



**CONFIDENTIAL
CONTAINERS**



KubeCon



CloudNativeCon

Europe 2023

Confidential Containers Made Easy

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Agenda

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- Confidential Containers in a Nutshell
- Basics: Kata Containers
- From Kata to Confidential Containers
- Different flavours of Confidential Containers
- Use Cases for Confidential Containers
- Demos

Confidential Containers in a Nutshell

Confidential Containers in a Nutshell

This is an umbrella project, which has its **Operator** as the project's front door

Apart from the Operator, we also develop:

- A key broker service
- An attestation agent and an attestation service
- A lightweight firmware for the Confidential Containers VMs (td-shim)
- Rust libraries for pulling, decrypting, and encrypting images (image-rs and ocicrypt-rs)
- Different flavours of Confidential Containers (cloud-api-adaptor, enclave CC)
- Have a strong relationship with Kata Containers

Confidential Containers in a Nutshell

Cloud Native Computing Foundation member

- Since March 8th, 2022

PROJECTS

Confidential Containers



CONFIDENTIAL
CONTAINERS

Confidential Containers is an open source community working to enable cloud native confidential computing by leveraging Trusted Execution Environments to protect containers and data.

Confidential Containers was accepted to CNCF on **March 8, 2022** and is at the **Sandbox** project maturity level.

VISIT PROJECT WEBSITE



<https://www.cncf.io/projects/confidential-containers/>

Confidential Containers in a Nutshell

Community members

- Alibaba Cloud
- AMD
- ARM
- IBM
- Intel
- Microsoft
- NVIDIA
- Red Hat
- RivOS
- and others ... :-)

Confidential Containers in a Nutshell

What is the value proposition of Confidential Containers?

Protect **data-in-use**, at the **pod level**, by leveraging **Trusted Execution Environments (TEE)**

- Simplify TEE technology usage for cloud native software with Confidential Containers
- Enforce security requirements and transparent deployment of unmodified containers
- Support multiple TEE and hardware platforms
- Separate Cloud Service Providers from guest applications, following least privilege principles for Kubernetes administration

Confidential Containers in a Nutshell

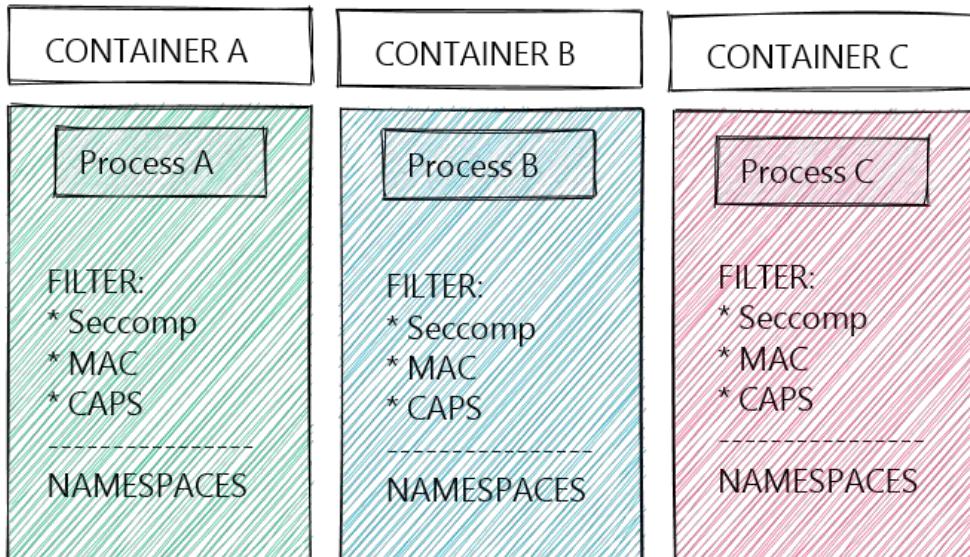
The project focuses on protecting ...

- Hold on! Let's talk about it a little bit later!

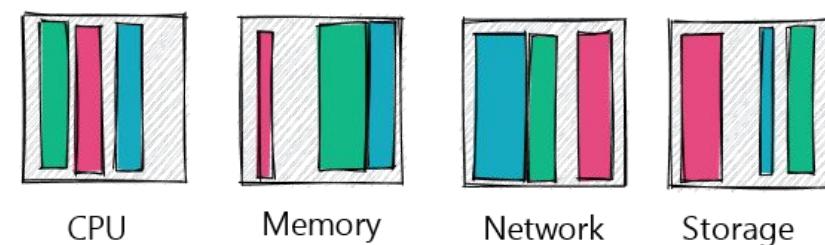
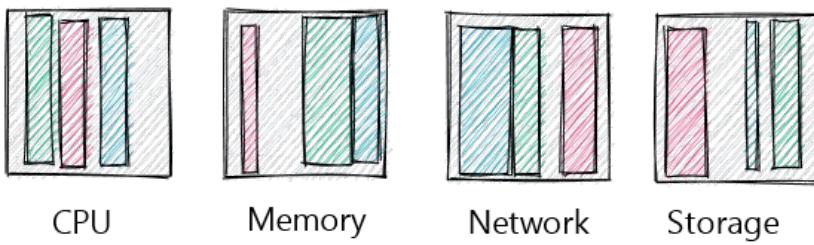
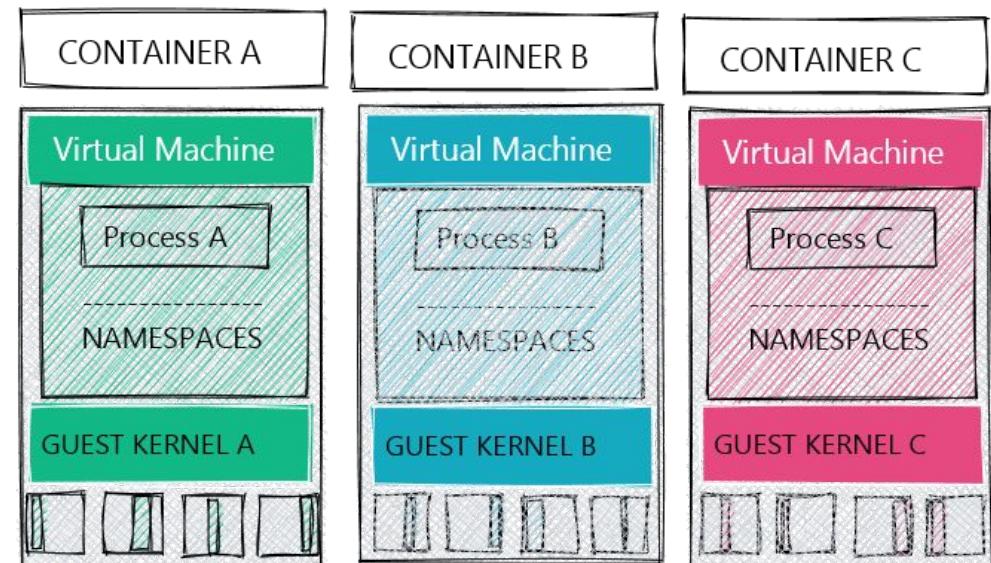
Basics: Kata Containers

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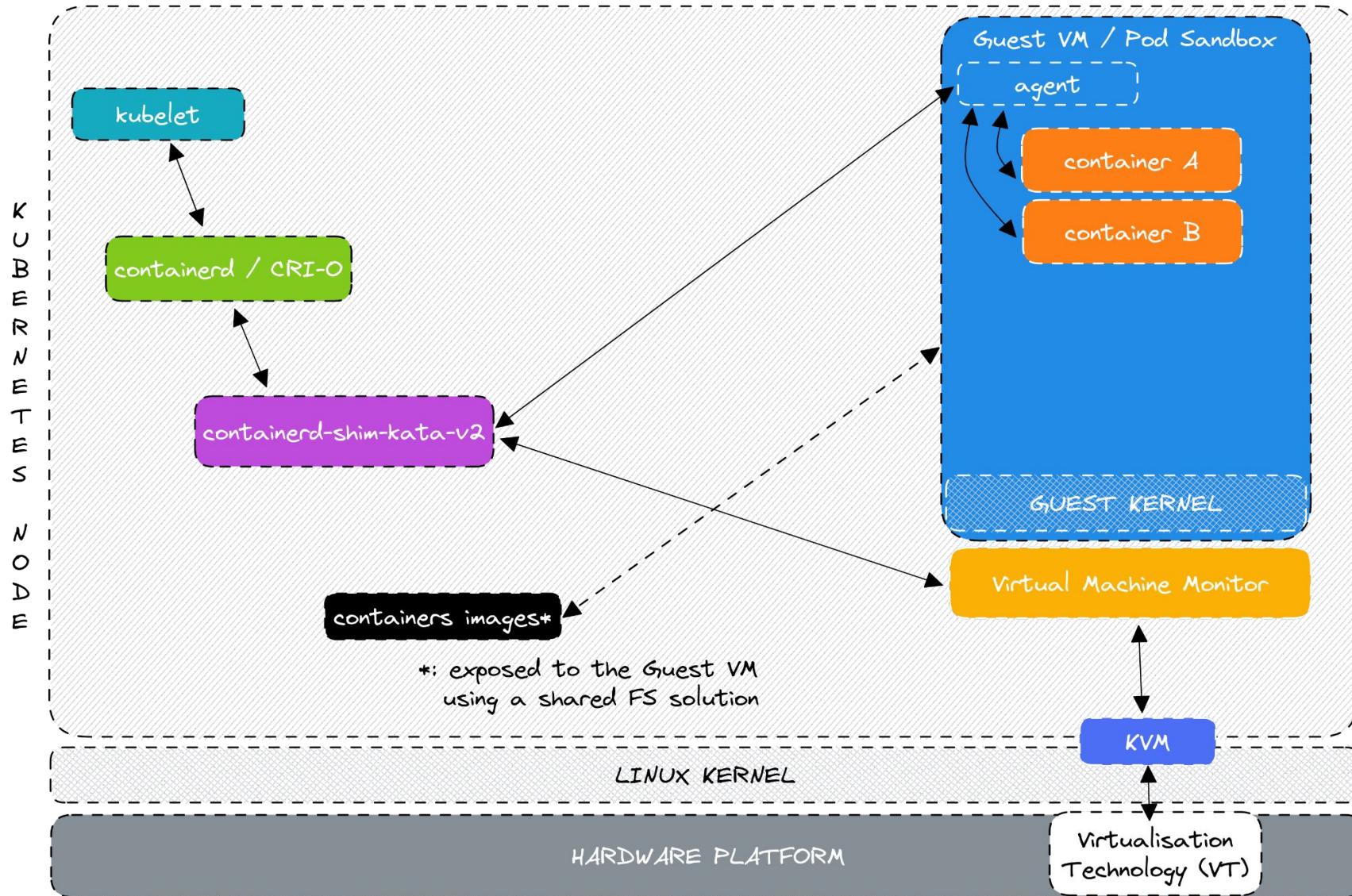
Traditional Containers



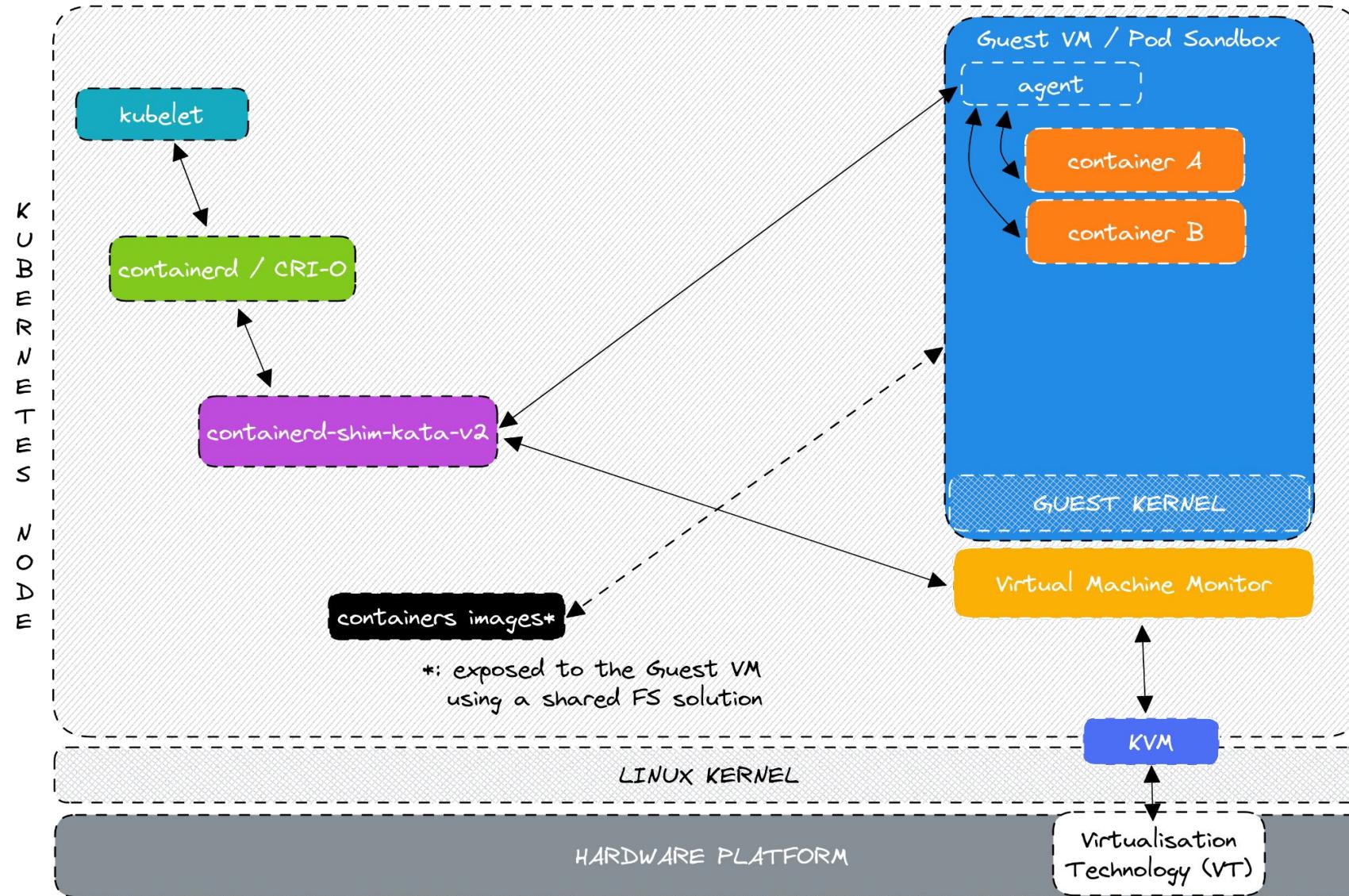
Kata Containers



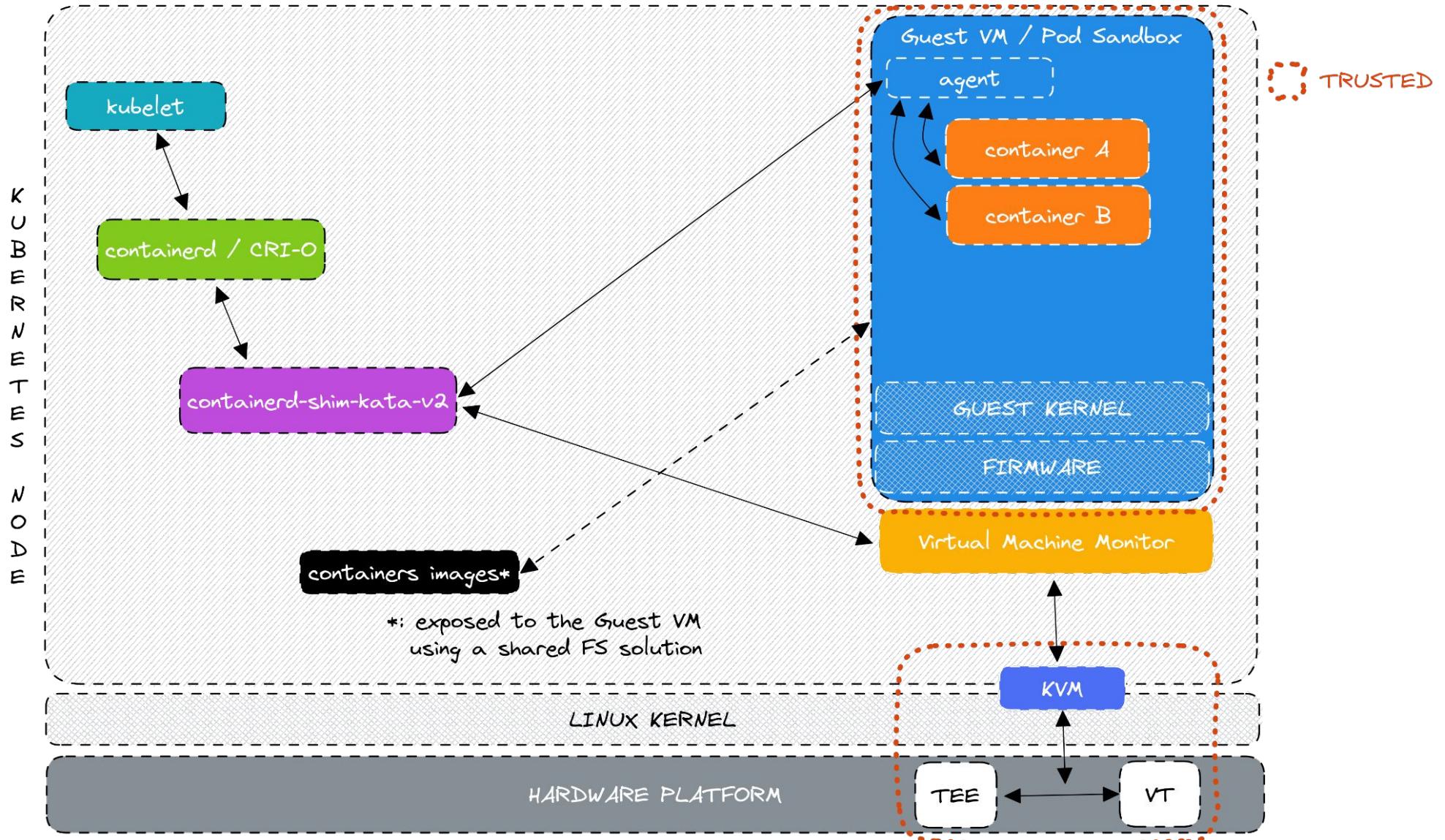
Basics: Kata Containers



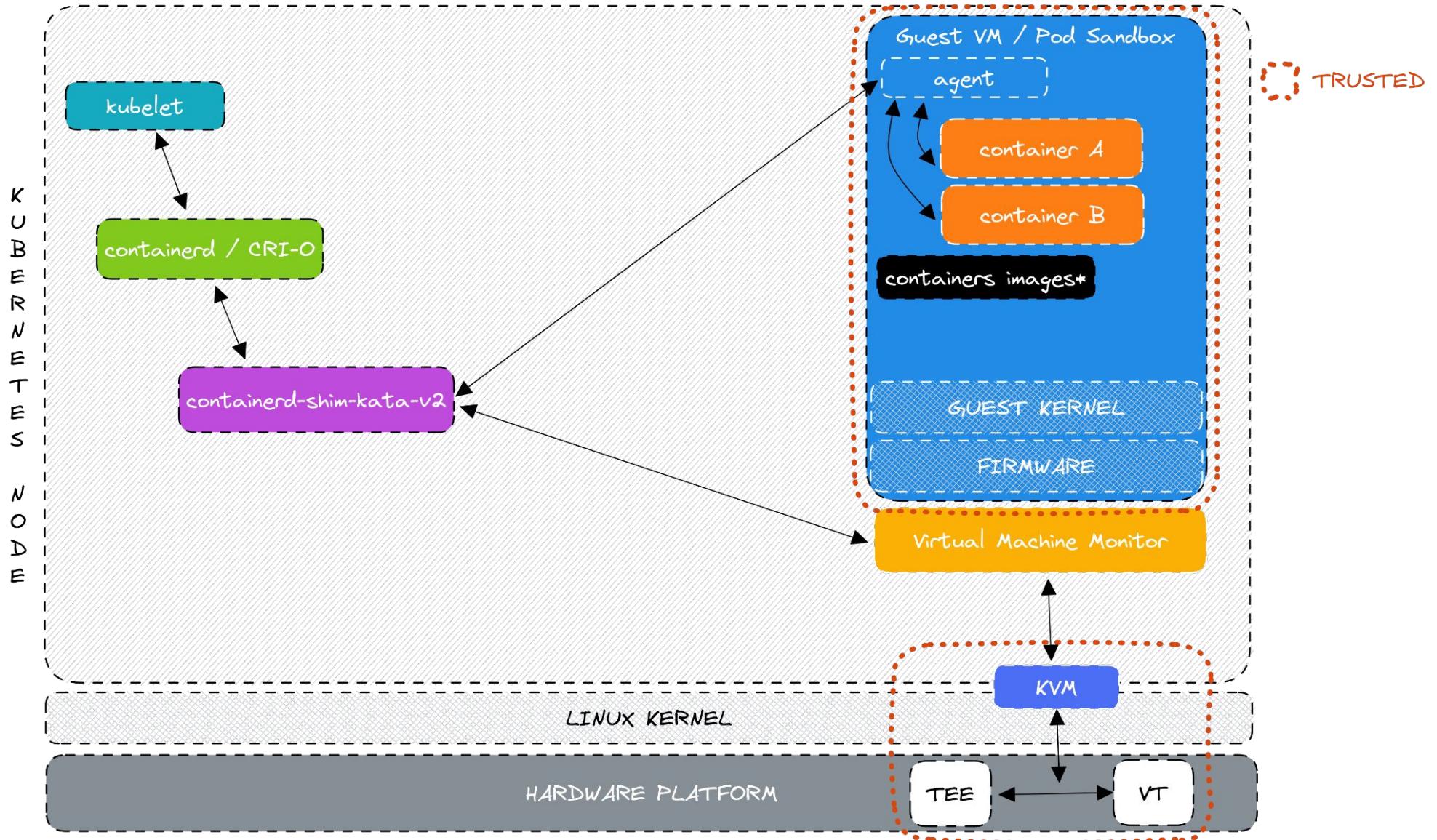
From Kata to Confidential Containers



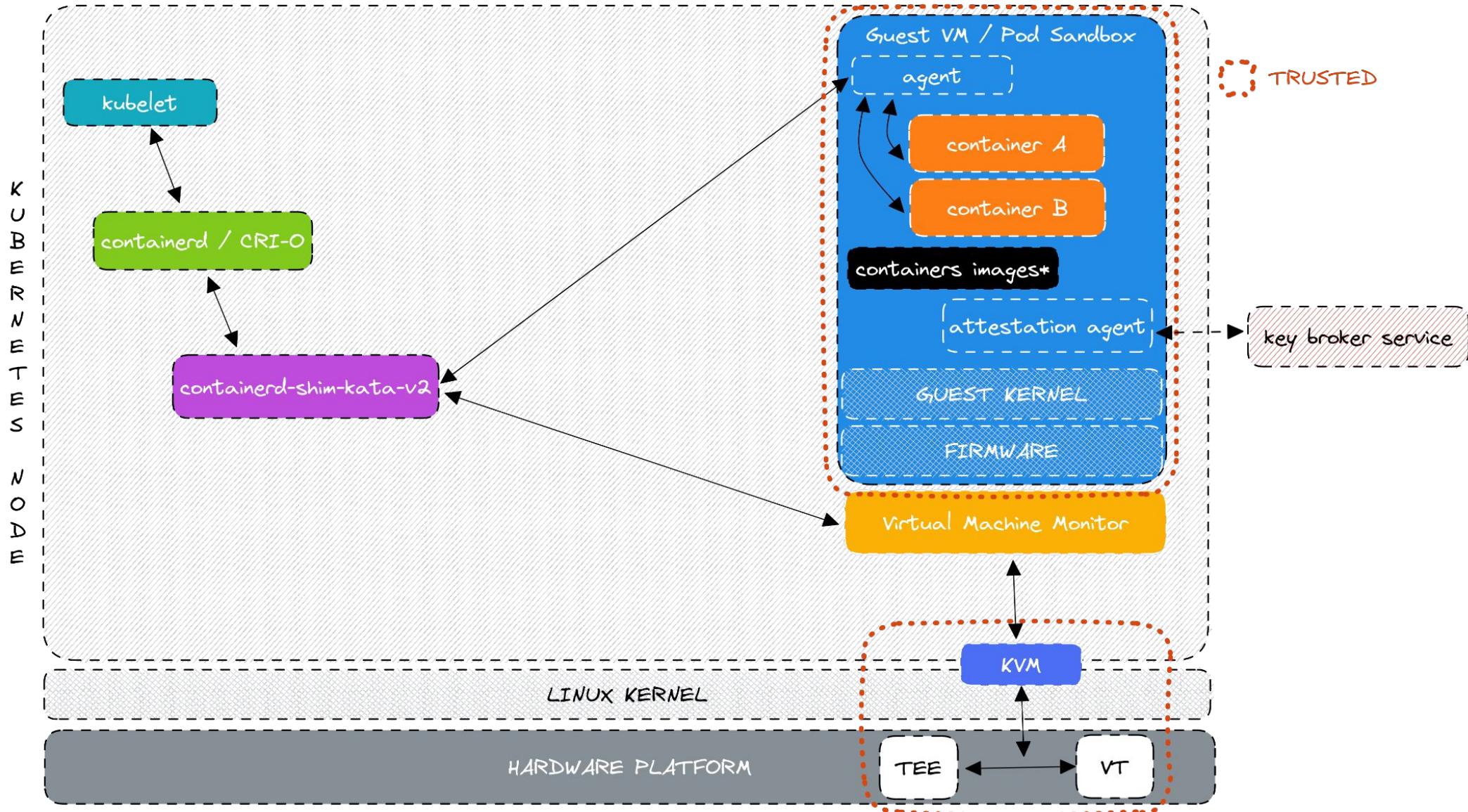
From Kata to Confidential Containers



From Kata to Confidential Containers



From Kata to Confidential Containers



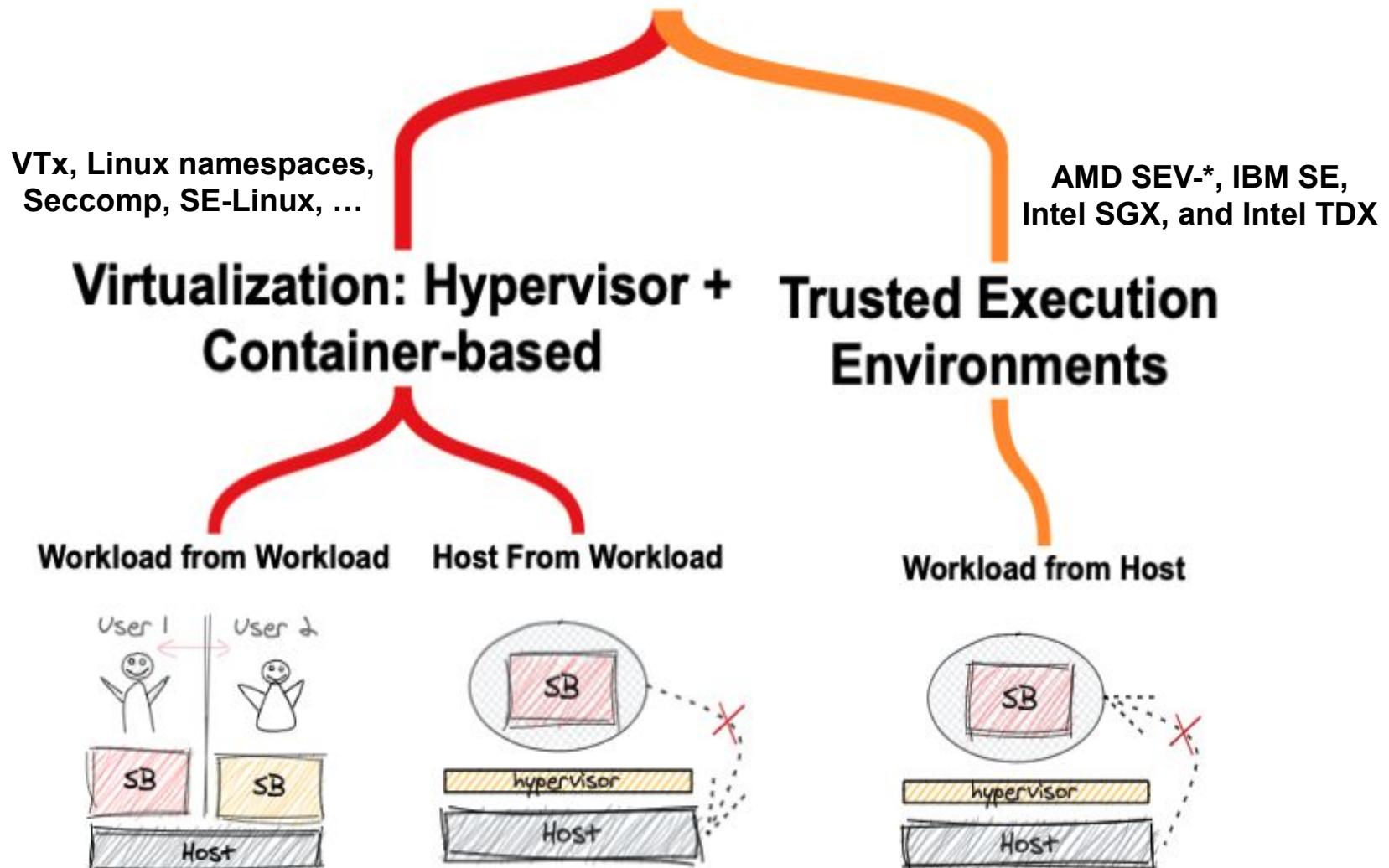
From Kata to Confidential Containers

The projects focus on ...

- Kata Containers:
 - Protecting the Host from a non-trusted workload
 - Protecting workloads from each other
- Confidential Containers adds:
 - Protecting the workload from a non-trusted infrastructure

From Kata to Confidential Containers

Types of Sandboxing



The different flavours

The different flavours

Process-based isolation

- Provided by Enclave CC
 - SGX (Intel)

VM-based isolation

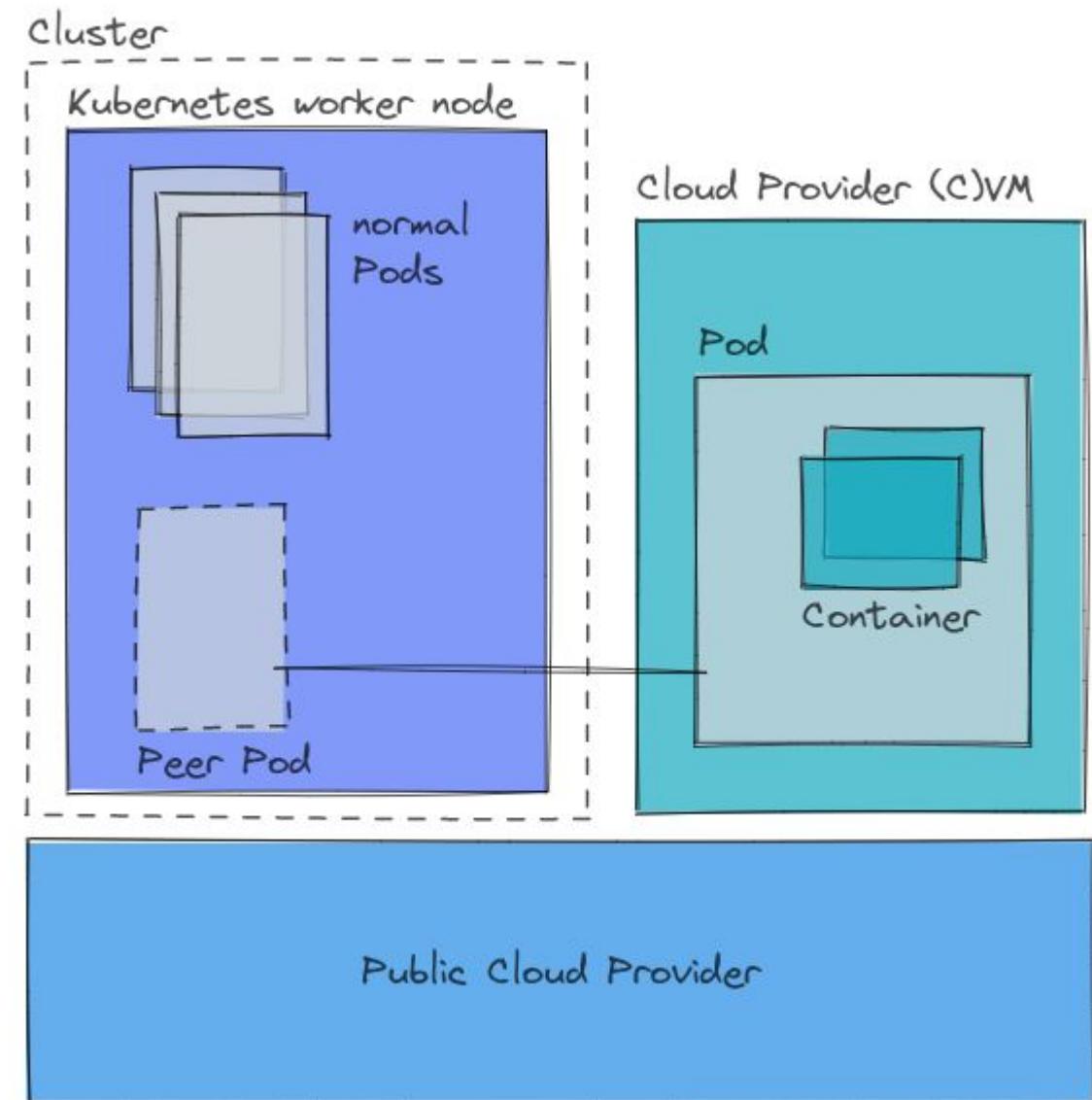
- Provided by Kata Containers
 - SE (IBM) / SEV-ES (AMD) / TDX (Intel)

The different flavours

Cloud API Adaptor (aka, Peer Pods)

- It could be its own talk!
- Takes advantage of the Kata Containers' remote hypervisor support
- Allows users to use a CSP's VM as the Guest VM / PodSandbox
 - AWS
 - Azure
 - GCP
 - IBM Cloud

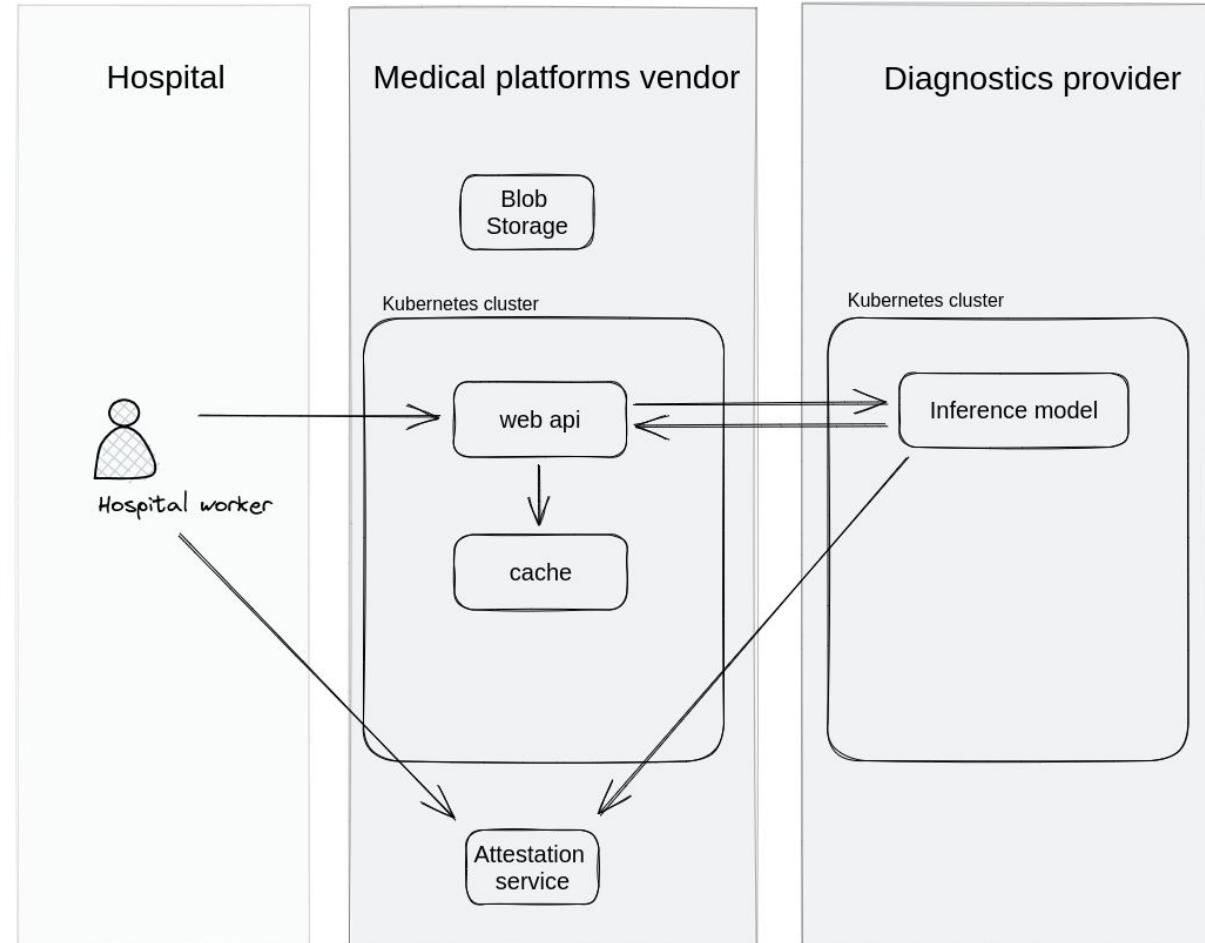
<https://www.youtube.com/watch?v=QPOcEGcqYfU>



Use cases of Confidential Containers

Confidential Containers in Healthcare Data Analysis

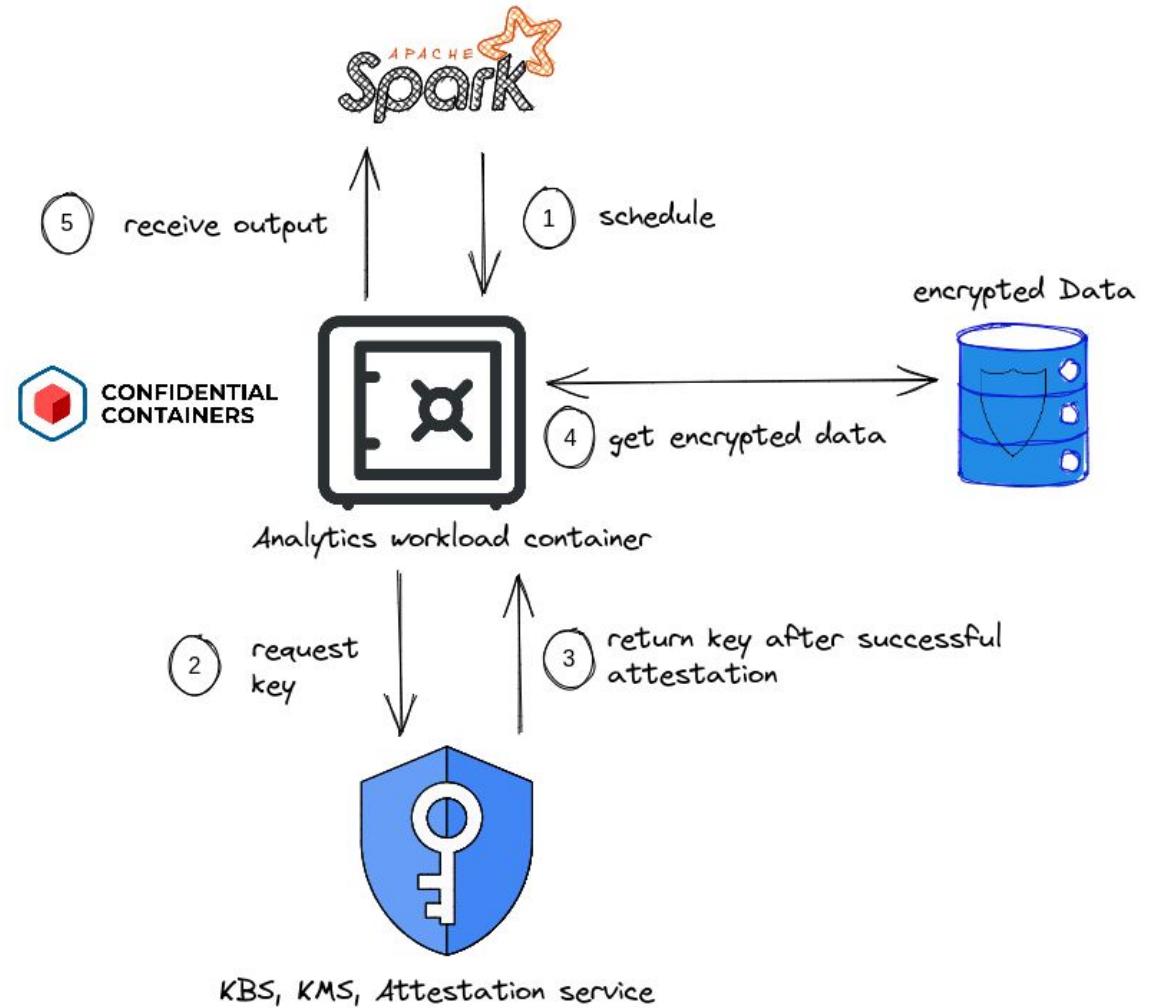
- Collaborate on sensitive patient data for research and analysis while ensuring data privacy and complying with regulations
- Use Confidential Containers to safeguard patient data in a Trusted Execution Environment
- Build your solution with Kubernetes cluster and Confidential Computing technologies, like TEEs
- Rely on Attestation Services, Key Management and other Confidential Computing building blocks for secure data sharing and analysis among collaborating institutions
- Achieve compliance with data privacy regulations and enhance trust in the execution environment



Use cases of Confidential Containers

Confidential Data Analytics with Apache Spark/PySpark

- Container Encryption: Datasets are encrypted, not the containers
- Remote Attestation: Used for secure key release
- K8s Dependency: Optimized for K8s deployments, HPA for large datasets
- Multi-Party Analytics: Extendable for data schema contracts between parties
- Forked Scenarios: Apache Spark Master Scheduler modified for secure job scheduling



DEMO

```
kube-system  pod/kube-proxy-467c9           1/1    Running   0          3d3h
kube-system  pod/kube-scheduler-kubecon23eu  1/1    Running   0          3d3h

NAMESPACE      NAME              DESIRED  CURRENT  READY   UP-TO-DATE  AVAILABLE  NODE SELECTOR          AGE
kube-flannel   daemonset.apps/kube-flannel-ds 1         1         1         1             1           <none>          3d3h
kube-system    daemonset.apps/kube-proxy        1         1         1         1             1           kubernetes.io/os=linux  3d3h

$ # Let's setup the Operator version we want to deploy
$ # - v0.5.0 is its latest release, from April 14th 2023
$ export RELEASE_VERSION=v0.5.0
$ kubectl apply -k "github.com/confidential-containers/operator/config/release?ref=v0.5.0"
namespace/confidential-containers-system created
customresourcedefinition.apiextensions.k8s.io/ccruntimes.confidentialcontainers.org created
serviceaccount/cc-operator-controller-manager created
role.rbac.authorization.k8s.io/cc-operator-leader-election-role created
clusterrole.rbac.authorization.k8s.io/cc-operator-manager-role created
clusterrole.rbac.authorization.k8s.io/cc-operator-metrics-reader created
clusterrole.rbac.authorization.k8s.io/cc-operator-proxy-role created
rolebinding.rbac.authorization.k8s.io/cc-operator-leader-election-rolebinding created
clusterrolebinding.rbac.authorization.k8s.io/cc-operator-manager-rolebinding created
clusterrolebinding.rbac.authorization.k8s.io/cc-operator-proxy-rolebinding created
configmap/cc-operator-manager-config created
service/cc-operator-controller-manager-metrics-service created
deployment.apps/cc-operator-controller-manager created
$ # Let's ensure the Operator pods are running
$ watch 'kubectl get pods -n confidential-containers-system'

$ # Let's ensure the CRD has been created
$ kubectl get crd | grep ccruntimes
ccruntimes.confidentialcontainers.org  2023-04-16T17:13:56Z

$ # Let's create the Operator custom resource
$ # The default sample config looks like:

$ # Now, let's apply it
$ kubectl apply -k "github.com/confidential-containers/operator/config/samples/ccruntime/default?ref=v0.5.0"
```



<https://asciinema.org/a/577943>

Confidential Containers 0.5.0 Release

Expanding Cloud-Native Confidential Computing Capabilities

- Largest release to date, featuring:
 1. Generic Key Broker Service (KBS)
 - Attestation Service and Resource Value Provider Service for diverse platforms and use cases
 2. Peer-pods for Kata Containers on multiple public clouds
 3. Resource URL for uniform attestation resources and secrets identification
 4. Enclave-CC for process-based confidential containers using Intel SGX

Check out the [Confidential Containers project](#)

- Contribute, [join community meetings](#)
- Slack: [#confidential-containers](#) in CNCF workspace

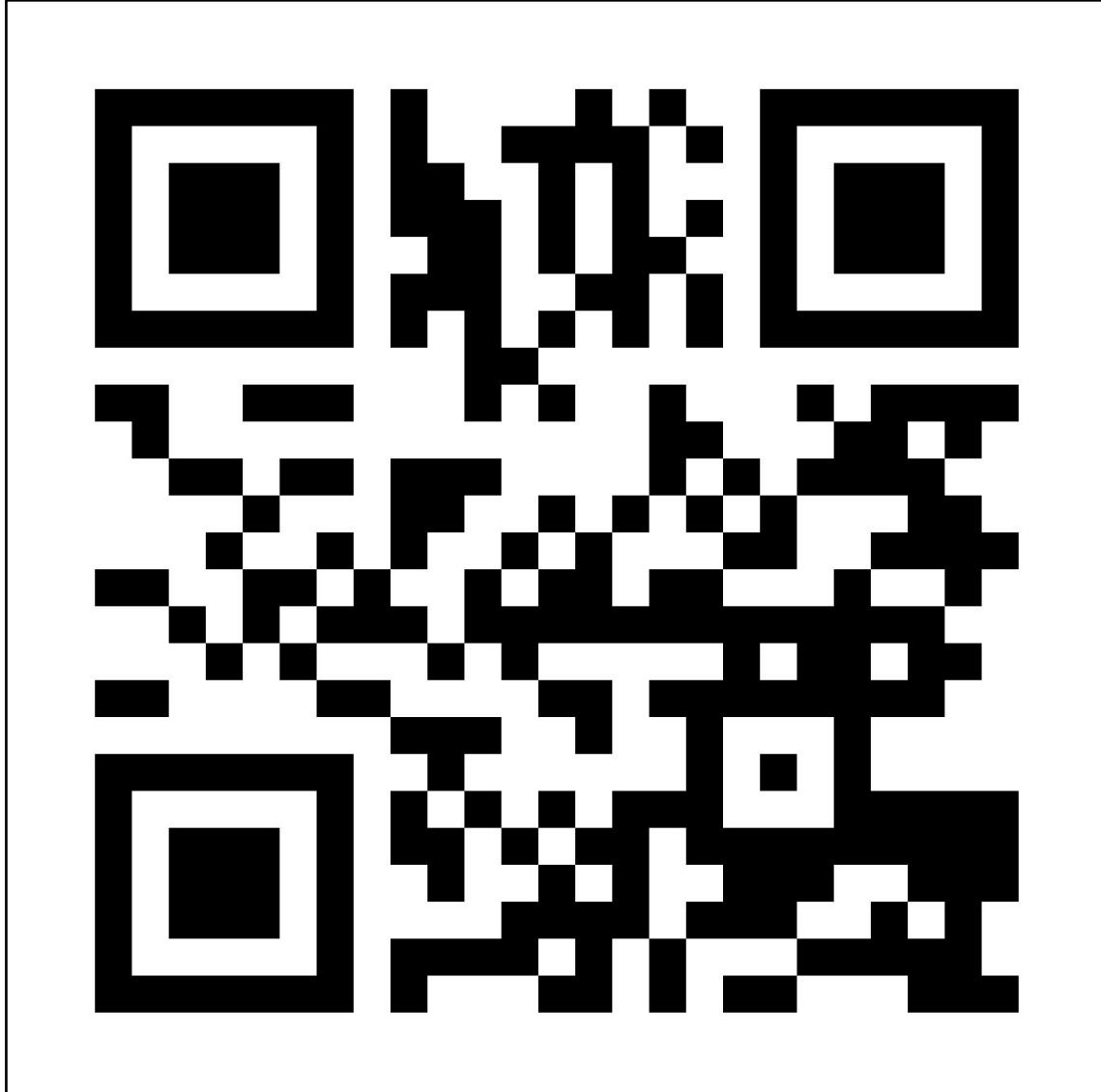
Also watch this talk which will happen directly after lunch

[The Next Episode in Workload Isolation: Confidential Containers - Jeremi Piotrowski](#)

Talks from previous KubeCon + CloudNativeCon editions

[Trust No One: Bringing Confidential Computing to Containers- Samuel Ortiz & Eric Ernst](#)

[Confidential Containers Explained - James Magowan & Samuel Ortiz](#)



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Why Confidential Computing?

- Confidential Computing technology is already being used in everyday devices such as smartphones and game consoles to protect biometric data, payments, and against cheating and piracy.
- Confidential Computing can be used for existing programming languages, toolchains, and applications, without requiring developers to change their programming approach.
- Confidential Computing ensures the code executed, data processed, and output results cannot be tampered with or disclosed.