

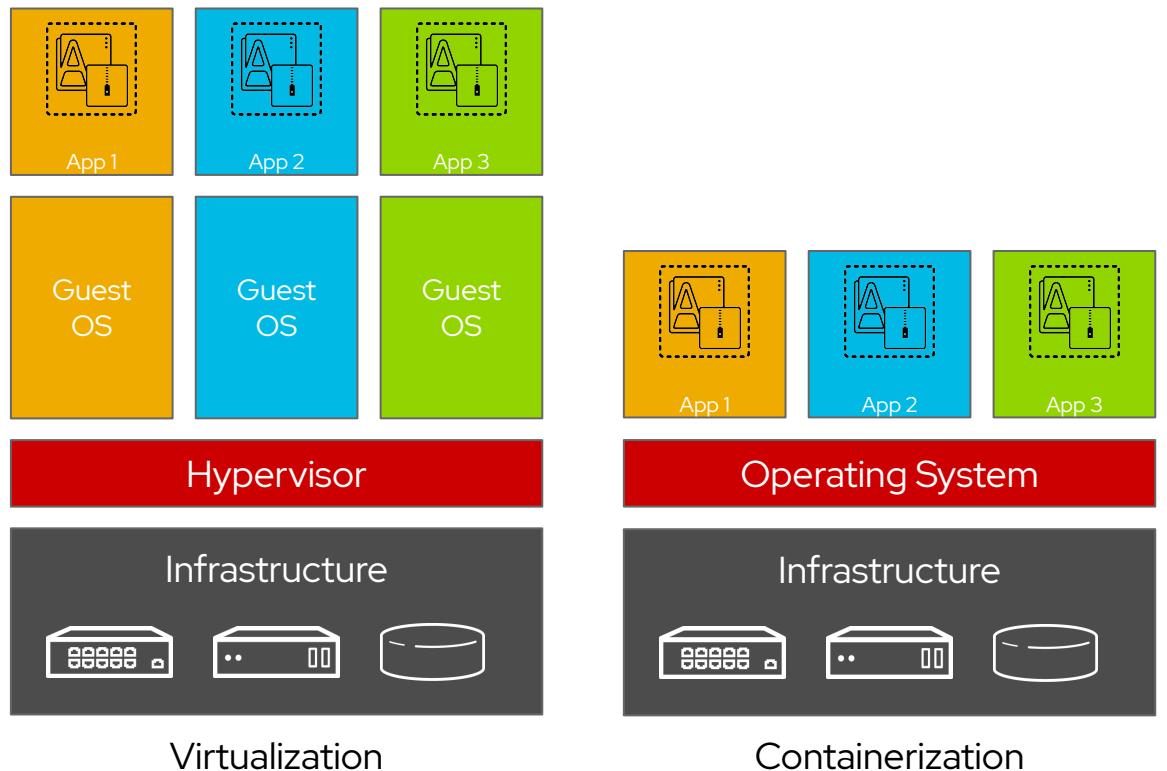


# OpenShift Virtualization

Technical presentation

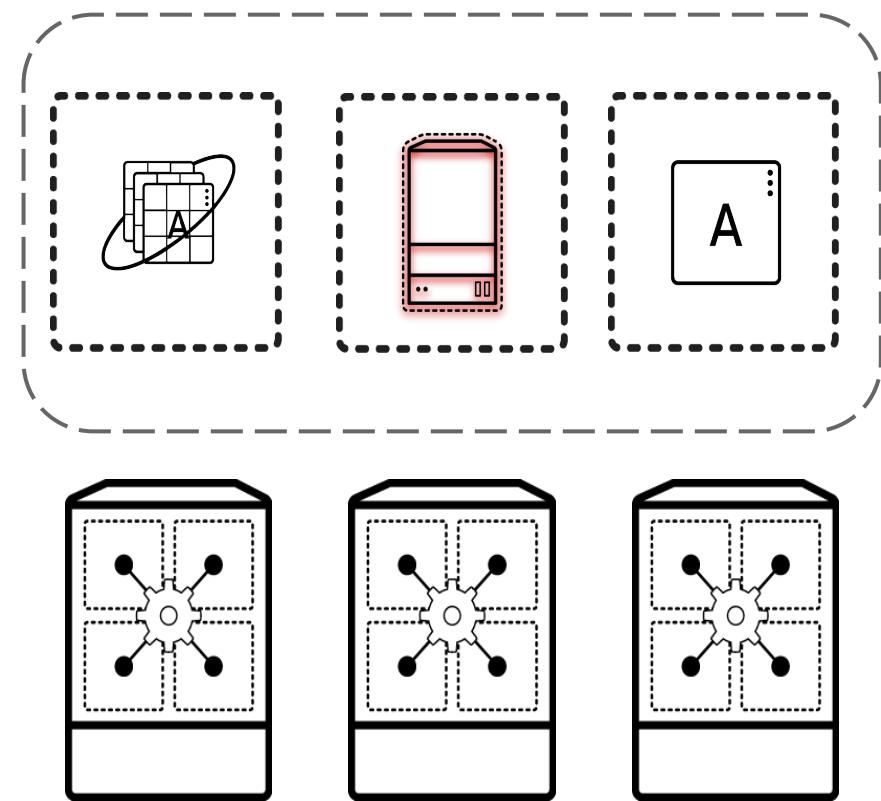
# Containers are not virtual machines

- Containers are process isolation
- Kernel namespaces provide isolation and cgroups provide resource controls
- No hypervisor needed for containers
- Contain only binaries, libraries, and tools which are needed by the application
- Ephemeral



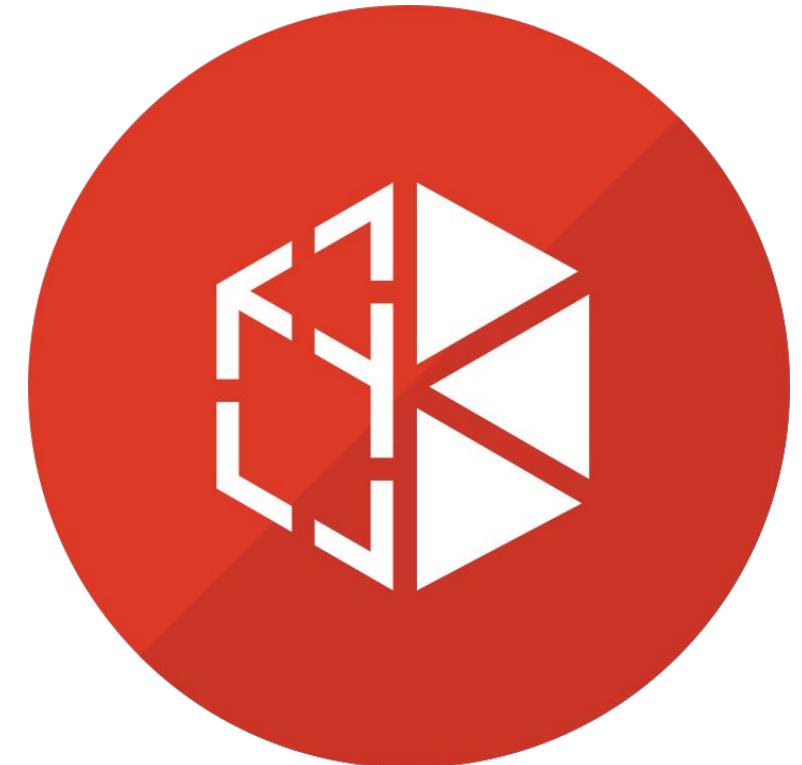
# Virtual machines can be put into containers

- A KVM virtual machine is a process
- Containers encapsulate processes
- Both have the same underlying resource needs:
  - Compute
  - Network
  - (sometimes) Storage



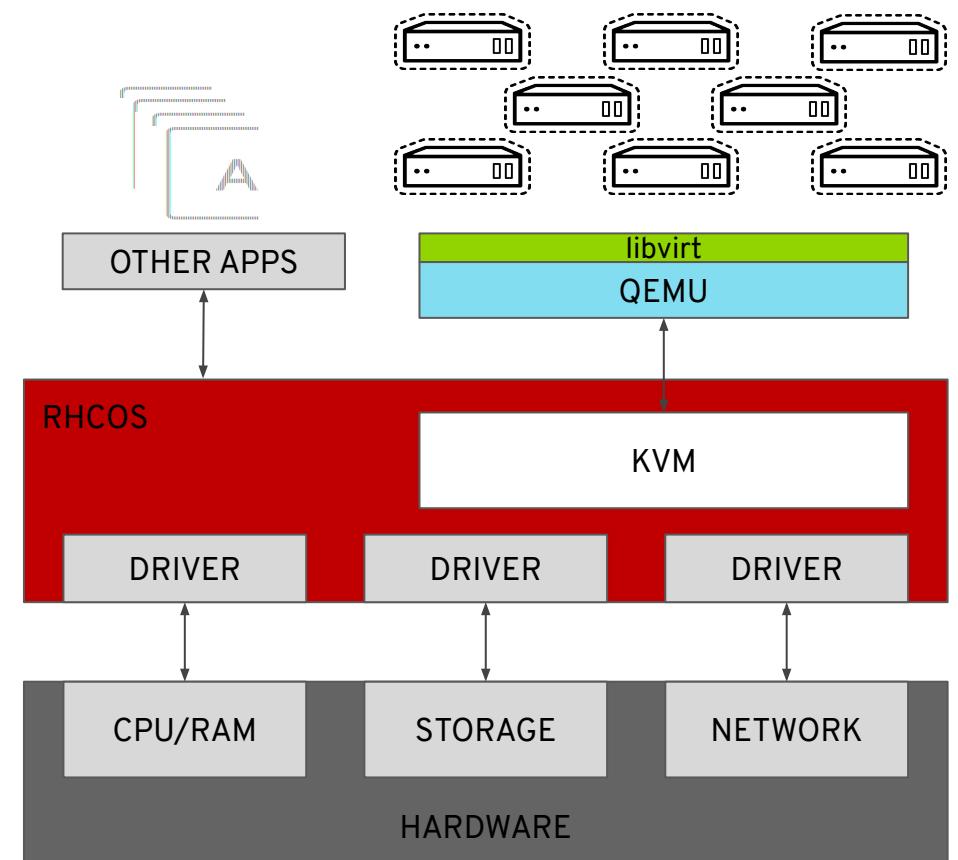
# OpenShift Virtualization

- Virtual machines
  - Running in containers
  - Using the KVM hypervisor
- Scheduled, deployed, and managed by Kubernetes
- Integrated with container orchestrator resources and services
  - Traditional Pod-like SDN connectivity and/or connectivity to external VLAN and other networks via multus
  - Persistent storage paradigm (PVC, PV, StorageClass)



# VM containers use KVM

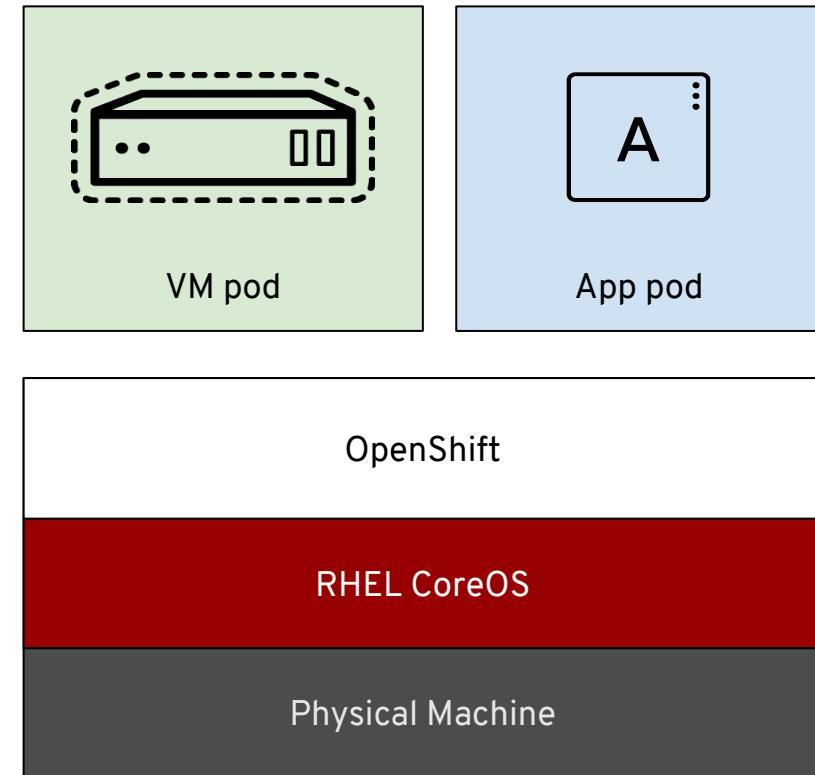
- OpenShift Virtualization uses KVM, the Linux kernel hypervisor
- KVM is a core component of the Red Hat Enterprise Linux kernel
  - KVM has 10+ years of production use: Red Hat Virtualization, Red Hat OpenStack Platform, and RHEL all leverage KVM, QEMU, and libvirt
- QEMU uses KVM to execute virtual machines
- libvirt provides a management abstraction layer



# Built with Kubernetes

# Virtual machines in a container world

- Provides a way to transition application components which can't be directly containerized into a Kubernetes system
  - Integrates directly into existing k8s clusters
  - Follows Kubernetes paradigms:
    - Container Networking Interface (CNI)
    - Container Storage Interface (CSI)
    - Custom Resource Definitions (CRD, CR)
- Schedule, connect, and consume VM resources as container-native

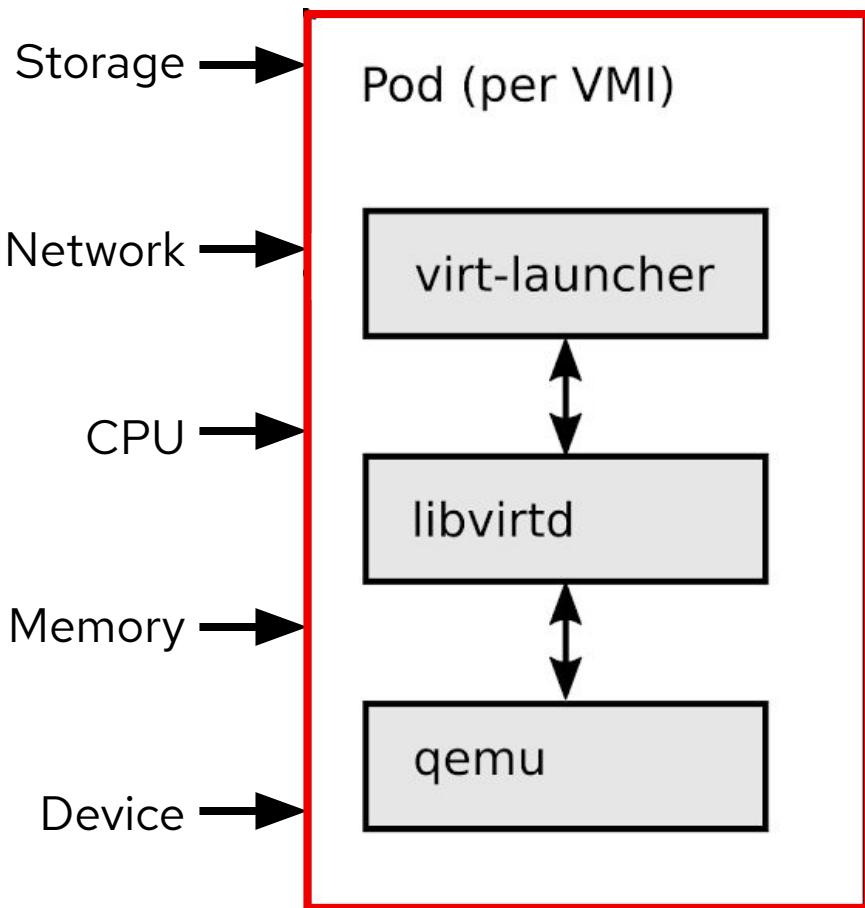


# Virtualization native to Kubernetes

- Operators are a Kubernetes-native way to introduce new capabilities
- New CustomResourceDefinitions (CRDs) for native VM integration, for example:
  - `VirtualMachine`
  - `VirtualMachineInstance`
  - `VirtualMachineInstanceMigration`
  - `DataVolume`

```
apiVersion: kubevirt.io/v1alpha3
kind: VirtualMachine
metadata:
  labels:
    app: demo
    flavor.template.kubevirt.io/small: "true"
  name: rhel
spec:
  dataVolumeTemplates:
  - apiVersion: cdi.kubevirt.io/v1alpha1
    kind: DataVolume
    metadata:
      creationTimestamp: null
      name: rhel-rootdisk
    spec:
      pvc:
        accessModes:
        - ReadWriteMany
      resources:
        requests:
          storage: 20Gi
      storageClassName: managed-nfs-storage
      volumeMode: Filesystem
```

# Containerized virtual machines



## Kubernetes resources

- Every VM runs in a launcher pod. The launcher process will supervise, using libvirt, and provide pod integration.

## Red Hat Enterprise Linux

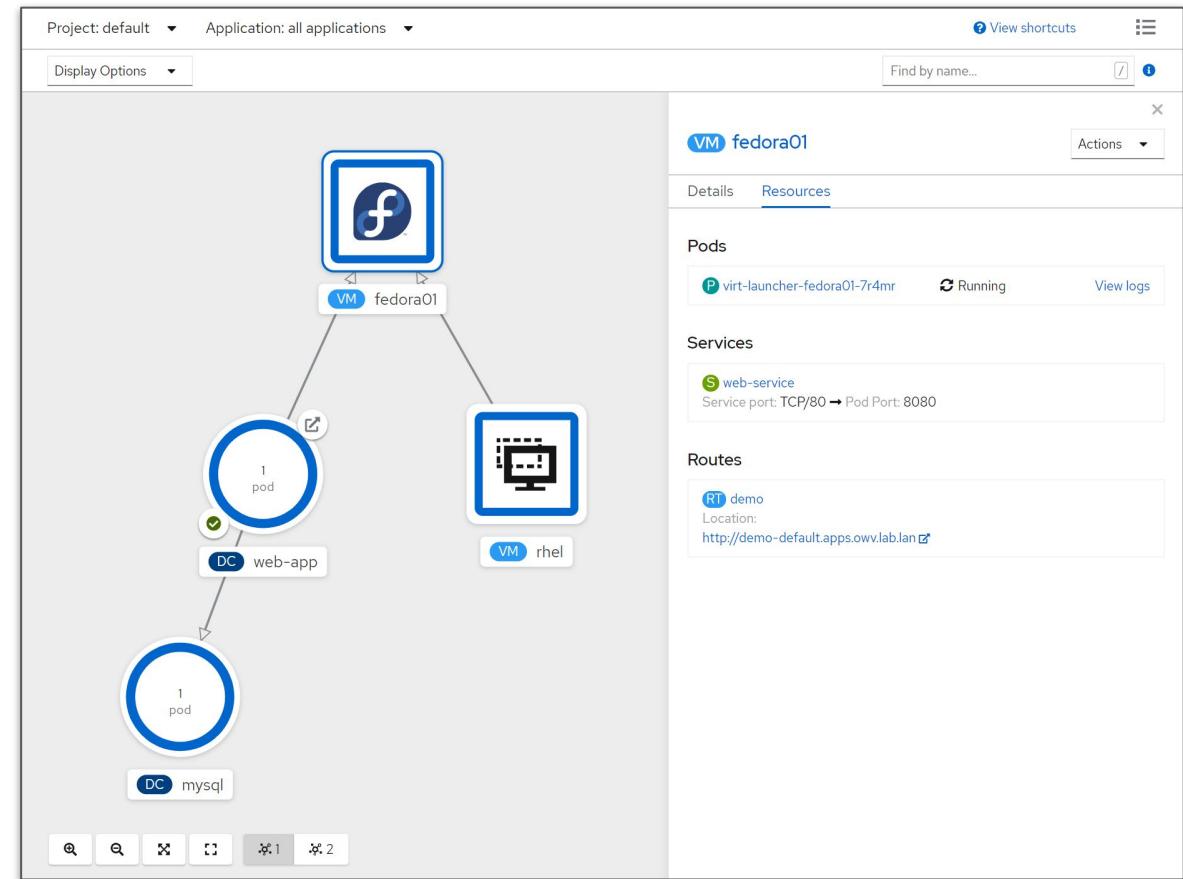
- libvirt and qemu from RHEL are mature, have high performance, provide stable abstractions, and have a minimal overhead.

## Security - Defense in depth

- Immutable RHCOS by default, SELinux MCS, plus KVM isolation - inherited from the Red Hat Portfolio stack

# Using VMs and containers together

- Virtual Machines connected to pod networks are accessible using standard Kubernetes methods:
  - Service
  - Route
  - Ingress
- Network policies apply to VM pods the same as application pods
- VM-to-pod, and vice-versa, communication happens over SDN or ingress depending on network connectivity



Managed with  
OpenShift

# Virtual Machine Management

- Create, modify, and destroy virtual machines, and their resources, using the OpenShift web interface or CLI
- Use the `virtctl` command to simplify virtual machine interaction from the CLI

The screenshot shows the Red Hat OpenShift Container Platform web interface. The left sidebar has a dark theme with white text and icons. It includes sections for Administrator, Home, Operators, Workloads (with sub-options like Pods, Virtualization, Deployments, DeploymentConfigs, StatefulSets, Secrets, ConfigMaps, CronJobs, Jobs, DaemonSets, ReplicaSets, ReplicationControllers, and HorizontalPodAutoscalers), and Networking. The 'Virtualization' option under Workloads is currently selected and highlighted in blue. The main content area is titled 'Virtualization' and contains a sub-section titled 'Virtual Machines'. It shows a table with the following data:

Name	Namespace	Status	Created	Node	IP Address
VM biological-impala	NS default	Running	Feb 23, 2:53 pm	worker-1.oww.work.lan	
VM content-hawk	NS default	Running	Feb 23, 2:37 pm	worker-0.oww.work.lan	10.131.0.49
VM everyday-quokka	NS default	Running	Feb 23, 1:35 pm	worker-1.oww.work.lan	10.129.2.13
VM japanese-koi	NS default	Running	Feb 23, 2:38 pm	worker-1.oww.work.lan	10.129.2.15
VM sticky-otter	NS default	Running	Feb 23, 2:39 pm	worker-0.oww.work.lan	10.0.101.102, fe80::dca3:8dff:fe67:bc49

# Create VMs

# Virtual Machine creation

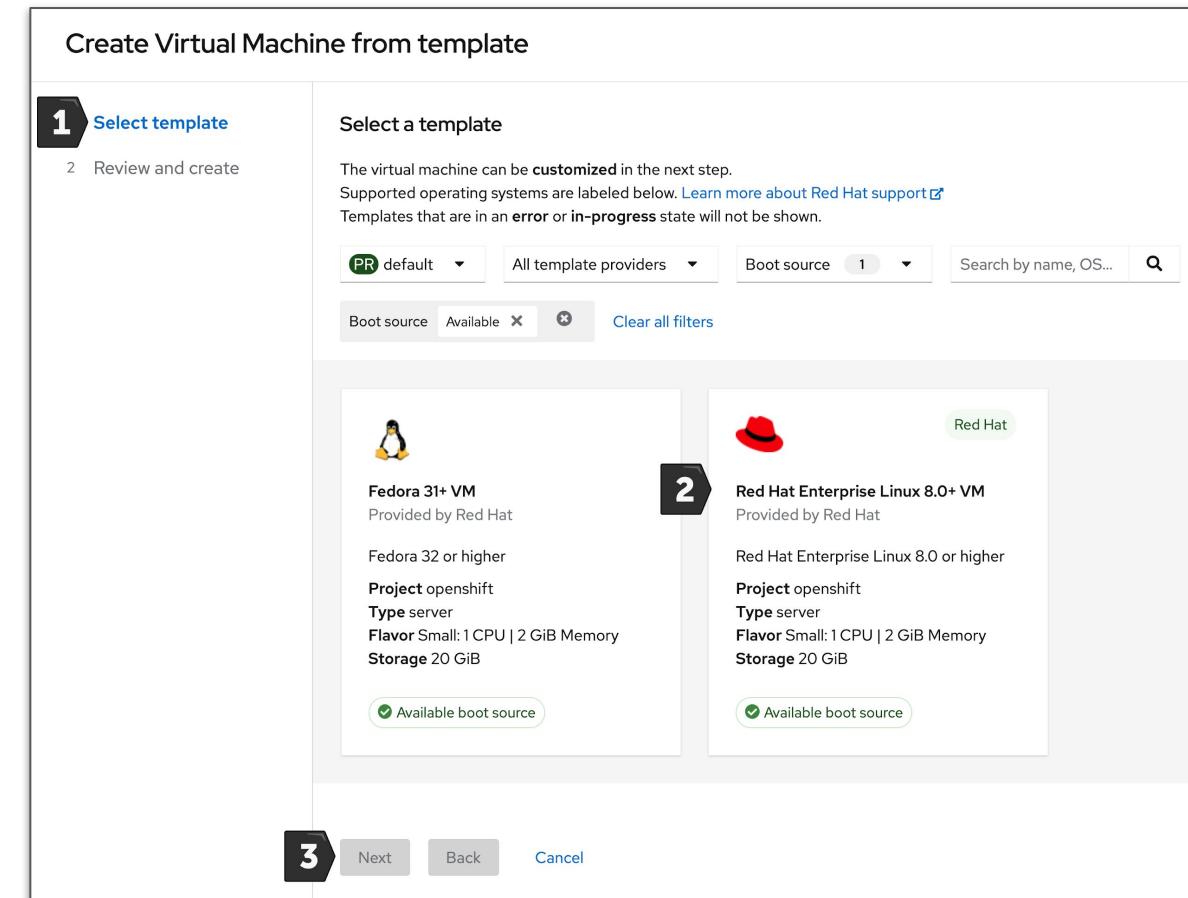
- Streamlined and simplified creation via the GUI or create VMs programmatically using YAML
- Full configuration options for compute, network, and storage resources
  - Clone VMs from templates or import disks using DataVolumes
  - Pre-defined and customizable presets for CPU/RAM allocations
  - Workload profile to tune KVM for expected behavior
- Import VMs from VMware vSphere or Red Hat Virtualization

The screenshot shows the Red Hat OpenShift Container Platform web interface. The left sidebar has a dark theme with the Red Hat logo and "Red Hat OpenShift Container Platform". It includes links for "Administrator", "Home", "Operators", "Workloads" (with sub-options like "Pods", "Virtualization", "Deployments", "DeploymentConfigs", "StatefulSets", "Secrets", "ConfigMaps", "CronJobs", and "Jobs"), and "Templates". The main content area is titled "Virtualization" and "Virtual Machines". It lists several virtual machines with their names, namespaces, and IP addresses. A "Create" button is at the top right, with a dropdown menu showing two options: "Virtual Machine With Wizard" (marked with a red arrow) and "Virtual Machine With Import wizard" (marked with a red arrow). To the right of the dropdown, there is a "Template" section with "With Wizard" and "With YAML" options.

Name	Namespace	IP Address
VM biological-impala	openlan	
VM content-hawk	openlan	10.131.0.49
VM everyday-quokka	openlan	10.129.2.13
VM japanese-koi	openlan	10.129.2.15
VM sticky-otter	openlan	10.0.101.102, fe80::dca3:8dff:fe67:bc49

# Using templates for virtual machines

- Simplified and streamlined virtual machine creation experience for VM consumers
- Administrators configure templates with an OS disk, consumers select from the options



# Creating a virtual machine

- Flavor represents the preconfigured CPU and RAM assignments
- Storage, including PVC size and storage class, are determined by the template administrator
- A default network configuration is defined in the template
- Workload profile defines the category of workload expected and is used to set KVM performance flags
- The VM can be further customized by selecting the option, or immediately created and deployed
  - Additional customization includes CPU/memory, storage, network, cloud-init, and more

Create Virtual Machine from template

1 Select template      2 Review and create      3      4 Create virtual machine      5 Customize virtual machine

**Review and create**  
You are creating a virtual machine from the **Red Hat Enterprise Linux 8.0+ VM** template.

**Project \***  
PR default

**Virtual Machine Name \*** [?](#)  
rhel8-pleasant-ladybug

**Flavor \***  
Small: 1 CPU | 2 GiB Memory

**Storage**  
20 GiB      **Workload profile** [?](#)  
server

**Boot source**  
Clone and boot from disk  
**PVC** rhel8

Start this virtual machine after creation

Back      Cancel

# VM Templates

# Templates

- Templates are a core concept for virtual machine creation with OpenShift Virtualization 2.6
- Red Hat provides default templates, administrators can create and customize additional as needed
- Boot sources provide disk images for the template
- Creating VMs can be done from the template page in just a few clicks

The screenshot shows the 'Virtualization' section of the OpenShift Virtualization interface. At the top, there's a navigation bar with 'Project: default' and a 'Create' button. Below it, the title 'Virtualization' is followed by 'Virtual Machine' and a 'Templates' tab (which is highlighted). There are filters for 'Name' and a search bar. A note says 'Supported operating systems are labeled below. Learn more about Red Hat support'.

The main area displays a table of templates:

Name	Provider	Boot source	Actions
fedora-33 ★	CPTMM	CPTMM	Details Create ⋮
2 rhel-83 ★	3 CPTMM	CPTMM	Details Create ⋮
Fedora 31+ VM	Red Hat	Available	Details Create ⋮
Red Hat Enterprise Linux 6.0+ VM	Red Hat	Add source	Details Create ⋮
Red Hat Enterprise Linux 7.0+ VM	Red Hat	Add source	Details Create ⋮
Red Hat Enterprise Linux 8.0+ VM	Red Hat	Available	Details Create ⋮

Five large black arrows with white numbers indicate a workflow:

- 1 Points to the 'Templates' tab.
- 2 Points to the 'rhel-83' template.
- 3 Points to the 'CPTMM' provider for the 'rhel-83' template.
- 4 Points to the 'Available' status for the 'Fedora 31+ VM' template.
- 5 Points to the 'Create' button for the 'Fedora 31+ VM' template.

# Create a template - General

- In addition to unique names, each template is associated with a provider
  - Providers represent who created the template, with optional support information
- The guest operating system and source boot disk are provided. A boot disk can be imported during the process, or an ISO can be used to boot and install the OS
- A default flavor, representing CPU and memory allotments, is provided
- Workload type determines KVM optimization to balance between performance and efficiency

Create Virtual Machine template

1 General

2 Networking

3 Storage

4 Advanced

5 Review

6 Result

1 Name \*

Template provider \*

example: your company name

Template support

No additional support

Description

2 Operating System \*

--- Select Operating System ---

3 Boot Source \*

--- Select Source ---

4 Flavor \*

--- Select Flavor ---

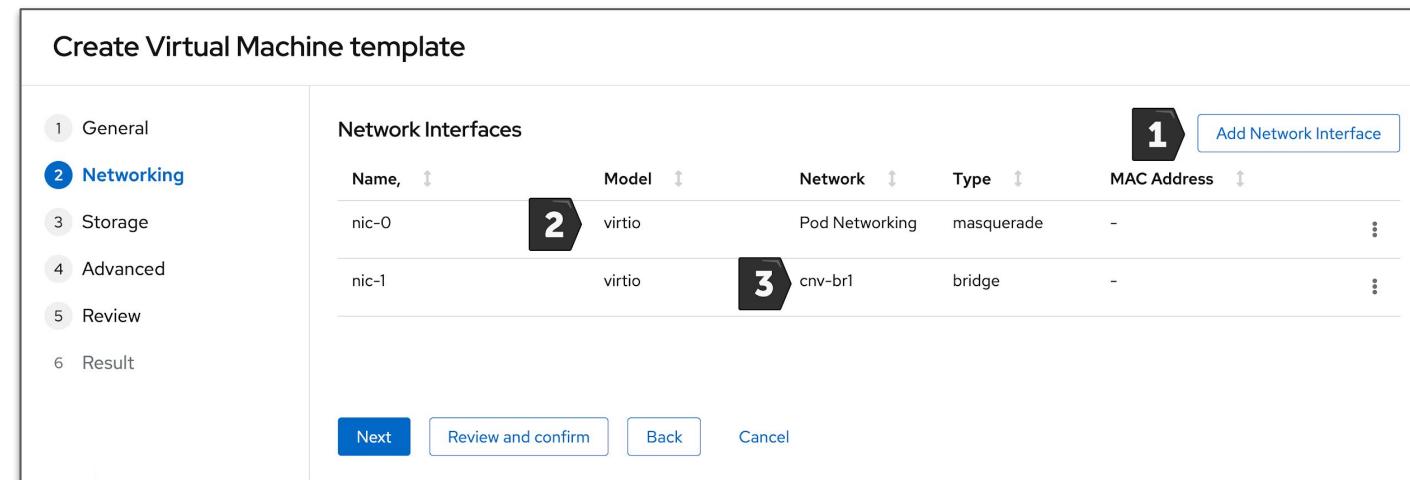
5 Workload Type \*

--- Select Workload Type ---

Next Review and confirm Back Cancel

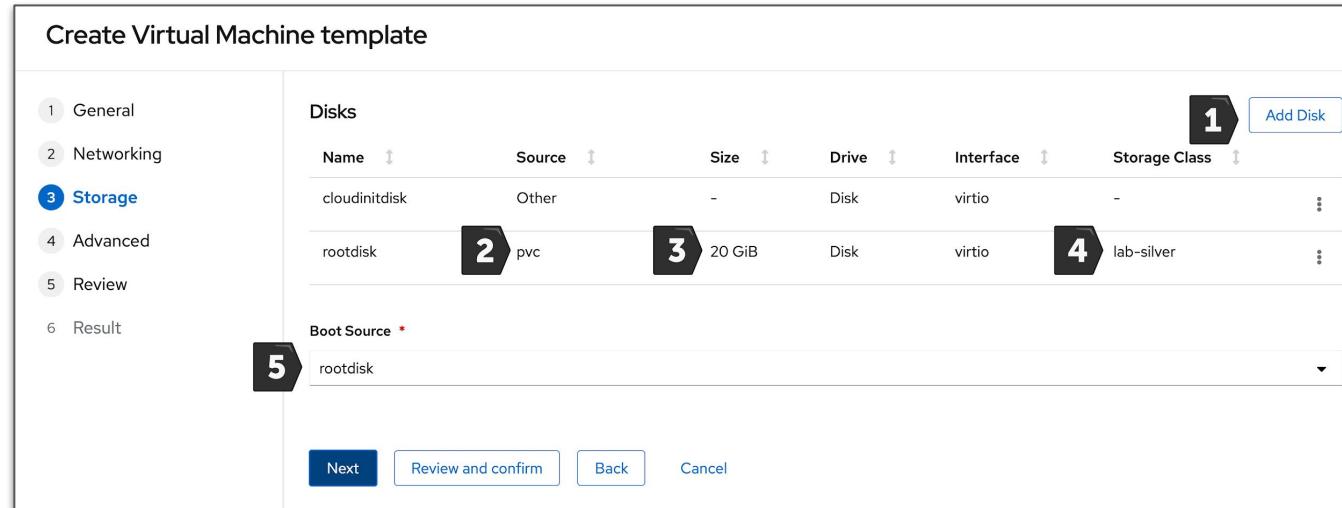
# Create a template - Networks

- Add or edit network adapters
- One or more network connections
  - Pod network for the default SDN
  - Additional multus-based interfaces for specific connectivity
- Multiple NIC models for guest OS compatibility or paravirtualized performance with VirtIO
- Masquerade, bridge, or SR-IOV connection types
- MAC address customization if desired



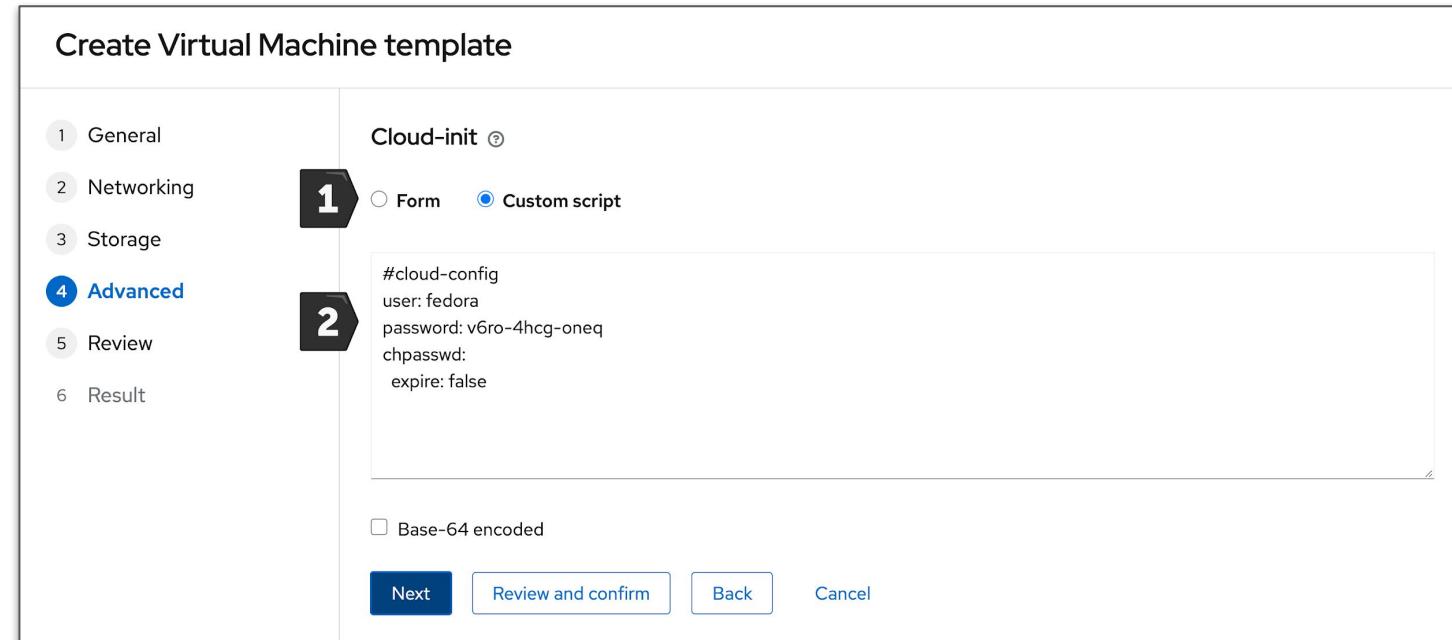
# Create a template - Storage

- Add or edit persistent storage
- Disks can be sourced from
  - Imported QCOW2 or raw images
  - New or existing PVCs
  - Clone existing PVCs
- Use SATA/SCSI interface for compatibility or VirtIO for paravirtual performance
- For new or cloned disks, select from available storage classes
  - Customize volume and access mode as needed
  - RWX PVCs are required for live migration



# Create a template - Advanced

- Customize the operating system deployment using cloud-init scripts
  - Guest OS must have cloud-init installed
  - RHEL, Fedora, etc. cloud images
  - Default templates will auto-generate a simple **cloud-init** to set the password



# Import VMs

# Virtual Machine Import

- Wizard supports importing from VMware or Red Hat Virtualization
  - Single-VM workflow
- VMware import uses VDDK to expedite the disk import process
  - User is responsible for downloading the VDDK from VMware and adding it to a container image
- Credentials stored as Secrets
- ResourceMapping CRD configures default source -> destination storage and network associations

Import Virtual Machine

1 Connect to Provider

Provider \* Red Hat Virtualization (RHV)

RHV Instance \* admin-rhvm-work-lan-qrgnd

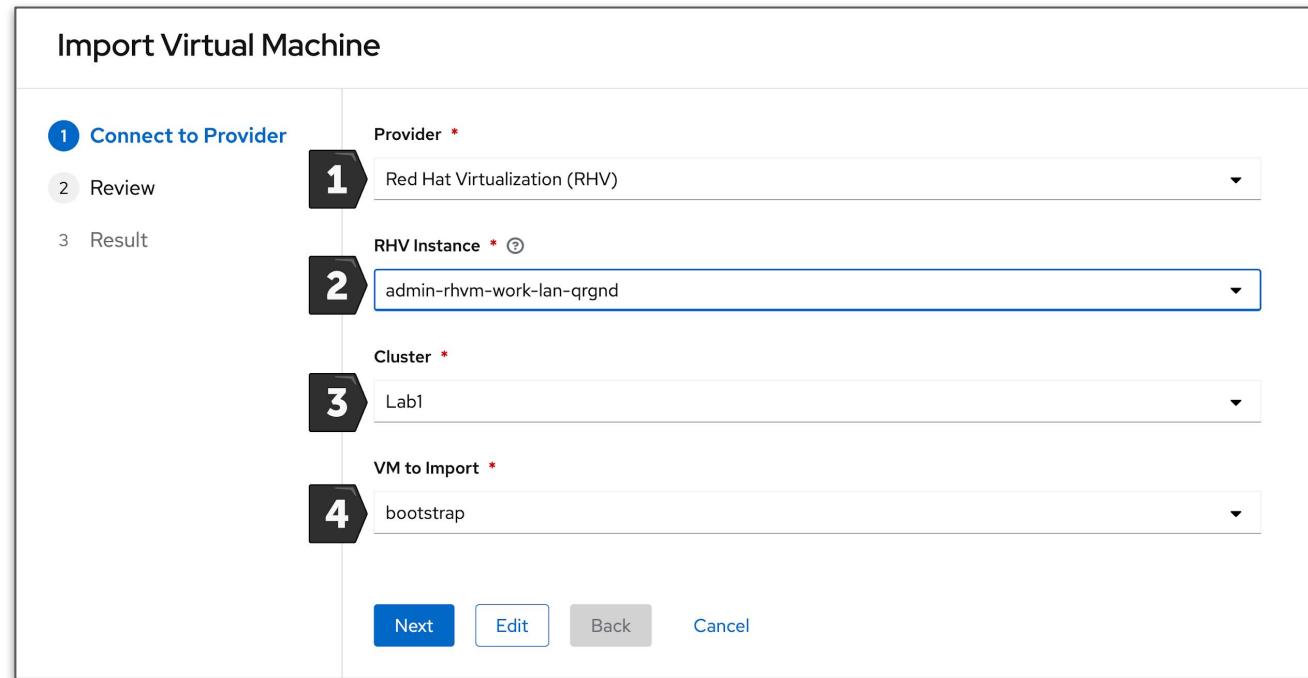
Cluster \* Lab1

VM to Import \* bootstrap

2 Review

3 Result

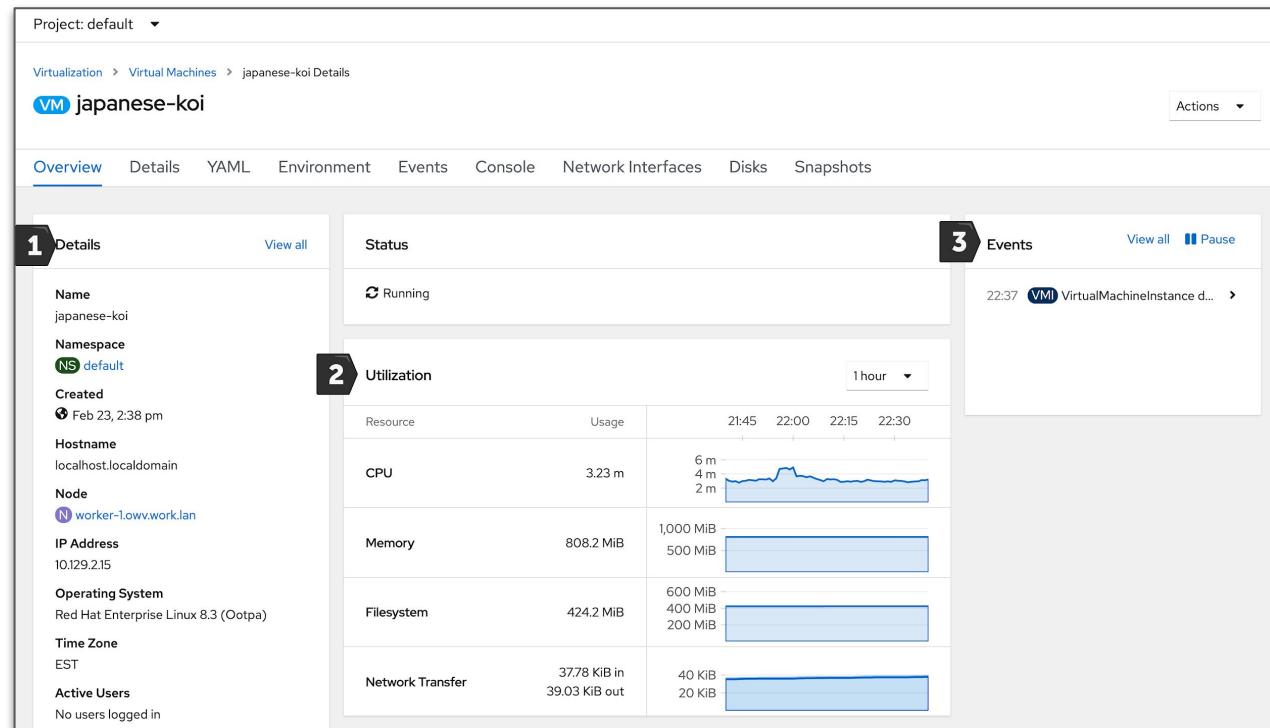
Next Edit Back Cancel



# View / manage VMs

# Virtual Machine – Overview

- General overview about the virtual machine
- Information populated from guest when integrations are available
  - IP address
- Inventory quickly shows configured hardware with access to view/manage
- Utilization reporting for CPU, RAM, disk, and network
- Events related to the Pod, scheduling, and resources are displayed



# Virtual Machine – Actions

- Actions menu allows quick access to common VM tasks
  - Start/stop/restart
  - Live migration
  - Clone
  - Edit application group, labels, and annotations
  - Delete
- Accessible from all tabs of VM details screen and the VM list

The screenshot shows the 'japanese-koi' virtual machine details page. The 'Actions' dropdown menu is open, displaying various management options. A red box highlights the 'Delete Virtual Machine' option at the bottom of the list.

**VM Details:**

- Name: japanese-koi
- Namespace: default
- Created: Feb 23, 2:38 pm
- Hostname: localhost.localdomain
- Node: worker-1.oww.work.lan
- IP Address: 10.129.2.15
- Operating System: Red Hat Enterprise Linux 8.3 (Ootpa)

**Status:** Running

**Utilization:**

Resource	Usage	22:15	22:30
CPU	3.9 m	8 m 6 m 4 m 2 m	8 m 6 m 4 m 2 m
Memory	808.2 MiB	1,000 MiB 500 MiB	1,000 MiB 500 MiB
Filesystem	424.8 MiB	600 MiB 400 MiB 200 MiB	600 MiB 400 MiB 200 MiB

# Virtual Machine - Details

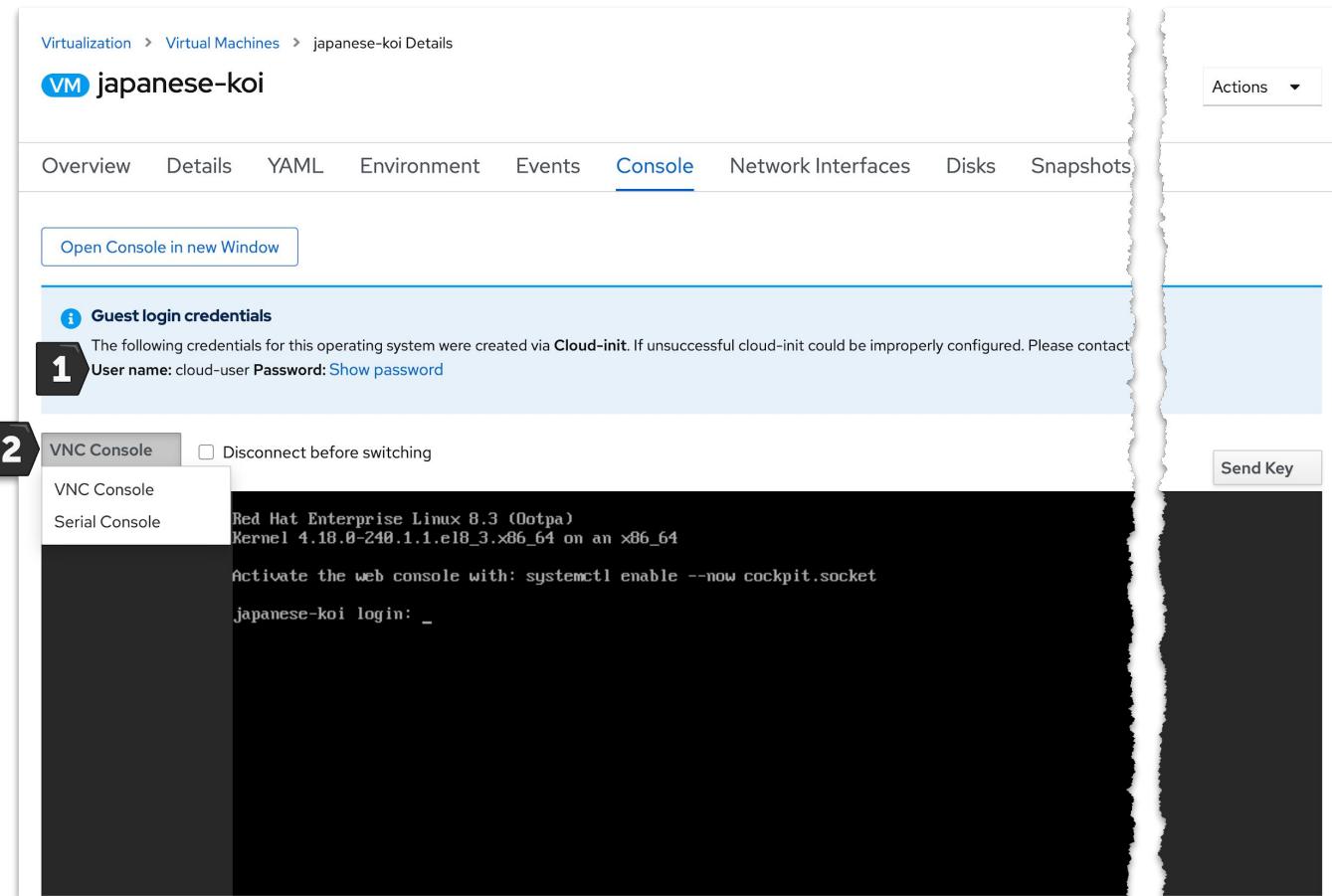
- Details about the virtual machine
  - Labels, annotations
  - Configured OS
  - Template used, if any
  - Configured boot order
  - Associated workload profile
  - Flavor
- Additional details about scheduling
  - Node selector, tolerations, (anti)affinity rules
- Services configured for the VM

The screenshot shows the Red Hat OpenShift Container Platform interface for viewing a Virtual Machine (VM) named 'rhel' in the 'default' project. The interface is dark-themed.

- 1 Labels:** Shows labels such as app=rhel, flavor=template.kubevirt.io/small=true, os=template.kubevirt.io/rhel8.2=true, vm.kubevirt.io/template=rhel8-desktop-small-v0.10.0, vm.kubevirt.io/template.namespace=openshift, vm.kubevirt.io/template.revision=1, and vm.kubevirt.io/template.version=v0.11.2.
- 2 Operating System:** Red Hat Enterprise Linux 8.0 or higher.
- 3 Template:** Not available.
- 4 Boot Order:** 1.rootdisk (Disk).
- 5 Workload Profile:** desktop.
- 6 Flavor:** Small:1 vCPU, 2 GiB Memory. Dedicated Resources: No Dedicated resources applied.
- 7 Scheduling and resources requirements:** Node Selector: No selector. Tolerations: No Toleration rules. Affinity Rules: No Affinity rules.
- 8 Services:** No Services Found.

# Virtual Machine - Console

- Browser-based access to the serial and graphical console of the virtual machine
- Access the console using native OS tools, e.g. `virt-viewer`, using the `virtctl` CLI command
  - `virtctl console vmname`
  - `virtctl vnc vmname`



# Virtual Machine - Disks and NICs

- Add, edit, and remove NICs and disks for non-running virtual machines

The screenshot shows two views of a virtual machine named "japanese-koi".

**Network Interfaces View:**

- Step 1:** A blue button labeled "Add Network Interface" is highlighted.
- Step 2:** The "Network" column for the default interface is set to "Pod Networking".

Name,	Model	Network	Type	MAC Address
default	virtio	Pod Networking	masquerade	-

**Disks View:**

- Step 1:** A blue button labeled "Add Disk" is highlighted.
- Step 2:** The "Storage Class" for the "rootdisk" is set to "lab-silver".

Name	Source	Size	Drive	Interface	Storage Class
cloudinitdisk	Other	-	Disk	virtio	-
rootdisk	pvc	20 GiB	Disk	virtio	lab-silver

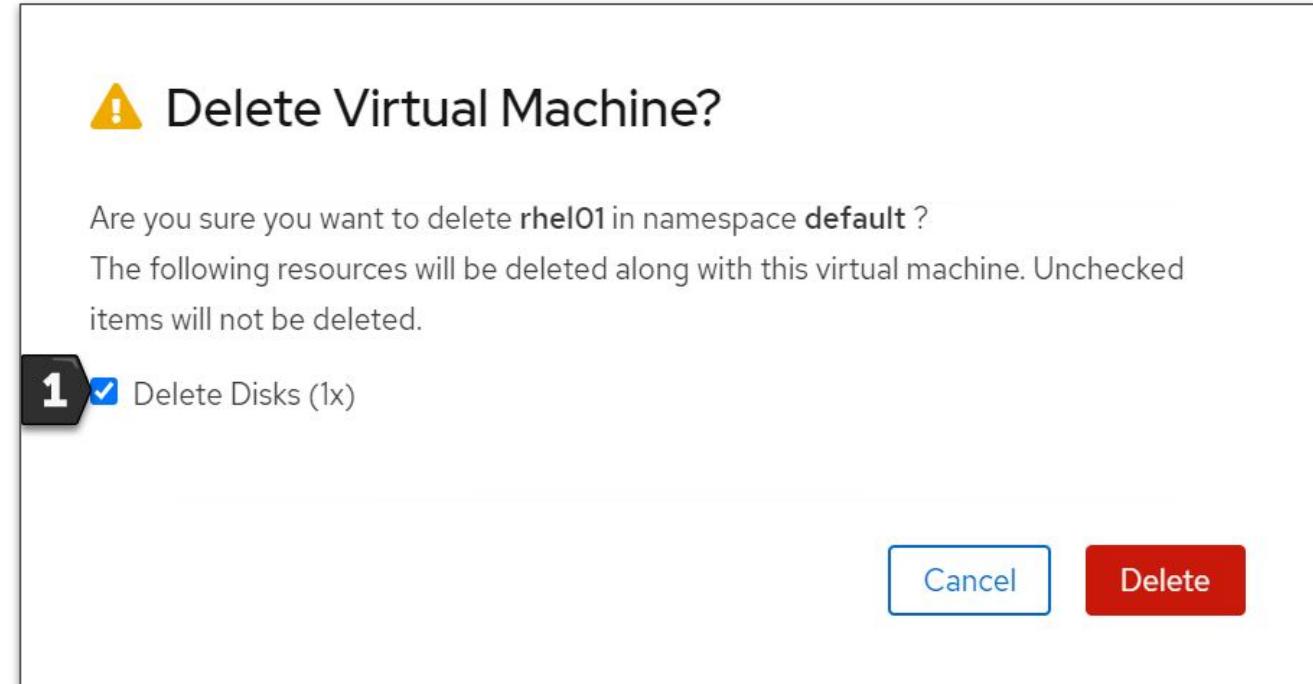
**File Systems View:**

Name	File System Type	Mount Point	Total Bytes	Used Bytes
vdb2	vfat	/boot/efi	99.79 MiB	6.84 MiB
vdb3	xfs	/	19.89 GiB	1.41 GiB

# Destroy VMs

# Destroying a Virtual Machine

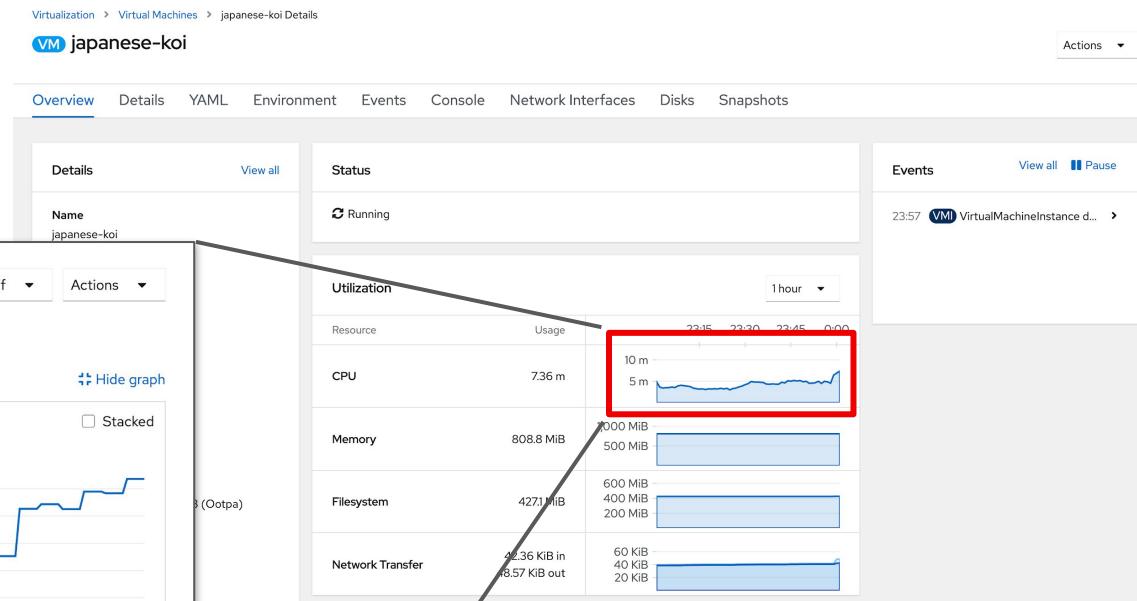
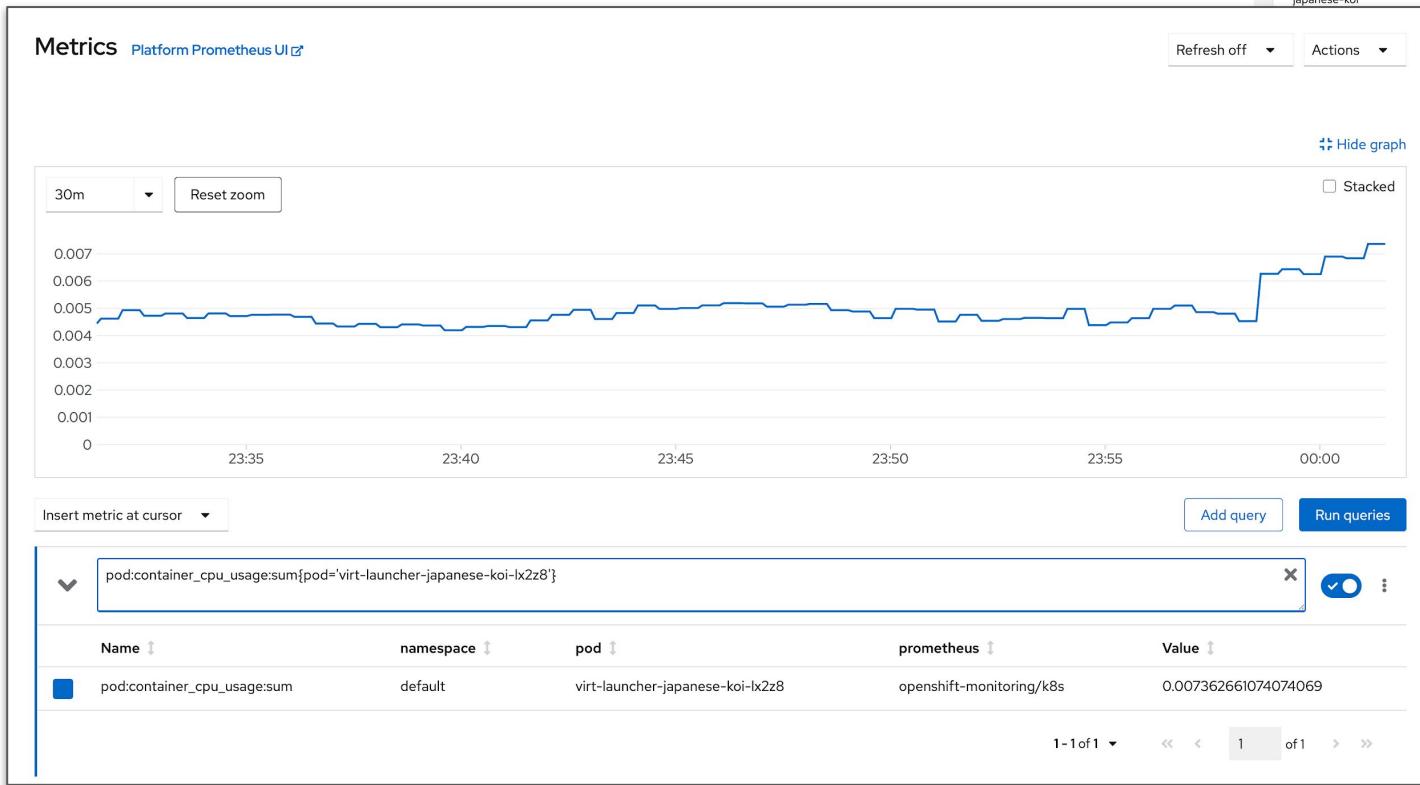
- Deleting a VM removes the VM definition
  - Optionally delete PVC-backed disks associated with the VM
- Running VMs are terminated first
- Other associated resources, e.g. Services, are not affected



# Metrics

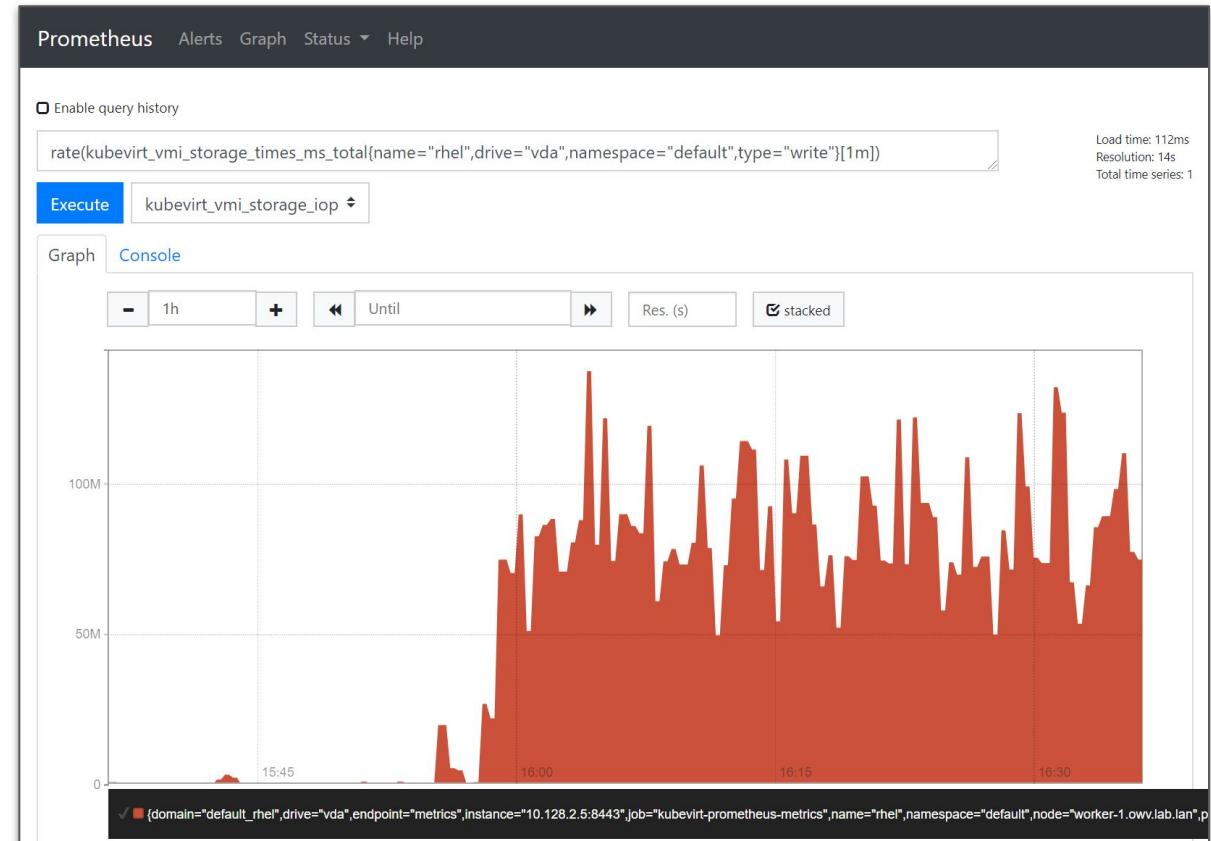
# Overview Virtual Machine metrics

- Summary metrics for 1, 6, and 24 hour periods are quickly viewable from the VM overview page
- Clicking a graph will display it enlarged in the metrics UI



# Detailed Virtual Machine metrics

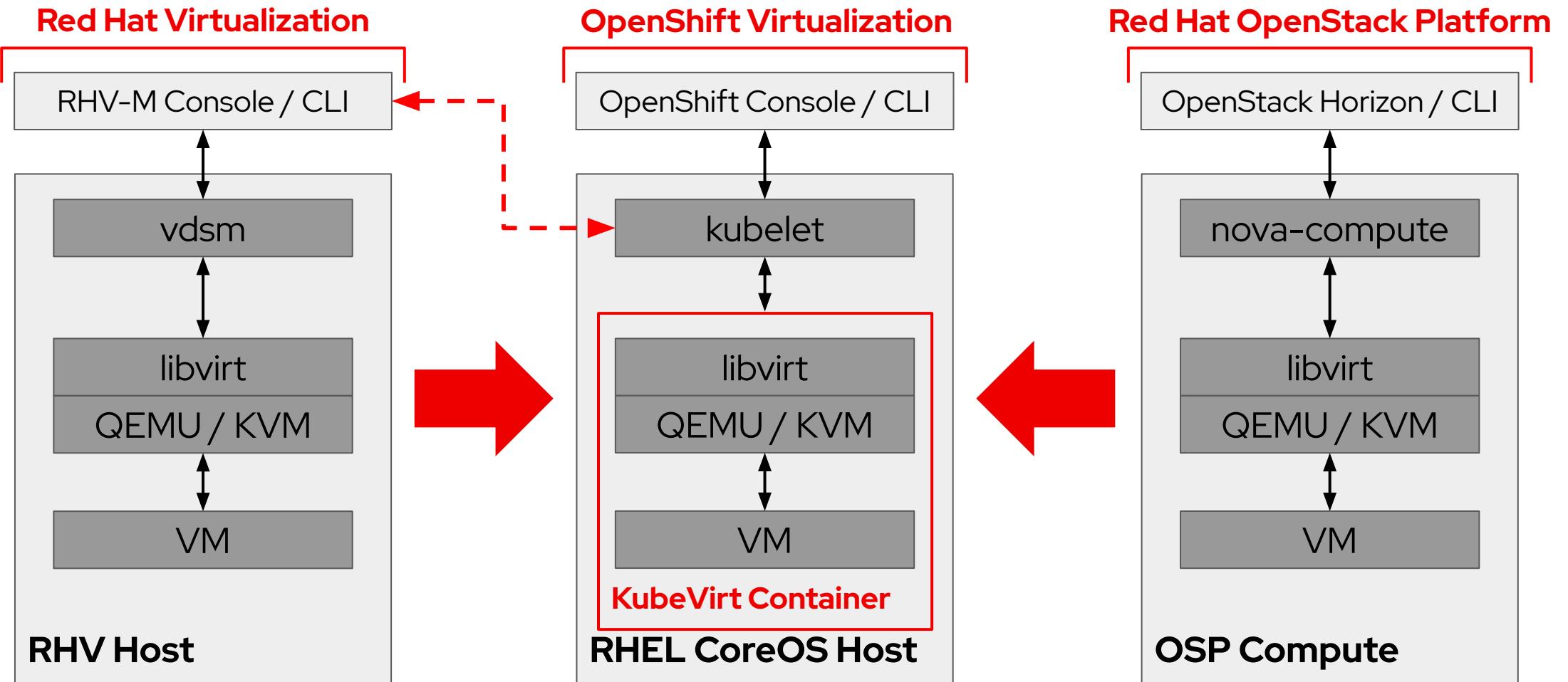
- Virtual machine, and VM pod, metrics are collected by the OpenShift metrics service
  - Available under the `kubevirt` namespace in Prometheus
- Available per-VM metrics include
  - Active memory
  - Active CPU time
  - Network in/out errors, packets, and bytes
  - Storage R/W IOPS, latency, and throughput
- VM metrics are for VMs, not for VM pods
  - Management overhead not included in output
  - Look at `virt-launcher` pod metrics for
- No preexisting Grafana dashboards



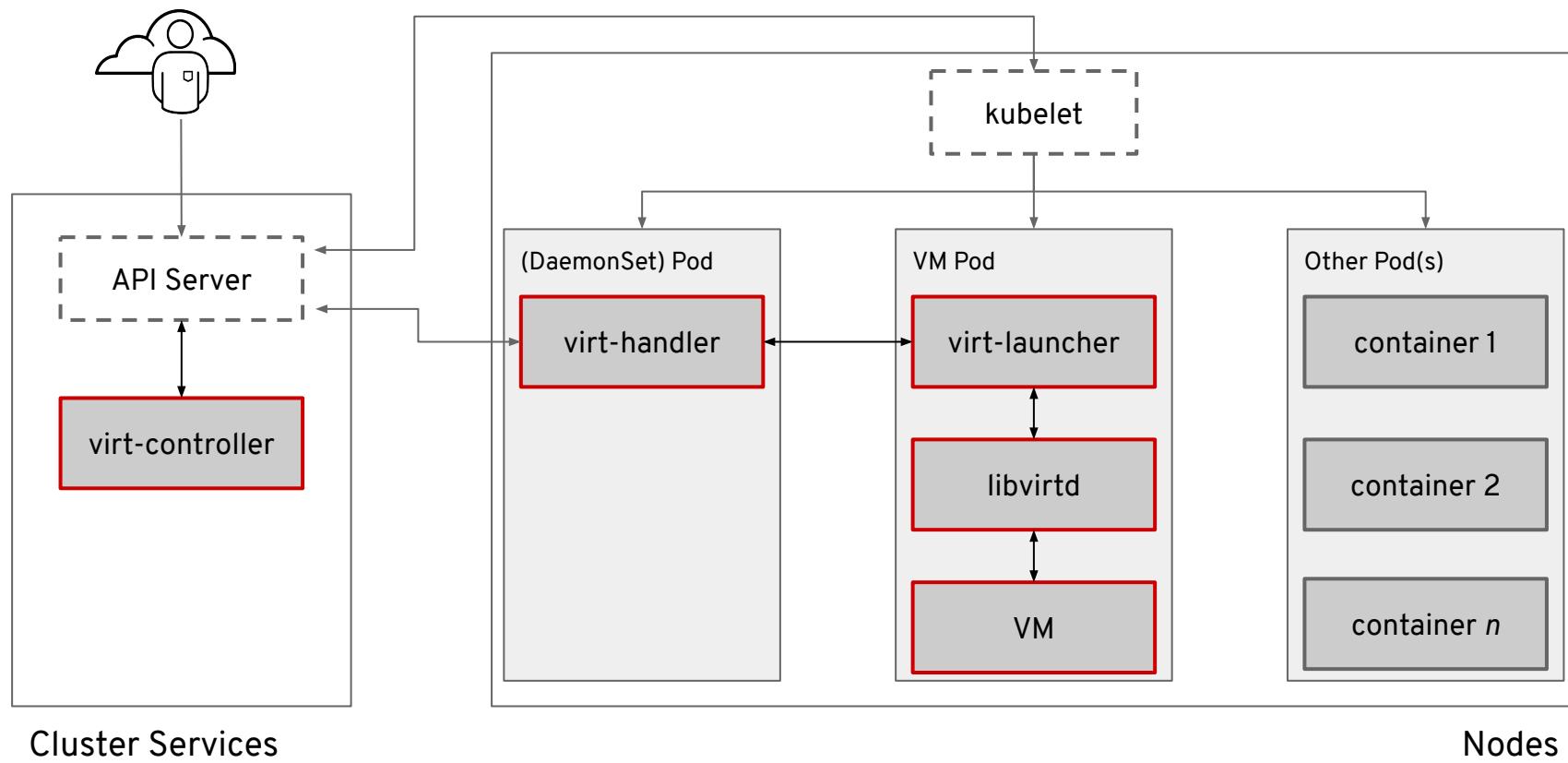
# Deeper into the technology

# Containerizing KVM

Trusted, mature KVM wrapped in modern management and automation



# Architectural Overview



# Terminology comparison

Feature	RHV	OpenShift Virtualization	vSphere
<b>Where VM disks are stored</b>	Storage Domain	PVC	datastore
<b>Policy based storage</b>	None	StorageClass	SPBM
<b>Non-disruptive VM migration</b>	Live migration	Live migration	vMotion
<b>Non-disruptive VM storage migration</b>	Storage live migration	N/A	Storage vMotion
<b>Active resource balancing</b>	Cluster scheduling policy	Pod eviction policy, descheduler	Dynamic Resource Scheduling (DRS)
<b>Physical network configuration</b>	Host network config (via nmstate w/4.4)	nmstate Operator, Multus	vSwitch / DvSwitch
<b>Overlay network configuration</b>	OVN	OCP SDN (OpenShiftSDN, OVNKubernetes, and partners), Multus	NSX-T
<b>Host / VM metrics</b>	Data warehouse + Grafana (RHV 4.4)	OpenShift Metrics, health checks	vCenter, vROps

# Thank you

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