KubeCon | CloudNativeCon

Europe 2019

Kubernetes + Encrypted Memory = Security * Privacy

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Who Are We?

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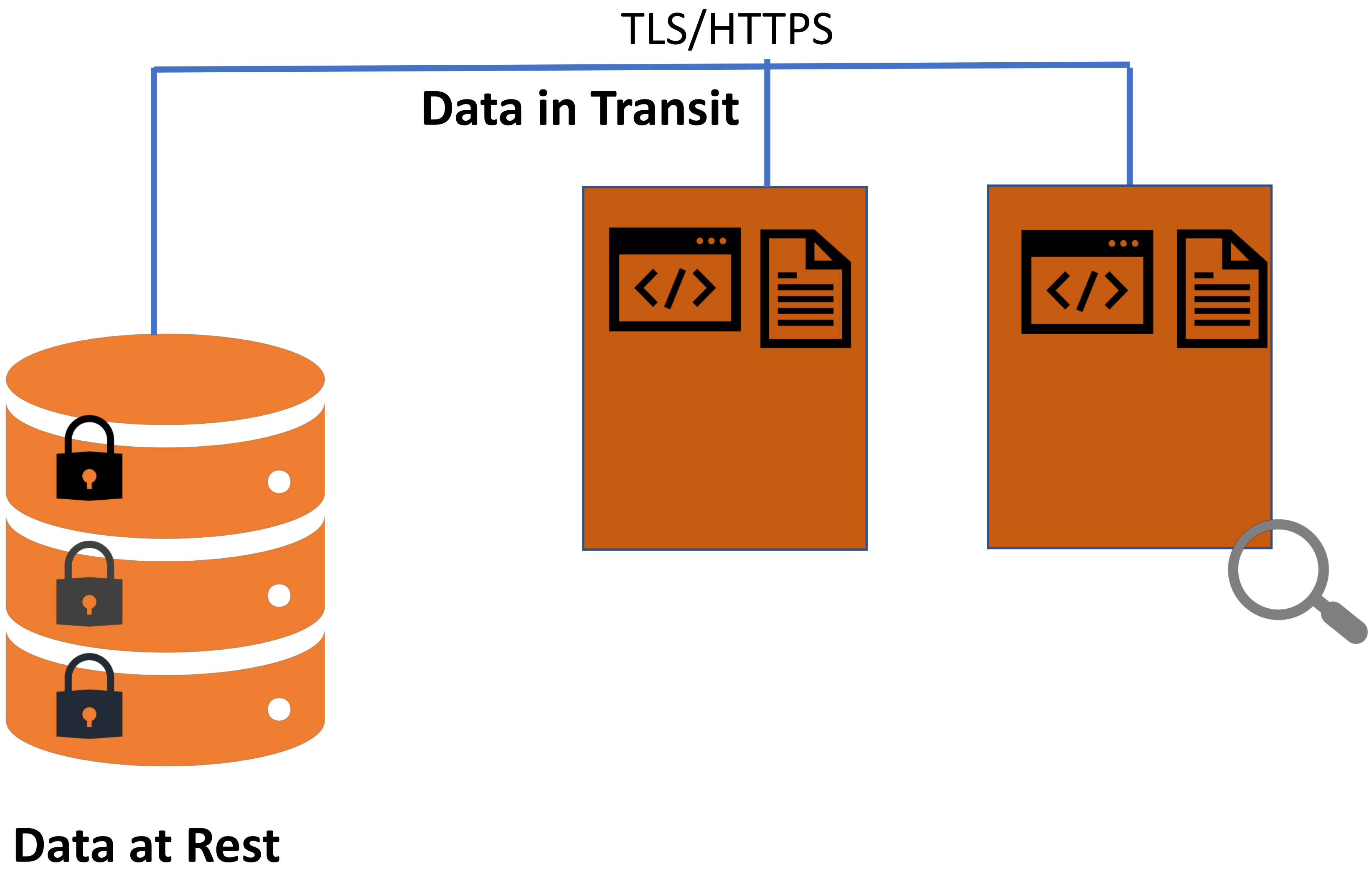
Agenda

- ➢ Securing Data
- ➢ Introducing Memory Protection
- ➢ Kubernetes Integration

How Do We Secure Data and Code?



TLS/HTTPS

Data in Transit

Data at Rest

Data in Use ??

- ➢ From other software
- ➢ Malicious Admins
- ➢ Compromised host/hypervisor

What is being done?

IBM Power

- Secure VM and Protected Execution Facility (PEF)

Intel

- *SGX*
- Total Memory Encryption - TME/MKTME

AMD

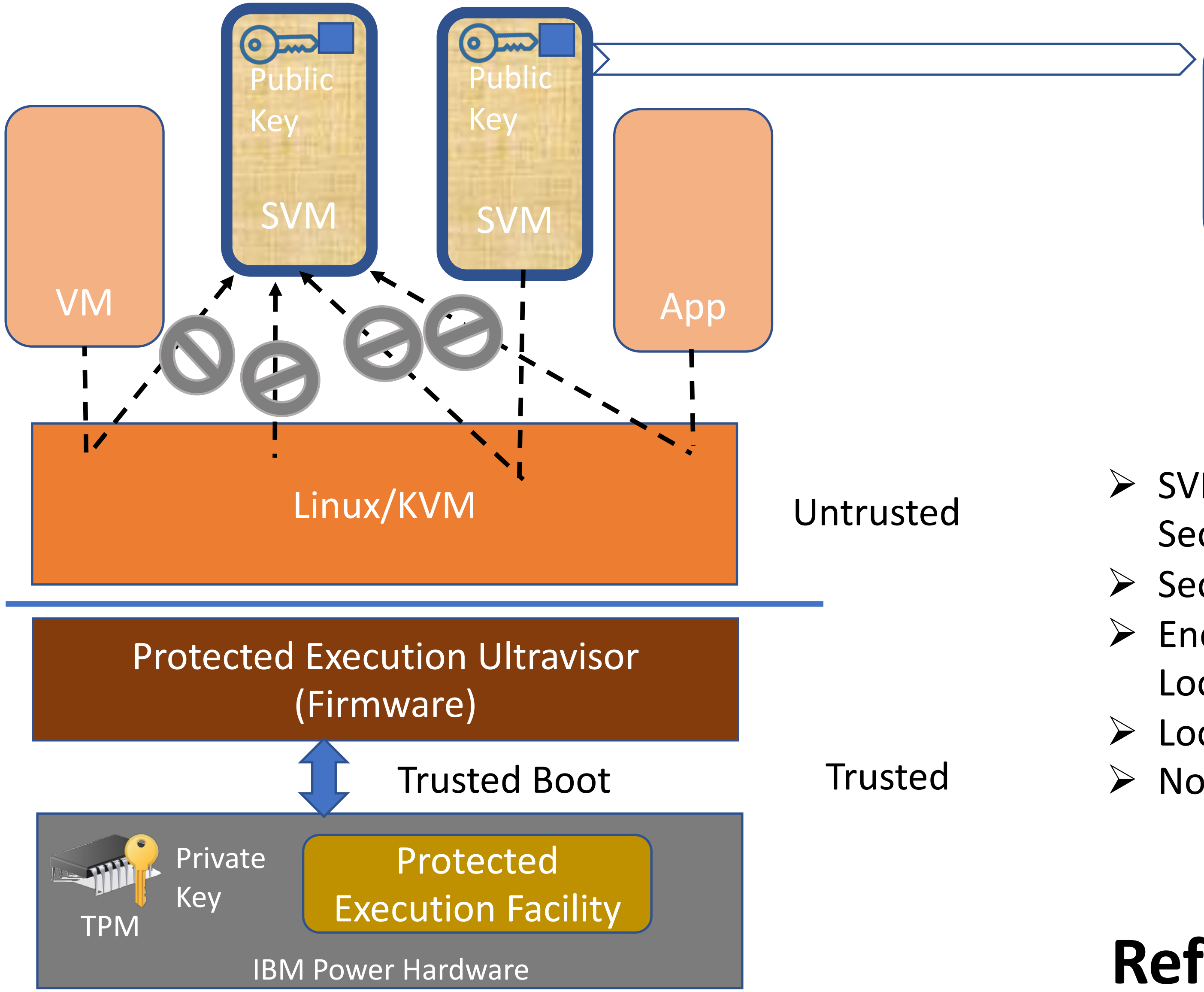
- Secure Memory Encryption
- Secure Encrypted Virtualization (SEV)

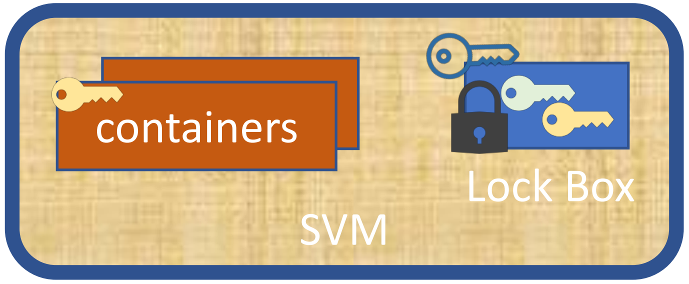
Explain Like I'm 5

Create a black box in memory

- Stuffs inside the black box is protected from anything that is outside.

Secure VM and Secure Containers





Secure Containers

- SVM Image = Encrypted RootFS + Lock Boxes + Encrypted Secrets
- Secure Container = SVM Image + Container RootFS
- Encryption Key (for rootfs, secrets) and integrity info put in Lock Box
- Lock Box is wrapped using system public key
- No code changes needed for application or container

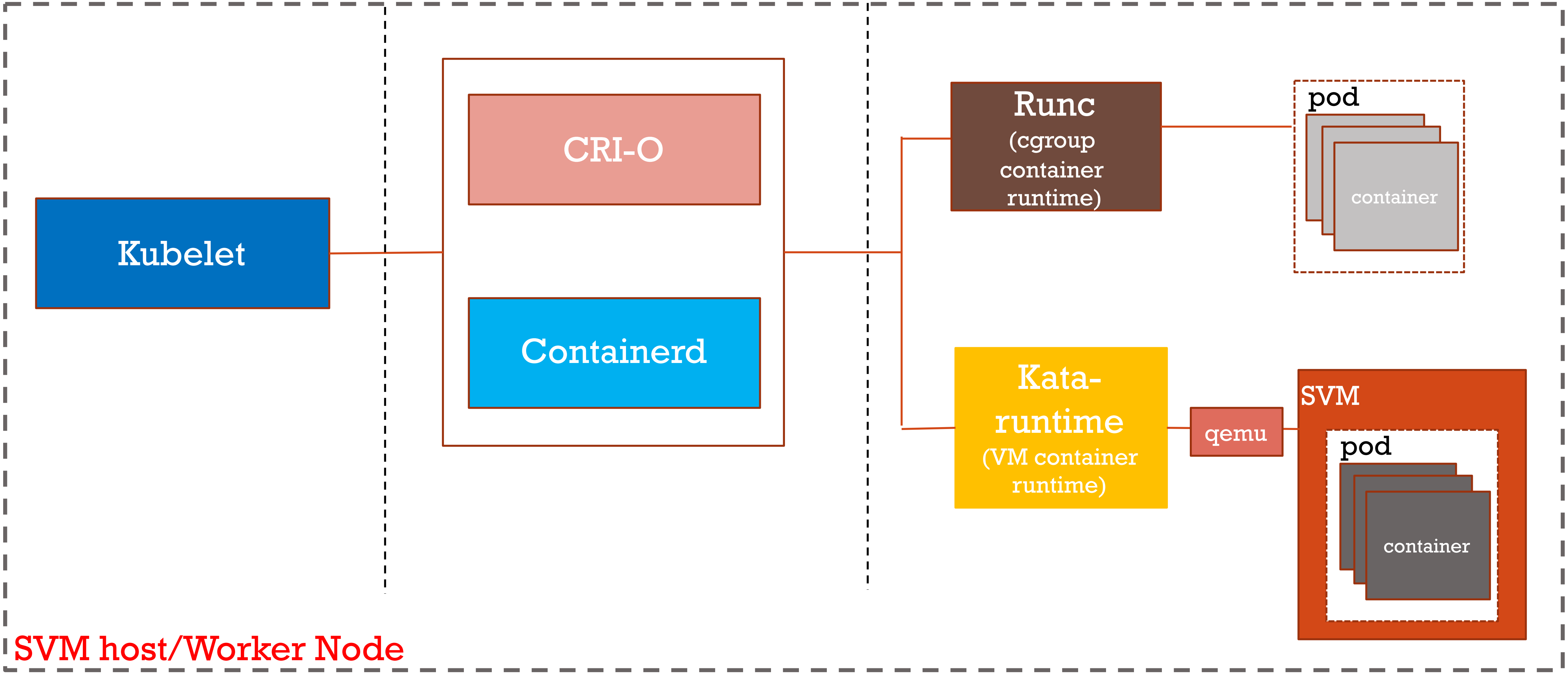
Ref: https://ibm.co/2DOL7LJ

How can we use it with k8s?

Leveraging Kata container runtime

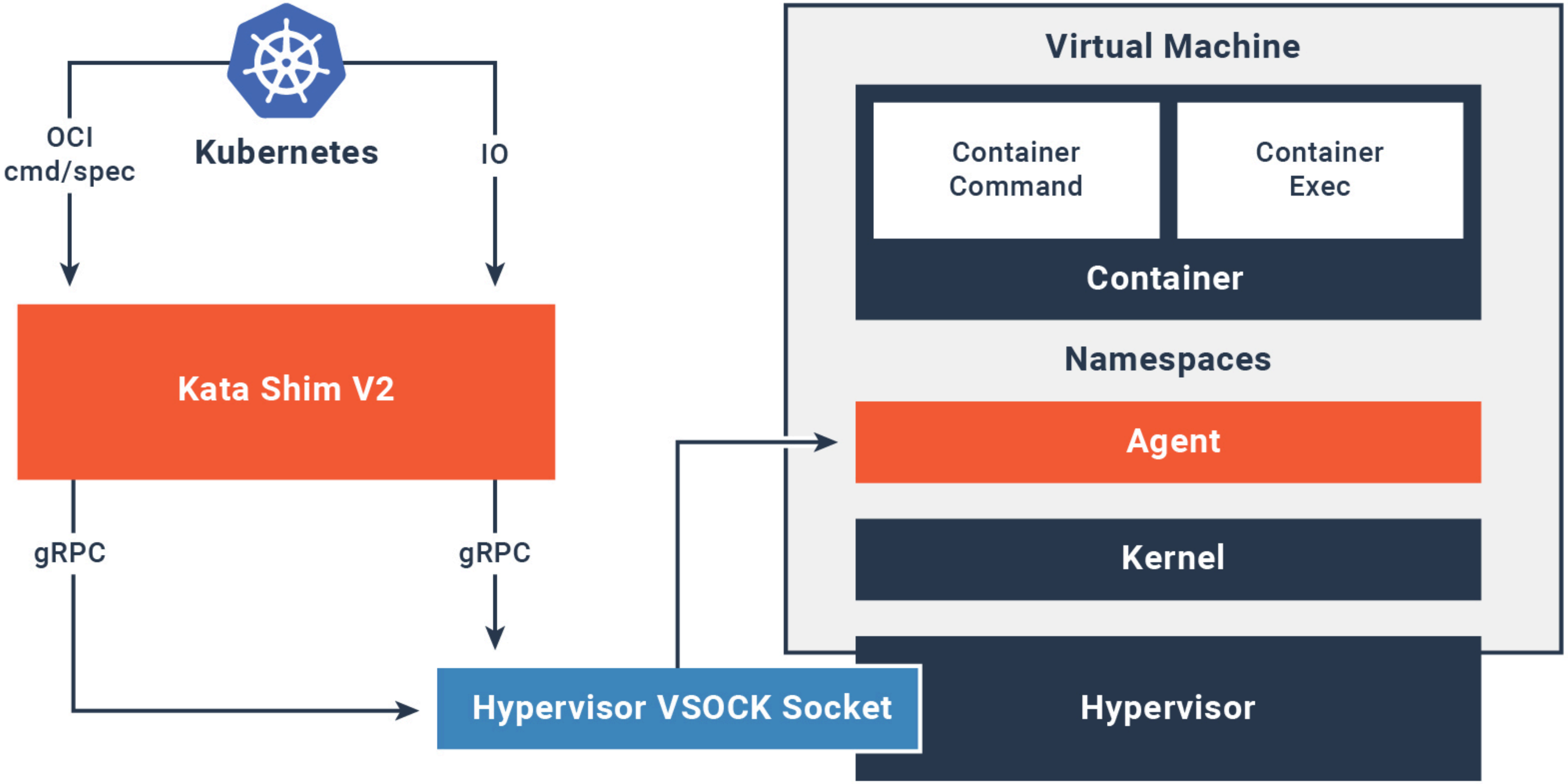
- Kata launches Secure containers (SVM + container)
- Aspects related to ephemeral volumes, extraction of container image etc needs to be handled

Secure Containers with Kata

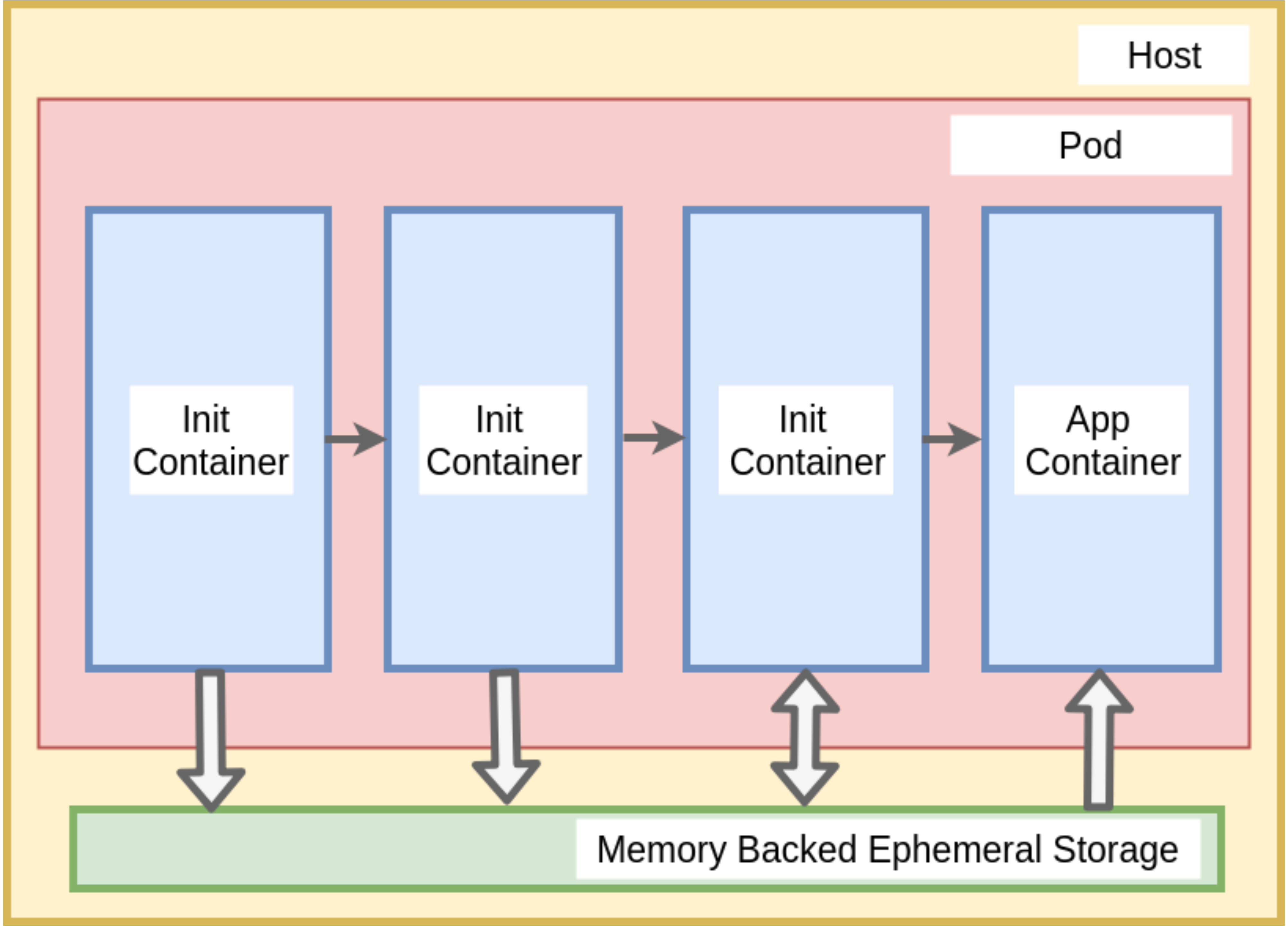


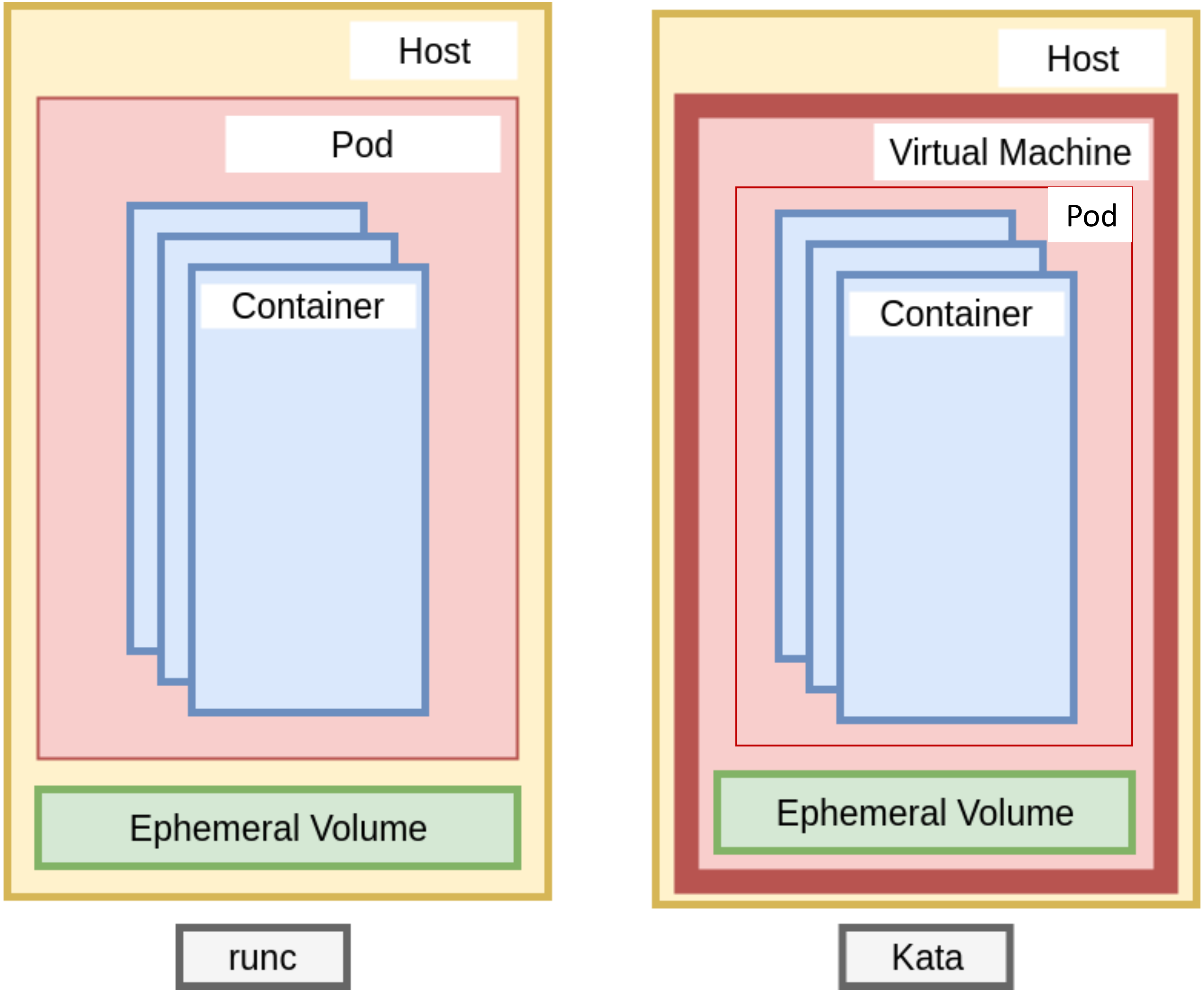
Kata Containers

katacontainers | Kata Shim V2



https://katacontainers.io/


Host
Pod
Init Container
Init Container
Init Container
App Container
Memory Backed Ephemeral Storage



Host

Pod

Container

Ephemeral Volume

runc

Host

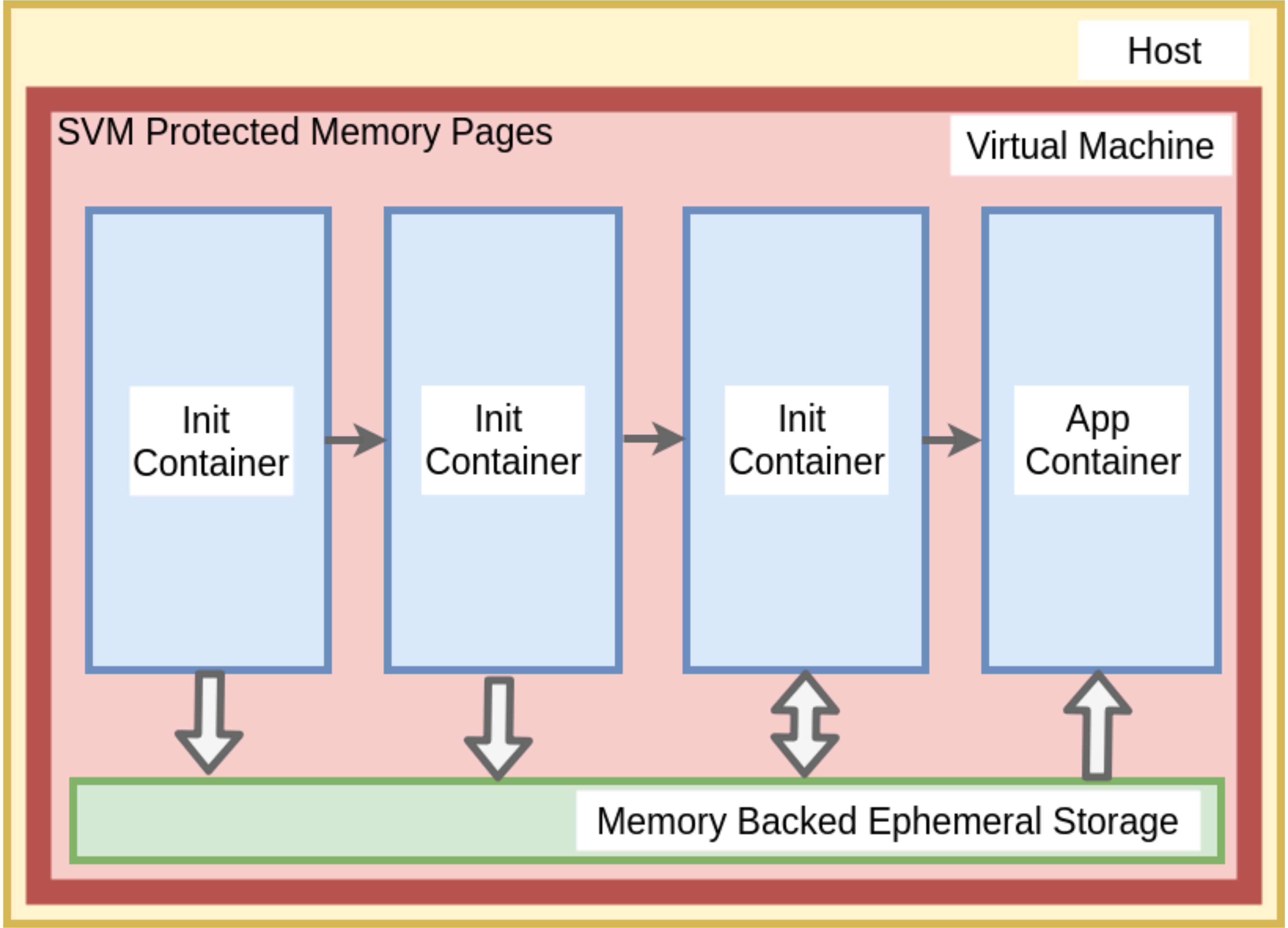
Virtual Machine

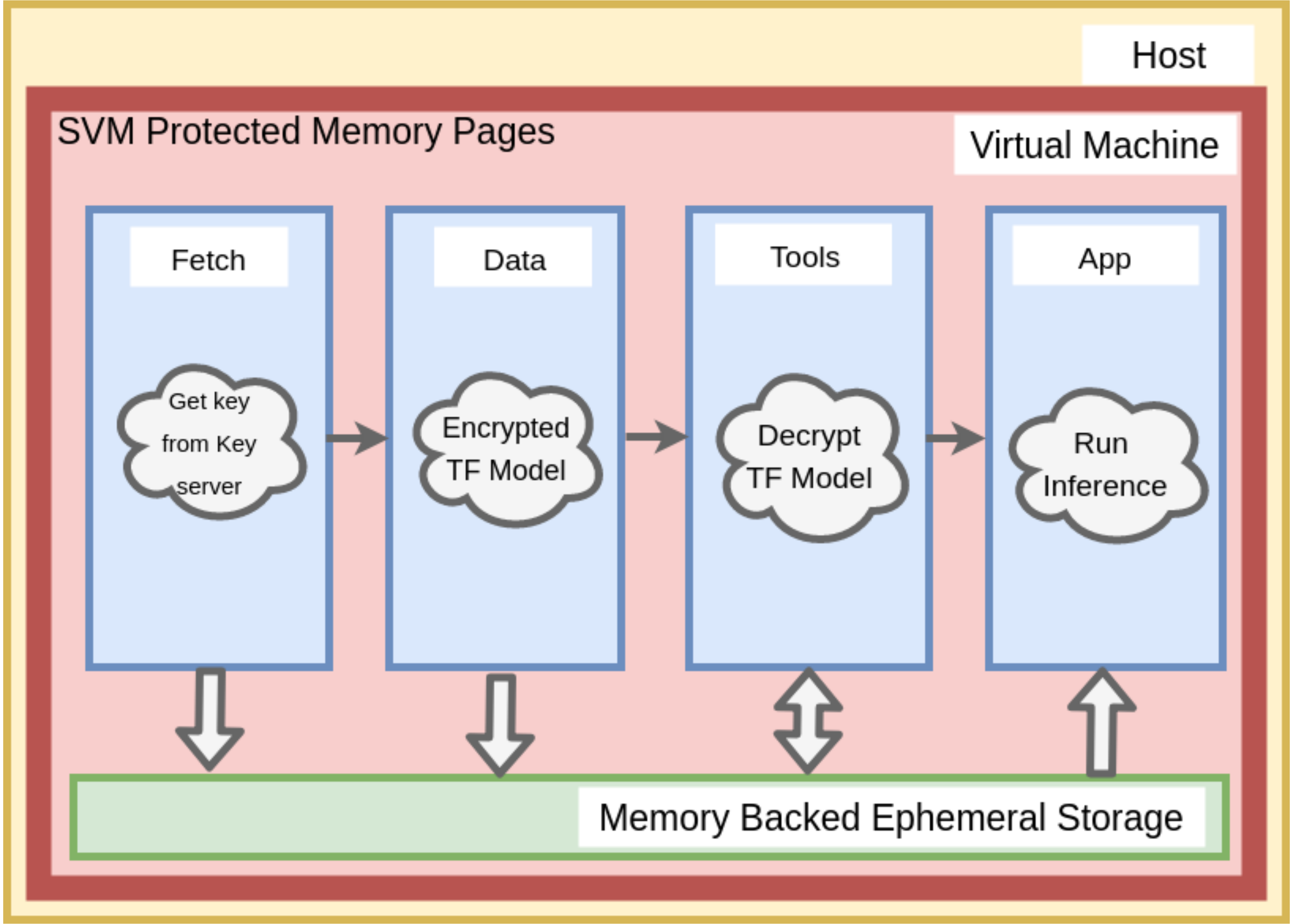
Pod

Container

Ephemeral Volume

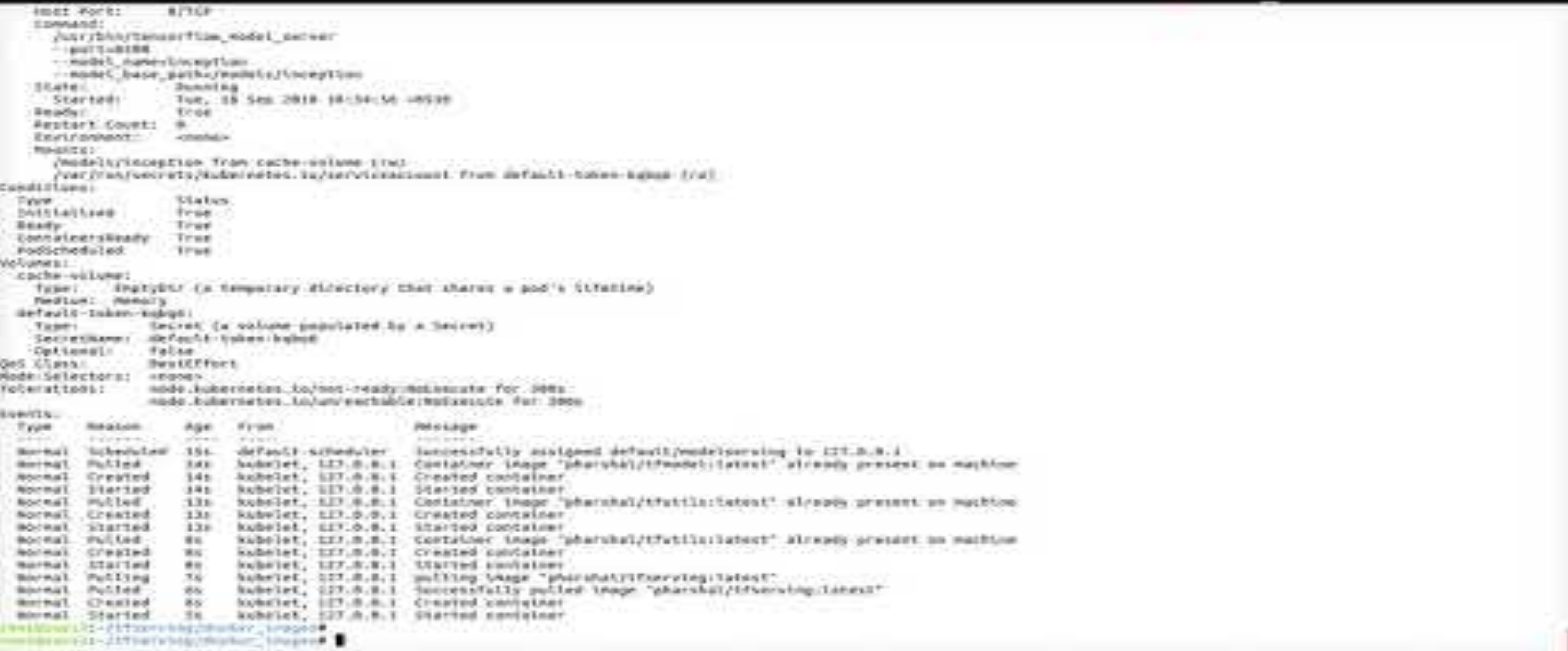
Kata


Host
SVM Protected Memory Pages
Virtual Machine
Init Container
Init Container
Init Container
App Container
Memory Backed Ephemeral Storage


Host
SVM Protected Memory Pages
Virtual Machine
Fetch
Get key from Key server
Data
Encrypted TF Model
Tools
Decrypt TF Model
App
Run Inference
Memory Backed Ephemeral Storage

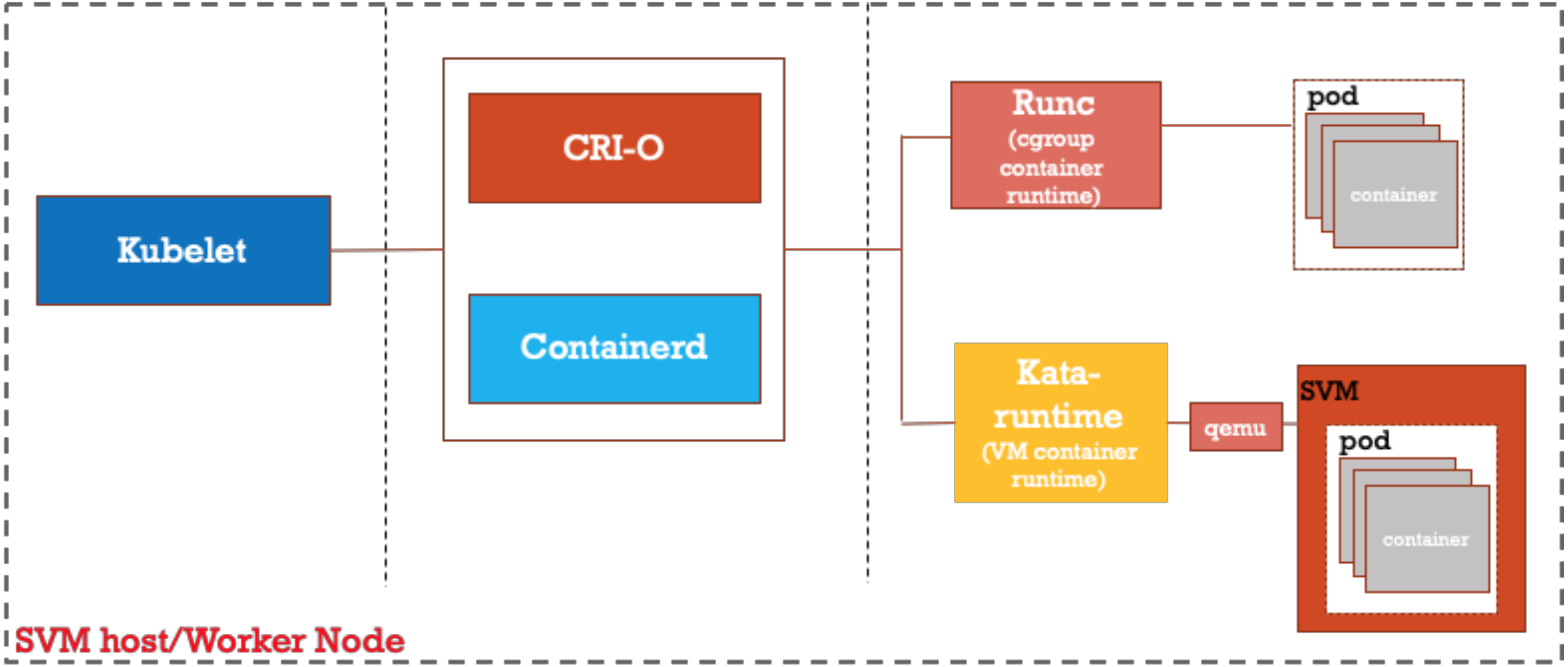
Demo

Image by Wikipedia



```
    Host Port:      0/TCP
    Command:
      /usr/bin/tensorflow_model_server
      --port=8500
      --model_name=inception
      --model_base_path=/models/inception
    State:          Running
      Started:      Tue, 18 Sep 2018 10:34:56 +0530
    Ready:          True
    Restart Count:  0
    Environment:    <none>
    Mounts:
      /models/inception from cache-volume (rw)
      /var/run/secrets/kubernetes.io/serviceaccount from default-token-kqbq6 (ro)
Conditions:
  Type              Status
  Initialized       True
  Ready             True
  ContainersReady   True
  PodScheduled      True
Volumes:
  cache-volume:
    Type:    EmptyDir (a temporary directory that shares a pod's lifetime)
    Medium:  Memory
  default-token-kqbq6:
    Type:        Secret (a volume populated by a Secret)
    SecretName:  default-token-kqbq6
    Optional:    false
QoS Class:       BestEffort
Node-Selectors:  <none>
Tolerations:     node.kubernetes.io/not-ready:NoExecute for 300s
                 node.kubernetes.io/unreachable:NoExecute for 300s
Events:
  Type    Reason     Age   From                Message
  ----    ------     ----  ----                -------
  Normal  Scheduled  15s   default-scheduler   Successfully assigned default/modelserving to 127.0.0.1
  Normal  Pulled     14s   kubelet, 127.0.0.1  Container image "pharshal/tfmodel:latest" already present on machine
  Normal  Created    14s   kubelet, 127.0.0.1  Created container
  Normal  Started    14s   kubelet, 127.0.0.1  Started container
  Normal  Pulled     13s   kubelet, 127.0.0.1  Container image "pharshal/tfutils:latest" already present on machine
  Normal  Created    13s   kubelet, 127.0.0.1  Created container
  Normal  Started    13s   kubelet, 127.0.0.1  Started container
  Normal  Pulled     8s    kubelet, 127.0.0.1  Container image "pharshal/tfutils:latest" already present on machine
  Normal  Created    8s    kubelet, 127.0.0.1  Created container
  Normal  Started    8s    kubelet, 127.0.0.1  Started container
  Normal  Pulling    7s    kubelet, 127.0.0.1  pulling image "pharshal/tfserving:latest"
  Normal  Pulled     6s    kubelet, 127.0.0.1  Successfully pulled image "pharshal/tfserving:latest"
  Normal  Created    6s    kubelet, 127.0.0.1  Created container
  Normal  Started    5s    kubelet, 127.0.0.1  Started container
[illegible]:~/tfserving/docker_images#
[illegible]:~/tfserving/docker_images#
```

But...



Registry is not encrypted

Images are extracted on the host

Work in Progress

Encrypt Container images

- Ongoing effort to bring encryption to container images
- Presented in DockerCon 2019 - https://bit.ly/2LQhq3v
- KEP with Kubernetes community to add support for Encrypted Container Images
- Join us in Kubecon Shanghai 2019 where we will talk in detail

Enable the OCI runtime to pull Images

- Directly inside the confines of the SVM

References

Kata support for EmptyDir type volumes of k8s

- https://github.com/kata-containers/runtime/issues/61

Blog post

- https://mawacake.blogspot.com/2018/09/trust-tensorflow-and-cloud.html

Kubernetes KEP for Image Encryption

- https://github.com/kubernetes/community/issues/2970

IBM Power Protected Computing

- https://developer.ibm.com/articles/l-support-protected-computing/

Acknowledgements

Community

- Containerd
- Kata
- Kubernetes
- Linux
- Qemu

Teams

- IBM Cognitive Systems
- IBM Linux Technology Center
- IBM Research

Many others…

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Thank You

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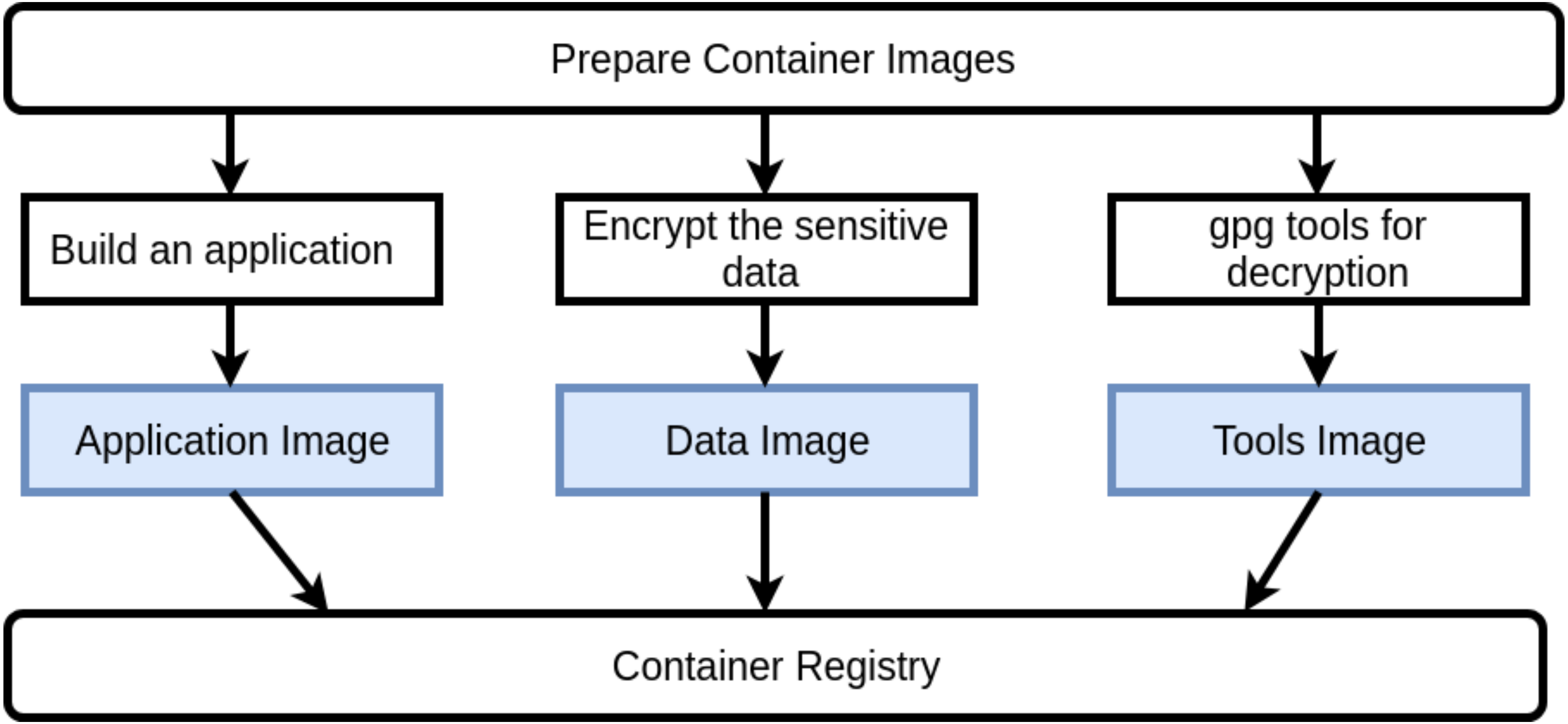
Back up

Prepare the Images



Untamed Root

Root User in the Cloud Systems

- Malicious root can snoop on all containers

System Vulnerabilities Can Lead to Privilege Escalation

- In Multi-tenant environment this could lead to snooping on unauthorized containers
- RunC Vulnerability (CVE-2019-5736)
- Dirty COW(CVE-2016-5195)

Conflict of Interest

- What if your Cloud Provider is also your competitor