Kata Containers: when OCI meets virtualization

彭涛 bergwolf@hyper.sh

HYPER.SH katacontainers

Outlines

- Docker and OCI Intro
- Kata Containers
- Kata Containers and OCI
- Kata Containers and CRI
- Q&A

About

- About me
- About hyper.sh
  - Pioneers on virtualized container technology
  - Creator of multiple OSS projects
    - hyperhq/runv
    - hyperhq/hyperd
    - kubernetes/frakti
  - Public cloud service
    - https://hyper.sh
    - The only Chinese startup in Forrester Enterprise Container Platforms, 2018.
- runV -> Kata Containers

Docker

- Hottest container technology
- From container runtime, to cluster management, network/storage plugin, container orchestration, even OS packaging
- Cornerstone of the container ecosystem
- Industry disruptors
  - Lots of OSS projects and startup companies

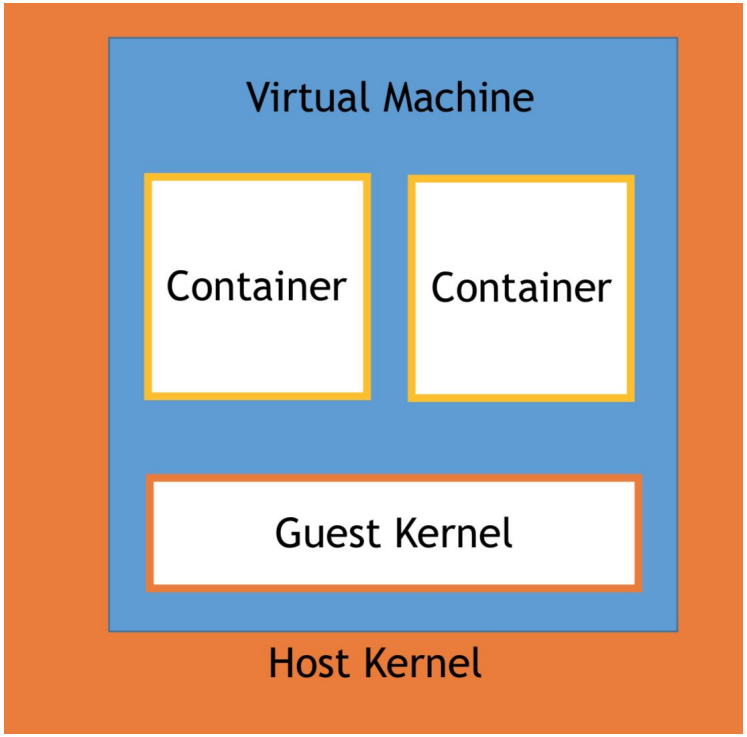
Docker and OCI

- De facto standard vs. Container industry standard
- Image-spec
  - How to building, transporting, and preparing a container image
  - A manifest, an image index (optional), a set of filesystem layers, and a configuration
- Runtime-spec
  - How to run a file system bundle
  - Configuration, execution environment, and lifecycle of a container

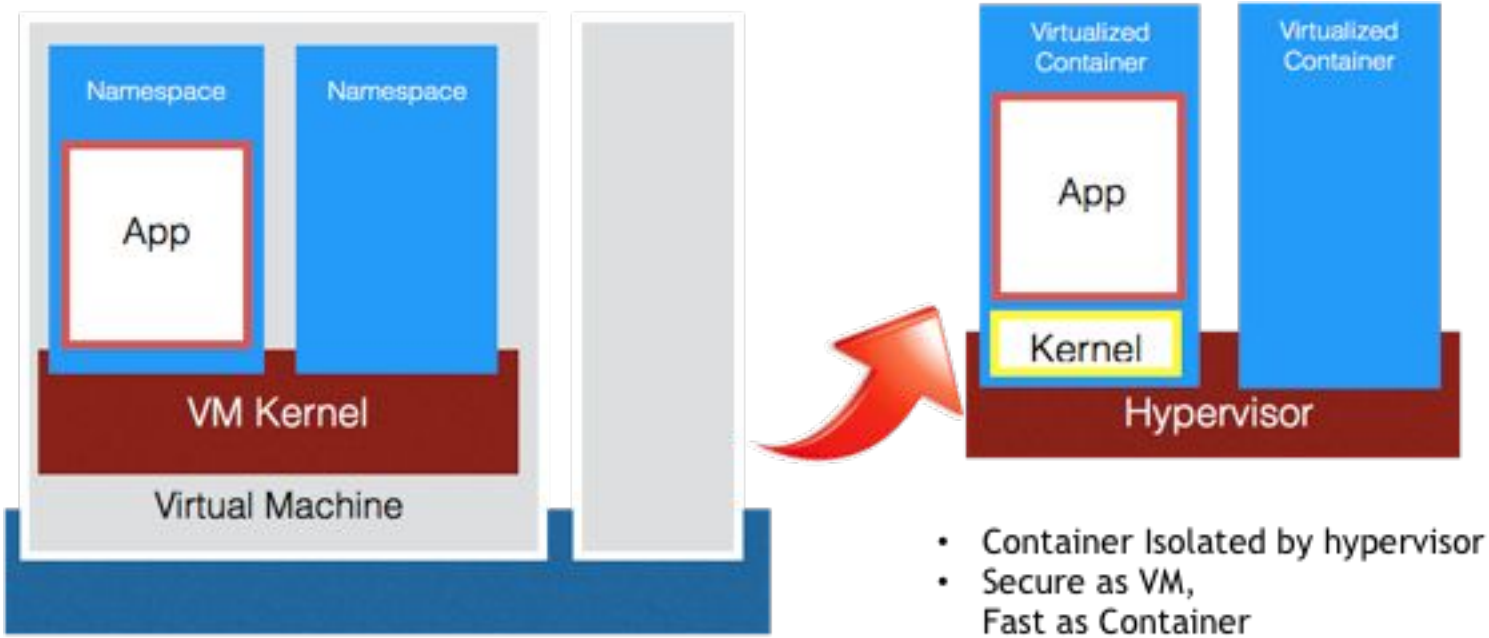
Docker Advantages

Container Isolation

- Container isolation has improved a lot
- Affected by security bugs from time to time
  - Dirty COW (CVE-2016-5195)
  - wait_pid (CVE-2017-5123)
- Resource utilization are affected too
  - Memcg oom
- Weaker than virtual machines

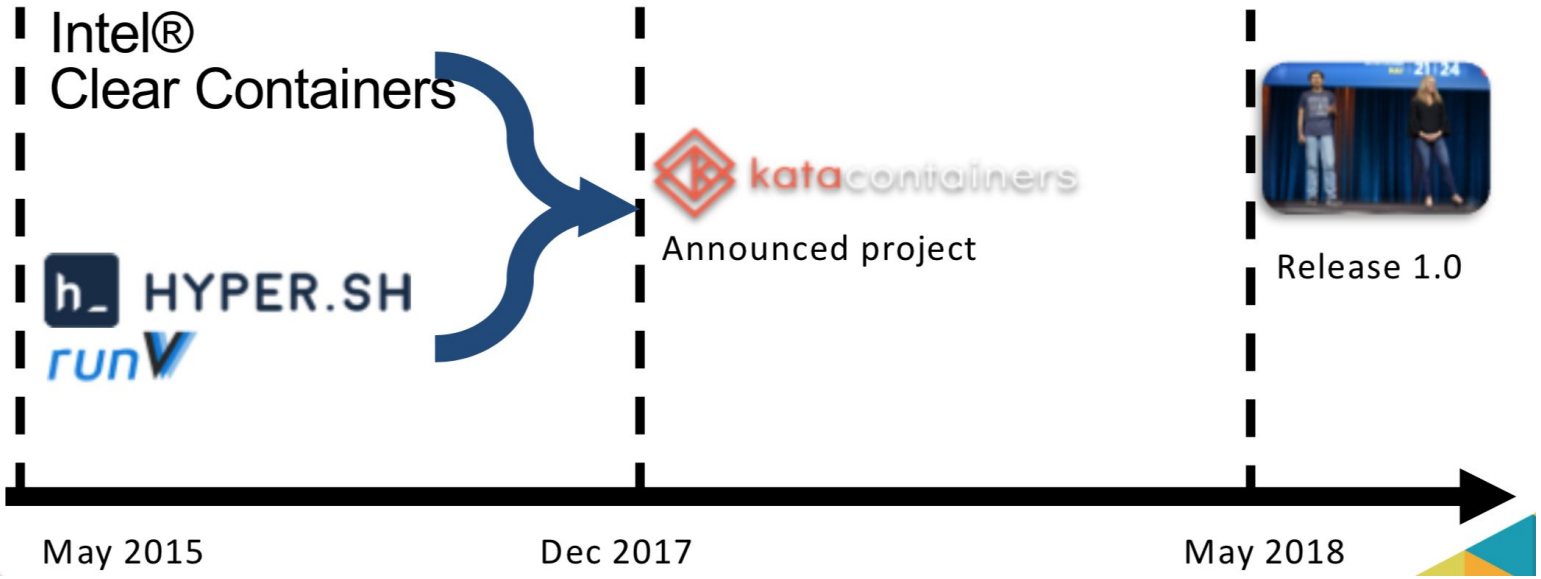


VM + Container Made Simple



- Container Isolated by hypervisor
- Secure as VM,
  Fast as Container

Kata Containers



Kata Containers

- Founded by Hyper.sh and Intel
- Managed by OpenStack Foundation
- Huawei, Google, MSFT in Arch Committee
- Contributors from Redhat, ARM, IBM etc.
- Apache 2.0 License

Industry Support

CNCF Landscape

Container Runtime

containerd
CNCF Incubating

rkt
CNCF Incubating

cri-o

Google Cloud gVisor

Intel Clear Containers

kata

lxd

Pouch

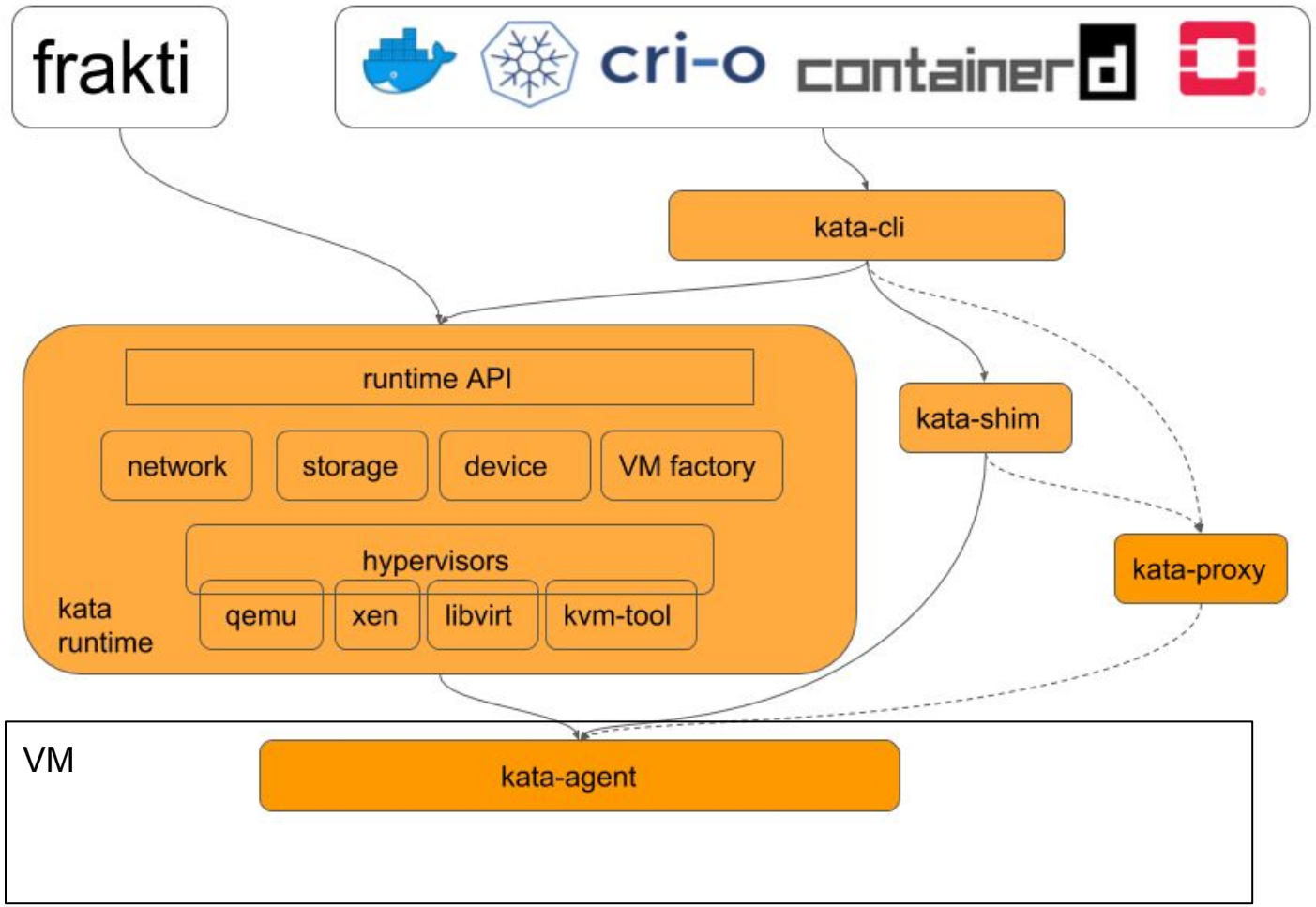
OPEN CONTAINER INITIATIVE

runV

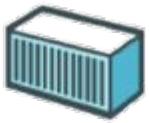
Singularity

SmartOS

Kata Containers



VM-based Containers

VM Container =  VM +  Docker Image

轻量级 (?)

快速 (?)

隔离性

随时随地 ✓

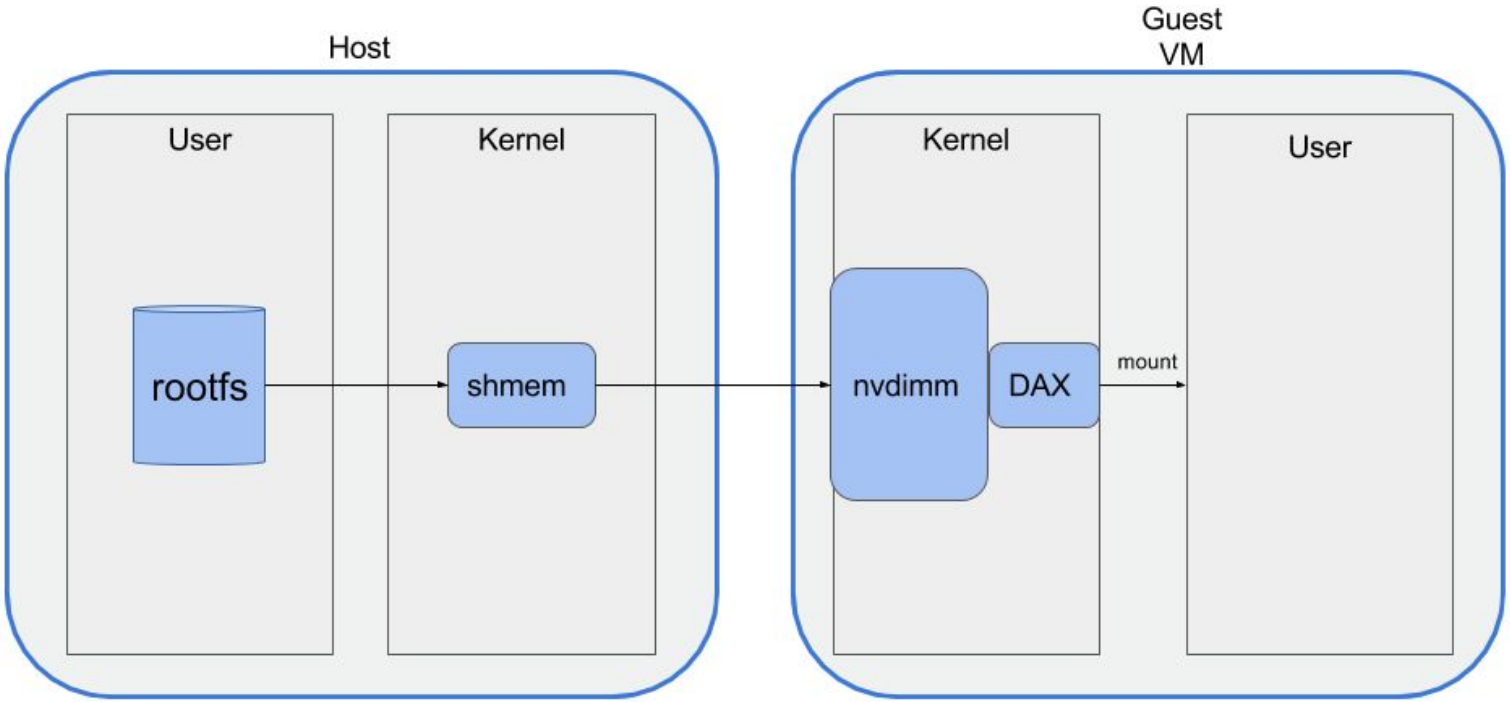
便携 ✓

不可变更 ✓

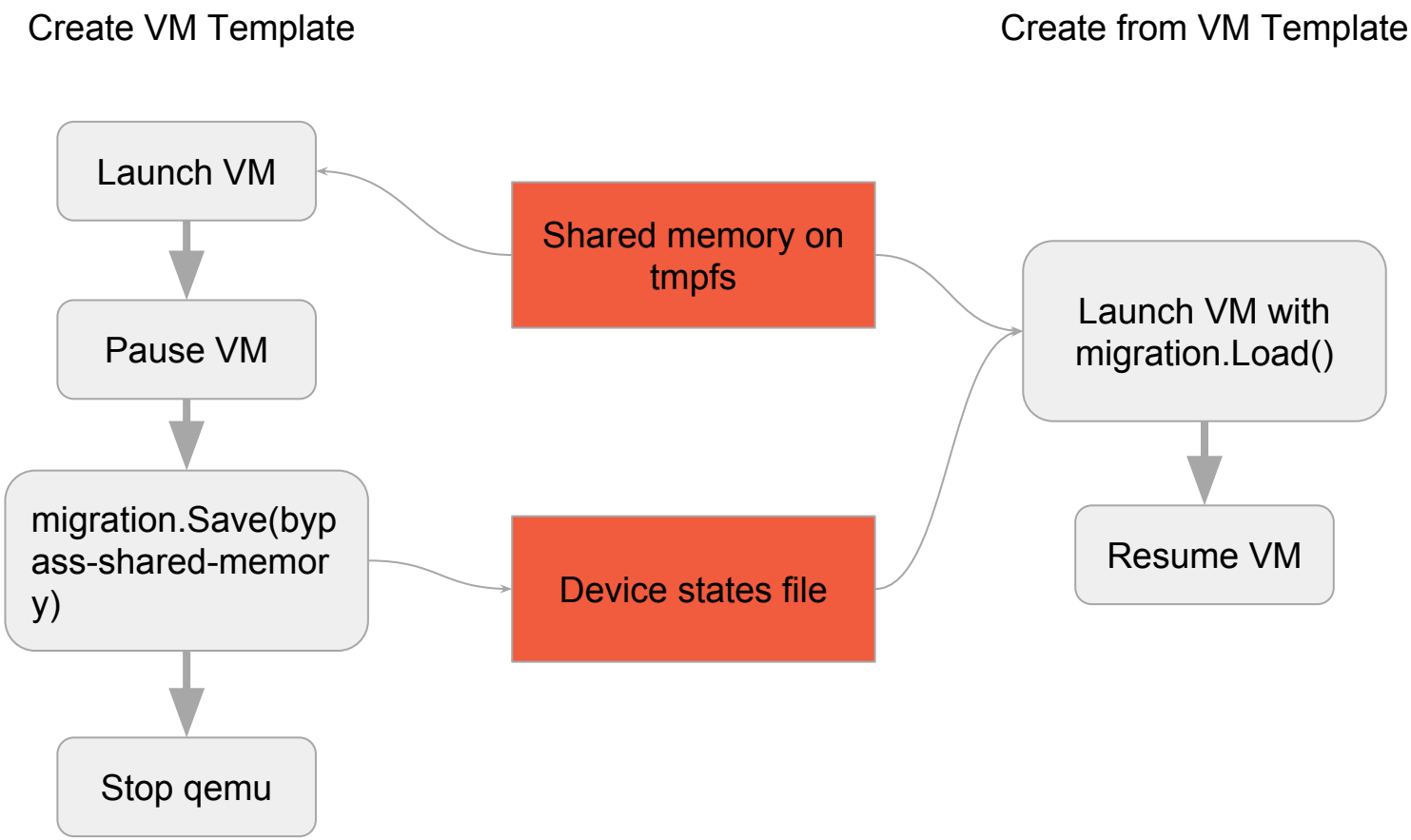
Lightweight and Fast

- Customised guest kernel
- Highly optimized qemu-lite
- DAX/nvdimm: map rootfs image to guest memory
- VM templating: Boot from VM templates to share all guest kernel, initramfs and initial memory states (patch being reviewed by QEMU upstream)
- VM caching: pre-boot guests

DAX/nvdimm


Host
User
Kernel
rootfs
shmem
Guest
VM
Kernel
User
nvdimm
DAX
mount

VM Templating



Lightweight and Fast

- Sub-second boot up time
- Very Small memory overhead
  - Small Qemu process footprint
  - Guest kernel/initramfs/rootfs/kata-agent neglectable

Kata Containers and OCI

- OCI runtime-spec compatible
- Replace runc in Docker
  - runc command line compatibility
  - Support docker CNM
  - Docker run -d --runtime kata nginx

However...

- OCI runtime-spec has some assumptions based on linux container
- But we are running VMs!!

Kata Containers and OCI

- Missing VM related configuration
  - Hypervisor, kernel, initramfs, rootfs image etc.
  - Default config file loaded on each invocation
  - VM description merged to OCI runtime-spec

Kata Containers and OCI

- Missing storage description -- rootfs and volumes are host directories
  - Map through shared file system -- 9pfs
  - Detects device mapper devices and passthrough to the guest if found
    - Still problematic

Kata Containers and OCI

- Device description based on device major/minor
  - Host device major/minor makes no sense to guests
  - Look for the device with major/minor
  - Hotplug to the guest

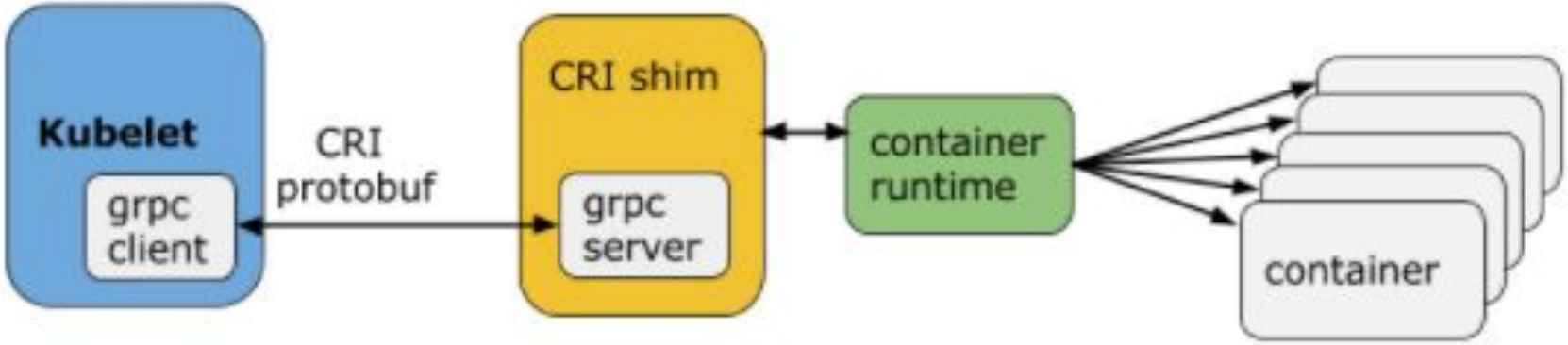
Kata Containers and OCI

- CPU and Memory limits description based on Linux cgroups
  - Approximate conversion
  - vCPU: (quota + period - 1) / period
  - Memory: Memory.Limit >> 20

Kubernetes CRI

- Plugin interface between kubelet and container runtime
- Allow multiple competing container runtime implementations
  - docker-shim
  - cri-o
  - containerd cri plugin
  - frakti

Kubernetes CRI



Kata Containers and Kubernetes

- Kubernetes pod
  - Multiple containers in a sandbox
  - Smallest schedule unit in a cluster
  - Boundary for resource isolation and sharing
- VM matches pod perfectly in Kata containers

Kata Containers and CRI

- Integration with runc compatible CLI
  - cri-o, containerd cri plugin, docker-shim
  - Missing sandbox abstraction
    - CRI CreateSandbox converted to pause container creation
  - OCI runtime-spec limitations
    - Missing storage description

Kata Containers and CRI

- Integration with CRI native runtime APIs
  - frakti
  - No restriction from runc CLI compatibility
    - No pause container
    - CRI CreateSandbox creates VM
  - Supports different storage types
    - Local block devices, Ceph rbd, iSCSI, NFS etc.

How to Contribute

- Code
  - https://github.com/kata-containers
- Slack
  - https://katacontainers.slack.com/
- Mailing List
  - http://lists.katacontainers.io/
- Freenode
  - #kata-dev
  - #kata-general

Future

- GPGPU for machine learning
- Edge and IoT
- Linuxd (“Run Linux Kernel as a Daemon“)

Thank YOU!

Q & A

We are hiring!!!

jobs@hyper.sh