2.369841] Forking spaghetti code...
[ 2.840216] Rewriting operating system in Javascript...
[ 2.956226] Creating bureaucratic processes...
[ 3.329981] Ready!
```

Looking good. And as required we finally write the `dmesg` output into the file:

```
k -n team-purple exec gvisor-test > /opt/course/10/gvisor-test-dmesg -- dmesg
```

## Question 11 | Secrets in ETCD

Task weight: 7%

Use context: `kubect1 config use-context workload-prod`

There is an existing *Secret* called `database-access` in *Namespace* `team-green`.

Read the complete *Secret* content from ETCD and store it into `/opt/course/11/etcd-secret-content`. Write the plain and decoded *Secret's* value of key "pass" into `/opt/course/11/database-password`.

Answer:

Let's try to get the *Secret* value directly from ETCD, which will work since it isn't encrypted.

First, we ssh into the master node where ETCD is running in this setup and check if `etcdctl` is installed and list its options:

```
→ ssh cluster1-master1

→ root@cluster1-master1:~# etcdctl
NAME:
  etcdctl - A simple command line client for etcd.

WARNING:
  Environment variable ETCDCTL_API is not set; defaults to etcdctl v2.
  Set environment variable ETCDCTL_API=3 to use v3 API or ETCDCTL_API=2 to use v2 API.

USAGE:
  etcdctl [global options] command [command options] [arguments...]
...
--cert-file value    identify HTTPS client using this SSL certificate file
--key-file value     identify HTTPS client using this SSL key file
--ca-file value      verify certificates of HTTPS-enabled servers using this CA bundle
...
```

Among others we see arguments to identify ourselves. The apiserver connects to ETCD, so we can run the following command to get the path of the necessary .crt and .key files:

```
cat /etc/kubernetes/manifests/kube-apiserver.yaml | grep etcd
```

The output is as follows :

```
- --etcd-cafile=/etc/kubernetes/pki/etcd/ca.crt
- --etcd-certfile=/etc/kubernetes/pki/apiserver-etcd-client.crt
- --etcd-keyfile=/etc/kubernetes/pki/apiserver-etcd-client.key
- --etcd-servers=https://127.0.0.1:2379 # optional since we're on same node
```

With this information we query ETCD for the secret value:

```
→ root@cluster1-master1:~# ETCDCTL_API=3 etcdctl \
--cert /etc/kubernetes/pki/apiserver-etcd-client.crt \
--key /etc/kubernetes/pki/apiserver-etcd-client.key \
--cacert /etc/kubernetes/pki/etcd/ca.crt get /registry/secrets/team-green/database-access
```

ETCD in Kubernetes stores data under `/registry/{type}/{namespace}/{name}`. This is how we came to look for `/registry/secrets/team-green/database-access`. There is also an example on a page [in the k8s documentation](#) which you could save as a bookmark to access fast during the exam.

The tasks requires us to store the output on our terminal. For this we can simply copy&paste the content into a new file on our terminal:

```
# /opt/course/11/etcd-secret-content
/registry/secrets/team-green/database-access
k8s

v1Secret

database-access
team-green"*$3e0acd78-709d-4f07-bdac-d5193d0f2aa32bb
0kubect1.kubernetes.io/last-applied-configuration{"apiVersion":"v1","data":
{"pass":"Y29uZm1kZW50aWFs"},"kind":"Secret","metadata":{"annotations":{"name":"database-
access","namespace":"team-green"}}
z
kubect1-client-side-applyupdatevFieldsV1:
{"f:data":{"":"{}","f:pass":{"}},"f:metadata":{"f:annotations":{"":"{}","f:kubect1.kubernetes.io/last-applied-
configuration":{"}},"f:type":{"}}
pass
confidentialopaque"
```

We're also required to store the plain and "decrypted" database password. For this we can copy the base64-encoded value from the ETCD output and run on our terminal:

```
→ echo Y29uZm1kZW50aWFs | base64 -d > /opt/course/11/database-password

→ cat /opt/course/11/database-password
confidential
```

## Question 12 | Hack Secrets

Task weight: 8%

Use context: `kubect1 config use-context restricted@infra-prod`

You're asked to investigate a possible permission escape in *Namespace* `restricted`. The context authenticates as user `restricted` which has only limited permissions and shouldn't be able to read *Secret* values.

Try to find the password-key values of the *Secrets* `secret1`, `secret2` and `secret3` in *Namespace* `restricted`. Write the decoded plaintext values into files `/opt/course/12/secret1`, `/opt/course/12/secret2` and `/opt/course/12/secret3`.

Answer:

First we should explore the boundaries, we can try:

```
→ k -n restricted get role,rolebinding,clusterrole,clusterrolebinding
Error from server (Forbidden): roles.rbac.authorization.k8s.io is forbidden: User "restricted" cannot list resource "roles" in API group "rbac.authorization.k8s.io" in the namespace "restricted"
Error from server (Forbidden): rolebindings.rbac.authorization.k8s.io is forbidden: User "restricted" cannot list resource "rolebindings" in API group "rbac.authorization.k8s.io" in the namespace "restricted"
Error from server (Forbidden): clusterroles.rbac.authorization.k8s.io is forbidden: User "restricted" cannot list resource "clusterroles" in API group "rbac.authorization.k8s.io" at the cluster scope
Error from server (Forbidden): clusterrolebindings.rbac.authorization.k8s.io is forbidden: User "restricted" cannot list resource "clusterrolebindings" in API group "rbac.authorization.k8s.io" at the cluster scope
```

But no permissions to view RBAC resources. So we try the obvious:

```
→ k -n restricted get secret
Error from server (Forbidden): secrets is forbidden: User "restricted" cannot list resource "secrets" in API group "" in the namespace "restricted"

→ k -n restricted get secret -o yaml
apiVersion: v1
items: []
kind: List
metadata:
  resourceVersion: ""
  selfLink: ""
Error from server (Forbidden): secrets is forbidden: User "restricted" cannot list resource "secrets" in API group "" in the namespace "restricted"
```

We're not allowed to get or list any *Secrets*. What can we see though?

```
→ k -n restricted get all
NAME                                READY   STATUS    RESTARTS   AGE
pod1-fd5d64b9c-pcx6q               1/1     Running   0           37s
pod2-6494f7699b-4hks5              1/1     Running   0           37s
pod3-748b48594-24s76               1/1     Running   0           37s
Error from server (Forbidden): replicationcontrollers is forbidden: User "restricted" cannot list resource "replicationcontrollers" in API group "" in the namespace "restricted"
Error from server (Forbidden): services is forbidden: User "restricted" cannot list resource "services" in API group "" in the namespace "restricted"
...
```

There are some *Pods*, lets check these out regarding *Secret* access:

```
k -n restricted get pod -o yaml | grep -i secret
```

This output provides us with enough information to do:

```
→ k -n restricted exec pod1-fd5d64b9c-pcx6q -- cat /etc/secret-volume/password
you-are

→ echo you-are > /opt/course/12/secret1
```

And for the second *Secret*:

```
→ k -n restricted exec pod2-6494f7699b-4hks5 -- env | grep PASS
PASSWORD=an-amazing

→ echo an-amazing > /opt/course/12/secret2
```

None of the *Pods* seem to mount **secret3** though. Can we create or edit existing *Pods* to mount **secret3**?

```
→ k -n restricted run test --image=nginx
Error from server (Forbidden): pods is forbidden: User "restricted" cannot create resource "pods" in API group "" in the namespace "restricted"

→ k -n restricted delete pod pod1
Error from server (Forbidden): pods "pod1" is forbidden: User "restricted" cannot delete resource "pods" in API group "" in the namespace "restricted"
```

Doesn't look like it.

But the *Pods* seem to be able to access the *Secrets*, we can try to use a *Pod's ServiceAccount* to access the third *Secret*. We can actually see (like using `k -n restricted get pod -o yaml | grep automountServiceAccountToken`) that only *Pod pod3-\** has the *ServiceAccount* token mounted:

```
→ k -n restricted exec -it pod3-748b48594-24s76 -- sh

/ # mount | grep serviceaccount
tmpfs on /run/secrets/kubernetes.io/serviceaccount type tmpfs (ro,relatime)

/ # ls /run/secrets/kubernetes.io/serviceaccount
ca.crt      namespace  token
```

**NOTE:** You should have knowledge about *ServiceAccounts* and how they work with *Pods* like [described in the docs](#)

We can see all necessary information to contact the apiserver manually:

```
/ # curl https://kubernetes.default/api/v1/namespaces/restricted/secrets -H "Authorization: Bearer $(cat /run/secrets/kubernetes.io/serviceaccount/token)" -k
...
{
  "metadata": {
    "name": "secret3",
    "namespace": "restricted",
    ...
  }
},
"data": {
  "password": "cEVuRXRSYVVRpT24tdEVzvGVSCg=="
},
"type": "Opaque"
}
...
```

Let's encode it and write it into the requested location:

```
→ echo cEVuRXRSYVRpT24tdEVzVGVSg== | base64 -d
pEnEtRaTiOn-tEsTeR

→ echo cEVuRXRSYVRpT24tdEVzVGVSg== | base64 -d > /opt/course/12/secret3
```

This will give us:

```
# /opt/course/12/secret1
you-are
```

```
# /opt/course/12/secret2
an-amazing
```

```
# /opt/course/12/secret3
pEnEtRaTiOn-tEsTeR
```

We hacked all *Secrets*! It can be tricky to get RBAC right and secure.

One thing to consider is that giving the permission to "list" *Secrets*, will also allow the user to read the *Secret* values like using `kubect1 get secrets -o yaml` even without the "get" permission set.

### Question 13 | Restrict access to Metadata Server

Task weight: 7%

Use context: `kubect1 config use-context infra-prod`

There is a metadata service available at `http://192.168.100.21:32000` on which *Nodes* can reach sensitive data, like cloud credentials for initialisation. By default, all *Pods* in the cluster also have access to this endpoint. The DevSecOps team has asked you to restrict access to this metadata server.

In *Namespace* `metadata-access`:

- Create a *NetworkPolicy* named `metadata-deny` which prevents egress to `192.168.100.21` for all *Pods* but still allows access to everything else
- Create a *NetworkPolicy* named `metadata-allow` which allows *Pods* having label `role: metadata-accessor` to access endpoint `192.168.100.21`

There are existing *Pods* in the target *Namespace* with which you can test your policies, but don't change their labels.

Answer:

There was a [famous hack at Spotify](#) which was based on revealed information via metadata for nodes.

Check the *Pods* in the *Namespace* `metadata-access` and their labels:

```
→ k -n metadata-access get pods --show-labels
NAME                                ... LABELS
pod1-7d67b4ff9-xrcd7               ... app=pod1,pod-template-hash=7d67b4ff9
pod2-7b6fc66944-2hc7n              ... app=pod2,pod-template-hash=7b6fc66944
pod3-7dc879bd59-hkgrr              ... app=pod3,role=metadata-accessor,pod-template-hash=7dc879bd59
```

There are three *Pods* in the *Namespace* and one of them has the label `role=metadata-accessor`.

Check access to the metadata server from the *Pods*:

```
→ k exec -it -n metadata-access pod1-7d67b4ff9-xrcd7 -- curl http://192.168.100.21:32000
metadata server

→ k exec -it -n metadata-access pod2-7b6fc66944-2hc7n -- curl http://192.168.100.21:32000
metadata server

→ k exec -it -n metadata-access pod3-7dc879bd59-hkgrr -- curl http://192.168.100.21:32000
metadata server
```

All three are able to access the metadata server.

To restrict the access, we create a *NetworkPolicy* to deny access to the specific IP.

```
vim 13_metadata-deny.yaml
```

```
# 13_metadata-deny.yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: metadata-deny
  namespace: metadata-access
spec:
  podSelector: {}
  policyTypes:
  - Egress
  egress:
  - to:
    - ipBlock:
        cidr: 0.0.0.0/0
        except:
        - 192.168.100.21/32
```

```
k -f 13_metadata-deny.yaml apply
```

**NOTE:** You should know about general [default-deny K8s NetworkPolicies](#).

Verify that access to the metadata server has been blocked, but other endpoints are still accessible:

```
→ k exec -it -n metadata-access pod1-7d67b4ff9-xrcd7 -- curl http://192.168.100.21:32000
curl: (28) Failed to connect to 192.168.100.21 port 32000: Operation timed out
command terminated with exit code 28

→ kubect1 exec -it -n metadata-access pod1-7d67b4ff9-xrcd7 -- curl -I https://kubernetes.io
HTTP/2 200
cache-control: public, max-age=0, must-revalidate
content-type: text/html; charset=UTF-8
```

```
date: Mon, 14 Sep 2020 15:39:39 GMT
etag: "b46e429397e5f1fecf48c10a533f5cd8-ss1"
strict-transport-security: max-age=31536000
age: 13
content-length: 22252
server: Netlify
x-nf-request-id: 1d94a1d1-6bac-4a98-b065-346f661fdb1-393998290
```

Similarly, verify for the other two *Pods*.

Now create another *NetworkPolicy* that allows access to the metadata server from *Pods* with label `role=metadata-accessor`.

```
vim 13_metadata-allow.yaml
```

```
# 13_metadata-allow.yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: metadata-allow
  namespace: metadata-access
spec:
  podSelector:
    matchLabels:
      role: metadata-accessor
  policyTypes:
  - Egress
  egress:
  - to:
    - ipBlock:
        cidr: 192.168.100.21/32
```

```
k -f 13_metadata-allow.yaml apply
```

Verify that required *Pod* has access to metadata endpoint and others do not:

```
→ k -n metadata-access exec pod3-7dc879bd59-hkgrr -- curl http://192.168.100.21:32000
metadata server

→ k -n metadata-access exec pod2-7b6fc66944-9ngzr -- curl http://192.168.100.21:32000
^Ccommand terminated with exit code 130
```

It only works for the *Pod* having the label. With this we implemented the required security restrictions.

If a *Pod* doesn't have a matching *NetworkPolicy* then all traffic is allowed from and to it. Once a *Pod* has a matching *NP* then the contained rules are additive. This means that for *Pods* having label `metadata-accessor` the rules will be combined to:

```
# merged policies into one for pods with label metadata-accessor
spec:
  podSelector: {}
  policyTypes:
  - Egress
  egress:
  - to: # first rule
    - ipBlock: # condition 1
        cidr: 0.0.0.0/0
        except:
        - 192.168.100.21/32
  - to: # second rule
    - ipBlock: # condition 1
        cidr: 192.168.100.21/32
```

We can see that the merged *NP* contains two separate rules with one condition each. We could read it as:

```
Allow outgoing traffic if:
(destination is 0.0.0.0/0 but not 192.168.100.21/32) OR (destination is 192.168.100.21/32)
```

Hence it allows *Pods* with label `metadata-accessor` to access everything.

## Question 14 | Syscall Activity

Task weight: 4%

Use context: `kubect1 config use-context workload-prod`

There are *Pods* in *Namespace* `team-yellow`. A security investigation noticed that some processes running in these *Pods* are using the Syscall `kill`, which is forbidden by a Team Yellow internal policy.

Find the offending *Pod(s)* and remove these by reducing the replicas of the parent *Deployment* to 0.

Answer:

Syscalls are used by processes running in Userspace to communicate with the Linux Kernel. There are many available syscalls: <http://man7.org/linux/man-pages/man2/syscalls.2.html>. It makes sense to restrict these for container processes and Docker does restrict already some by default, like the `reboot` Syscall. Restricting even more is possible for example using Seccomp or AppArmor.

But for this task we should simply find out which binary process executes a specific Syscall. Processes in containers are simply run on the same Linux operating system, but isolated. That's why we first check on which nodes the *Pods* are running:

```
→ k -n team-yellow get pod -owide
NAME                                ... NODE                                NOMINATED NODE    READINESS GATES
collector1-59ddb6c7f-ffjjv          ... cluster1-worker1    <none>            <none>
collector1-59ddb6c7f-p9qqz          ... cluster1-worker1    <none>            <none>
collector2-7b6868b5dc-h6zxx        ... cluster1-worker1    <none>            <none>
collector3-77b7c5bf47-5hgcb        ... cluster1-worker1    <none>            <none>
collector3-77b7c5bf47-rswr1        ... cluster1-worker1    <none>            <none>
```

All on `cluster1-worker1`, hence we ssh into it and find the processes for the first *Deployment* `collector1`.

```
→ ssh cluster1-worker1

→ root@cluster1-worker1:~# docker ps | grep collector1
3e07aee08a48      registry.killer.sh:5000/collector1    "/collector1-process"    14 seconds ago      Up
13 seconds      k8s_c_collector1-59ddb6c7f-vvwgt_team-yellow_099822ad-2dfc-4963-bfc7-
d806e00c0daf_0
...
```

*Deployment* `collector1` has two replicas, and we can see that the processes execute `./collector1-process`. We can find the process PIDs:

```
→ root@cluster1-worker1:~# ps aux | grep collector1-process
root      10991  0.0  0.0   2412   760 ?        Ssl  22:41   0:00 ./collector1-process
root      11150  0.0  0.0   2412   756 ?        Ssl  22:41   0:00 ./collector1-process
```

Using the PIDs we can call `strace` to find Sycalls:

```
→ root@cluster1-worker1:~# strace -p 10991
strace: Process 10991 attached
restart_syscall(<... resuming interrupted futex ...>) = -1 ETIMEDOUT (Connection timed out)
futex(0x4ad5d0, FUTEX_WAKE, 1)                = 1
kill(666, SIGTERM)                            = -1 ESRCH (No such process)
futex(0xc420030948, FUTEX_WAKE, 1)            = 1
futex(0x4afe80, FUTEX_WAIT, 0, {tv_sec=0, tv_nsec=999998945}) = -1 ETIMEDOUT (Connection timed out)
...
```

First try and already a catch! We see it uses the forbidden Syscall by calling `kill(666, SIGTERM)`.

Next let's check the *Deployment* `collector2` processes:

```
→ root@cluster1-worker1:~# docker ps | grep collector2
60531737cb83      registry.killer.sh:5000/collector2      "/collector2-process"   4 minutes ago        Up
4 minutes      k8s_c_collector2-7b6868b5dc-

→ root@cluster1-worker1:~# ps aux | grep collector2-process
root      10438  0.0  0.0   2420   764 ?        Ssl  20:19   0:00 ./collector2-process
root      26442  0.0  0.0  14856  1000 pts/0    S+   21:13   0:00 grep --color=auto collector2-process

→ root@cluster1-worker1:~# strace -p 10438
strace: Process 11080 attached
restart_syscall(<... resuming interrupted futex ...>) = -1 ETIMEDOUT (Connection timed out)
futex(0x4af3d0, FUTEX_WAKE, 1)                = 1
futex(0x4af2f0, FUTEX_WAKE, 1)                = 1
futex(0xc420030548, FUTEX_WAKE, 1)            = 1
futex(0x4b1c80, FUTEX_WAIT, 0, {tv_sec=0, tv_nsec=999999578}) = -1 ETIMEDOUT (Connection timed out)
...
```

Looks alright. What about `collector3`:

```
→ root@cluster1-worker1:~# docker ps | grep collector3
4db52d9aa69e      registry.killer.sh:5000/collector3      "/collector3-process"   6 minutes ago        Up
6 minutes      k8s_c_collector3-77b7c5bf47-

→ root@cluster1-worker1:~# ps aux | grep collector3-process
root      10915  0.0  0.0   2428   756 ?        Ssl  22:41   0:00 ./collector3-process
root      11135  0.0  0.0   2428   760 ?        Ssl  22:41   0:00 ./collector3-process
root      13374  0.0  0.1  14856  1104 pts/0    S+   22:49   0:00 grep --color=auto collector3-process

→ root@cluster1-worker1:~# strace -p 10915
strace: Process 10915 attached
restart_syscall(<... resuming interrupted futex ...>) = -1 ETIMEDOUT (Connection timed out)
futex(0x4b13d0, FUTEX_WAKE, 1)                = 1
futex(0x4b12f0, FUTEX_WAKE, 1)                = 1
futex(0xc420030548, FUTEX_WAKE, 1)            = 1
futex(0x4b3c80, FUTEX_WAIT, 0, {tv_sec=0, tv_nsec=999999504}) = -1 ETIMEDOUT (Connection timed out)
```

Also nothing about the forbidden Syscall. So we finalise the task:

```
k -n team-yellow scale deploy collector1 --replicas 0
```

And the world is a bit safer again.

## Question 15 | Configure TLS on Ingress

*Task weight: 4%*

Use context: `kubect1 config use-context workload-prod`

In *Namespace* `team-pink` there is an existing Nginx *Ingress* resources named `secure` which accepts two paths `/app` and `/api` which point to different ClusterIP *Services*.

From your main terminal you can connect to it using for example:

- HTTP: `curl -v http://secure-ingress.test:31080/app`
- HTTPS: `curl -kv https://secure-ingress.test:31443/app`

Right now it uses a default generated TLS certificate by the Nginx Ingress Controller.

You're asked to instead use the key and certificate provided at `/opt/course/15/tls.key` and `/opt/course/15/tls.crt`. As it's a self-signed certificate you need to use `curl -k` when connecting to it.

**Answer:**

**Investigate**

We can get the IP address of the *Ingress* and we see it's the same one to which `secure-ingress.test` is pointing to:

```
→ k -n team-pink get ing secure
NAME      CLASS      HOSTS              ADDRESS          PORTS   AGE
secure    <none>     secure-ingress.test 192.168.100.12  80      7m11s

→ ping secure-ingress.test
PING cluster1-worker1 (192.168.100.12) 56(84) bytes of data.
64 bytes from cluster1-worker1 (192.168.100.12): icmp_seq=1 ttl=64 time=0.316 ms
```

Now, let's try to access the paths `/app` and `/api` via HTTP:

```
→ curl http://secure-ingress.test:31080/app
This is the backend APP!

→ curl http://secure-ingress.test:31080/api
This is the API Server!
```

What about HTTPS?

```
→ curl https://secure-ingress.test:31443/api
curl: (60) SSL certificate problem: unable to get local issuer certificate
More details here: https://curl.haxx.se/docs/sslcerts.html

curl failed to verify the legitimacy of the server and therefore could not
establish a secure connection to it. To learn more about this situation and
how to fix it, please visit the web page mentioned above.

→ curl -k https://secure-ingress.test:31443/api
This is the API Server!
```

HTTPS seems to be already working if we accept self-signed certificated using `-k`. But what kind of certificate is used by the server?

```
→ curl -kv https://secure-ingress.test:31443/api
...
* Server certificate:
*  subject: O=Acme Co; CN=Kubernetes Ingress Controller Fake Certificate
*  start date: Sep 28 12:28:35 2020 GMT
*  expire date: Sep 28 12:28:35 2021 GMT
*  issuer: O=Acme Co; CN=Kubernetes Ingress Controller Fake Certificate
*  SSL certificate verify result: unable to get local issuer certificate (20), continuing anyway.
...
```

It seems to be "Kubernetes Ingress Controller Fake Certificate".

Implement own TLS certificate

First, let us generate a *Secret* using the provided key and certificate:

```
→ cd /opt/course/15

→ ./opt/course/15$ ls
tls.crt  tls.key

→ ./opt/course/15$ k -n team-pink create secret tls tls-secret --key tls.key --cert tls.crt
secret/tls-secret created
```

Now, we configure the *Ingress* to make use of this *Secret*:

```
→ k -n team-pink get ing secure -oyaml > 15_ing_bak.yaml

→ k -n team-pink edit ing secure
```

```
# kubectl -n team-pink edit ing secure
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  annotations:
  ...
  generation: 1
  name: secure
  namespace: team-pink
  ...
spec:
  tls:
    # add
    - hosts:
      # add
      - secure-ingress.test
      # add
      secretName: tls-secret
      # add
  rules:
    - host: secure-ingress.test
      http:
        paths:
          - backend:
              serviceName: secure-app
              servicePort: 80
            path: /app
            pathType: ImplementationSpecific
          - backend:
              serviceName: secure-api
              servicePort: 80
            path: /api
            pathType: ImplementationSpecific
        ...
```

After adding the changes we check the *Ingress* resource again:

```
→ k -n team-pink get ing
NAME      CLASS      HOSTS                ADDRESS      PORTS      AGE
secure    <none>     secure-ingress.test  192.168.100.12  80, 443    25m
```

It now actually lists port 443 for HTTPS. To verify:

```
→ curl -k https://secure-ingress.test:31443/api
This is the API Server!

→ curl -kv https://secure-ingress.test:31443/api
...
* Server certificate:
*  subject: CN=secure-ingress.test; O=secure-ingress.test
*  start date: Sep 25 18:22:10 2020 GMT
*  expire date: Sep 20 18:22:10 2040 GMT
*  issuer: CN=secure-ingress.test; O=secure-ingress.test
*  SSL certificate verify result: self signed certificate (18), continuing anyway.
...
```

We can see that the provided certificate is now being used by the *Ingress* for TLS termination.

Question 16 | Docker Image Attack Surface

Task weight: 7%

Use context: `kubectl config use-context workload-prod`

There is a *Deployment* `image-verify` in *Namespace* `team-blue` which runs image `registry.killer.sh:5000/image-verify:v1`. DevSecOps has asked you to improve this image by:



- 1. Changing the base image to `alpine:3.12`
- 2. Not installing `curl`
- 3. Updating `nginx` to version `>=1.18.0`
- 4. Running the main process as user `myuser`

Do not add any new lines to the Dockerfile, just edit existing ones. The file is located at `/opt/course/16/image/bockerfile`.

Tag your version as `v2`. You can build, tag and push using:

```
cd /opt/course/16/image
sudo docker build -t registry.killer.sh:5000/image-verify:v2 .
sudo docker run registry.killer.sh:5000/image-verify:v2 # to test your changes
sudo docker push registry.killer.sh:5000/image-verify:v2
```

Make the *Deployment* use your updated image tag `v2`.

Answer:

We should have a look at the Docker Image at first:

```
cd /opt/course/16/image

cp Dockerfile Dockerfile.bak

vim Dockerfile
```

```
# /opt/course/16/image/Dockerfile
FROM alpine:3.4
RUN apk update && apk add vim curl nginx=1.10.3-r0
RUN addgroup -S myuser && adduser -S myuser -G myuser
COPY ./run.sh run.sh
RUN ["chmod", "+x", "./run.sh"]
USER root
ENTRYPOINT ["/bin/sh", "./run.sh"]
```

Very simple Dockerfile which seems to execute a script `run.sh` :

```
# /opt/course/16/image/run.sh
while true; do date; id; echo; sleep 1; done
```

So it only outputs current date and credential information in a loop. We can see that output in the existing *Deployment* `image-verify`:

```
→ k -n team-blue logs -f -l id=image-verify
Fri Sep 25 20:59:12 UTC 2020
uid=0(root) gid=0(root)
groups=0(root),1(bin),2(daemon),3(sys),4(adm),6(disk),10(wheel),11(floppy),20(dialout),26(tape),27(video)
```

We see its running as root.

Next we update the `Dockerfile` according to the requirements:

```
# /opt/course/16/image/Dockerfile

# change
FROM alpine:3.12

# change
RUN apk update && apk add vim nginx>=1.18.0

RUN addgroup -S myuser && adduser -S myuser -G myuser
COPY ./run.sh run.sh
RUN ["chmod", "+x", "./run.sh"]

# change
USER myuser

ENTRYPOINT ["/bin/sh", "./run.sh"]
```

Then we build the new image:

```
→ ./opt/course/16/image$ sudo docker build -t registry.killer.sh:5000/image-verify:v2 .
Sending build context to Docker daemon 3.072kB
...
Successfully built a5df16d42c5b
Successfully tagged registry.killer.sh:5000/image-verify:v2
```

We can then test our changes by running the container locally:

```
→ ./opt/course/16/image$ sudo docker run registry.killer.sh:5000/image-verify:v2
Fri Sep 25 21:02:09 UTC 2020
uid=101(myuser) gid=102(myuser) groups=102(myuser)
```

Looking good, so we push:

```
→ ./opt/course/16/image$ sudo docker push registry.killer.sh:5000/image-verify:v2
The push refers to repository [registry.killer.sh:5000/image-verify]
bf21d6611c7c: Layer already exists
82eb465441ab: Layer already exists
f88b13f57e3a: Pushed
32099b2fa646: Pushed
50644c29ef5a: Pushed
v2: digest: sha256:867c1fded95faec9e73404e822f6ed001b83163bd1e86f8945e8c00a758fdae size: 1362
```

And we update the *Deployment* to use the new image:

```
k -n team-blue edit deploy image-verify
```

```
# kubectl -n team-blue edit deploy image-verify
apiVersion: apps/v1
kind: Deployment
metadata:
...
spec:
...
  template:
...
    spec:
      containers:
      - image: registry.killer.sh:5000/image-verify:v2 # change
```

And afterwards we can verify our changes by looking at the *Pod* logs:

```
→ k -n team-blue logs -f -l id=image-verify
Fri Sep 25 21:06:55 UTC 2020
uid=101(myuser) gid=102(myuser) groups=102(myuser)
```

Also to verify our changes even further:

```
→ k -n team-blue exec image-verify-55fbcd4c9b-x2f1c -- curl
OCI runtime exec failed: exec failed: container_linux.go:349: starting container process caused "exec:
\"curl\": executable file not found in $PATH": unknown
command terminated with exit code 126

→ k -n team-blue exec image-verify-55fbcd4c9b-x2f1c -- nginx -v
nginx version: nginx/1.18.0
```

Another task solved.

## Question 17 | Audit Log Policy

Task weight: 7%

Use context: `kubectl config use-context infra-prod`

Audit Logging has been enabled in the cluster with an Audit *Policy* located at `/etc/kubernetes/audit/policy.yaml` on `cluster2-master1`.

Change the configuration so that only one backup of the logs is stored.

Alter the *Policy* in a way that it only stores logs:

- 1. From *Secret* resources, level Metadata
- 2. From "system:nodes" userGroups, level RequestResponse

After you altered the *Policy* make sure to empty the log file so it only contains entries according to your changes, like using `truncate -s 0 /etc/kubernetes/audit/logs/audit.log`.

Answer:

First we check the apiserver configuration and change as requested:

```
→ ssh cluster2-master1

→ root@cluster2-master1:~# cp /etc/kubernetes/manifests/kube-apiserver.yaml ~/17_kube-apiserver.yaml #
backup

→ root@cluster2-master1:~# vim /etc/kubernetes/manifests/kube-apiserver.yaml

# /etc/kubernetes/manifests/kube-apiserver.yaml
apiVersion: v1
kind: Pod
metadata:
  annotations:
    kubeadm.kubernetes.io/kube-apiserver.advertise-address.endpoint: 192.168.100.21:6443
  creationTimestamp: null
  labels:
    component: kube-apiserver
    tier: control-plane
  name: kube-apiserver
  namespace: kube-system
spec:
  containers:
  - command:
    - kube-apiserver
    - --audit-policy-file=/etc/kubernetes/audit/policy.yaml
    - --audit-log-path=/etc/kubernetes/audit/logs/audit.log
    - --audit-log-maxsize=5
    - --audit-log-maxbackup=1
    - --advertise-address=192.168.100.21
    - --allow-privileged=true
    ...
```

**NOTE:** You should know how to enable Audit Logging completely yourself [as described in the docs](#). Feel free to try this in another cluster in this environment.

Now we look at the existing *Policy*:

```
→ root@cluster2-master1:~# vim /etc/kubernetes/audit/policy.yaml

# /etc/kubernetes/audit/policy.yaml
apiVersion: audit.k8s.io/v1
kind: Policy
rules:
- level: Metadata
```

We can see that this simple *Policy* logs everything on Metadata level. So we change it to the requirements:

```
# /etc/kubernetes/audit/policy.yaml
apiVersion: audit.k8s.io/v1
kind: Policy
rules:

# log Secret resources audits, level Metadata
```

```
- level: Metadata
resources:
- group: ""
  resources: ["secrets"]

# log node related audits, level RequestResponse
- level: RequestResponse
  userGroups: ["system:nodes"]

# for everything else don't log anything
- level: None
```

After saving the changes we have to restart the apiserver:

```
→ root@cluster2-master1:~# cd /etc/kubernetes/manifests/

→ root@cluster2-master1:/etc/kubernetes/manifests# mv kube-apiserver.yaml ..

→ root@cluster2-master1:/etc/kubernetes/manifests# truncate -s 0 /etc/kubernetes/audit/logs/audit.log

→ root@cluster2-master1:/etc/kubernetes/manifests# mv ../kube-apiserver.yaml .
```

Once the apiserver is running again we can check the new logs and scroll through some entries:

```
{
  "kind": "Event",
  "apiVersion": "audit.k8s.io/v1",
  "level": "Metadata",
  "auditID": "e598dc9e-fc8b-4213-ae3-0719499ab1bd",
  "stage": "RequestReceived",
  "requestURI": "...",
  "verb": "watch",
  "user": {
    "username": "system:serviceaccount:gatekeeper-system:gatekeeper-admin",
    "uid": "79870838-75a8-479b-ad42-4b7b75bd17a3",
    "groups": [
      "system:serviceaccounts",
      "system:serviceaccounts:gatekeeper-system",
      "system:authenticated"
    ]
  },
  "sourceIPs": [
    "192.168.102.21"
  ],
  "userAgent": "manager/v0.0.0 (linux/amd64) kubernetes/$Format",
  "objectRef": {
    "resource": "secrets",
    "apiVersion": "v1"
  },
  "requestReceivedTimestamp": "2020-09-27T20:01:36.238911Z",
  "stageTimestamp": "2020-09-27T20:01:36.238911Z",
  "annotations": {
    "authentication.k8s.io/legacy-token": "..."
  }
}
```

Above we logged a watch action by OPA Gatekeeper for *Secrets*, level Metadata.

```
{
  "kind": "Event",
  "apiVersion": "audit.k8s.io/v1",
  "level": "RequestResponse",
  "auditID": "c90e53ed-b0cf-4cc4-889a-f1204dd39267",
  "stage": "ResponseComplete",
  "requestURI": "...",
  "verb": "list",
  "user": {
    "username": "system:node:cluster2-master1",
    "groups": [
      "system:nodes",
      "system:authenticated"
    ]
  },
  "sourceIPs": [
    "192.168.100.21"
  ],
  "userAgent": "kubelet/v1.19.1 (linux/amd64) kubernetes/206bcad",
  "objectRef": {
    "resource": "configmaps",
    "namespace": "kube-system",
    "name": "kube-proxy",
    "apiVersion": "v1"
  },
  "responseStatus": {
    "metadata": {},
    "code": 200
  },
  "responseObject": {
    "kind": "ConfigMapList",
    "apiVersion": "v1",
    "metadata": {
      "selfLink": "/api/v1/namespaces/kube-system/configmaps",
      "resourceVersion": "83409"
    },
    "items": [
      {
        "metadata": {
          "name": "kube-proxy",
          "namespace": "kube-system",
          "selfLink": "/api/v1/namespaces/kube-system/configmaps/kube-proxy",
          "uid": "0f1c3950-430a-4543-83e4-3f9c87a478b8",
          "resourceVersion": "232",
          "creationTimestamp": "2020-09-26T20:59:50Z",
          "labels": {
            "app": "kube-proxy"
          },
          "annotations": {
            "kubeadm.kubernetes.io/component-config.hash": "..."
          },
          "managedFields": [
            {
              ...
            }
          ]
        },
        ...
      }
    ]
  },
}
```

```
...
    }
  ]
},
"requestReceivedTimestamp": "2020-09-27T20:01:36.223781z",
"stageTimestamp": "2020-09-27T20:01:36.225470z",
"annotations": {
  "authorization.k8s.io/decision": "allow",
  "authorization.k8s.io/reason": ""
}
}
```

And in the one above we logged a list action by system:nodes for a *ConfigMaps*, level *RequestResponse*.

Because all JSON entries are written in a single line in the file we could also run some simple verifications on our *Policy*:

```
# shows Secret entries
cat audit.log | grep '"resource":"secrets"' | wc -l

# confirms Secret entries are only of level Metadata
cat audit.log | grep '"resource":"secrets"' | grep -v '"level":"Metadata"' | wc -l

# shows RequestResponse level entries
cat audit.log | grep -v '"level":"RequestResponse"' | wc -l

# shows RequestResponse level entries are only for system:nodes
cat audit.log | grep '"level":"RequestResponse"' | grep -v "system:nodes" | wc -l
```

Looks like our job is done.

## Question 18 | Investigate Break-in via Audit Log

Task weight: 4%

Use context: `kubect1 config use-context infra-prod`

*Namespace* `security` contains five *Secrets* of type *Opaque* which can be considered highly confidential. The latest Incident-Prevention-Investigation revealed that *ServiceAccount* `p.auster` had too broad access to the cluster for some time. This *SA* should've never had access to any *Secrets* in that *Namespace*.

Find out which *Secrets* in *Namespace* `security` this *SA* did access by looking at the Audit Logs under `/opt/course/18/audit.log`.

Change the password to any new string of only those *Secrets* that were accessed by this *SA*.

### Answer:

First we look at the *Secrets* this is about:

```
→ k -n security get secret | grep Opaque
kubeadmin-token      Opaque      1      37m
mysql-admin          Opaque      1      37m
postgres001          Opaque      1      37m
postgres002          Opaque      1      37m
vault-token           Opaque      1      37m
```

Next we investigate the Audit Log file:

```
→ cd /opt/course/18

→ ./opt/course/18$ ls -lh
total 7.1M
-rw-r--r-- 1 k8s k8s 7.5M Sep 24 21:31 audit.log

→ ./opt/course/18$ cat audit.log | wc -l
4451
```

Audit Logs can be huge and it's common to limit the amount by creating an Audit *Policy* and to transfer the data in systems like Elasticsearch. In this case we have a simple JSON export, but it already contains 4451 lines.

We should try to filter the file down to relevant information:

```
→ ./opt/course/18$ cat audit.log | grep "p.auster" | wc -l
28
```

Not too bad, only 28 logs for *ServiceAccount* `p.auster`.

```
→ ./opt/course/18$ cat audit.log | grep "p.auster" | grep Secret | wc -l
2
```

And only 2 logs related to *Secrets*...

```
→ ./opt/course/18$ cat audit.log | grep "p.auster" | grep Secret | grep list | wc -l
0

→ ./opt/course/18$ cat audit.log | grep "p.auster" | grep Secret | grep get | wc -l
2
```

No list actions, which is good, but 2 get actions, so we check these out:

```
cat audit.log | grep "p.auster" | grep Secret | grep get | vim -
```

```
{
  "kind": "Event",
  "apiVersion": "audit.k8s.io/v1",
  "level": "RequestResponse",
  "auditID": "74fd9e03-abea-4df1-b3d0-9cfeff9ad97a",
  "stage": "ResponseComplete",
  "requestURI": "/api/v1/namespaces/security/secrets/vault-token",
  "verb": "get",
  "user": {
    "username": "system:serviceaccount:security:p.auster",
    "uid": "29ecb107-c0e8-4f2d-816a-b16f4391999c",
    "groups": [
      "system:serviceaccounts",
      "system:serviceaccounts:security",

```

```
      "system:authenticated"
    ]
  },
  ...
  "userAgent": "curl/7.64.0",
  "objectRef": {
    "resource": "secrets",
    "namespace": "security",
    "name": "vault-token",
    "apiVersion": "v1"
  },
  ...
}
{
  "kind": "Event",
  "apiVersion": "audit.k8s.io/v1",
  "level": "RequestResponse",
  "auditID": "aed6caf9-5af0-4872-8f09-ad55974bb5e0",
  "stage": "ResponseComplete",
  "requestURI": "/api/v1/namespaces/security/secrets/mysql-admin",
  "verb": "get",
  "user": {
    "username": "system:serviceaccount:security:p.auster",
    "uid": "29ecb107-c0e8-4f2d-816a-b16f4391999c",
    "groups": [
      "system:serviceaccounts",
      "system:serviceaccounts:security",
      "system:authenticated"
    ]
  },
  ...
  "userAgent": "curl/7.64.0",
  "objectRef": {
    "resource": "secrets",
    "namespace": "security",
    "name": "mysql-admin",
    "apiVersion": "v1"
  },
  ...
}
```

There we see that *Secrets* `vault-token` and `mysql-admin` were accessed by `p.auster`. Hence we change the passwords for those.

```
→ echo new-vault-pass | base64
bmV3LXZhdwx0LXBhc3MK

→ k -n security edit secret vault-token

→ echo new-mysql-pass | base64
bmV3LW15c3FsLXBhc3MK

→ k -n security edit secret mysql-admin
```

Audit Logs ftw.

By running `cat audit.log | grep "p.auster" | grep Secret | grep password` we can see that passwords are stored in the Audit Logs, because they store the complete content of *Secrets*. It's never a good idea to reveal passwords in logs. In this case it would probably be sufficient to only store Metadata level information of *Secrets* which can be controlled via a Audit *Policy*.

## Question 19 | Immutable Root FileSystem

Task weight: 2%

Use context: `kubectl config use-context workload-prod`

The *Deployment* `immutable-deployment` in *Namespace* `team-purple` should run immutable, it's created from file `/opt/course/19/immutable-deployment.yaml`. Even after a successful break-in, it shouldn't be possible for an attacker to modify the filesystem of the running container.

Modify the *Deployment* in a way that no processes inside the container can modify the local filesystem, only `/tmp` directoy should be writeable. Don't modify the Docker image.

Save the updated YAML under `/opt/course/19/immutable-deployment-new.yaml` and update the running *Deployment*.

### Answer:

Processes in containers can write to the local filesystem by default. This increases the attack surface when a non-malicious process gets hijacked. Preventing applications to write to disk or only allowing to certain directories can mitigate the risk. If there is for example a bug in Nginx which allows an attacker to override any file inside the container, then this only works if the Nginx process itself can write to the filesystem in the first place.

Making the root filesystem readonly can be done in the Docker image itself or in a *Pod* declaration.

Let us first check the *Deployment* `immutable-deployment` in *Namespace* `team-purple`:

```
→ k -n team-purple edit deploy -o yaml
```

```
# kubectl -n team-purple edit deploy -o yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  namespace: team-purple
  name: immutable-deployment
  labels:
    app: immutable-deployment
  ...
spec:
  replicas: 1
  selector:
    matchLabels:
      app: immutable-deployment
  template:
    metadata:
      labels:
        app: immutable-deployment
    spec:
      containers:
        - image: busybox:1.32.0
          command: ['sh', '-c', 'tail -f /dev/null']
```

```
imagePullPolicy: IfNotPresent
name: busybox
restartPolicy: Always
...
```

The container has write access to the Root File System, as there are no restrictions defined for the *Pods* or containers by an existing *SecurityContext*. And based on the task we're not allowed to alter the Docker image.

So we modify the YAML manifest to include the required changes:

```
cp /opt/course/19/immutable-deployment.yaml /opt/course/19/immutable-deployment-new.yaml

vim /opt/course/19/immutable-deployment-new.yaml
```

```
# /opt/course/19/immutable-deployment-new.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  namespace: team-purple
  name: immutable-deployment
  labels:
    app: immutable-deployment
spec:
  replicas: 1
  selector:
    matchLabels:
      app: immutable-deployment
  template:
    metadata:
      labels:
        app: immutable-deployment
    spec:
      containers:
        - image: busybox:1.32.0
          command: ['sh', '-c', 'tail -f /dev/null']
          imagePullPolicy: IfNotPresent
          name: busybox
          securityContext:
            readOnlyRootFilesystem: true
          volumeMounts:
            - mountPath: /tmp
              name: temp-vol
          volumes:
            - name: temp-vol
              emptyDir: {}
          restartPolicy: Always
```

*SecurityContexts* can be set on *Pod* or container level, here the latter was asked. Enforcing `readOnlyRootFilesystem: true` will render the root filesystem read-only. We can then allow some directories to be writable by using an `emptyDir` volume.

Once the changes are made, let us update the *Deployment*:

```
→ k delete -f /opt/course/19/immutable-deployment-new.yaml
deployment.apps "immutable-deployment" deleted

→ k create -f /opt/course/19/immutable-deployment-new.yaml
deployment.apps/immutable-deployment created
```

We can verify if the required changes are propagated:

```
→ k -n team-purple exec immutable-deployment-5b7ff8d464-j2nrj -- touch /abc.txt
touch: /abc.txt: Read-only file system
command terminated with exit code 1

→ k -n team-purple exec immutable-deployment-5b7ff8d464-j2nrj -- touch /var/abc.txt
touch: /var/abc.txt: Read-only file system
command terminated with exit code 1

→ k -n team-purple exec immutable-deployment-5b7ff8d464-j2nrj -- touch /etc/abc.txt
touch: /etc/abc.txt: Read-only file system
command terminated with exit code 1

→ k -n team-purple exec immutable-deployment-5b7ff8d464-j2nrj -- touch /tmp/abc.txt

→ k -n team-purple exec immutable-deployment-5b7ff8d464-j2nrj -- ls /tmp
abc.txt
```

The *Deployment* has been updated so that the container's file system is read-only, and the updated YAML has been placed under the required location. Sweet!

## Question 20 | Update Kubernetes

Task weight: 8%

Use context: `kubect1 config use-context workload-stage`

The cluster is running Kubernetes `1.18.6`. Update it to `1.19.4` available via `apt` package manager.

Use `ssh cluster3-master1` and `ssh cluster3-worker1` to connect to the instances.

Answer:

Let's have a look at the current versions:

```
→ k get node

NAME             STATUS    ROLES    AGE   VERSION
cluster3-master1 Ready     master   13m   v1.18.6
cluster3-worker1 Ready     <none>   11m   v1.18.6
```

### Control Plane Master Components

First we should update the control plane components running on the master node, so we drain it:

```
→ k drain cluster3-master1 --ignore-daemonsets
```

Next we `ssh` into it and check versions:

```
→ ssh cluster3-master1

→ root@cluster3-master1:~# kubectl version
kubectl version: &version.Info{Major:"1", Minor:"19", GitVersion:"v1.19.4",
GitCommit:"d360454c9bcd1634cf4cc52d1867af5491dc9c5f", GitTreeState:"clean", BuildDate:"2020-11-
11T13:15:05Z", GoVersion:"go1.15.2", Compiler:"gc", Platform:"linux/amd64"}

→ root@cluster3-master1:~# kubectl --version
Kubernetes v1.18.6
```

We can see that `kubectl` is already installed in the wanted version. Otherwise we would have to run `apt-get install kubectl=1.19.4-00`.

We check what kubectl has available as an upgrade plan:

```
→ root@cluster3-master1:~# kubectl upgrade plan
[upgrade/config] Making sure the configuration is correct:
[upgrade/config] Reading configuration from the cluster...
...
```

And we apply it using:

```
→ root@cluster3-master1:~# kubectl upgrade apply v1.19.4
[upgrade/config] Making sure the configuration is correct:
[upgrade/config] Reading configuration from the cluster...
[upgrade/config] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubectl-config -
oyaml'
[preflight] Running pre-flight checks.
[upgrade] Running cluster health checks
[upgrade/version] You have chosen to change the cluster version to "v1.19.4"
[upgrade/versions] Cluster version: v1.18.6
[upgrade/versions] kubectl version: v1.19.4
[upgrade/confirm] Are you sure you want to proceed with the upgrade? [y/N]: y
[upgrade/prepull] Pulling images required for setting up a Kubernetes cluster
[upgrade/prepull] This might take a minute or two, depending on the speed of your internet connection
[upgrade/prepull] You can also perform this action in beforehand using 'kubectl config images pull'
[upgrade/apply] Upgrading your Static Pod-hosted control plane to version "v1.19.4"...
Static pod: kube-apiserver-cluster3-master1 hash: adc96284622362c262f132006844c0a0
Static pod: kube-controller-manager-cluster3-master1 hash: 96824fdf76a8620088483fdb73e906e
Static pod: kube-scheduler-cluster3-master1 hash: 3dd66788a2c7782d910d05ea37b91678
[upgrade/etcd] Upgrading to TLS for etcd
...
```

Now we verify we're up to date by showing upgrade plans again:

```
→ root@cluster3-master1:~# kubectl upgrade plan
[upgrade/config] Making sure the configuration is correct:
[upgrade/config] Reading configuration from the cluster...
[upgrade/config] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubectl-config -
oyaml'
[preflight] Running pre-flight checks.
[upgrade] Running cluster health checks
[upgrade] Fetching available versions to upgrade to
[upgrade/versions] Cluster version: v1.19.4
[upgrade/versions] kubectl version: v1.19.4
...
```

Control Plane kubelet and kubectl

```
→ root@cluster3-master1:~# apt-get update

→ root@cluster3-master1:~# apt-get install kubelet=1.19.4-00 kubectl=1.19.4-00
...

(Reading database ... 60158 files and directories currently installed.)
Preparing to unpack ../kubectl_1.19.4-00_amd64.deb ...
Unpacking kubectl (1.19.4-00) over (1.18.6-00) ...
Preparing to unpack ../kubelet_1.19.4-00_amd64.deb ...
Unpacking kubelet (1.19.4-00) over (1.18.6-00) ...
Setting up kubelet (1.19.4-00) ...
Setting up kubectl (1.19.4-00) ...

→ root@cluster3-master1:~# systemctl daemon-reload && systemctl restart kubelet

→ root@cluster3-master1:~# kubectl get node
NAME          STATUS          ROLES    AGE   VERSION
cluster3-master1  Ready,SchedulingDisabled  master   18h   v1.19.4
cluster3-worker1  Ready           <none>    18h   v1.18.6
```

Done, and uncordon:

```
→ k uncordon cluster3-master1
node/cluster3-master1 uncordoned
```

Data Plane

```
→ k get node
NAME          STATUS    ROLES    AGE   VERSION
cluster3-master1  Ready    master   18h   v1.19.4
cluster3-worker1  Ready    <none>    18h   v1.18.6
```

Our data plane consist of one single worker node, so let's update it. First thing is we should drain it:

```
k drain cluster3-worker1 --ignore-daemonsets
```

Next we ssh into it and upgrade kubectl to the wanted version, or check if already done:

```
→ ssh cluster3-worker1

→ root@cluster3-worker1:~# apt-get update
...

→ root@cluster3-worker1:~# apt-get install kubectl=1.19.4-00
Reading package lists... Done
Building dependency tree
Reading state information... Done
kubectl is already the newest version (1.19.4-00).
0 upgraded, 0 newly installed, 0 to remove and 35 not upgraded.
```



```
→ root@cluster3-worker1:~# kubeadm upgrade node
[upgrade] Reading configuration from the cluster...
[upgrade] FYI: You can look at this config file with 'kubectl -n kube-system get cm kubeadm-config -oyaml'
[preflight] Running pre-flight checks
[preflight] Skipping prepull. Not a control plane node.
[upgrade] Skipping phase. Not a control plane node.
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[upgrade] The configuration for this node was successfully updated!
[upgrade] Now you should go ahead and upgrade the kubelet package using your package manager.
```

Now we follow that kubeadm told us in the last line and upgrade kubelet (and kubectl):

```
→ root@cluster3-worker1:~# apt-get install kubelet=1.19.4-00 kubectl=1.19.4-00
...
Preparing to unpack .../kubelet_1.19.4-00_amd64.deb ...
Unpacking kubelet (1.19.4-00) over (1.18.6-00) ...
Setting up kubernetes-cni (0.8.7-00) ...
Setting up kubelet (1.19.4-00) ...
Setting up kubectl (1.19.4-00) ...

→ root@cluster3-worker1:~# systemctl daemon-reload && systemctl restart kubelet
```

Looking good, what does the node status say?

```
→ k get node
NAME                STATUS              ROLES    AGE   VERSION
cluster3-master1    Ready              master   18h   v1.19.4
cluster3-worker1    Ready,SchedulingDisabled <none>   18h   v1.19.4
```

Beautiful, let's make it schedulable again:

```
→ k uncordon cluster3-worker1
node/cluster3-worker1 uncordoned

→ k get node
NAME                STATUS    ROLES    AGE   VERSION
cluster3-master1    Ready    master   18h   v1.19.4
cluster3-worker1    Ready    <none>   18h   v1.19.4
```

We're up to date.

## Question 21 | Image Vulnerability Scanning

Task weight: 2%

(can be solved in any kubectl context)

The Vulnerability Scanner `trivy` is installed on your main terminal. Use it to scan the following images for known CVEs:

- `nginx:1.16.1-alpine`
- `k8s.gcr.io/kube-apiserver:v1.18.0`
- `k8s.gcr.io/kube-controller-manager:v1.18.0`
- `docker.io/weaveworks/weave-kube:2.7.0`

Write all images that don't contain the vulnerabilities `CVE-2020-10878` or `CVE-2020-1967` into `/opt/course/21/good-images`.

Answer:

The tool `trivy` is very simple to use, it compares images against public databases.

```
→ trivy nginx:1.16.1-alpine
2020-10-09T20:59:39.198Z      INFO    Need to update DB
2020-10-09T20:59:39.198Z      INFO    Downloading DB...
18.81 MiB / 18.81 MiB [-----]
2020-10-09T20:59:45.499Z      INFO    Detecting Alpine vulnerabilities...

nginx:1.16.1-alpine (alpine 3.10.4)
=====
Total: 7 (UNKNOWN: 0, LOW: 0, MEDIUM: 7, HIGH: 0, CRITICAL: 0)

+-----+-----+-----+-----+
|  LIBRARY  | VULNERABILITY ID | SEVERITY | INSTALLED VERSION |
+-----+-----+-----+-----+
| libcrypto1.1 | CVE-2020-1967   | MEDIUM  | 1.1.1d-r2         |
...

```

To solve the task we can run:

```
→ trivy nginx:1.16.1-alpine | grep -E 'CVE-2020-10878|CVE-2020-1967'
| libcrypto1.1 | CVE-2020-1967 | MEDIUM
| libssl1.1    | CVE-2020-1967 |

→ trivy k8s.gcr.io/kube-apiserver:v1.18.0 | grep -E 'CVE-2020-10878|CVE-2020-1967'
| perl-base   | CVE-2020-10878 | HIGH

→ trivy k8s.gcr.io/kube-controller-manager:v1.18.0 | grep -E 'CVE-2020-10878|CVE-2020-1967'
| perl-base   | CVE-2020-10878 | HIGH

→ trivy docker.io/weaveworks/weave-kube:2.7.0 | grep -E 'CVE-2020-10878|CVE-2020-1967'
→
```

The only image without the any of the two CVEs is `docker.io/weaveworks/weave-kube:2.7.0`, hence our answer will be:

```
# /opt/course/21/good-images
docker.io/weaveworks/weave-kube:2.7.0
```

## Question 22 | Manual Static Security Analysis

Task weight: 3%

(can be solved in any kubectl context)

The Release Engineering Team has shared some YAML manifests and Dockerfiles with you to review. The files are located under `/opt/course/22/files`.

As a container security expert, you are asked to perform a manual static analysis and find out possible security issues with respect to unwanted credential exposure.

Write the filenames which have issues into `/opt/course/22/security-issues`.

**NOTE:** In the Dockerfile and YAML manifests, assume that the referred files, folders, secrets and volume mounts are present. Disregard syntax or logic errors.

Answer:

We check location `/opt/course/22/files` and list the files.

```
→ ls -la /opt/course/22/files
total 48
drwxr-xr-x 2 k8s k8s 4096 Sep 16 19:08 .
drwxr-xr-x 3 k8s k8s 4096 Sep 16 19:08 ..
-rw-r--r-- 1 k8s k8s  692 Sep 16 19:08 Dockerfile-go
-rw-r--r-- 1 k8s k8s  897 Sep 16 19:08 Dockerfile-mysql
-rw-r--r-- 1 k8s k8s  743 Sep 16 19:08 Dockerfile-py
-rw-r--r-- 1 k8s k8s  341 Sep 16 19:08 deployment-nginx.yaml
-rw-r--r-- 1 k8s k8s  705 Sep 16 19:08 deployment-redis.yaml
-rw-r--r-- 1 k8s k8s  392 Sep 16 19:08 pod-nginx.yaml
-rw-r--r-- 1 k8s k8s  228 Sep 16 19:08 pv-manual.yaml
-rw-r--r-- 1 k8s k8s  188 Sep 16 19:08 pvc-manual.yaml
-rw-r--r-- 1 k8s k8s  211 Sep 16 19:08 sc-local.yaml
-rw-r--r-- 1 k8s k8s  902 Sep 16 19:08 statefulset-nginx.yaml
```

We have 3 Dockerfiles and 7 Kubernetes Resource YAML manifests. Next we should go over each to find security issues with the way credentials have been used.

**NOTE:** You should be comfortable with [Docker Best Practices](#) and the [Kubernetes Configuration Best Practices](#).

While navigating through the files we might notice:

Number 1

File `dockerfile-mysql` might look innocent on first look. It copies a file `secret-token` over, uses it and deletes it afterwards. But because of the way Docker works, every `RUN`, `COPY` and `ADD` command creates a new layer and every layer is persistet in the image.

This means even if the file `secret-token` get's deleted in layer Z, it's still included with the image in layer X and Y. In this case it would be better to use for example variables passed to Docker.

```
# /opt/course/22/files/dockerfile-mysql
FROM ubuntu

# Add MySQL configuration
COPY my.cnf /etc/mysql/conf.d/my.cnf
COPY mysqld_charset.cnf /etc/mysql/conf.d/mysqld_charset.cnf

RUN apt-get update && \
    apt-get -yq install mysql-server-5.6 &&

# Add MySQL scripts
COPY import_sql.sh /import_sql.sh
COPY run.sh /run.sh

# Configure credentials
COPY secret-token . # LAYER X
RUN /etc/register.sh ./secret-token # LAYER Y
RUN rm ./secret-token # delete secret token again # LATER Z

EXPOSE 3306
CMD ["/run.sh"]
```

So we do:

```
echo Dockerfile-mysql >> /opt/course/22/security-issues
```

Number 2

The file `deployment-redis.yaml` is fetching credentials from a `Secret` named `mysecret` and writes these into environment variables. So far so good, but in the command of the `container` it's echoing these which can be directly read by any user having access to the logs.

```
# /opt/course/22/files/deployment-redis.yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: mycontainer
          image: redis
          command: ["/bin/sh"]
          args:
            - "-c"
            - "echo $SECRET_USERNAME && echo $SECRET_PASSWORD && docker-entrypoint.sh" # NOT GOOD
          env:
            - name: SECRET_USERNAME
              valueFrom:
                secretKeyRef:
                  name: mysecret
```

```
      key: username
    - name: SECRET_PASSWORD
      valueFrom:
        secretKeyRef:
          name: mysecret
          key: password
```

Credentials in logs is never a good idea, hence we do:

```
echo deployment-redis.yaml >> /opt/course/22/security-issues
```

Number 3

In file `statefulset-nginx.yaml`, the password is directly exposed in the environment variable definition of the *container*.

```
# /opt/course/22/files/statefulset-nginx.yaml
...
apiVersion: apps/v1
kind: StatefulSet
metadata:
  name: web
spec:
  serviceName: "nginx"
  replicas: 2
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
        - name: nginx
          image: k8s.gcr.io/nginx-slim:0.8
          env:
            - name: Username
              value: Administrator
            - name: Password
              value: MyDiReCtP@ssw0rd # NOT GOOD
          ports:
            - containerPort: 80
              name: web
      ..
```

This should better be injected via a *Secret*. So we do:

```
echo statefulset-nginx.yaml >> /opt/course/22/security-issues
```

```
→ cat /opt/course/22/security-issues
Dockerfile-mysql
deployment-redis.yaml
statefulset-nginx.yaml
```

## CKS Simulator Preview Kubernetes 1.19

<https://killer.sh>

This is a preview of the full CKS Simulator course content.

The full course contains 22 questions and scenarios which cover all the CKS areas. The course also provides a browser terminal which is a very close replica of the original one. This is great to get used and comfortable before the real exam. After the test session (120 minutes), or if you stop it early, you'll get access to all questions and their detailed solutions. You'll have 36 hours cluster access in total which means even after the session, once you have the solutions, you can still play around.

The following preview will give you an idea of what the full course will provide. These preview questions are not part of the 22 in the full course but in addition to it. But the preview questions are part of the same CKS simulation environment which we setup for you, so with access to the full course you can solve these too.

The answers provided here assume that you did run the initial terminal setup suggestions as provided in the tips section, but especially:

```
alias k=kubectl

export do="-o yaml --dry-run=client"
```

These questions can be solved in the test environment provided through the CKS Simulator

### Preview Question 1

Use context: `kubectl config use-context infra-prod`

You have admin access to cluster2. There is also context `gianna@infra-prod` which authenticates as user `gianna` with the same cluster.

There are existing cluster-level RBAC resources in place to, among other things, ensure that user `gianna` can never read *Secret* contents cluster-wide. Confirm this is correct or restrict the existing RBAC resources to ensure this.

I addition, create more RBAC resources to allow user `gianna` to create *Pods* and *Deployments* in *Namespaces* `security`, `restricted` and `internal`. It's likely the user will receive these exact permissions as well for other *Namespaces* in the future.

Answer:

Part 1 - check existing RBAC rules

We should probably first have a look at the existing RBAC resources for user `gianna`. We don't know the resource names but we know these are cluster-level so we can search for a *ClusterRoleBinding*:

```
k get clusterrolebinding -oyaml | grep gianna -A10 -B20
```

From this we see the binding is also called `gianna`:

```
k edit clusterrolebinding gianna

# kubectl edit clusterrolebinding gianna
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  creationTimestamp: "2020-09-26T13:57:58Z"
  name: gianna
  resourceVersion: "3049"
  selfLink: /apis/rbac.authorization.k8s.io/v1/clusterrolebindings/gianna
  uid: 72b64a3b-5958-4cf8-8078-e5be2c55b25d
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: gianna
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: gianna
```

It links user `gianna` to same named *ClusterRole*:

```
k edit clusterrole gianna

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  creationTimestamp: "2020-09-26T13:57:55Z"
  name: gianna
  resourceVersion: "3038"
  selfLink: /apis/rbac.authorization.k8s.io/v1/clusterroles/gianna
  uid: b713c1cf-87e5-4313-808e-1a51f392adc0
rules:
- apiGroups:
  - ""
  resources:
  - secrets
  - configmaps
  - pods
  - namespaces
  verbs:
  - list
```

According to the task the user should never be able to read *Secrets* content. They verb `list` might indicate on first look that this is correct. We can also check using [K8s User Impersonation](#):

```
→ k auth can-i list secrets --as gianna
yes

→ k auth can-i get secrets --as gianna
no
```

But let's have a closer look:

```
→ k config use-context gianna@infra-prod
Switched to context "gianna@infra-prod".

→ k -n security get secrets
NAME                                TYPE                                DATA  AGE
default-token-gn455                 kubernetes.io/service-account-token 3      20m
kubeadmin-token                     Opaque                              1      20m
mysql-admin                         Opaque                              1      20m
postgres001                        Opaque                              1      20m
postgres002                        Opaque                              1      20m
vault-token                         Opaque                              1      20m

→ k -n security get secret kubeadmin-token
Error from server (Forbidden): secrets "kubeadmin-token" is forbidden: User "gianna" cannot get resource "secrets" in API group "" in the namespace "security"
```

Still all expected, but being able to list resources also allows to specify the format:

```
→ k -n security get secrets -oyaml | grep password
password: ekhHYw5lQUVTaVVxCg==
  {"apiVersion":"v1","data":{"password":"ekhHYw5lQUVTaVVxCg=="},"kind":"Secret","metadata":{"annotations":{},"name":"kubeadmin-token","namespace":"security"},"type":"Opaque"}
    f:password: {}
password: bwdFVlBSdEpEWHBFCg==
...
```

The user `gianna` is actually able to read *Secret* content. To prevent this we should remove the ability to list these:

```
k config use-context infra-prod # back to admin context

k edit clusterrole gianna

# kubectl edit clusterrole gianna
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  creationTimestamp: "2020-09-26T13:57:55Z"
  name: gianna
  resourceVersion: "4496"
  selfLink: /apis/rbac.authorization.k8s.io/v1/clusterroles/gianna
  uid: b713c1cf-87e5-4313-808e-1a51f392adc0
rules:
- apiGroups:
  - ""
  resources:
# - secrets          # remove
  - configmaps
  - pods
  - namespaces
  verbs:
  - list
```

Part 2 - create additional RBAC rules

Let's talk a little about RBAC resources:

A *ClusterRole* | *Role* defines a set of permissions and **where it is available**, in the whole cluster or just a single *Namespace*.

A *ClusterRoleBinding* | *RoleBinding* connects a set of permissions with an account and defines **where it is applied**, in the whole cluster or just a single *Namespace*.

Because of this there are 4 different RBAC combinations and 3 valid ones:

- 1. *Role* + *RoleBinding* (available in single *Namespace*, applied in single *Namespace*)
- 2. *ClusterRole* + *ClusterRoleBinding* (available cluster-wide, applied cluster-wide)
- 3. *ClusterRole* + *RoleBinding* (available cluster-wide, applied in single *Namespace*)
- 4. *Role* + *ClusterRoleBinding* (**NOT POSSIBLE**: available in single *Namespace*, applied cluster-wide)

The user `gianna` should be able to create *Pods* and *Deployments* in three *Namespace*s. We can use number 1 or 3 from the list above. But because the task says: "The user might receive these exact permissions as well for other *Namespace*s in the future", we choose number 3 as it requires to only create one *ClusterRole* instead of three *Roles*.

```
k create clusterrole gianna-additional --verb=create --resource=pods --resource=deployments
```

This will create a *ClusterRole* like:

```
# kubectl create clusterrole gianna-additional --verb=create --resource=pods --resource=deployments
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  creationTimestamp: null
  name: gianna-additional
rules:
- apiGroups:
  - ""
  resources:
  - pods
  verbs:
  - create
- apiGroups:
  - apps
  resources:
  - deployments
  verbs:
  - create
```

Next the three bindings:

```
k -n security create rolebinding gianna-additional \
--clusterrole=gianna-additional --user=gianna

k -n restricted create rolebinding gianna-additional \
--clusterrole=gianna-additional --user=gianna

k -n internal create rolebinding gianna-additional \
--clusterrole=gianna-additional --user=gianna
```

Which will create *RoleBindings* like:

```
# k -n security create rolebinding gianna-additional --clusterrole=gianna-additional --user=gianna
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  creationTimestamp: null
  name: gianna-additional
  namespace: security
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: gianna-additional
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: gianna
```

And we test:

```
→ k -n default auth can-i create pods --as gianna
no

→ k -n security auth can-i create pods --as gianna
yes

→ k -n restricted auth can-i create pods --as gianna
yes

→ k -n internal auth can-i create pods --as gianna
yes
```

Feel free to verify this as well by actually creating *Pods* and *Deployments* as user `gianna` through context `gianna@infra-prod`.

## Preview Question 2

Use context: `kubectl config use-context infra-prod`

There is an existing Open Policy Agent + Gatekeeper policy to enforce that all *Namespace*s need to have label `security-level` set. Extend the policy constraint and template so that all *Namespace*s also need to set label `management-team`. Any new *Namespace* creation without these two labels should be prevented.

Write the names of all existing *Namespace*s which violate the updated policy into `/opt/course/p2/fix-namespaces`.

**Answer:**

We look at existing OPA constraints, these are implemeted using CRDs by Gatekeeper:

```
→ k get crd
NAME                                     CREATED AT
blacklistimages.constraints.gatekeeper.sh 2020-09-14T19:29:31Z
configs.config.gatekeeper.sh             2020-09-14T19:29:04Z
constraintpodstatuses.status.gatekeeper.sh 2020-09-14T19:29:05Z
constrainttemplatepodstatuses.status.gatekeeper.sh 2020-09-14T19:29:05Z
constrainttemplates.templates.gatekeeper.sh 2020-09-14T19:29:05Z
requiredlabels.constraints.gatekeeper.sh 2020-09-14T19:29:31Z
```

So we can do:

```
→ k get constraint
NAME                                                                                                     AGE
blacklistimages.constraints.gatekeeper.sh/pod-trusted-images      10m

NAME                                                                                                     AGE
requiredlabels.constraints.gatekeeper.sh/namespace-mandatory-labels 10m
```

And check violations for the `namespace-mandatory-label` one, which we can do in the resource status:

```
→ k describe requiredlabels namespace-mandatory-labels
Name:      namespace-mandatory-labels
Namespace:
Labels:    <none>
Annotations: <none>
API Version: constraints.gatekeeper.sh/v1beta1
Kind:      RequiredLabels
...
Status:
...
  Total Violations: 1
  Violations:
    Enforcement Action: deny
    Kind:              Namespace
    Message:           you must provide labels: {"security-level"}
    Name:              sidecar-injector
Events:
```

We see one violation for *Namespace* "sidecar-injector". Let's get an overview over all *Namespaces*:

```
→ k get ns --show-labels
NAME                STATUS   AGE   LABELS
default            Active   21m   management-team=green,security-level=high
gatekeeper-system  Active   14m   admission.gatekeeper.sh/ignore=no-self-managing,control-plane=controller-manager,gatekeeper.sh/system=yes,management-team=green,security-level=high
jeffs-playground   Active   14m   security-level=high
kube-node-lease    Active   21m   management-team=green,security-level=high
kube-public        Active   21m   management-team=red,security-level=low
kube-system        Active   21m   management-team=green,security-level=high
restricted         Active   14m   management-team=blue,security-level=medium
security           Active   14m   management-team=blue,security-level=medium
sidecar-injector   Active   14m   <none>
```

When we try to create a *Namespace* without the required label we get an OPA error:

```
→ k create ns test
Error from server ([denied by namespace-mandatory-labels] you must provide labels: {"security-level"}):
error when creating "ns.yaml": admission webhook "validation.gatekeeper.sh" denied the request: [denied by namespace-mandatory-labels] you must provide labels: {"security-level"}
```

Next we edit the constraint to add another required label:

```
k edit requiredlabels namespace-mandatory-labels
```

```
# kubectl edit requiredlabels namespace-mandatory-labels
apiVersion: constraints.gatekeeper.sh/v1beta1
kind: RequiredLabels
metadata:
  annotations:
    kubectl.kubernetes.io/last-applied-configuration: |
      {"apiVersion":"constraints.gatekeeper.sh/v1beta1","kind":"RequiredLabels","metadata":{"annotations":{}},
"name":"namespace-mandatory-labels"},"spec":{"match":{"kinds":[{"apiGroups":[""],"kinds":["Namespace"]}]}},
"parameters":{"labels":["security-level"]}}}
  creationTimestamp: "2020-09-14T19:29:53Z"
  generation: 1
  name: namespace-mandatory-labels
  resourceVersion: "3081"
  selfLink: /apis/constraints.gatekeeper.sh/v1beta1/requiredlabels/namespace-mandatory-labels
  uid: 2a51a291-e07f-4bab-b33c-9b8c90e5125b
spec:
  match:
    kinds:
      - apiGroups:
          - ""
          kinds:
            - Namespace
  parameters:
    labels:
      - security-level
      - management-team # add
```

As we can see the constraint is using `kind: RequiredLabels` as template, which is a CRD created by Gatekeeper. Let's apply the change and see what happens (give OPA a minute to apply the changes internally):

```
→ k describe requiredlabels namespace-mandatory-labels
...
  Violations:
    Enforcement Action: deny
    Kind:              Namespace
    Message:           you must provide labels: {"management-team"}
    Name:              jeffs-playground
```

After the changes we can see that now another *Namespace* `jeffs-playground` is in trouble. Because that one only specifies one required label. But what about the earlier violation of *Namespace* `sidecar-injector`?

```
→ k get ns --show-labels
NAME                STATUS   AGE   LABELS
default            Active   21m   management-team=green,security-level=high
gatekeeper-system  Active   17m   admission.gatekeeper.sh/ignore=no-self-managing,control-plane=controller-manager,gatekeeper.sh/system=yes,management-team=green,security-level=high
jeffs-playground   Active   17m   security-level=high
kube-node-lease    Active   21m   management-team=green,security-level=high
kube-public        Active   21m   management-team=red,security-level=low
kube-system        Active   21m   management-team=green,security-level=high
restricted         Active   17m   management-team=blue,security-level=medium
security           Active   17m   management-team=blue,security-level=medium
sidecar-injector   Active   17m   <none>
```

*Namespace* `sidecar-injector` should also be in trouble, but it isn't any longer. This doesn't seem right, it means we could still create *Namespaces* without any labels just like using `k create ns test`.

So we check the template:

```
→ k get constrainttemplates
NAME          AGE
blacklistimages 20m
requiredlabels 20m

→ k edit constrainttemplates requiredlabels
```

```
# kubectl edit constrainttemplates requiredlabels
apiVersion: templates.gatekeeper.sh/v1beta1
kind: ConstraintTemplate
...
spec:
  crd:
    spec:
      names:
        kind: RequiredLabels
      validation:
        openAPIV3Schema:
          properties:
            labels:
              items: string
              type: array
  targets:
  - rego: |
      package k8srequiredlabels

      violation[{"msg": msg, "details": {"missing_labels": missing}}] {
        provided := {label | input.review.object.metadata.labels[label]}
        required := {label | label := input.parameters.labels[_]}
        missing := required - provided
        # count(missing) == 1 # WRONG
        count(missing) > 0
        msg := sprintf("you must provide labels: %v", [missing])
      }
    target: admission.k8s.gatekeeper.sh
```

In the rego script we need to change `count(missing) == 1` to `count(missing) > 0` . If we don't do this then the policy only complains if there is one missing label, but there can be multiple missing ones.

After waiting a bit we check the constraint again:

```
→ k describe requiredlabels namespace-mandatory-labels
...
Total Violations: 2
Violations:
  Enforcement Action: deny
  Kind: Namespace
  Message: you must provide labels: {"management-team"}
  Name: jeffs-playground
  Enforcement Action: deny
  Kind: Namespace
  Message: you must provide labels: {"security-level", "management-team"}
  Name: sidecar-injector
Events: <none>
```

This looks better. Finally we write the *Namespace* names with violations into the required location:

```
# /opt/course/p2/fix-namespaces
sidecar-injector
jeffs-playground
```

### Preview Question 3

Use context: `kubectl config use-context workload-stage`

A security scan result shows that there is an unknown miner process running on one of the *Nodes* in cluster3. The report states that the process is listening on port 6666. Kill the process and delete the binary.

**Answer:**

We have a look at existing *Nodes*:

```
→ k get node
NAME             STATUS  ROLES  AGE  VERSION
cluster3-master1 Ready   master  24m  v1.18.6
cluster3-worker1 Ready   <none>  22m  v1.18.6
```

First we check the master:

```
→ ssh cluster3-master1

→ root@cluster3-master1:~# netstat -plnt | grep 6666

→ root@cluster3-master1:~#
```

Doesn't look like any process listening on this port. So we check the worker:

```
→ ssh cluster3-worker1

→ root@cluster3-worker1:~# netstat -plnt | grep 6666
tcp6      0      0 :::6666          :::*              LISTEN     9591/system-atm
```

There we go! We could also use `lsof`:

```
→ root@cluster3-worker1:~# lsof -i :6666
COMMAND  PID USER  FD  TYPE DEVICE SIZE/OFF NODE NAME
system-at 9591 root   3u  IPv6 47760      0t0  TCP *:6666 (LISTEN)
```

Before we kill the process we can check the magic `/proc` directory for the full process path:

```
→ root@cluster3-worker1:~# ls -lh /proc/9591/exe
lrwxrwxrwx 1 root root 0 Sep 26 16:10 /proc/9591/exe -> /bin/system-atm
```

So we finish it:



```
→ root@cluster3-worker1:~# kill -9 9591

→ root@cluster3-worker1:~# rm /bin/system-atm
```

Done.

## CKS Tips Kubernetes 1.19

In this section we'll provide some tips on how to handle the CKS exam and browser terminal.

### Knowledge

#### Pre-Knowledge

You should have your CKA knowledge up to date and be fast with kubectl, so we suggest to do:

- the [CKAD series with scenarios](#) on Medium
- the [CKA series with scenarios](#) on Medium

#### Knowledge

- Study all topics as proposed in the curriculum till you feel comfortable with all.
- Check our [CKS Exam Series](#)
- Read the free Sysdig [Kubernetes Security Guide](#)
- Also a nice read (though based on outdated k8s version) is the [Kubernetes Security book](#) by Liz Rice
- Check out the [Cloud Native Security Whitepaper](#)
- Great repository with many tips and sources: [walidshari](#)

#### Approach

- Do 1 or 2 test session with this CKS Simulator. Understand the solutions and maybe try out other ways to achieve the same thing.
- Setup your aliases, be fast and breath `kubectl`

#### Content

- Be comfortable with changing the kube-apiserver in a kubeadm setup
- Be able to work with [AdmissionControllers](#)
- Know how to create and use the [ImagePolicyWebhook](#)
- Know how to use opensource tools [Falco](#), [Sysdig](#), [Tracee](#), [Trivy](#)

### CKS Exam Info

#### Read the Curriculum

<https://github.com/cncf/curriculum>

#### Read the Handbook

<https://docs.linuxfoundation.org/tc-docs/certification/lf-candidate-handbook>

#### Read the important tips

<https://docs.linuxfoundation.org/tc-docs/certification/important-instructions-cks>

#### Read the FAQ

<https://docs.linuxfoundation.org/tc-docs/certification/faq-cka-ckad-cks>

### Kubernetes documentation

Get familiar with the Kubernetes documentation and be able to use the search. You can have one browser tab open with one of the allowed links ([check the official docs for updated list](#)):

- <https://kubernetes.io/docs>
- <https://github.com/kubernetes>
- <https://kubernetes.io/blog>
- <https://github.com/aquasecurity/trivy>
- <https://docs.sysdig.com>
- <https://falco.org/docs>
- <https://gitlab.com/apparmor/apparmor/-/wikis/Documentation>

**NOTE:** You can have the other tab open as a separate window, this is why a big screen is handy

### Deprecated commands

Make sure to not depend on deprecated commands as they might stop working at any time. When you execute a deprecated `kubectl` command a message will be shown, so you know which ones to avoid.

### The Test Environment / Browser Terminal

You'll be provided with a browser terminal which uses Ubuntu 18. The standard shells included with a minimal install of Ubuntu 18 will be available, including bash.

#### Laggin

There could be some lagging, definitely make sure you are using a good internet connection because your webcam and screen are uploading all the time.

#### Kubectl autocompletion

Autocompletion is not configured by default. Some wouldn't recommend setting this up because of the lagging internet connection but you can check if it works for you. See further down for how to set up.

#### Copy & Paste

There could be issues copying text (like pod names) from the left task information into the terminal. Some suggested to "hard" hit or long hold `Cmd/Ctrl+C` a few times to take action. Apart from that copy and paste should just work like in normal terminals.

#### Percentages and Score

There are ~24 questions in the exam and 100% of total percentage to reach. Each questions shows the % it gives if you solve it. Your results will be automatically checked according to the handbook. If you don't agree with the results you can request a review.

#### Notepad & Skipping Questions

You have access to a simple notepad in the browser which can be used for storing any kind of plain text. It makes sense to use this for saving skipped question numbers and their percentages. This way it's possible to move some questions to the end. It might make sense to skip 2% or 3% questions and go directly to higher ones.

Contexts

You'll receive access to various different clusters and resources in each. They provide you the exact command you need to run to connect to another cluster/context. But you should be comfortable working in different namespaces with `kubect1`.

Your Desktop

You are allowed to have multiple monitors connected and have to share every monitor with the proctor. Having one large screen definitely helps as you're only allowed **one** application open (Chrome Browser) with two tabs, one terminal and one k8s docs.

**NOTE:** You can have the other tab open as a separate window, this is why a big screen is handy

The questions will be on the left (default maybe ~30% space), the terminal on the right. You can adjust the size of the split though to your needs in the real exam.

If you use a laptop you could work with lid closed, external mouse+keyboard+monitor attached. Make sure you also have a webcam+microphone working.

You could also have both monitors, laptop screen and external, active. Though Chrome can only run on one screen. You might be asked that your webcam points straight into your face. So using an external screen and your laptop webcam could not be accepted. Just keep that in mind.

You have to be able to move your webcam around in the beginning to show your whole room and desktop. Have a clean desk with only the necessary on it. You can have a glass/cup with water without anything printed on.

In the end you should feel very comfortable with your setup.

CKS clusters

In the CKS exam you'll get access to as many clusters as you have questions, each will be solved in its own cluster. This is great because you cannot interfere with other tasks by breaking one. Every cluster will have one master and one worker node.

Browser Terminal Setup

It should be considered to spend ~1 minute in the beginning to setup your terminal. In the real exam the vast majority of questions will be done from the main terminal. For few you might need to ssh into another machine. Just be aware that configurations to your shell will not be transferred in this case.

Minimal Setup

Alias

We would suggest to minimally setup this alias:

```
alias k=kubect1
```

which means you always run `kubect1` just with `k`.

Vim

Also create the file `~/.vimrc` with the following content:

```
set tabstop=2
set expandtab
```

The `expandtab` make sure to use spaces for tabs. Memorize these and just type them down. You can't have any written notes with commands on your desktop etc.

Optional Setup

Variables

```
export do="--dry-run=client -o yaml"
```

This way you can just run `k run pod1 --image=nginx $do`. Short for "dry output", but use whatever you like.

Vim

You can also add the following to `~/.vimrc` to be able to apply tab on multiple selected lines.

```
set shiftwidth=2
```

More further down in the `vim` section.

Kubectl autocompletion

Depending on how much is already pre-installed but it should be enough for these two lines:

```
source <(kubect1 completion bash)
complete -F __start_kubect1 k # to make it work with the alias k
```

Else you need to run these lines before:

```
sudo apt-get install bash-completion
source ~/.bashrc
```

Persist bash settings

You can store aliases and other setup in `~/.bashrc` if you're planning on using different shells or `tmux`.

Be fast

Use the `history` command to reuse already entered commands or use even faster history search through `Ctrl r`.

If a command takes some time to execute, like sometimes `kubect1 delete pod x`. You can put a task in the background using `Ctrl z` and pull it back into foreground running command `fg`.

You can delete *Pods* fast with:

```
k delete pod x --grace-period 0 --force
```

Vim

Be great with vim.

toggle vim line numbers

When in `vim` you can press **Esc** and type `:set number` or `:set nonumber` followed by **Enter** to toggle line numbers. This can be useful when finding syntax errors based on line - but can be bad when wanting to mark&copy by mouse. You can also just jump to a line number with **Esc** `:22` **Enter**.

copy&paste

Get used to copy/paste/cut with vim:

```
Mark lines: Esc+v (then arrow keys)
Copy marked lines: y
Cut marked lines: d
Past lines: p or P
```

Indent multiple lines

To indent multiple lines press **Esc** and type `:set shiftwidth=2`. First mark multiple lines using **Shift** `v` and the up/down keys. Then to indent the marked lines press `>` or `<`. You can then press `.` to repeat the action.

Split terminal screen

By default `tmux` is installed and can be used to split your one terminal into multiple. **But** just do this if you know your shit, because scrolling is different and copy&pasting might be weird.

<https://www.hamvocke.com/blog/a-quick-and-easy-guide-to-tmux>

