Red Hat OpenShift

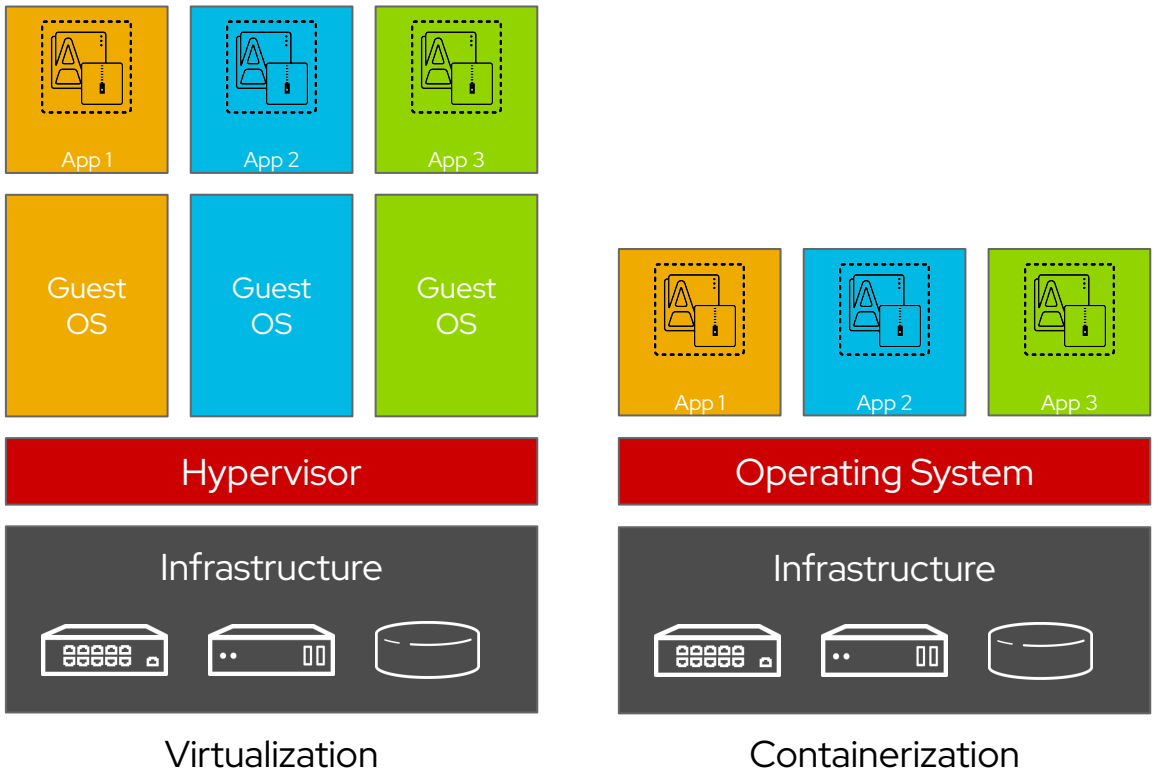
OpenShift Virtualization

Technical presentation

Red Hat

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



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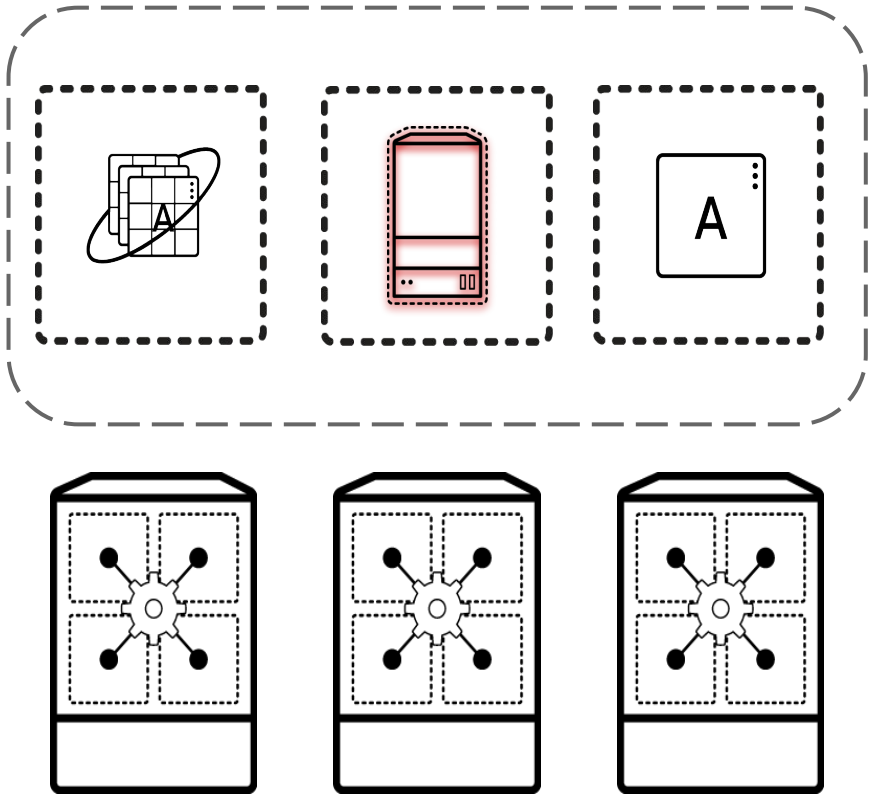
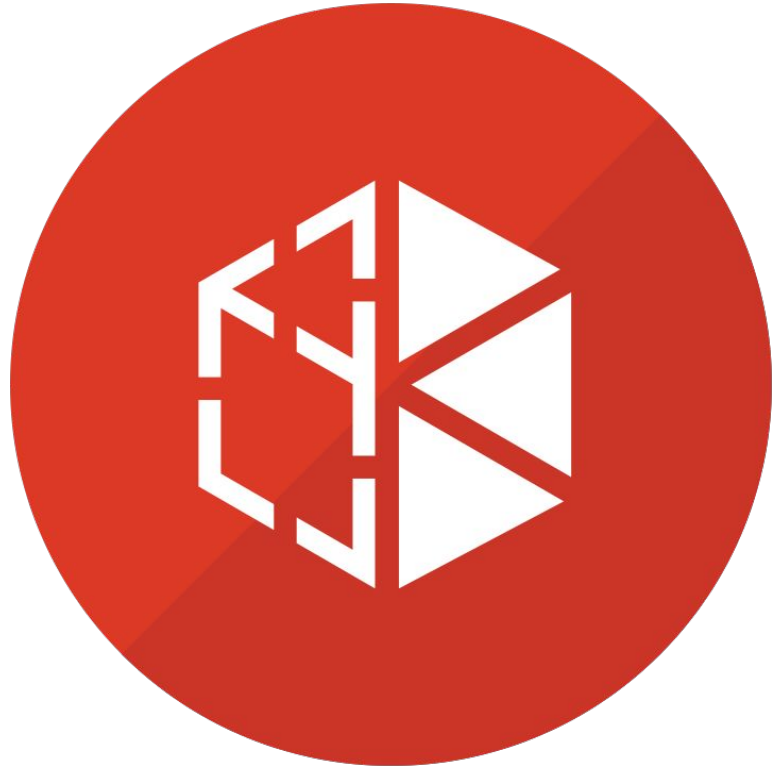
Virtual machines can be put into containers

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



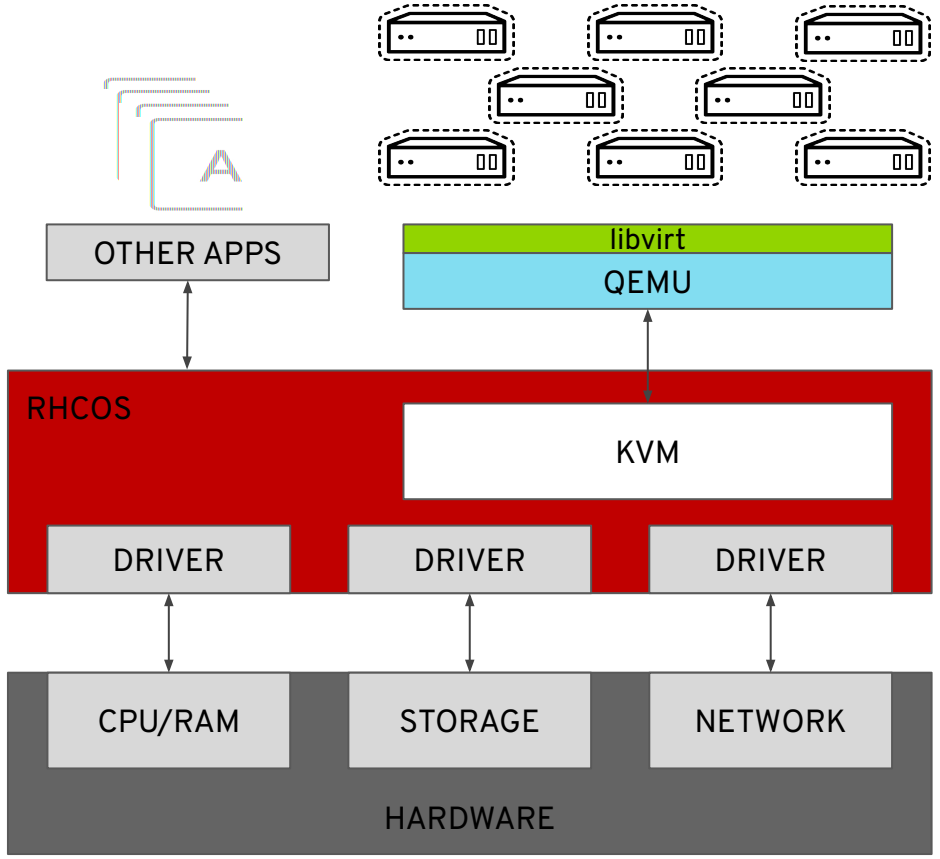
OpenShift Virtualization

- 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



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Built with Kubernetes

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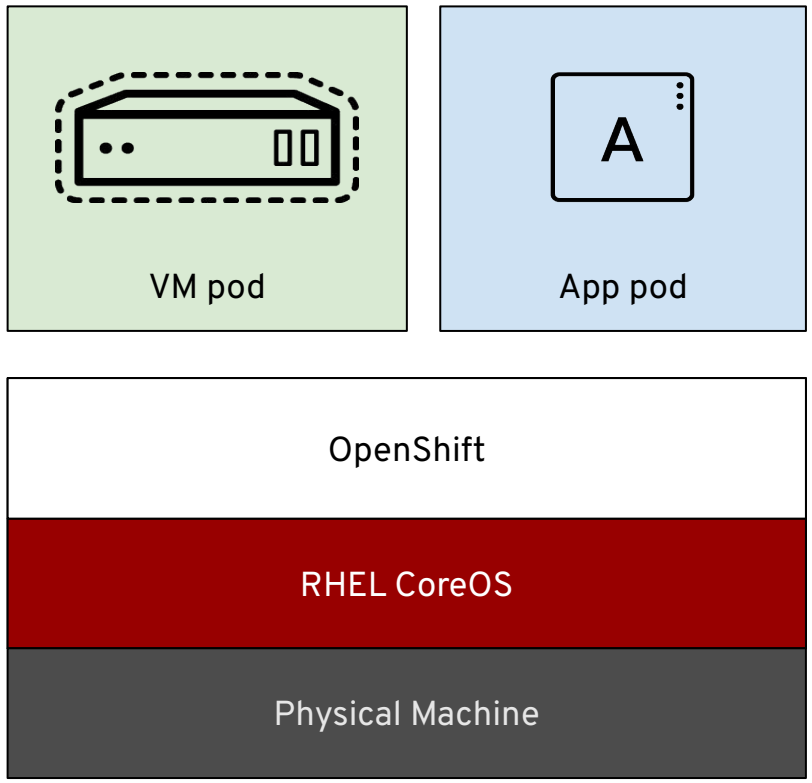
Virtual machines in a container world

- 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

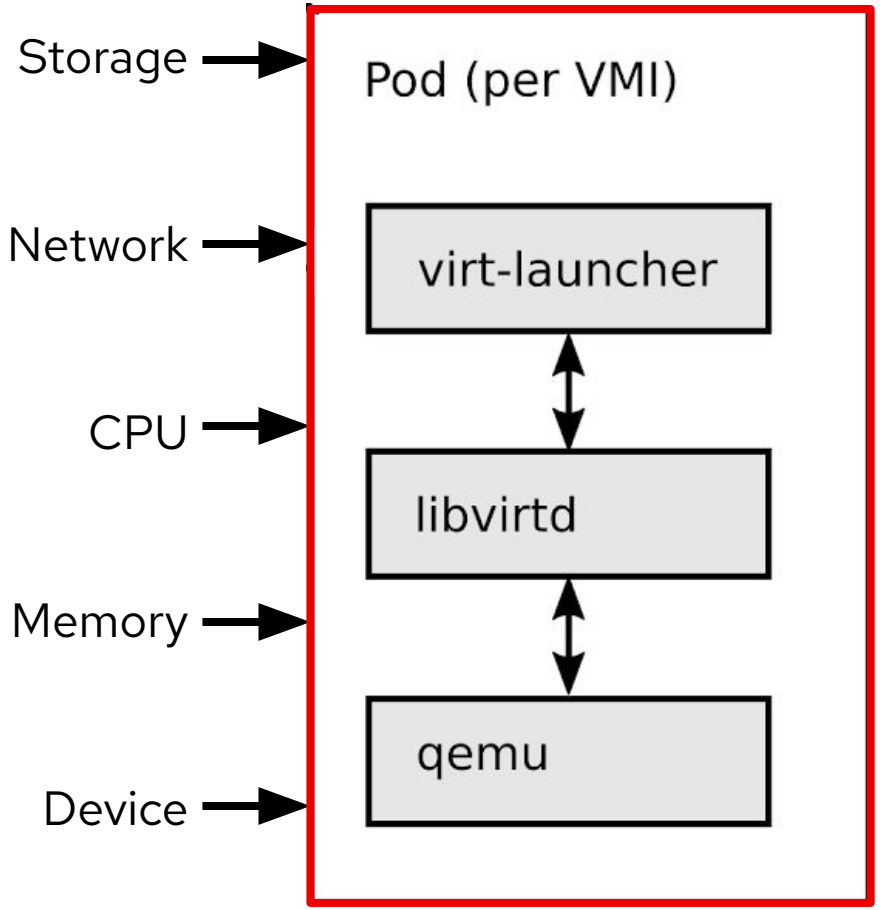


Virtualization native to Kubernetes

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

```yaml
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

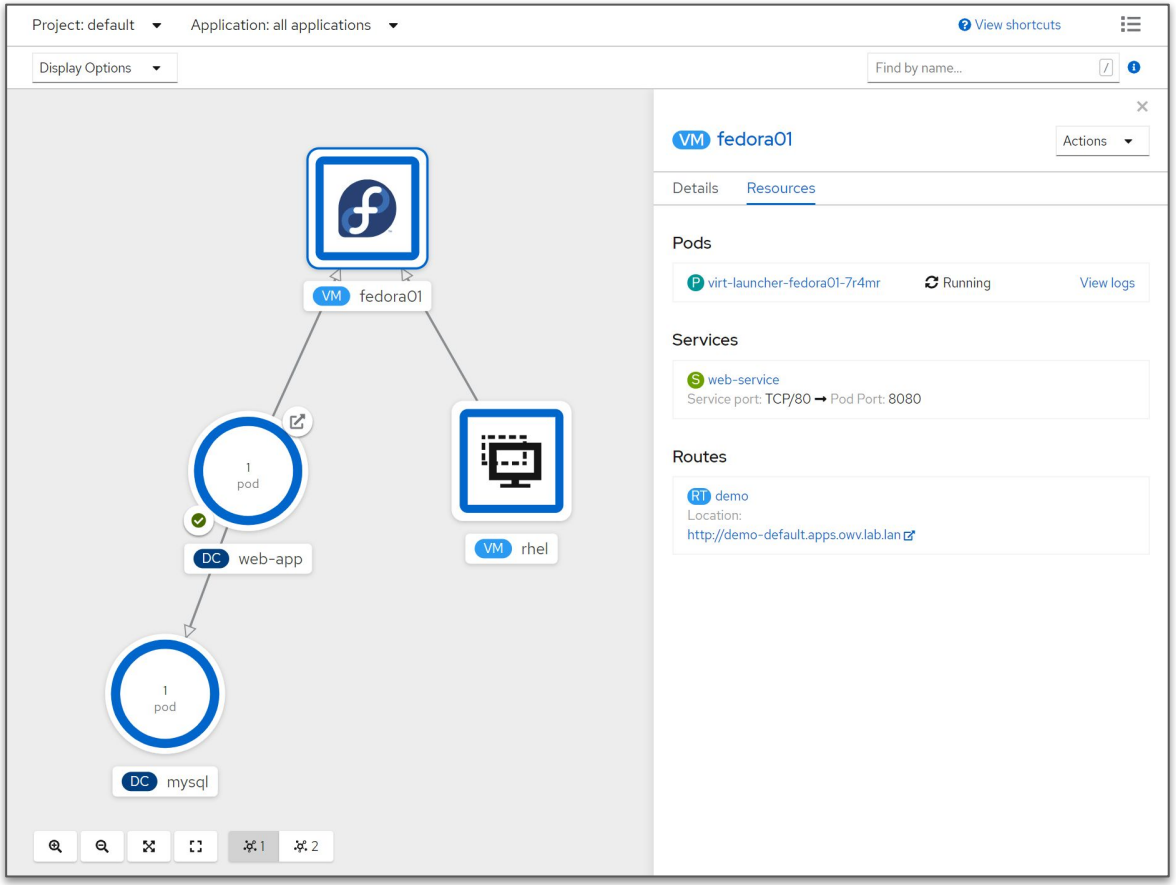
- libvirt and qemu from RHEL are mature, have high performance, provide stable abstractions, and have a minimal overhead.

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



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Managed with OpenShift

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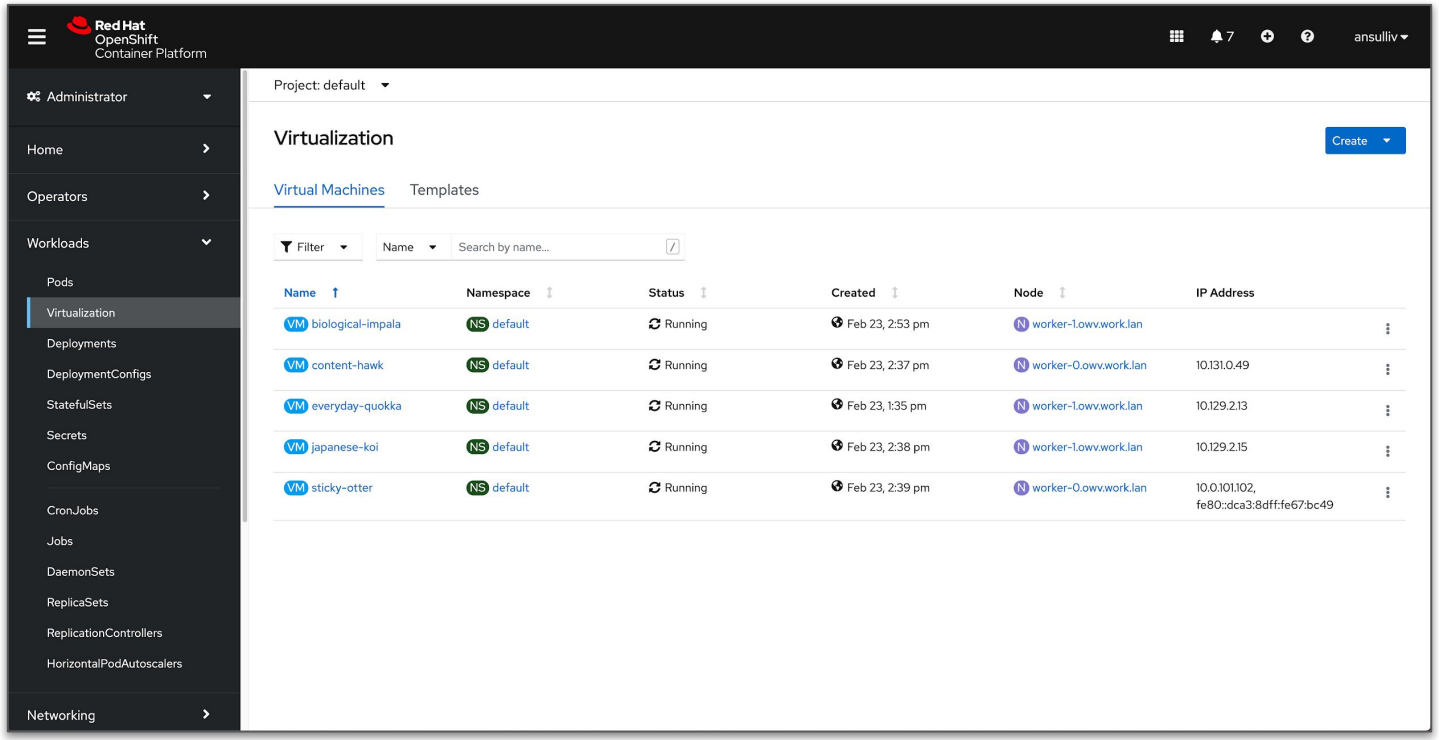
Virtual Machine Management

- 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



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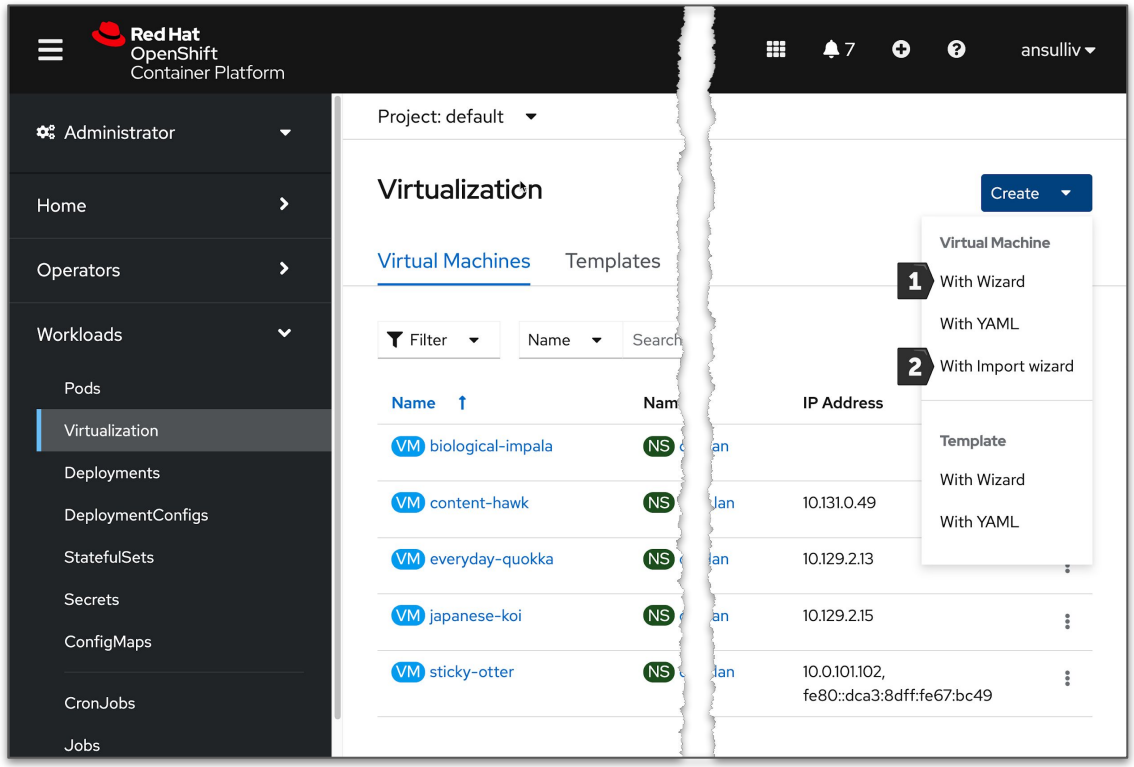
Create VMs

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



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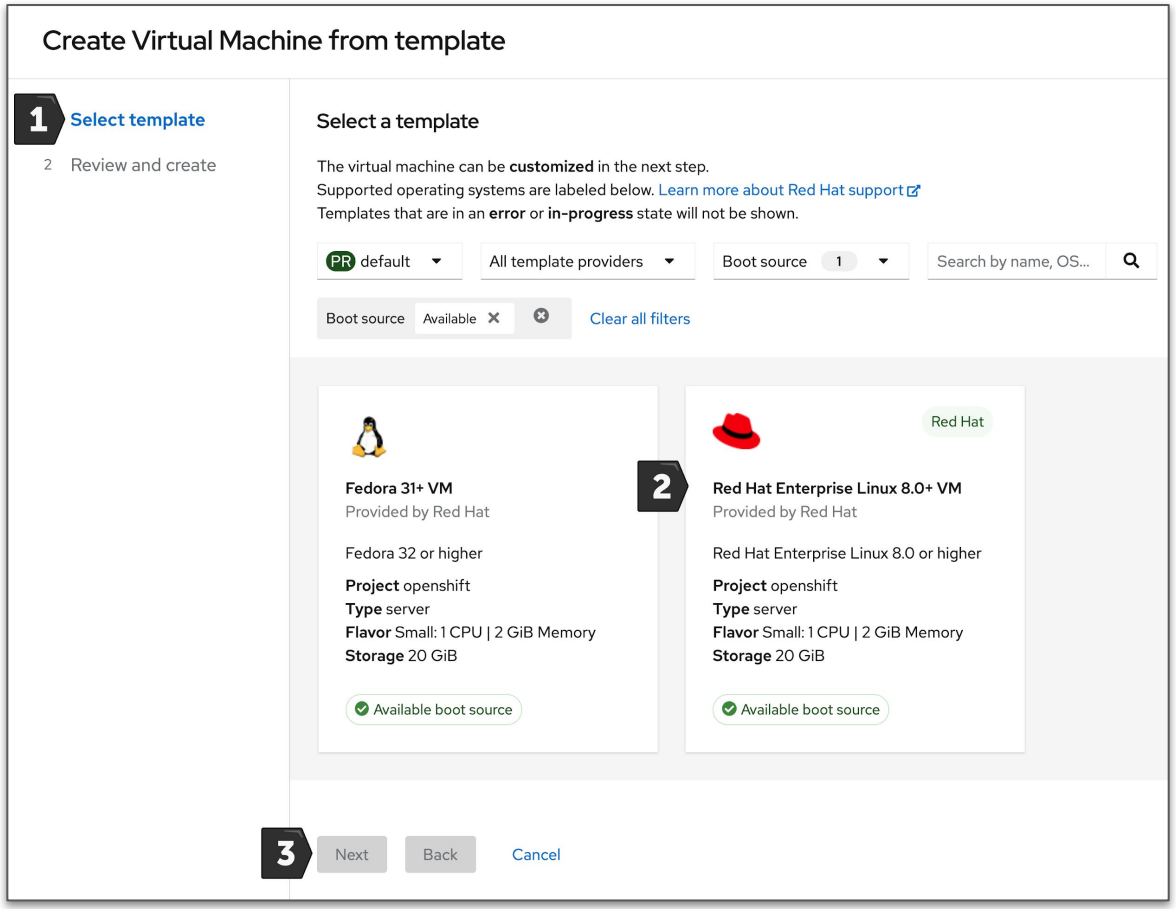
Using templates for virtual machines

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



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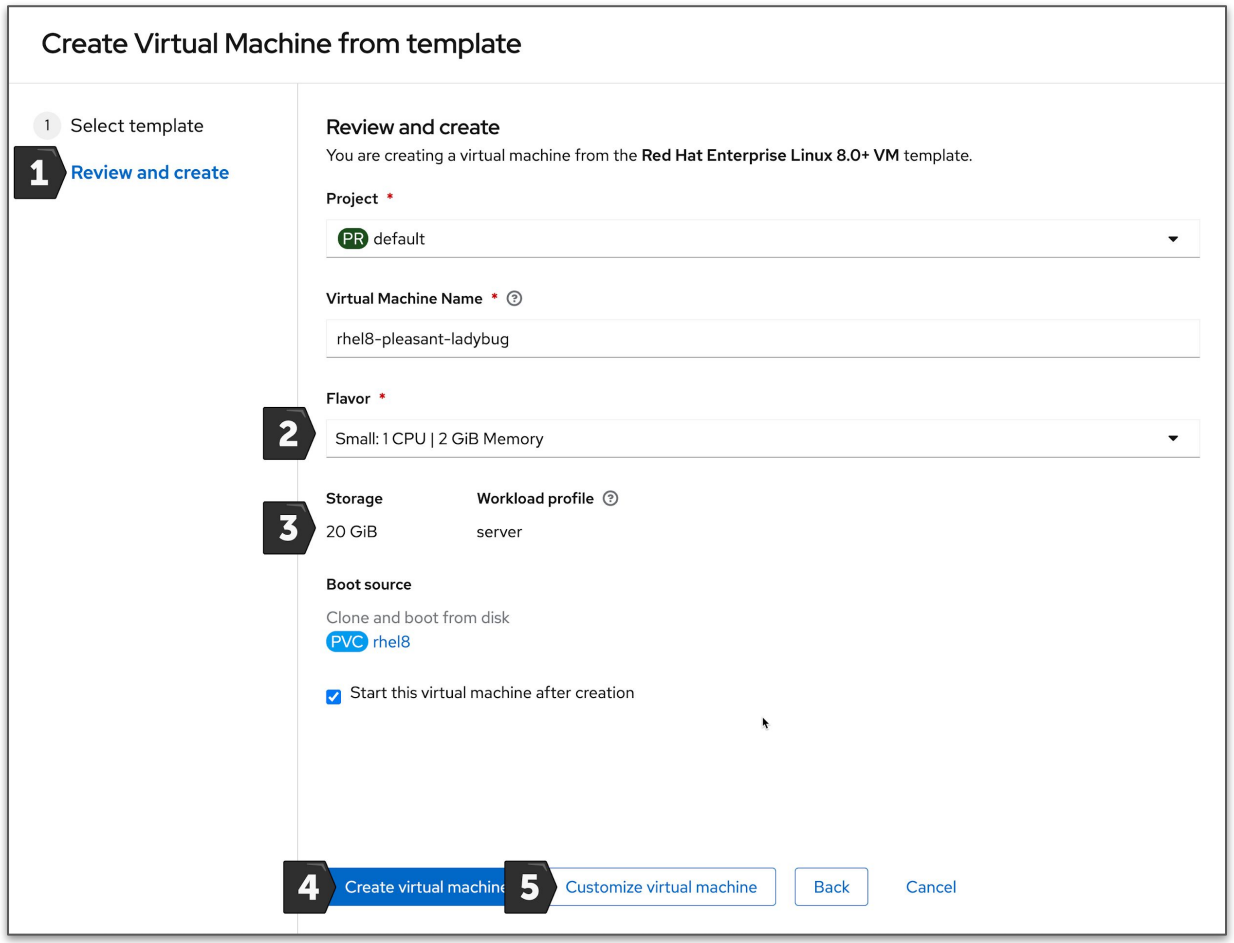
Creating a virtual machine

- 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



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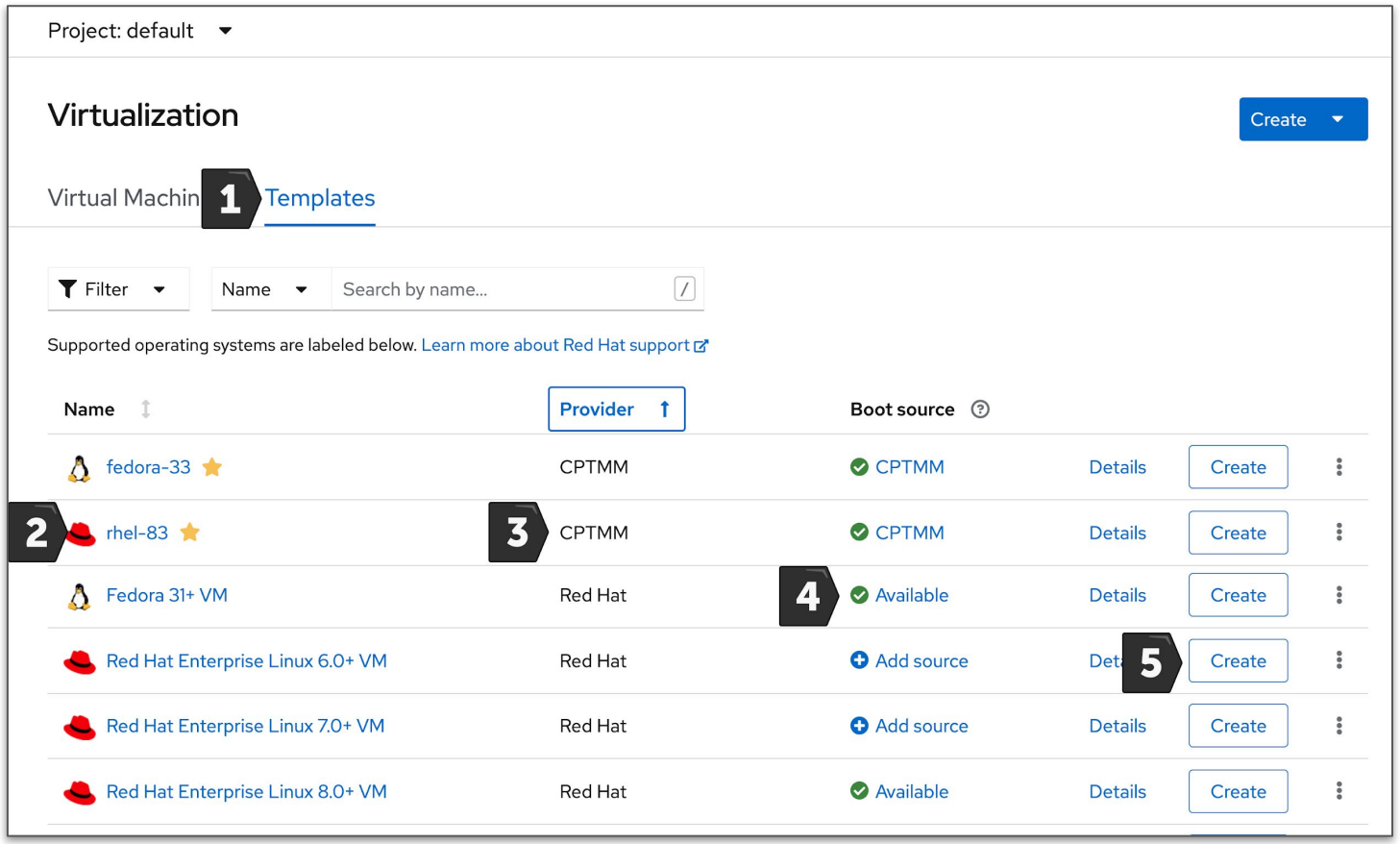
VM Templates

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



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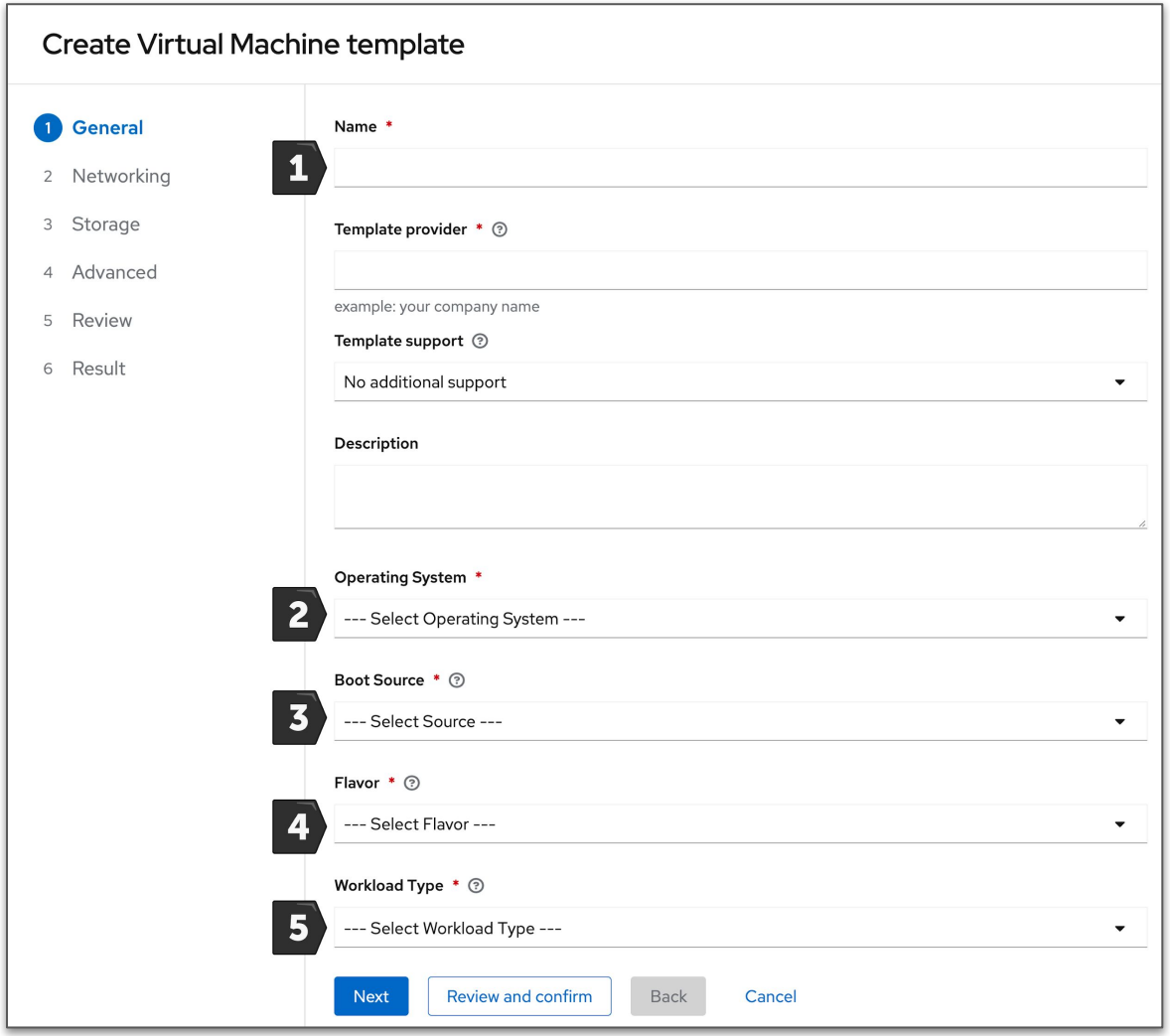
Create a template - General

- 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



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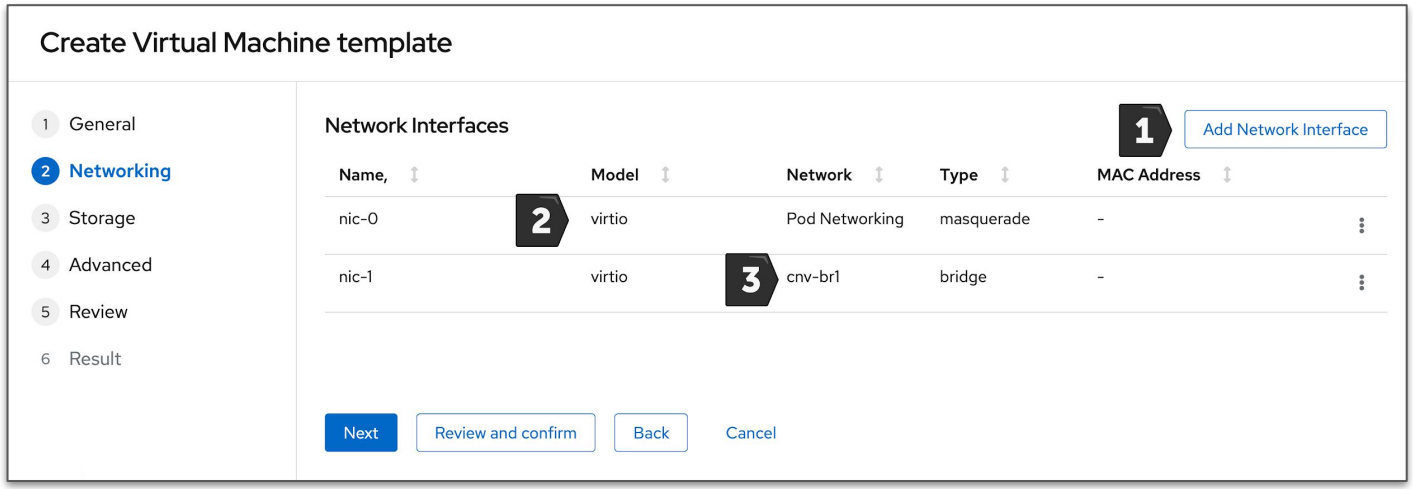
Create a template - Networks

- 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



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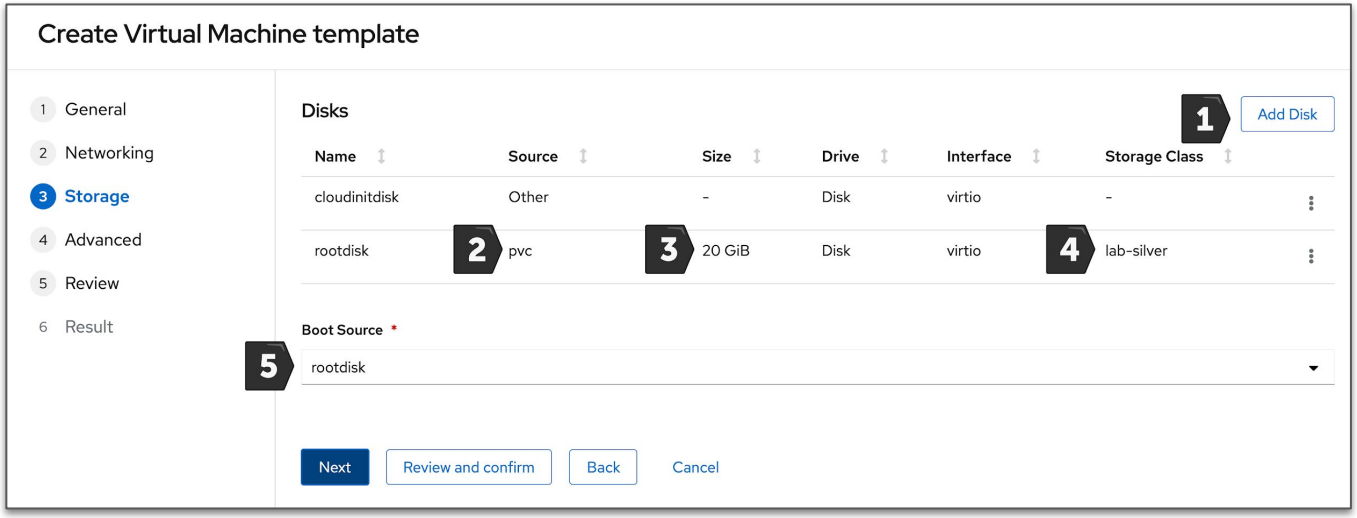
Create a template - Storage

- 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



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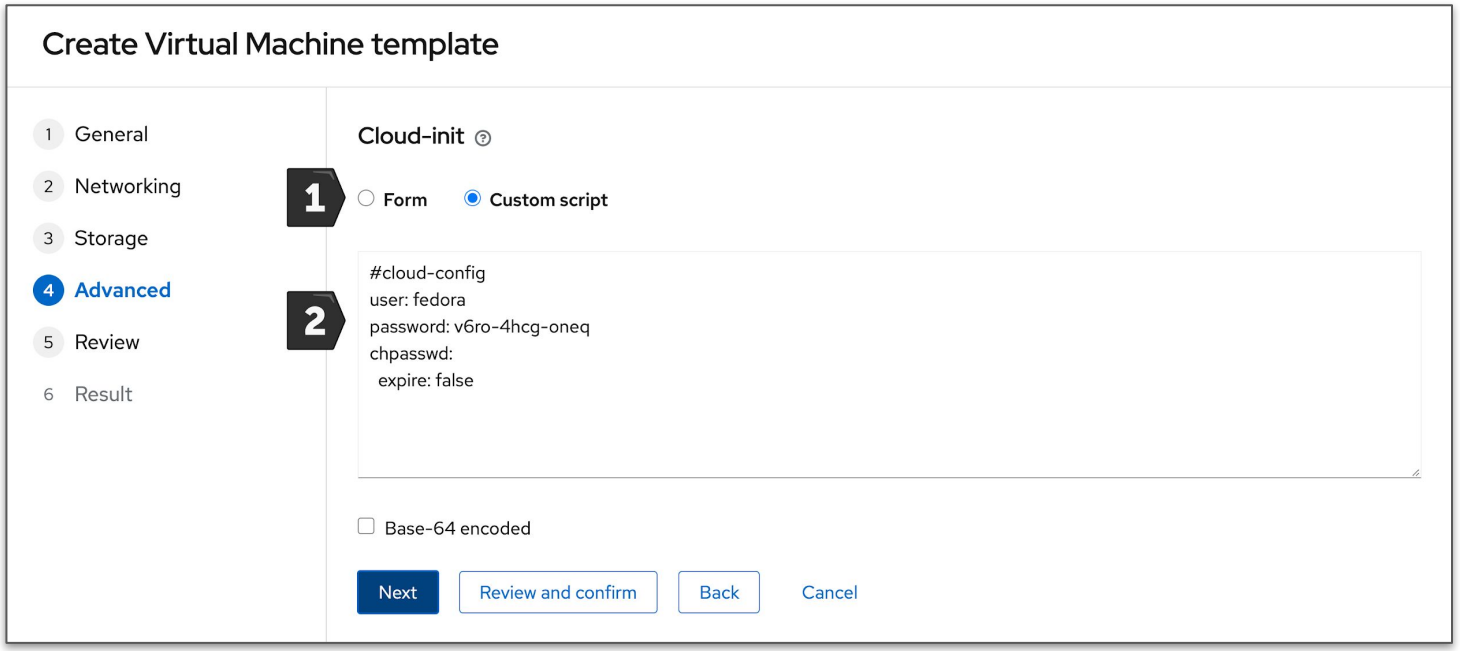
Create a template - Advanced

- 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



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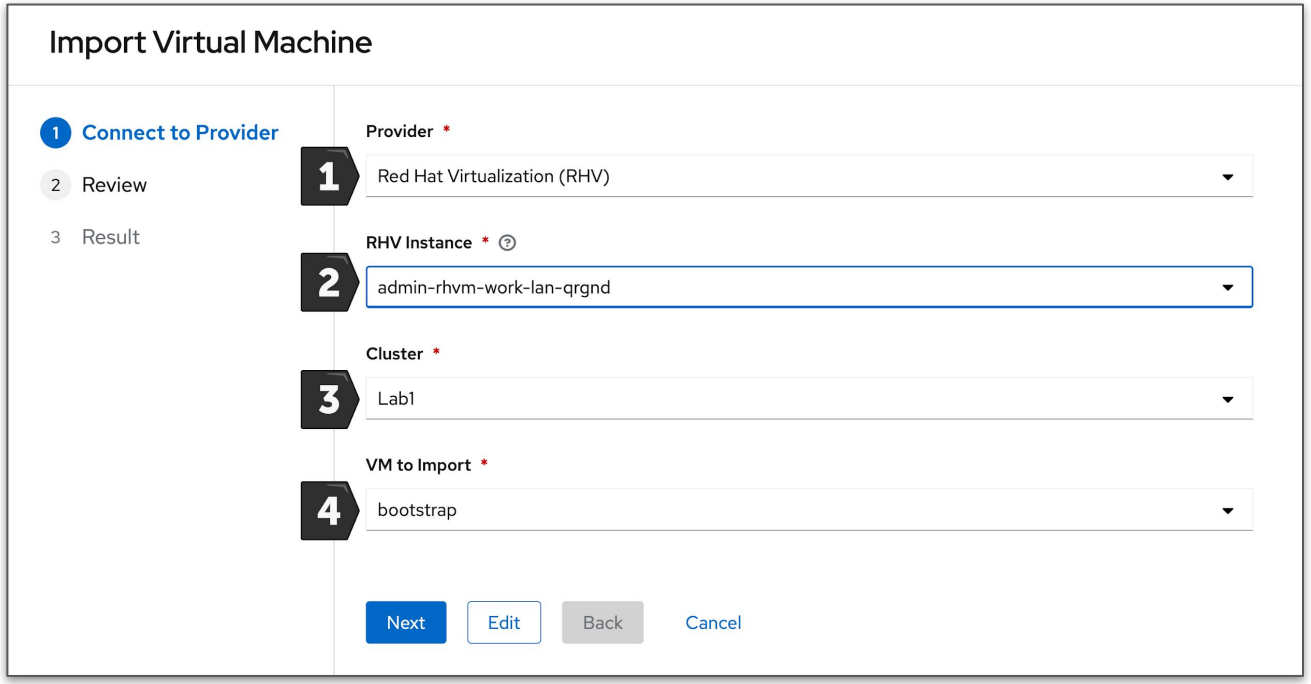
Import VMs

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



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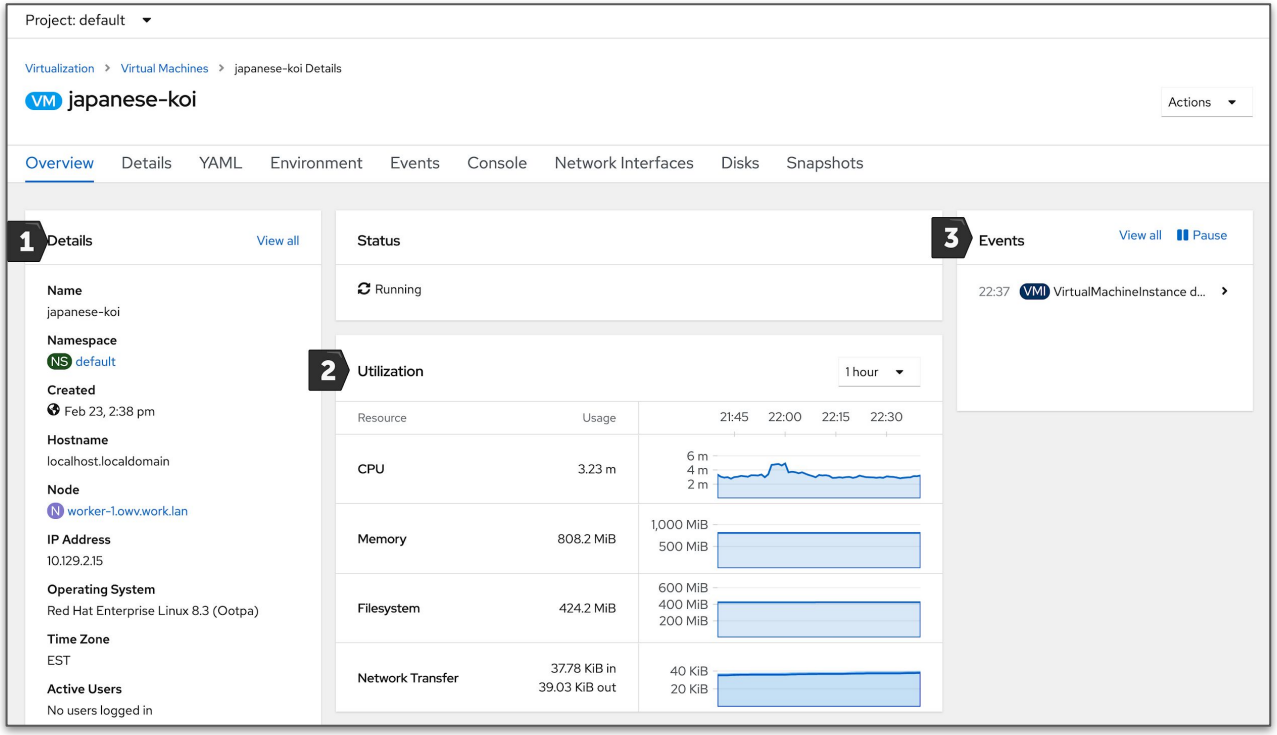
View / manage VMs

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



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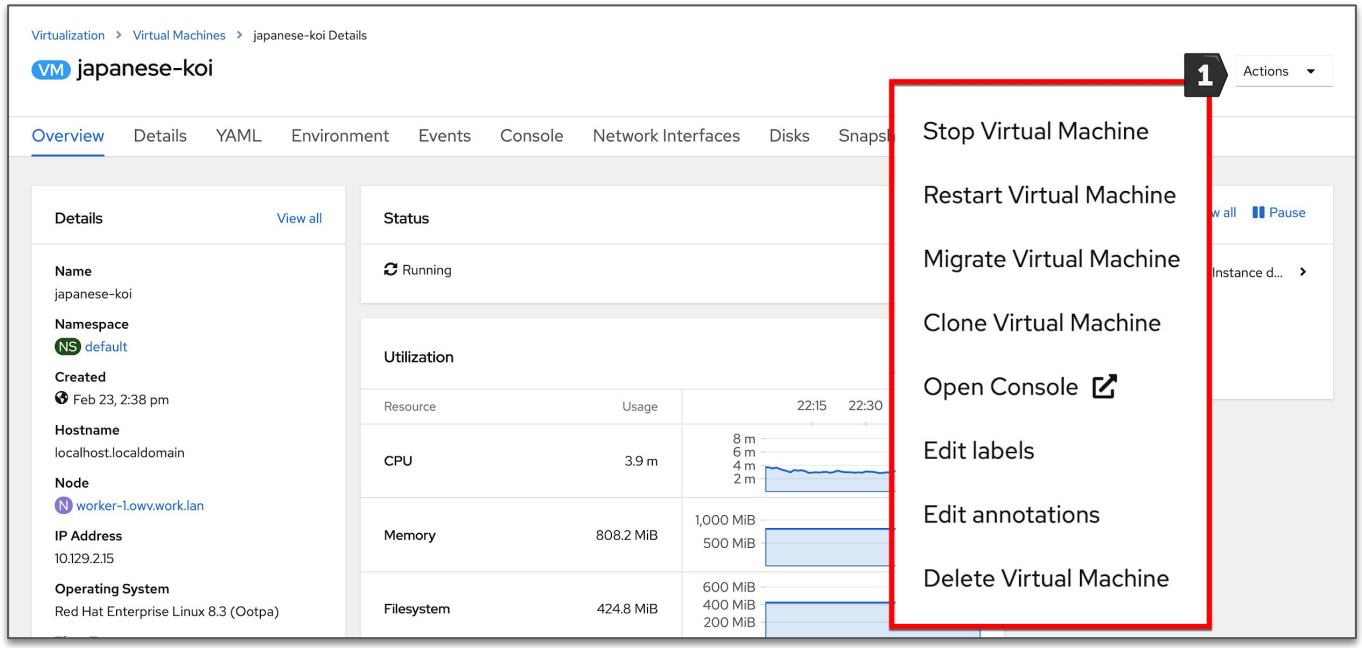
Virtual Machine - Actions

- 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



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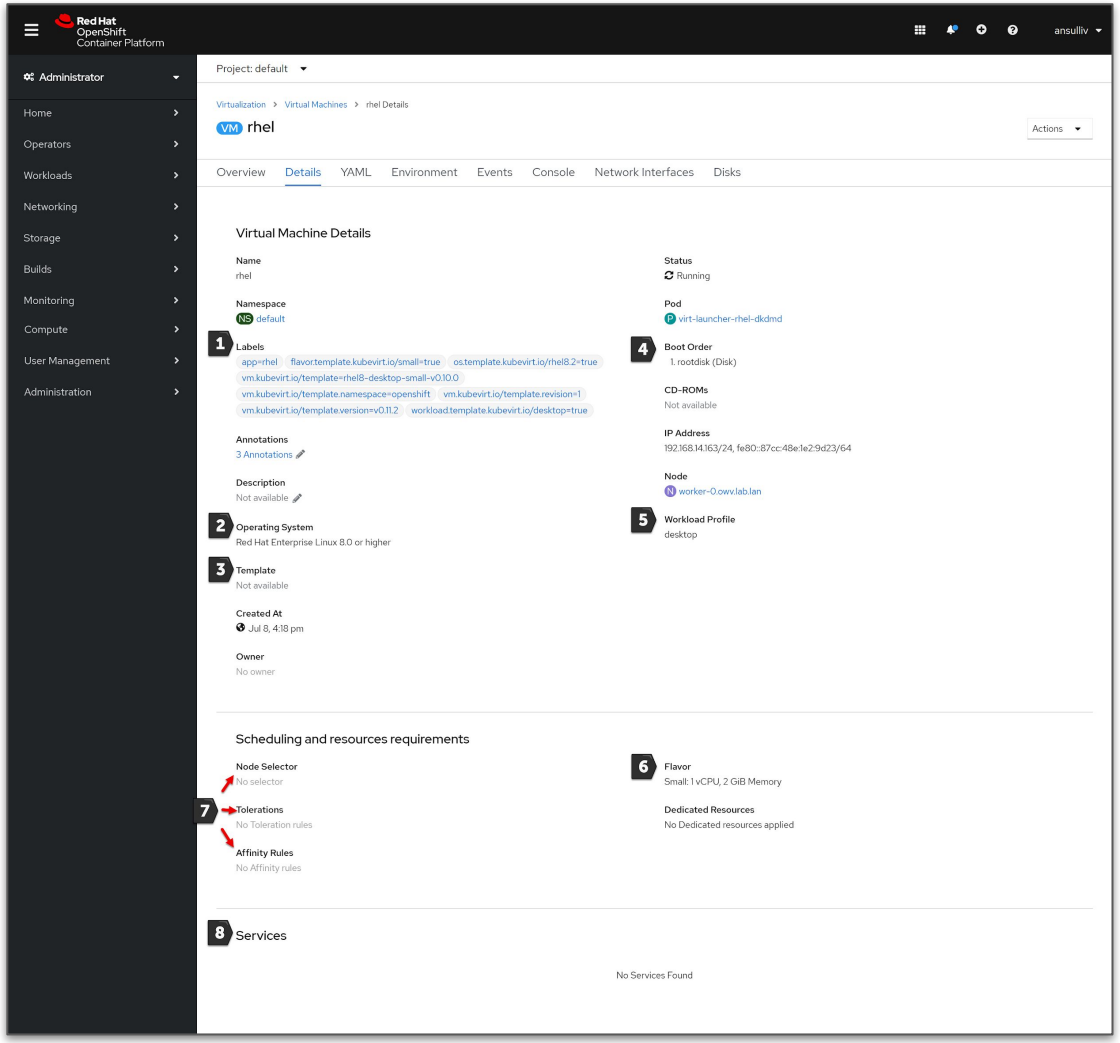
Virtual Machine - Details

- 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



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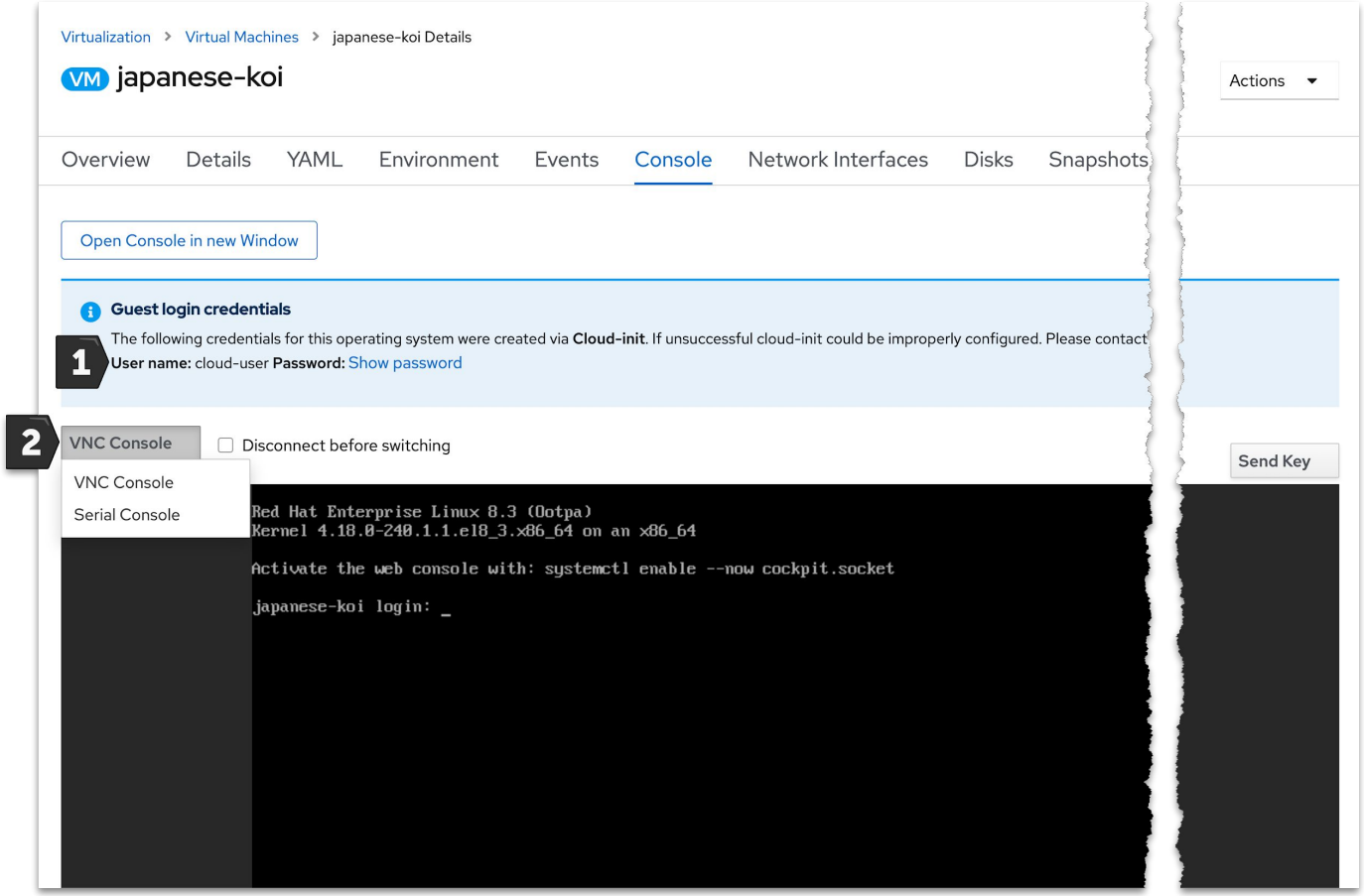
Virtual Machine - Console

- 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`



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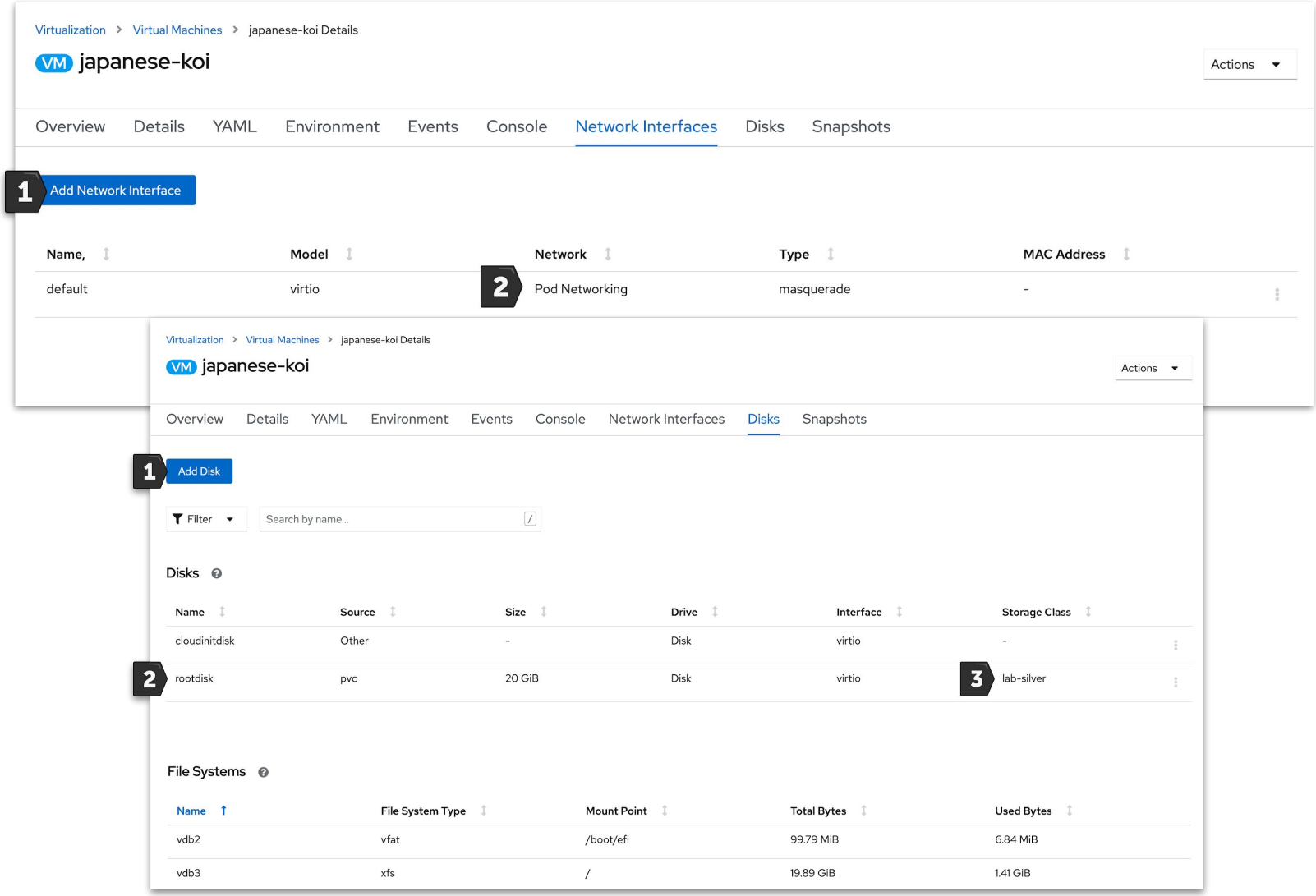
Virtual Machine - Disks and NICs

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



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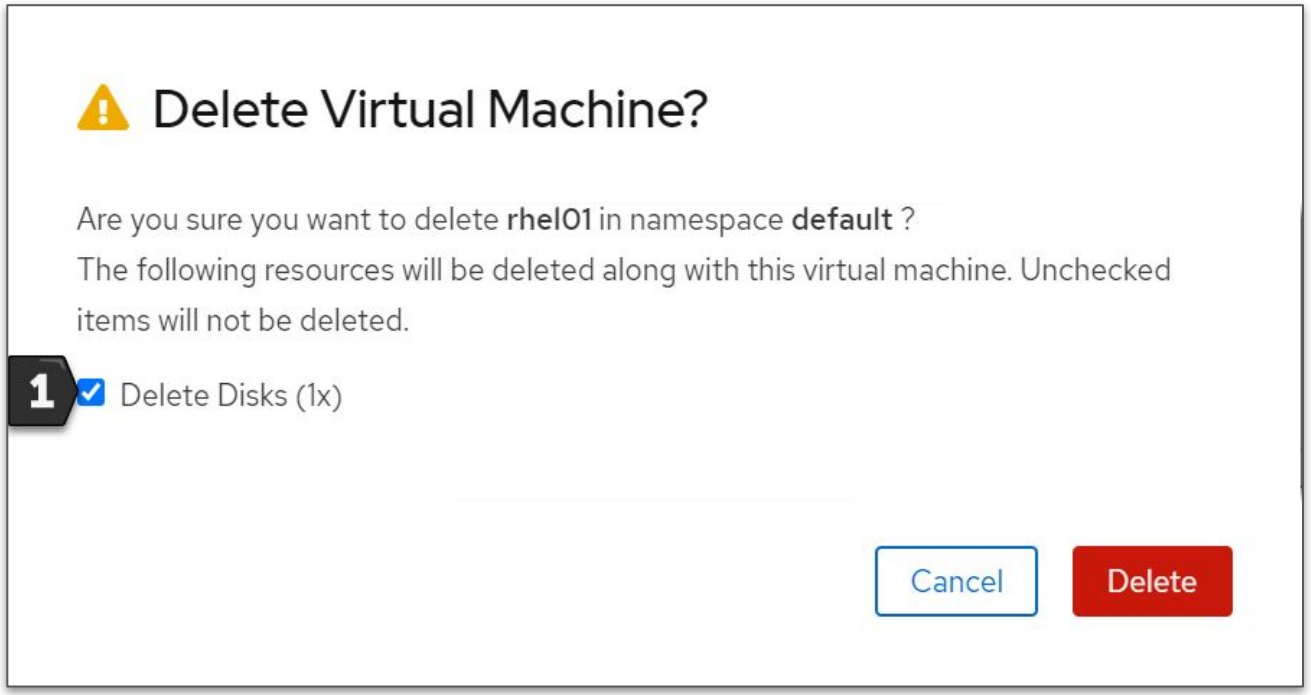
Destroy VMs

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



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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

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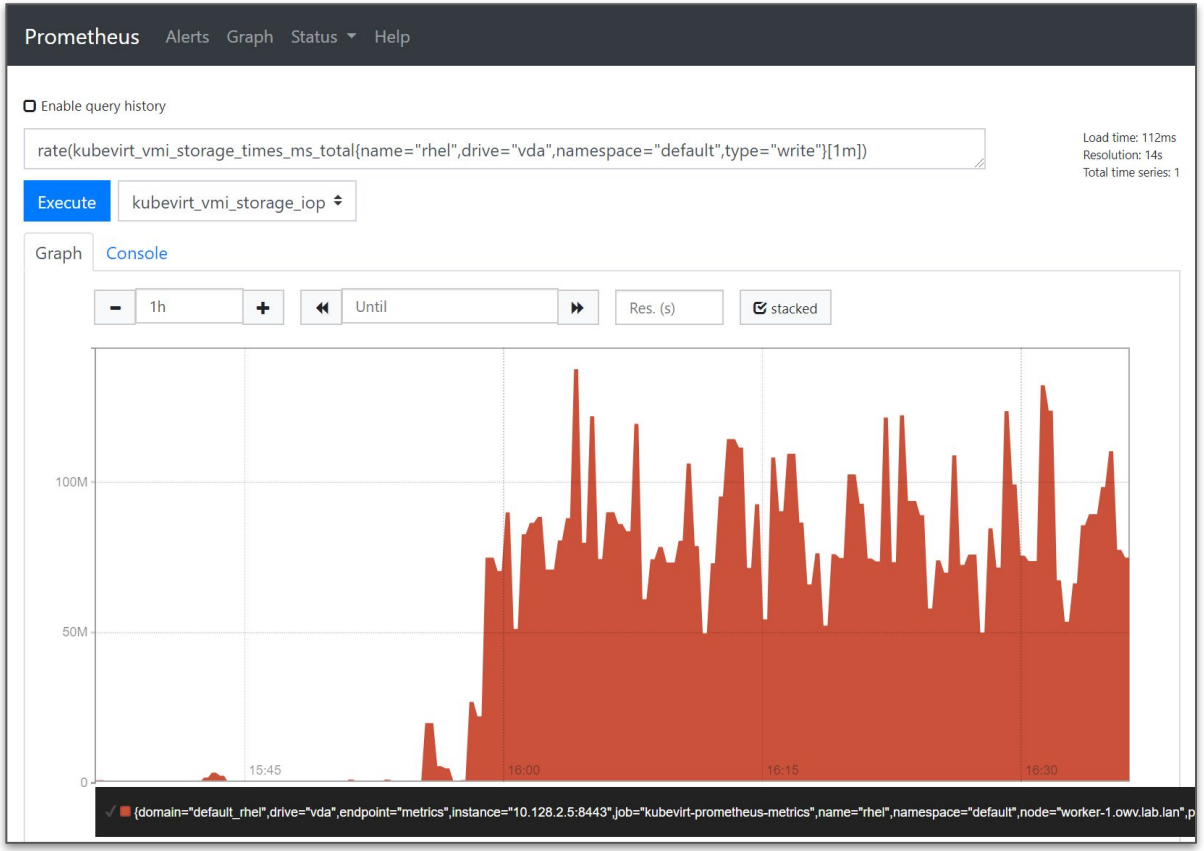
Detailed Virtual Machine metrics

- 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



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Deeper into the technology

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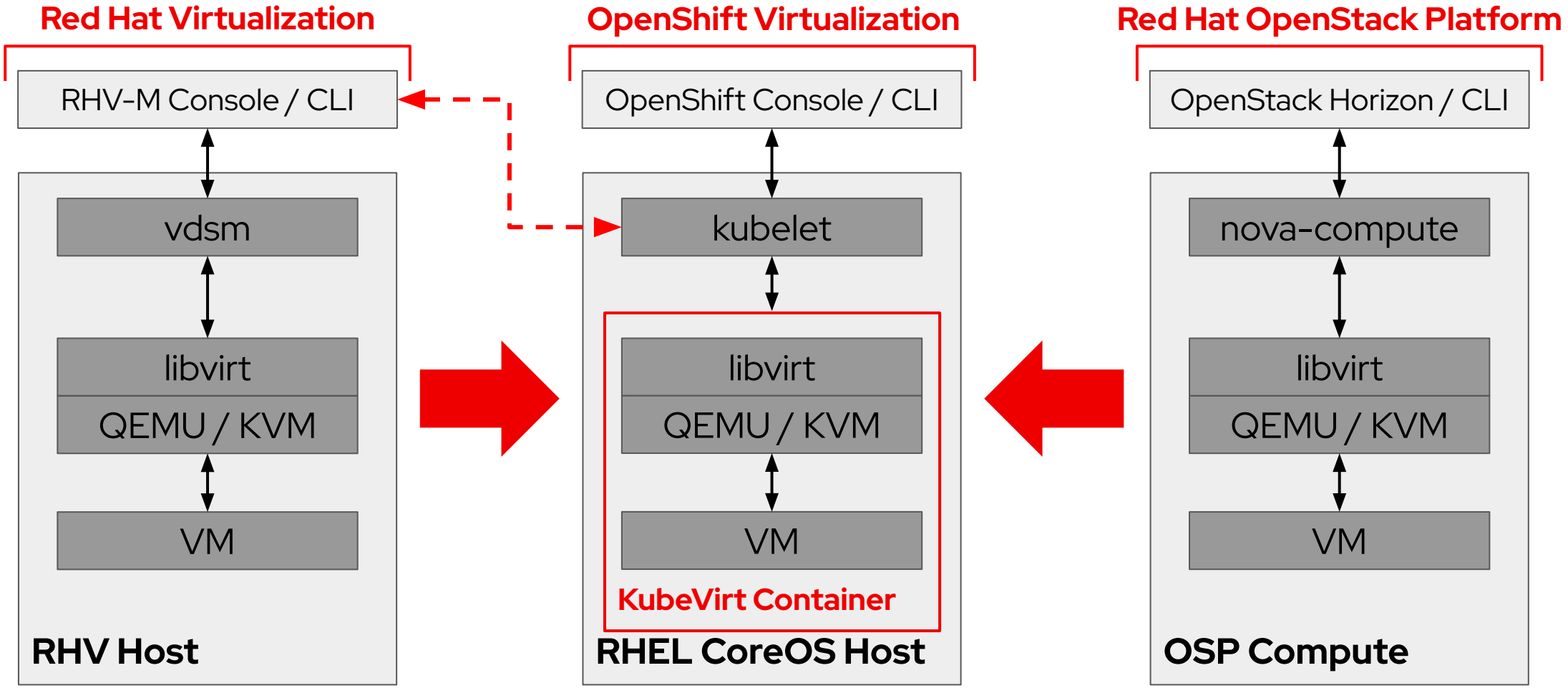
Containerizing KVM

Trusted, mature KVM wrapped in modern management and automation



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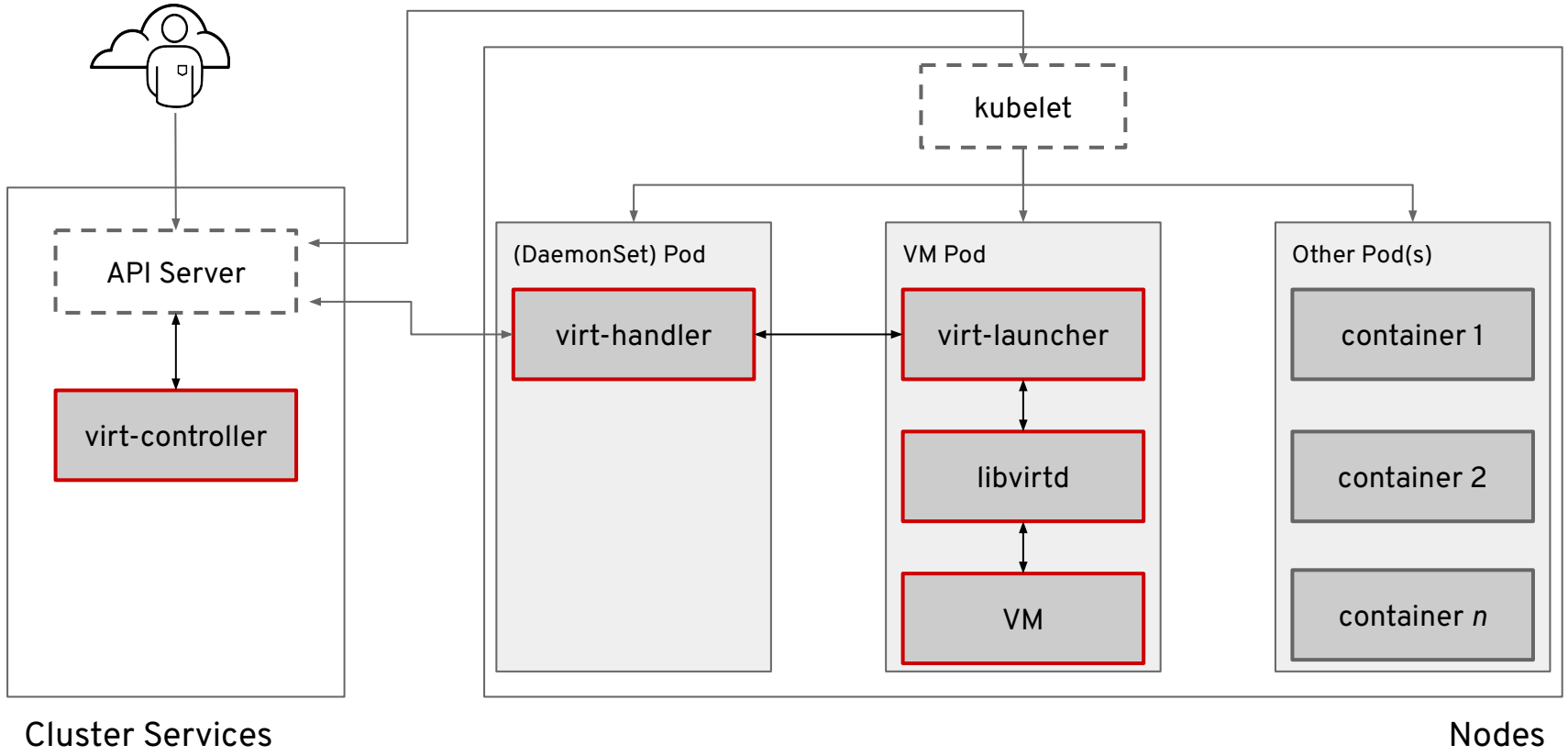
Architectural Overview



Terminology comparison

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

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