

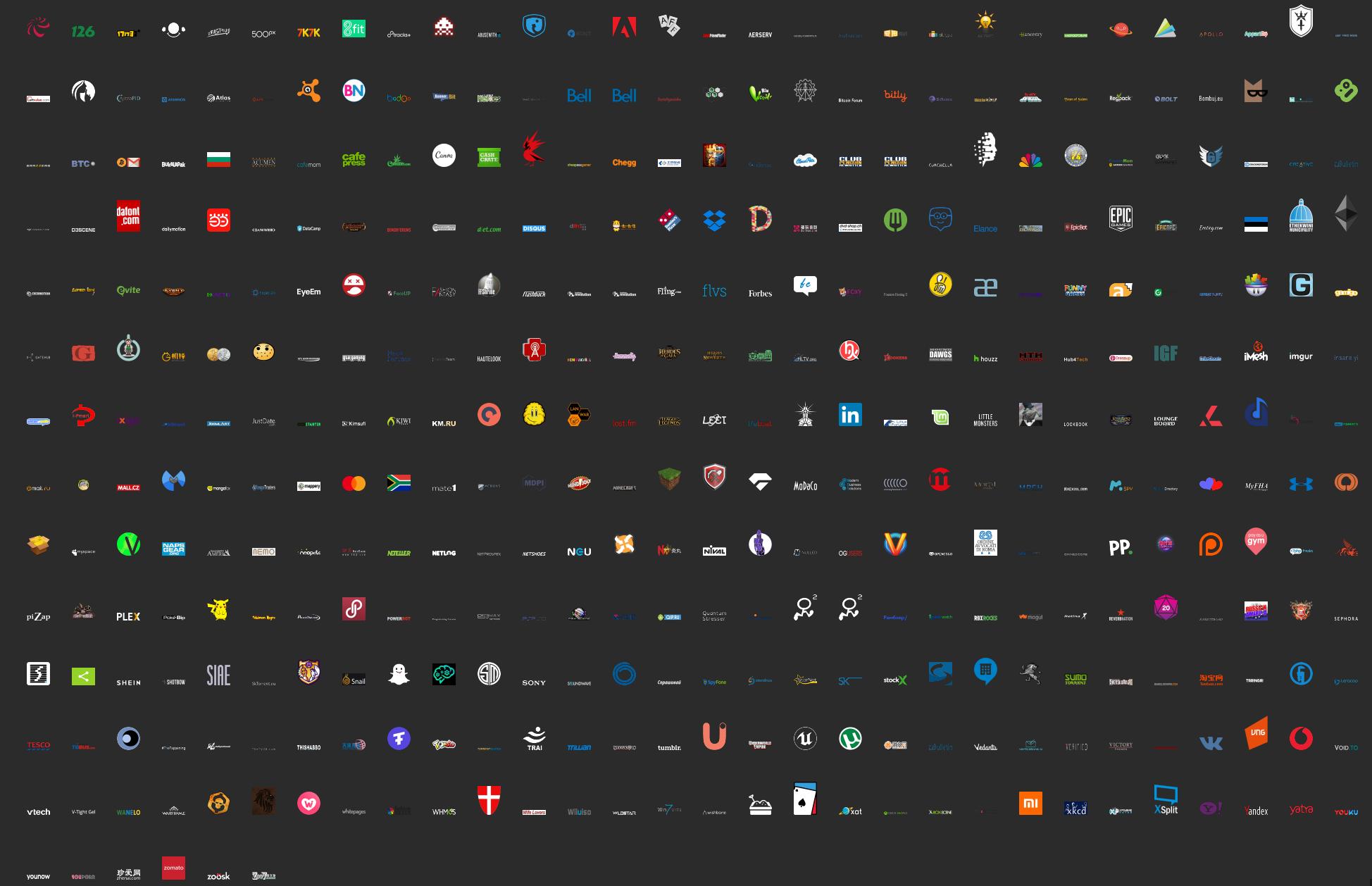
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Johannes Schnatterer, Cloudogu GmbH

Kubernetes-Security: 3 Dinge, die jeder Entwickler wissen sollte

#ittage
@jschnatterer



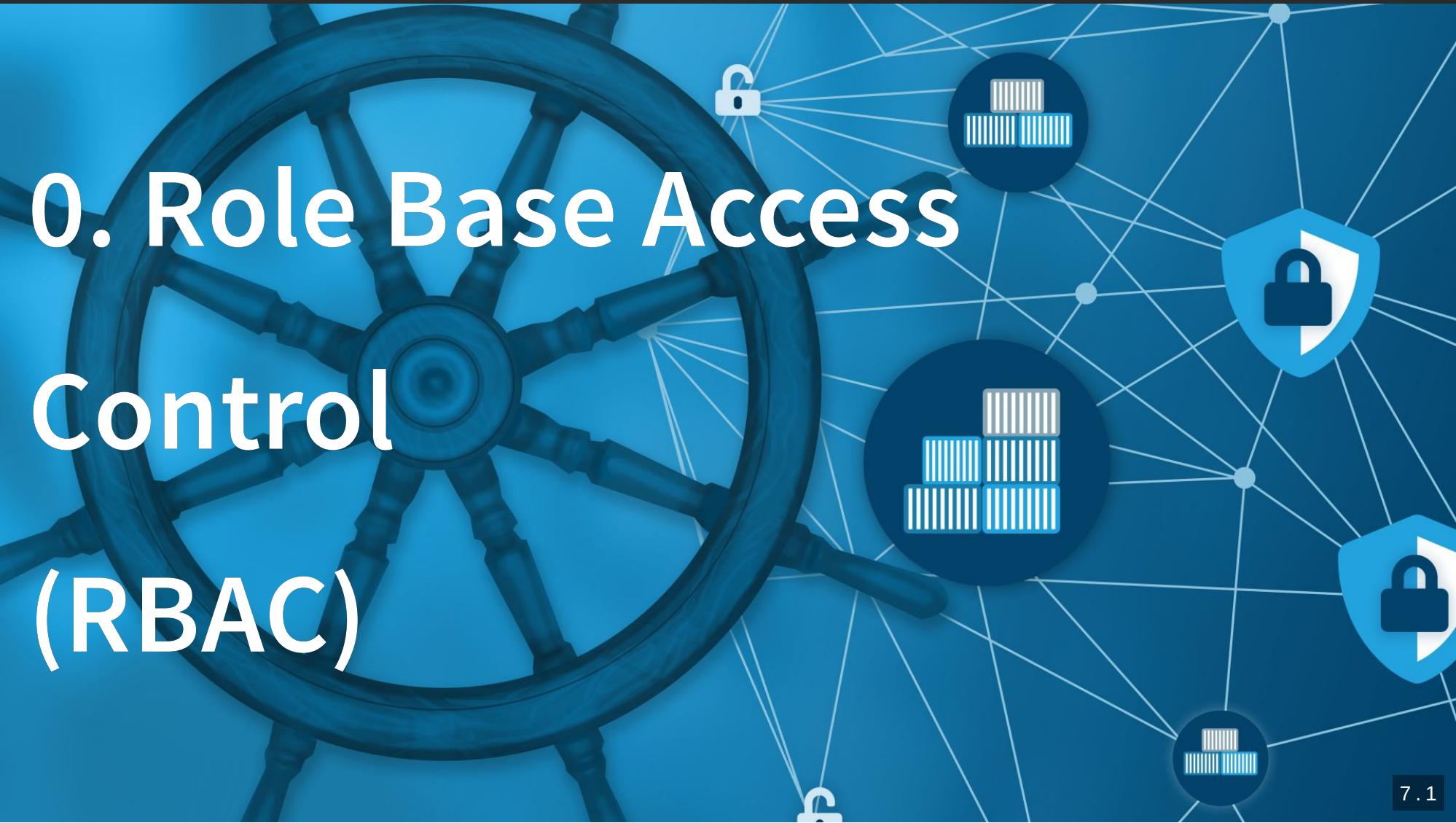


Plenty of security options

securityContext runAsNonRoot **runAsUser** privileged procMount
allowPrivilegeEscalation readOnlyRootFilesystem PodSecurityPolicy RBAC
NetworkPolicy seccomp Linux Capabilities
AppArmor SELinux Falco Open Policy Agent gVisor Kata Containers Nabla
Containers Service Mesh **KubeSec** KubeBench

3 Things Every Developer Should Know About K8s Security

0. Role Base Access Control (RBAC)





🌐 <https://memegenerator.net/instance/83566913/homer-simpson-boring>

- RBAC active by default since K8s 1.6
- ... but not if you migrated!

- Try

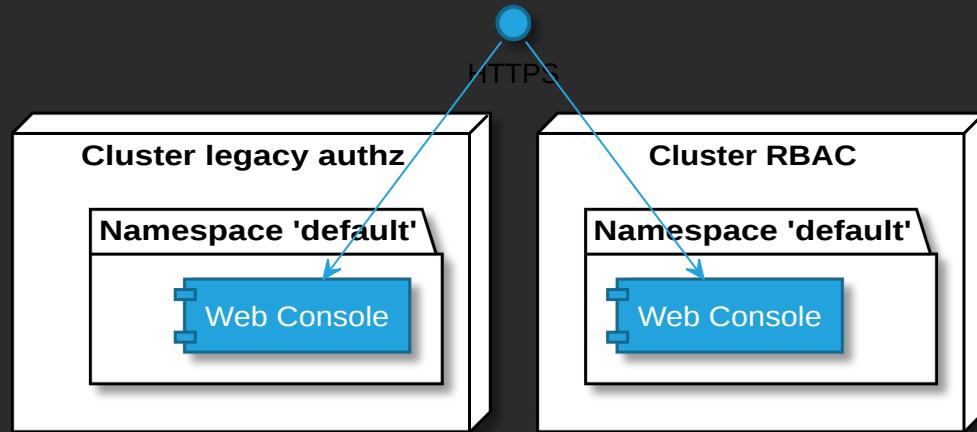
```
curl --cacert /var/run/secrets/kubernetes.io/serviceaccount/ca.crt \  
-H "Authorization: Bearer $(cat /var/run/secrets/kubernetes.io/serviceaccount/token)" \  
https://${KUBERNETES_SERVICE_HOST}/api/v1/secrets
```

- If not needed, disable access to K8s API

```
automountServiceAccountToken: false
```

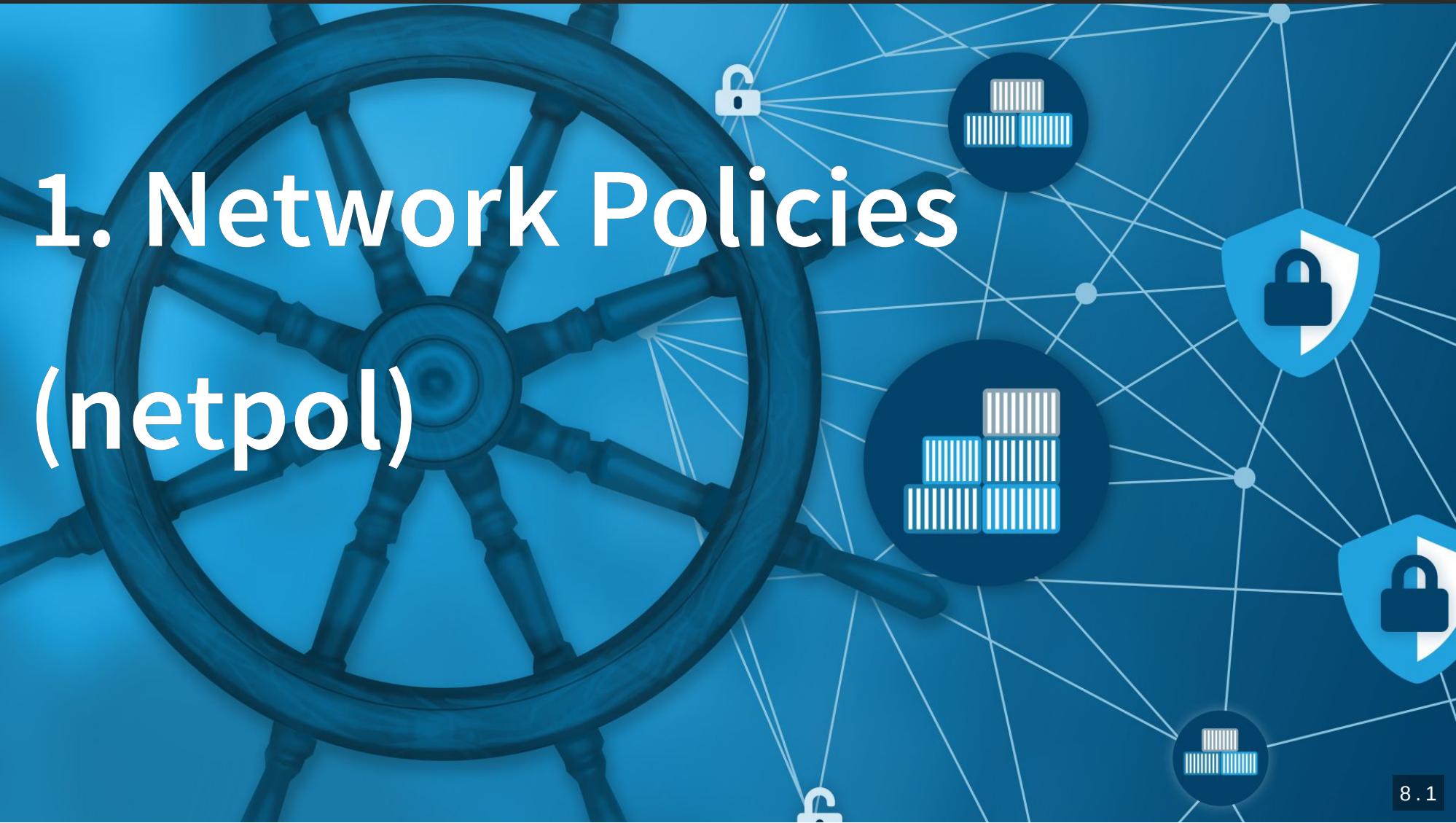


Demo



- legacy-authz
- RBAC

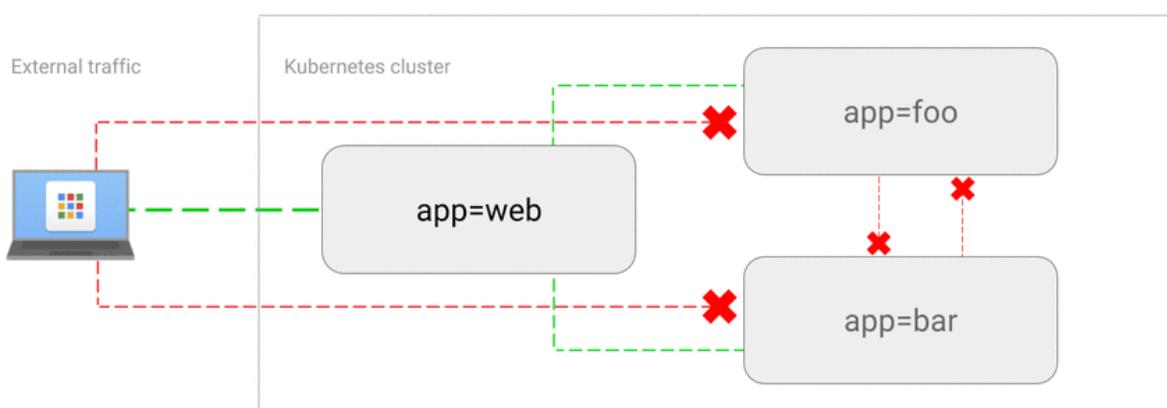
1. Network Policies (netpol)



A "firewall" for communication between pods.

- Applied to pods
 - within namespace
 - via labels
- Ingress / egress
 - to/from pods (in namespaces) or CIDRs (egress only)
 - for specific ports (optional)
- Enforced by the CNI Plugin (e.g. Calico)
- ⚠️ No Network Policies: All traffic allowed

💡 Helpful to get started



- GitHub: <https://github.com/ahmetb/kubernetes-network-policy-recipes>
- Securing Cluster Networking with Network Policies - Ahmet Balkan
- YouTube: <https://www.youtube.com/watch?v=3gGpMmYeEO8>
- Interactively describes what a netpol does:

```
kubectl describe netpol <name>
```

Recommendation: Whitelist ingress traffic

In every namespace except kube-system:

- Deny ingress between pods,
- then whitelist all allowed routes.

Advanced: ingress to kube-system

⚠ Might stop the apps in your cluster from working

Don't forget to:

- Allow external access to ingress controller
- Allow access to kube-dns/core-dns to every namespace

Advanced: egress

- Verbose solution:
 - Deny egress between pods,
 - then whitelist all allowed routes,
 - repeating all ingress rules. 😞
- More pragmatic solution:
 - Allow only egress within the cluster,
 - then whitelist pods that need access to internet.

Net pol pitfalls

- Whitelisting monitoring tools (e.g. Prometheus)
- Restart might be necessary (e.g. Prometheus)
- No labels on namespaces by default
- egress more recent than ingress rules and less sophisticated
- Policies might not be supported by CNI Plugin.

Testing!

 <https://www.inovex.de/blog/test-kubernetes-network-policies/>

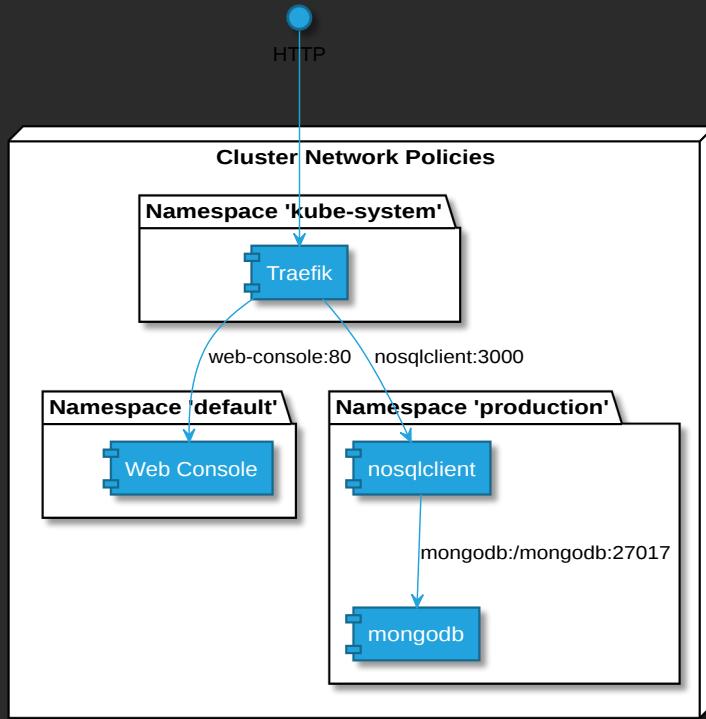
More Features?

- Proprietary extensions of CNI Plugin (e.g. cilium or calico)
- Service Meshes: similar features, also work with multiple clusters
→ different strengths, support each other

 <https://istio.io/blog/2017/0.1-using-network-policy/>



Demo



- nosqlclient
- web-console



Wrap-Up: Network Policies

My recommendations:

- Ingress whitelisting in non-kube-system namespaces
- Use with care
 - whitelisting in kube-system
 - egress whitelisting for cluster-external traffic

2. Security Context

Defines security parameter per pod/container → container runtime

⬇️ Secure Pods - Tim Allclair

▶️ <https://www.youtube.com/watch?v=GLwmJh-j3rs>

Recommendations per Container

```
apiVersion: v1
kind: Pod
metadata:
  annotations:
    seccomp.security.alpha.kubernetes.io/pod: runtime/default
spec:
  containers:
  - name: restricted
    securityContext:
      runAsNonRoot: true
      runAsUser: 100000
      runAsGroup: 100000
      readOnlyRootFilesystem: true
      allowPrivilegeEscalation: false
    capabilities:
      drop:
      - ALL
  enableServiceLinks: false
```

Recommendation per Container in Detail

Enable seccomp

- Enables e.g. docker's seccomp default profile that block 44/~300 Syscalls
- Has mitigated Kernel vulns in past and might in future 
- See also k8s security audit:
 <https://docs.docker.com/engine/security/non-events/>
- See also k8s security audit:
 <https://www.cncf.io/blog/2019/08/06/open-sourcing-the-kubernetes-security-audit/>

Run as unprivileged user

- `runAsNonRoot: true`
Container is not started when the user is root
- `runAsUser` and `runAsGroup > 10000`
 - Reduces risk to run as user existing on host
 - In case of container escape UID/GID does not have privileges on host
- Mitigates vuln in runc (used by Docker among others)
 <https://kubernetes.io/blog/2019/02/11/runc-and-cve-2019-5736/>

No Privilege escalation

- Container can't increase privileges
- E.g. sudo, setuid, Kernel vulnerabilities

Read-only root file system

- Starts container without read-write layer
- Writing only allowed in volumes
- Config or code within the container cannot be manipulated
- Perk: More efficient (no CoW)

Drop Capabilities

- Drops even the default caps:
🌐 <https://github.com/moby/moby/blob/3152f94/oci/caps/defaults.go>
- Mitigates CapNetRaw attack - DNS Spoofing on Kubernetes Clusters
🌐 <https://blog.aquasec.com/dns-spoofing-kubernetes-clusters>

Bonus: No Services in Environment

- By default: Each K8s service written to each container's env vars
→ Docker Link legacy, no longer needed
- But convenient info for attacker where to go next



Security context pitfalls

Read-only root file system

Application might need temp folder to write to

- Run image locally using docker, access app
-  Run automated e2e/integration tests
- Review container's read-write layer via

```
docker diff <containerName>
```

- Mount folders as `emptyDir` volumes in pod

Drop Capabilities

Some images require capabilities

- Find out needed Caps locally:

```
docker run --rm --cap-drop ALL <image>
# Check error
docker run --rm --cap-drop ALL --cap-add CAP_CHOWN <image>
# Keep adding caps until no more error
```

- Add necessary caps to k8s resource
- Alternative: Find image with same app that does not require caps, e.g. nginxinc/nginx-unprivileged

Run as unprivileged user

- Non-root verification only supports numeric user. 😕
 - `runAsUser : 100000` in `securityContext` of pod or
 - `USER 100000` in `Dockerfile` of image.
- Some official images run as root by default.
 - Find a **trusted** image that does not run as root
 - e.g. for mongo or postgres:
 <https://hub.docker.com/r/bitnami/>
 - Derive from the original image and create your own non-root image
 - e.g. nginx:  <https://github.com/schnatterer/nginx-unpriv>

- UID 100000 might not have permissions. Solutions:
 - Init Container sets permissions for PVCs
 - Permissions in image → chmod/chown in Dockerfile
- Application requires user for UID in /etc/passwd
 - New image that contains a user for UID e.g. 100000 or
 - Create /etc/passwd in init container and mount into app container
- runAsGroup - beta from K8s 1.14. Before that defaults to GID 0 😞
🌐 <https://github.com/kubernetes/enhancements/issues/213>

Tools

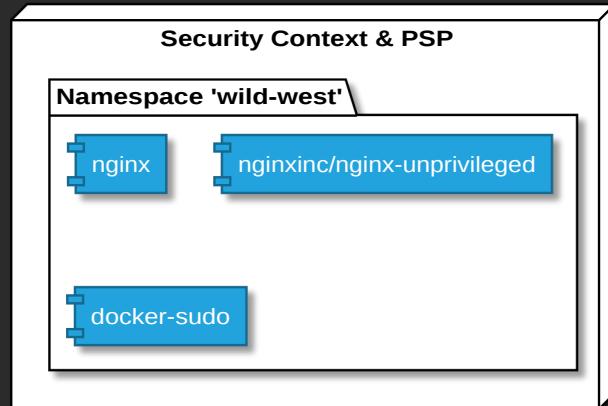
Find out if your cluster adheres to these and other good security practices:

-  [controlplaneio/kubesec](#) - manageable amount of checks
-  [Shopify/kubeaudit](#)
 - a whole lot of checks,
 - even deny all ingress and egress NetPols and AppArmor Annotations

- Be prepared for a lot of findings
- Create your own good practices



Demo





Wrap-Up: Security Context

My recommendations:

- Start with least privilege
- Only differ if there's absolutely no other way

3. Pod Security Policies (PSP)



- enforce security context cluster-wide
 - additional options for blocking pods trying to
 - enter node's Linux namespaces (net, PID, etc.)
 - mounting docker socket,
 - binding ports to nodes,
 - starting privileged containers
 - etc.
 - more effort than security context and different syntax 😕
- Still highly recommended!

Recommendation

 <https://github.com/cloudogu/k8s-security-demos/blob/master/4-pod-security-policies/demo/01-psp-restrictive.yaml>

Too much ground to cover for 45 min!



See Demo Repo on last slide

Summary

- Enable RBAC
- Don't allow arbitrary connections between pods, e.g. via NetPols
- Start with least privilege for your containers
 - using either securityContext or
 - PodSecurityPolicy

What for?

- Increase security
- Reduce risk of data breach
- Don't end up on  @haveibeenpwned

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🌐 <https://cloudogu.com/schulungen>

K8s Security series on JavaSPEKTRUM starting 05/2019

See also 🌐 <https://cloudogu.com/blog>

🐦 [@jschnatterer](#)

🐦 [@cloudogu](#)

Demo Source: 🐾 <https://github.com/cloudogu/k8s-security-demos>

