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CLOUD NATIVE COMPUTING FOUNDATION

KUBERNETES SECURITY

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$WHOAMI

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AGENDA

- Security 101
- RBAC
- Admission Controller
- Network Policies
- Runtime Security
- Isolation
- Encryption
- Sample Security Architecture

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SECURITY 101

PUBLIC ATTACK SURFACE

Master Ports

Protocol	Direction	Port Range	Purpose	Used By
TCP	Inbound	6443	Kubernetes API server	All
TCP	Inbound	2379-2380	etcd server client API	kube-apiserver, etcd
TCP	Inbound	10250	Kubelet API	Self, Control plane
TCP	Inbound	10259	kube-scheduler	Self
TCP	Inbound	10257	kube-controller-manager	Self

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SECURITY 101

PUBLIC ATTACK SURFACE

Worker Ports

Protocol	Direction	Port Range	Purpose	Used By
TCP	Inbound	10250	Kubelet API	Self, Control plane
TCP	Inbound	30000-32767	NodePort Services†	All

SECURITY 101

PUBLIC ATTACK SURFACE

- Cluster Architecture is important (Public/Private Cluster)
- Kubernetes has public Accessable https endpoints, that can be accessed without authentication
  - /version
  - /healthz
  - /livez
- Your exposed Apps

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SECURITY 101

CONTAINER IMAGE SCANNING

- Scan container images to find vulnerabilities

DEMO1

SECURITY 101

POD SECURITY CONTEXT

- Security Contexts are used to set the security settings for a Pod
  - runAsUser
  - runAsGroup
  - fsGroup
  - fsGroupChangePolicy
  - seLinuxOptions
  - supplementalGroups
  - runAsNonRoot
  - seccompProfile
  - sysctls
  - windowsOptions

SECURITY 101

CONTAINER SECURITY CONTEXT

- Security Contexts are used to set the security settings for a Container
  - runAsUser
  - runAsGroup
  - readOnlyRootFilesystem
  - allowPrivilegeEscalation
  - privileged
  - capabilities
  - seLinuxOptions
  - procMount
  - windowsOptions

SECURITY 101

OTHER DANGEROUS MANIFEST FIELDS

- Host Process (windowsOptions.hostProcess)
- Host Namespaces (hostNetwork, hostPID, hostIPC)
- Host Ports (hostPort)
- Host Path Volume (hostPath)
- Service externalIPs

DEMO2

SECURITY 101

SERVICE ACCOUNTS

- Every Pod has a Service Account Token mounted at `/var/run/secrets/kubernetes.io/serviceaccount/token`
- Service Account Tokens are used to authenticate against the API

LEAST PRIVILEGE PRINCIPLE!

DEMO3

RBAC

ROLES AND CLUSTERROLES

- Roles are namespaced
- ClusterRoles are cluster wide

RBAC

ROLEBINDINGS AND CLUSTERROLEBINDINGS

- Rolebindings are namespaced
- ClusterRolebindings are cluster wide

RBAC

PERMISSIONS

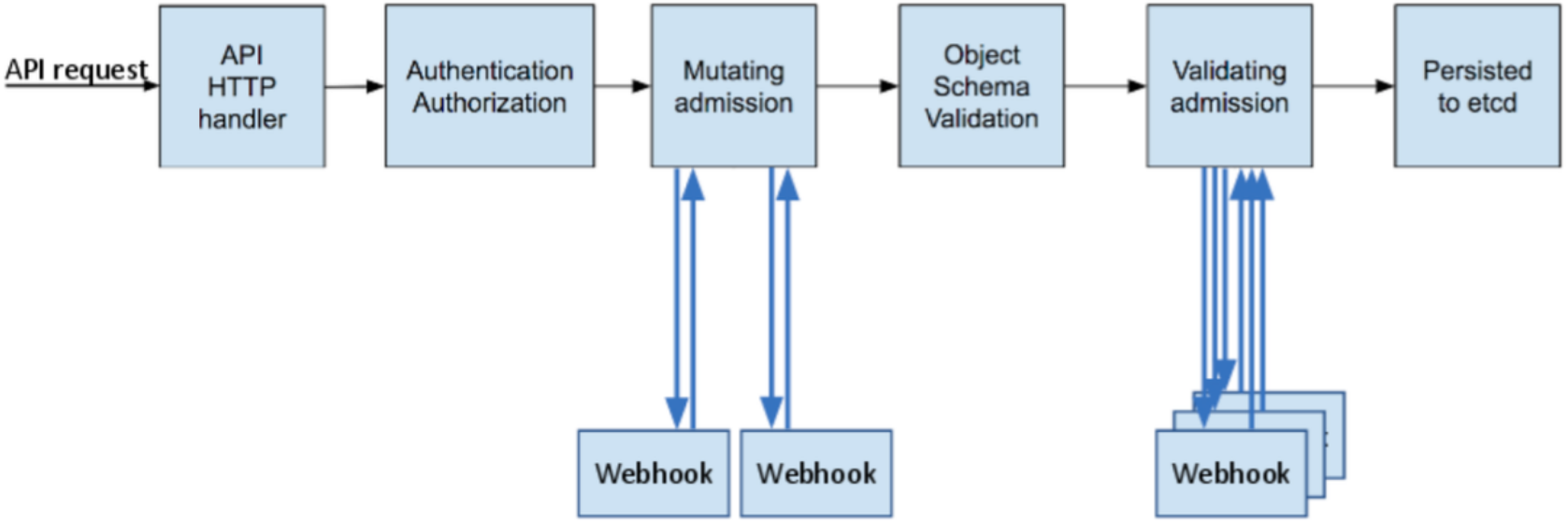
- Limit access to API resources
- Limit access to API verbs
- Limit access to API resource fields

DEMO4

ADMISSION CONTROLLERS

- Bouncer for the Kubernetes API
- Rejects dangerous manifests
- Ensures manifests conform to a certain standards or compliance
- Mutating Admission Controllers
- Validating Admission Controllers

ADMISSION CONTROLLERS



ADMISSION CONTROLLERS

- Several built-in Admission Controllers
- PodSecurity Admission (PSA) together with PodSecurity Standards (PSS)
- ValidatingAdmssionPolicies
- Third Party Admission Controllers

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ADMISSION CONTROLLERS

POD SECURITY STANDARDS

- Privileged
- Baseline
- Restricted

ADMISSION CONTROLLERS

POD SECURITY ADMISSION

- Warn
- Audit
- Enforce

DEMO5

NETWORK POLICIES

- Firewall in Kubernetes
- Ingress and Egress
- Namespaced
- Enforced by the CNI
- Some CNI's implement Network Policies differently

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NETWORK POLICIES

Network Policy Editor

https://editor.networkpolicy.io/

DEMO6

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RUNTIME SECURITY

- Detect and prevent malicious activity at Runtime after the Pod has started
  - `/etc/passwd`
  - Backconnecting shells
  - Maleware
  - Malicous Executables

ISOLATION

- Namespaces are no isolation! They are logical separation of resources!
- Isolation is based on Namespaces

DEMO7

ISOLATION

- Network Isolation => Network Policies
- Ressource Limitation => Resource Quotas
- Ressource/Process Isolation => Container Runtime
- Pod Isolation => Label/Taints that Pods are scheduled on different Nodes

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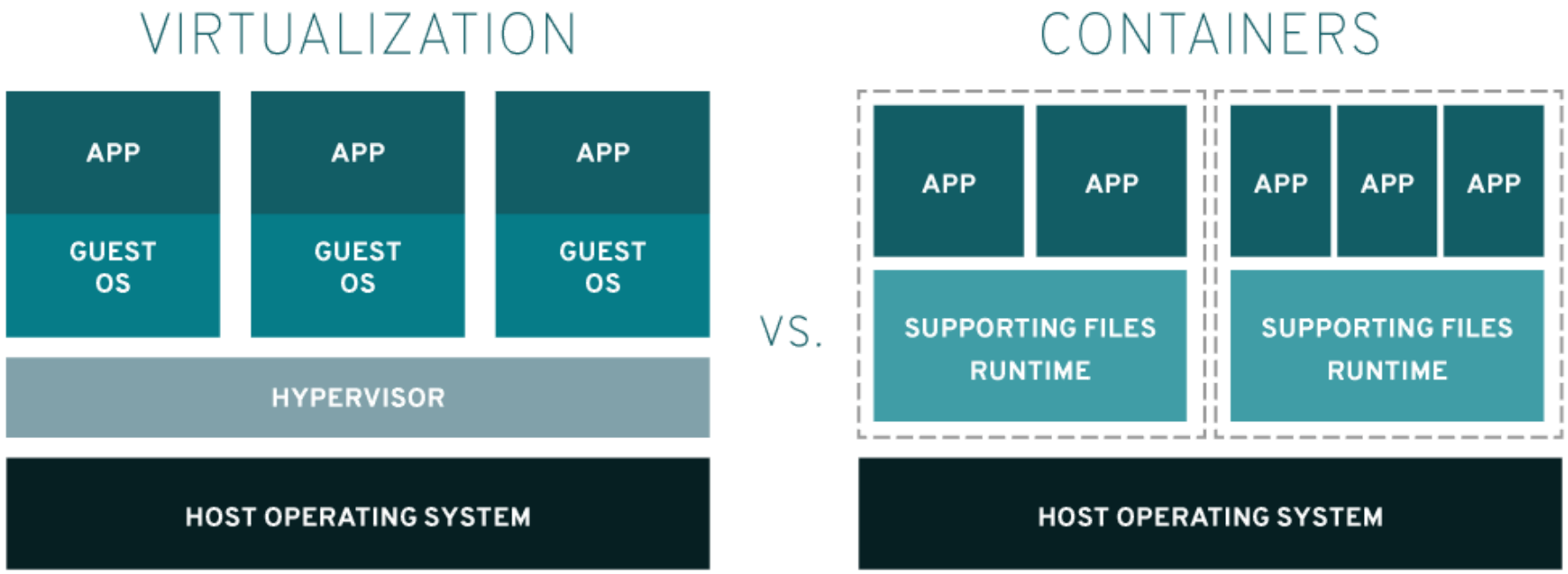
ISOLATION

CONTAINER VS VMS



ISOLATION

CONTAINER RUNTIME

- Linux Namespaces
- Cgroups
- Capabilities

CONTAINERD, CRI-O, DOCKER, ...

But what if thats not enough?

ISOLATION

CONTAINER RUNTIME

- VM based Container Runtime
  - Kata Containers
  - Firecracker
- Confidential Computing
  - Confidential Containers

ENCRYPTION

What can be encrypted in Kubernetes?

- Secrets
- Persistent Volumes
- Etcd
- Network Communication

ENCRYPTION

SECRETS

- By default Base64 encoded
- Stored in etcd
- Secret Vault should be used

DEMO8

ENCRYPTION

PERSISTENT VOLUMES

- Container Storage Interface (CSI) needs to support encryption

ENCRYPTION

ETCD

- Etcd is unencrypted by default
- Encryptionconfiguration is used to encrypt etcd

DEMO9

ENCRYPTION

NETWORK COMMUNICATION

- mTLS
- Service Mesh should be used

MAYBE DEMO 10, IF WE HAVE TIME

SAMPLE SECURITY ARCHITECTURE

- Private Cluster, API only Accessible via VPN or through a Bastion Host
- Container Images are regulary scanned
- One Service Account per Deployment/DaemonSet/StatefulSet
- RBAC to limit access to the API, least privilege principle
- Secret Vault for Secrets
- Network Policies to isolate Workloads
- Encrypted Persistent Volumes for Workloads
- Service Mesh to encrypt Network Communication
- Encryptionconfiguration to encrypt etcd
- Admission Controllers to enforce compliance
- Runtime Security to detect malicious activity

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THANKS FOR LISTENING