

OPENSIFT CONTAINER STORAGE

OpenShift commons Milan

Carlos Torres
Storage SA

Chris Blum
Senior Architect
Storage BU

POSSIBLE STORAGE PROVIDERS

- NFS
- GlusterFS
- OpenStack Cinder

- 
- iSCSI
 - Fibre Channel

- Ceph RBD
- AWS Elastic Block Store (EBS)
- GCE Persistent Disk

- Azure Disk
- Azure File
- FlexVolume

- VMWare vSphere
- Container Storage Interface (CSI)
- Dynamic Provisioning and Creating Storage Classes

STORAGE PROVISIONING IN OPENSIFT

- **STATIC PROVISIONING**

Storage Admin creates storage volumes upfront

OpenShift selects a predefined volume based upon claim, nearest available size

No automated housekeeping - causing administrative burden

Error Prone due to increasing complexity and resulting administrative overhead

- **DYNAMIC PROVISIONING**

OpenShift user requests for storage by persistent volume claim (PVC)

Storage system does the needful in an automated way

Delivers the exact requested size and type storage volume

No administrative overhead and storage admin involvement upfront

Automated housekeeping, better efficiency

4 BASIC STORAGE NEEDS IN OPENSIFT

- **REGISTRY STORE**

Where container base images reside.

By default not redundant, therefore possible point of failure. OCS resolves this.

- **PERSISTENT FILE STORAGE FOR CONTAINERS**

Container application state is held in this persistent file storage

- **PERSISTENT BLOCK STORAGE FOR CONTAINERS**

Specific storage type for specific workloads that require certain performance
i.e. Database workloads, Logging where Elastic or equivalents are involved.

- **EPHEMERAL STORAGE**

Application internal storage, also named EmptyDir.

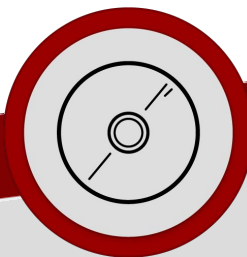
Outside scope for container storage

STORAGE OPTIONS FOR CONTAINERS



STORAGE ARRAYS AND APPLIANCES

- Scalability and high availability fall short of customer needs
- Vendor lock in and high TCO
- Monolithic appliance model



SILOED OR POINT PLAY STORAGE SOLUTIONS

- No hybrid cloud support
- No unified control plane (K8s)
- Lack of automated or dynamic handling of storage needs



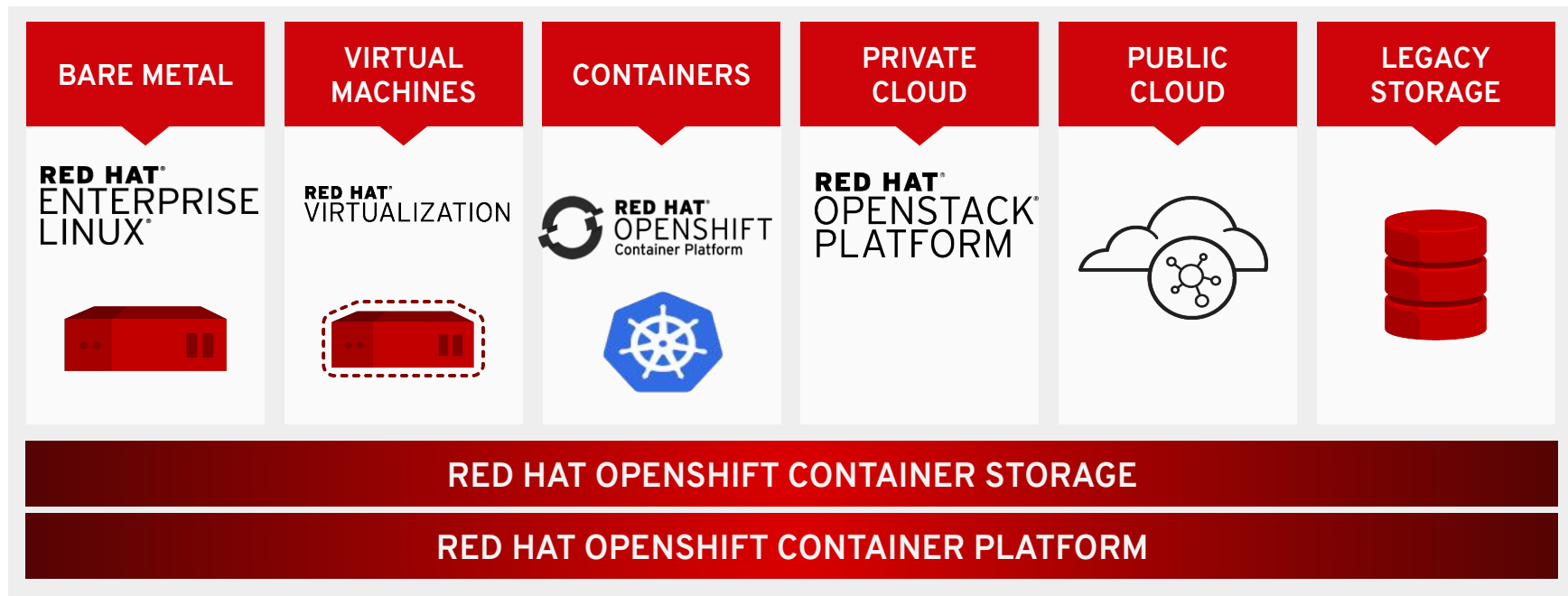
PORTABLE STORAGE ACROSS ON-PREM / MULTIPLE PUBLIC CLOUDS

OpenShift Container Storage from Red Hat

- Runs in public clouds
- Single Vendor Support model
- Seamless user experience for developers and DevOps
- Full integration and all automated

Consistent Storage Experience Across Hybrid Cloud

APPLICATION PORTABILITY AND LOWER COSTS



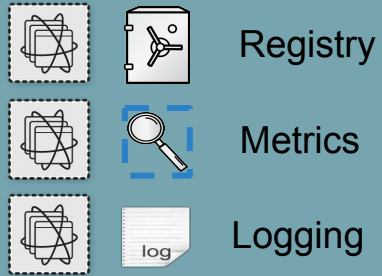
A low-angle, upward-looking perspective of several modern skyscrapers with glass facades. The image is heavily stylized with a semi-transparent red overlay that covers most of the frame. The buildings are arranged in a way that they appear to converge towards the top center, creating a sense of height and scale. The red overlay is not uniform, with some areas being darker than others, and there are some geometric shapes and lines that cut across the image, adding to the abstract, architectural feel.

OCS 3

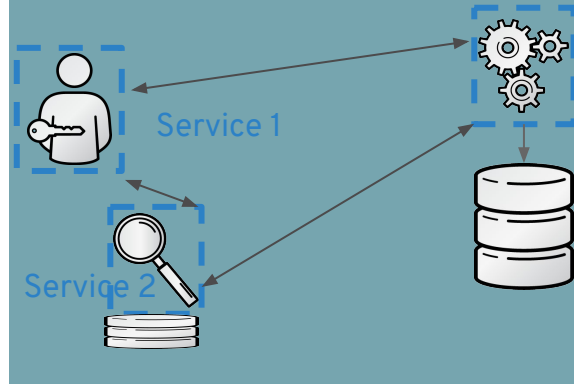
OpenShift Container Storage
Based on GlusterFS technology

OPENSIFT PLATFORM STORAGE NEEDS

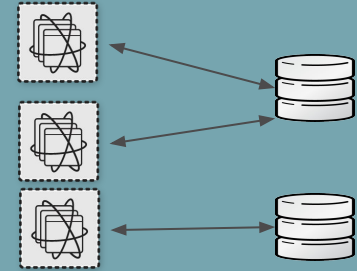
OCP Infrastructure



OCP Application



Local/Ephemeral Storage



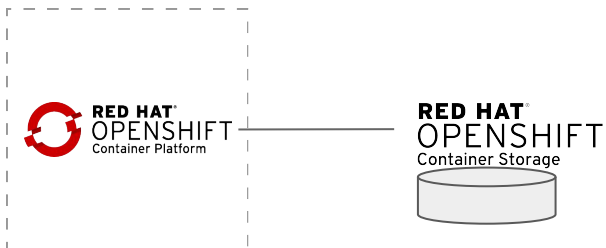
Openshift Container Storage focus

PERSISTENT STORAGE FOR CONTAINERS

VALUE PROPOSITION FOR STORAGE ADMIN VS. DEVOPS

STORAGE FOR CONTAINERS

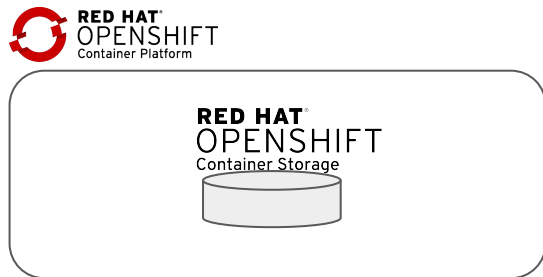
Persona: Storage Admins, Infrastructure Admins



- Leverage existing investment in traditional storage, managed by storage admin
- Attach to stand alone storage

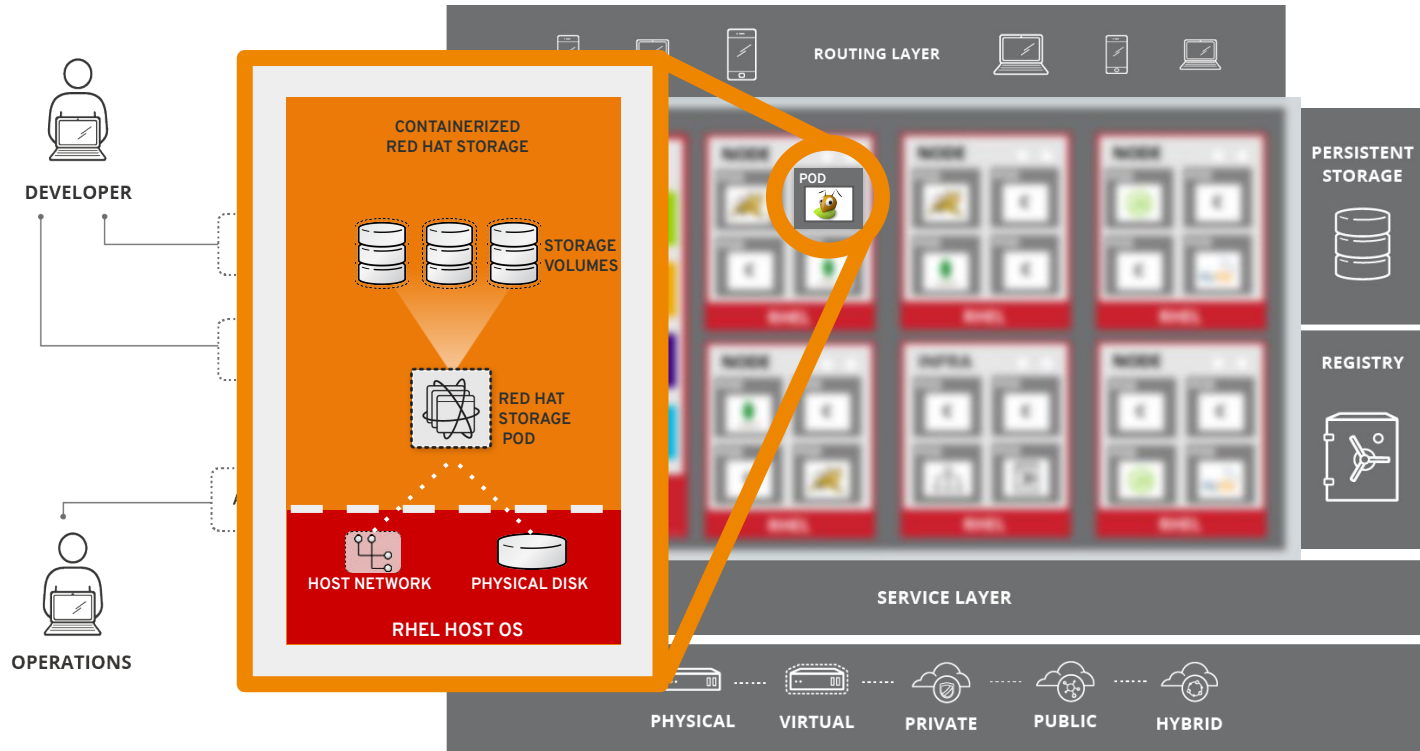
STORAGE IN CONTAINERS

Persona: DevOps, App Architects

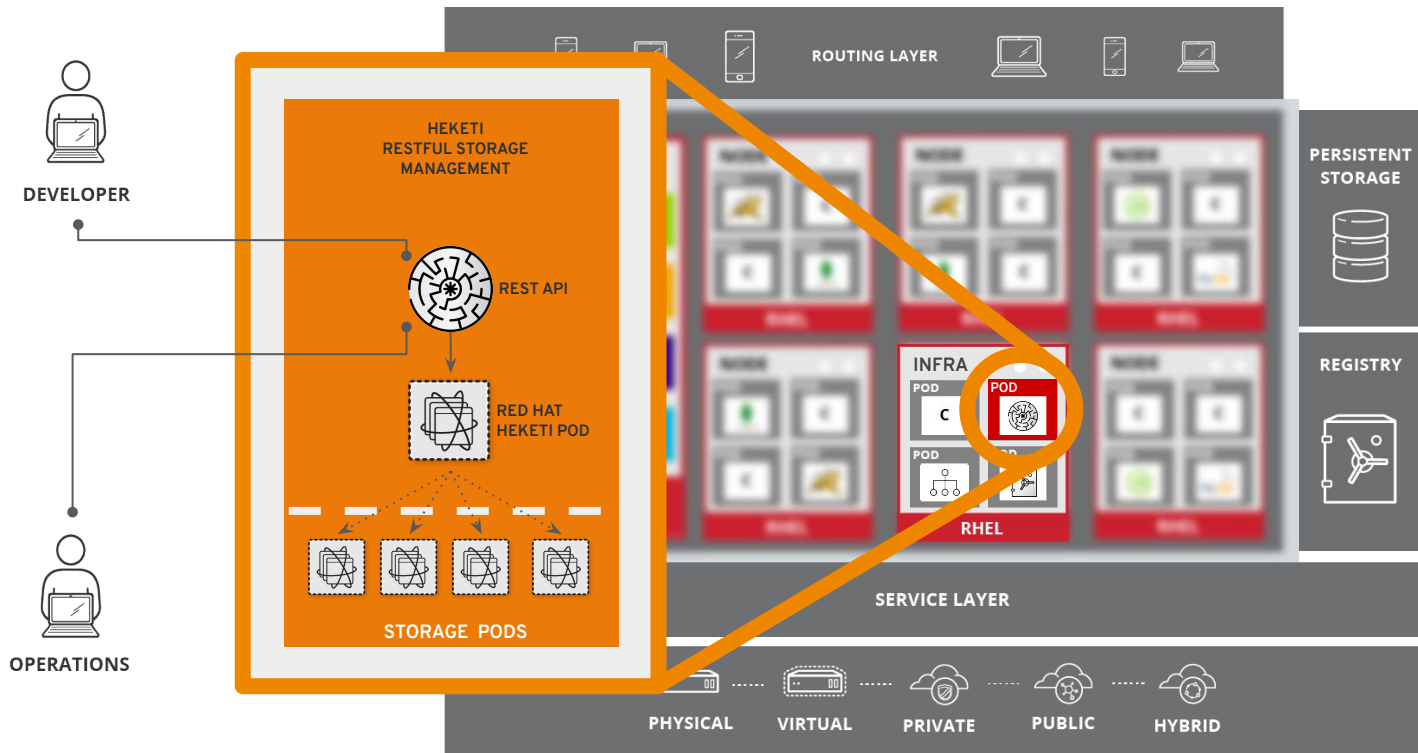


- Highly scalable, enterprise-grade storage, fully integrated into OpenShift Container Platform

OCS Data Plane



OCS Control Plane



OCS product features

More relevant since v3.9

Integration	Features	CNS 3.9	OCS 3.10	OCS 3.11
kubernetes	Support RWX, RWO, ROX	✓	✓	✓
	Dynamic provisioning	✓	✓	✓
	PVC resize (oc edit pvc)	✓	✓	✓
Openshift	Prometheus storage API metrics	☐	✓	✓
	Deploy with OCP ansible playbook	☐	✓	✓
	PVC resize (web-console)	☐	☐	✓
	Storage class volume options	☐	✓	✓
	Infra support registry, metrics, logging	✓	✓	✓
Storage	Block storage with iSCSI support	✓	✓	✓
	File sharing with glusterfs-fuse	✓	✓	✓
	Object with S3/Swift (tech preview)	✓	✓	✓
	Snapshot and geo-replication	✓	✓	✓
	Arbiter volume (replica 2 + metadata)	☐	✓	✓
Infrastructure	Public Azure, AWS, GCP	✓	✓	✓
	Private Openstack	✓	✓	✓
	Virtualization (VMW, RHV)	✓	✓	✓

OCS 3.11 support

Aligned with the OCP lifecycle support

Life Cycle Phases

Full Support

Full support is provided according to the published Scope of Coverage and Service Level Agreement^[5&6]. Likewise, Development Support is provided according to the published Scope of Coverage and Service Level Agreement.

During the Full Support Phase, qualified Critical and Important Security errata advisories (RHSAs) and Urgent and Selected High Priority Bug Fix errata advisories (RHBAs) may be released as they become available, all other available fix and qualified patches may be released via periodic updates. Customers are expected to upgrade their OpenShift environment to the most current supported version. On request, and at Red Hat's discretion, qualified Critical Security errata advisories (RHSAs) and Critical Bug Fix errata advisories (RHBAs) may be made available to non-current minor versions.

Non-current releases within the full support phase which are no longer eligible for maintenance updates of any kind are marked as unmaintained. The following tables outlines the schedule for which minor versions of OpenShift v3 will no longer be eligible for maintenance updates:

v3.X End of Maintenance Schedule

Nov 2018	Jan 2019	Apr 2019	Jul 2019	Oct 2019	Jun 2022
3.0 & 3.1	3.2 & 3.3	3.4 & 3.5	3.6 & 3.7	3.9 & 3.10	3.11

<https://access.redhat.com/support/policy/updates/openshift>

OCP v4 storage integration requirements

New challenge for storage vendors

- Operator framework for standard lifecycle management
- New industry standard storage API with CSI (Container Storage Interface) integrated with kubernetes offering:
 - Storage Classes which provide configuration to CSI drivers
 - Ability to encrypt credentials
 - Multiple CSI drivers can co-exist
 - Ensure that one controller service start at a time

CSI plugin components (API calls)

CONTROLLER Service

- . CreateVolume
- . DeleteVolume
- . ListVolume

- . ControllerPublishVolume
- . ControllerUnpublishVolume
- . ValidateVolumeCapabilities
- . GetCapacity

- . CreateSnapshot
- . DeleteSnapshot
- . ListSnapshot

- . ControllerGetCapabilities

NODE Service

- . NodeStageVolume
- . NodeUnstageVolume

- . NodePublishVolume
- . NodeUnpublishVolume

- . NodeGetVolumeStats

- . NodeGetInfo
- . NodeGetCapabilities

IDENTITY Service

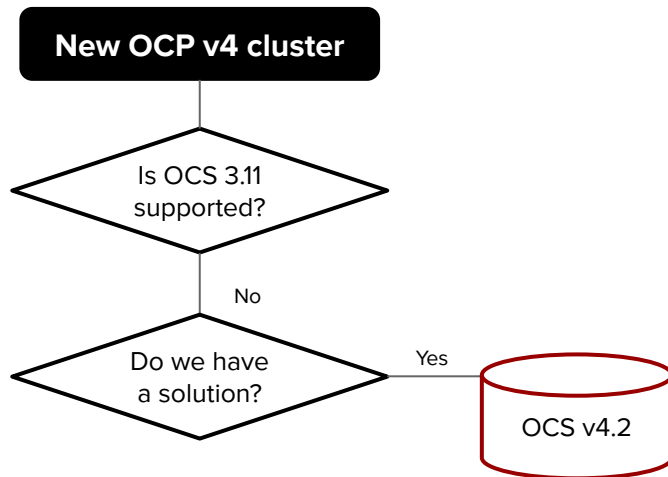
- . GetPluginInfo

- . GetPluginCapabilities

- . Probe(ProbeRequest)

It's OCS 3.11 ready for OCP 4.2?

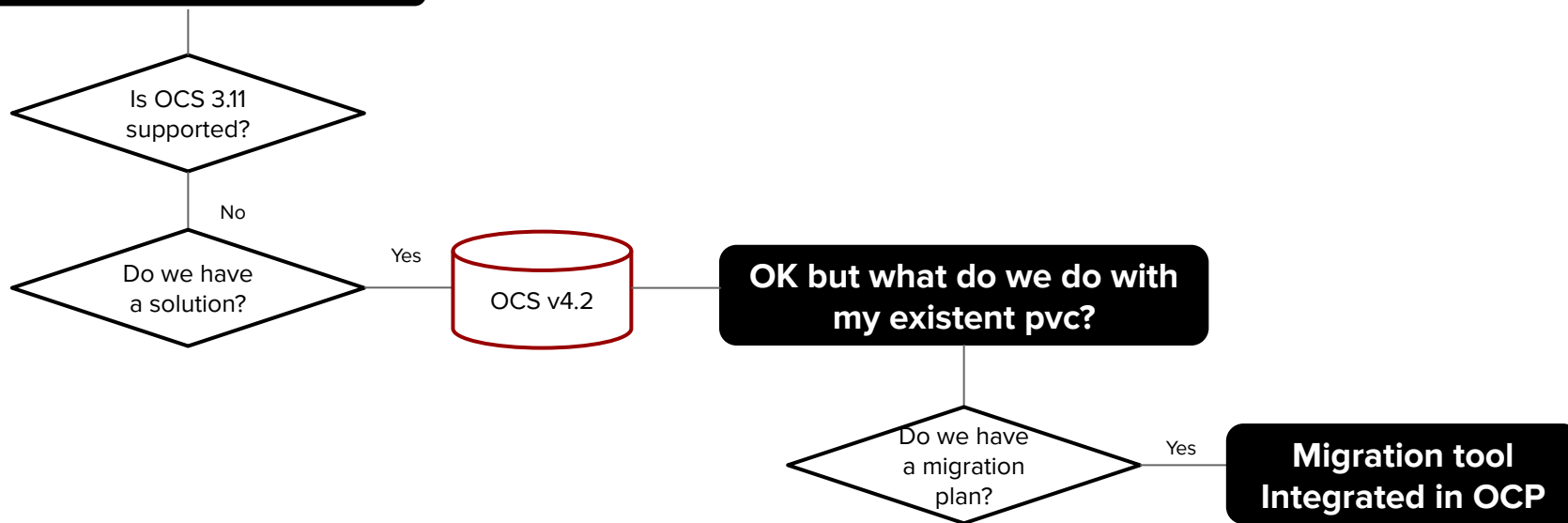
Use case for fresh new OCP 4.2 cluster



It's OCS 3.11 ready for OCP 4.2?

Use case for existent OCP 3.11 to OCP 4.2

From OCP v3.11 to OCP 4.2



A low-angle, upward-looking photograph of several modern skyscrapers. The image is heavily stylized with a semi-transparent red overlay that covers most of the frame. The perspective creates a sense of height and architectural scale. The text is centered in the middle of the image.

OCS 4

OpenShift Container Storage

OPENSIFT OPERATOR FRAMEWORK

- Goal of an Operator: Put operational knowledge into software
- Day-1: Operators implement and automate common installation, configuration
- Day-2: Re-configuration, update, backup, failover, restore
- Kubernetes-native application
(integrating natively with Kubernetes concepts and APIs)

WHAT CHANGED

- **OPENSIFT**

OpenShift transitions from OCP 3 to OCP 4

- **OPENSIFT CONTAINER STORAGE**

also transitions from OCS 3 to OCS 4

- **OCS 4** will be based on **ROOK.IO**, which uses **Red Hat Ceph Storage** and the recently acquired **NooBaa** technology as the **Red Hat Multi Cloud Gateway**

- **Will OCS 3 work with OCP 4?**

NO. [Migration tooling](#) will be available to facilitate the move to OCS 4.x.

- **MIGRATION PATH**

There will be a supported migration path offered for OCS 3 to OCS 4

THE OCS 4 TECHNOLOGY STACK

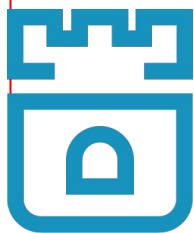


WHY WE MOVE TO CEPH

- **MOTIVATION**

As cloud-native applications have evolved, we are noticing more customer requests for a native, easy to use S3/object interface (apps like registry, chargeback, metering, AI/ML) in addition to traditional persistent volumes (RWX & RWO) on the platform.

By leveraging Ceph, OCS can now provide a production-grade S3 interface in addition to persistent volumes for stateful applications.



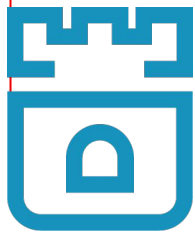
ROOK

- ROOK Project

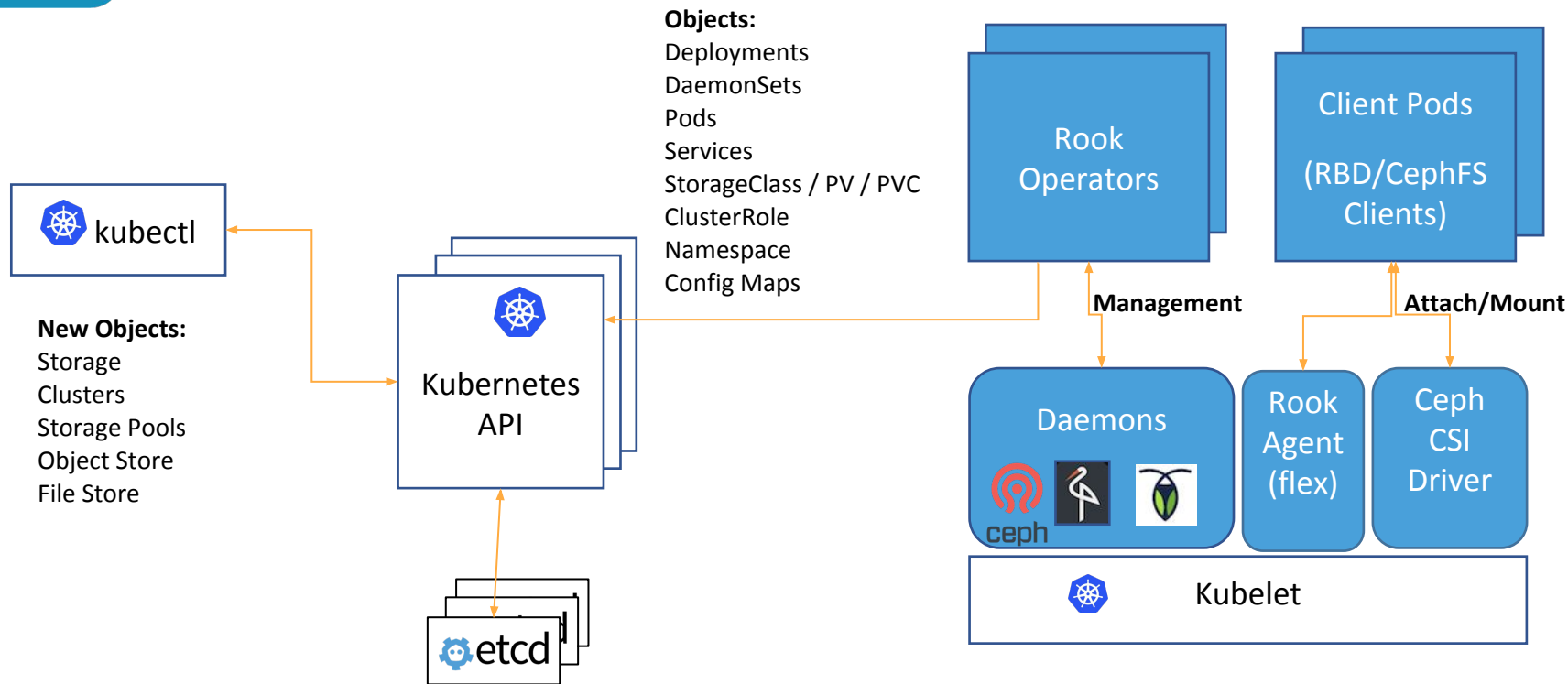
CLOUD-NATIVE STORAGE ORCHESTRATOR
automated deployment and life-cycle management

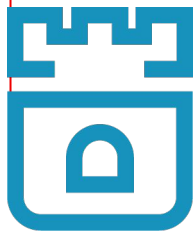
- Bootstrapping
- Configuration, provisioning, scaling, upgrading, migration, disaster recovery, monitoring, and resource management

<https://rook.io>



ROOK ARCHITECTURE





CEPH ON OPENSSHIFT WITH ROOK



Volume Claim



Volume Claim



 ROOK pods

 Agent

 Agent

 Operator

 Agent

 Agent

 Agent

 Mon  MGR

 MDS

 Mon  RGW

 RGW

 Mon





NOOBAA.IO

ABOUT NOOBAA

- **OCS MULTI CLOUD GATEWAY (NOOBAA)**

NooBaa provides a consistent S3 endpoint across different infrastructures (AWS, Azure, GCP, Bare Metal, VMware)

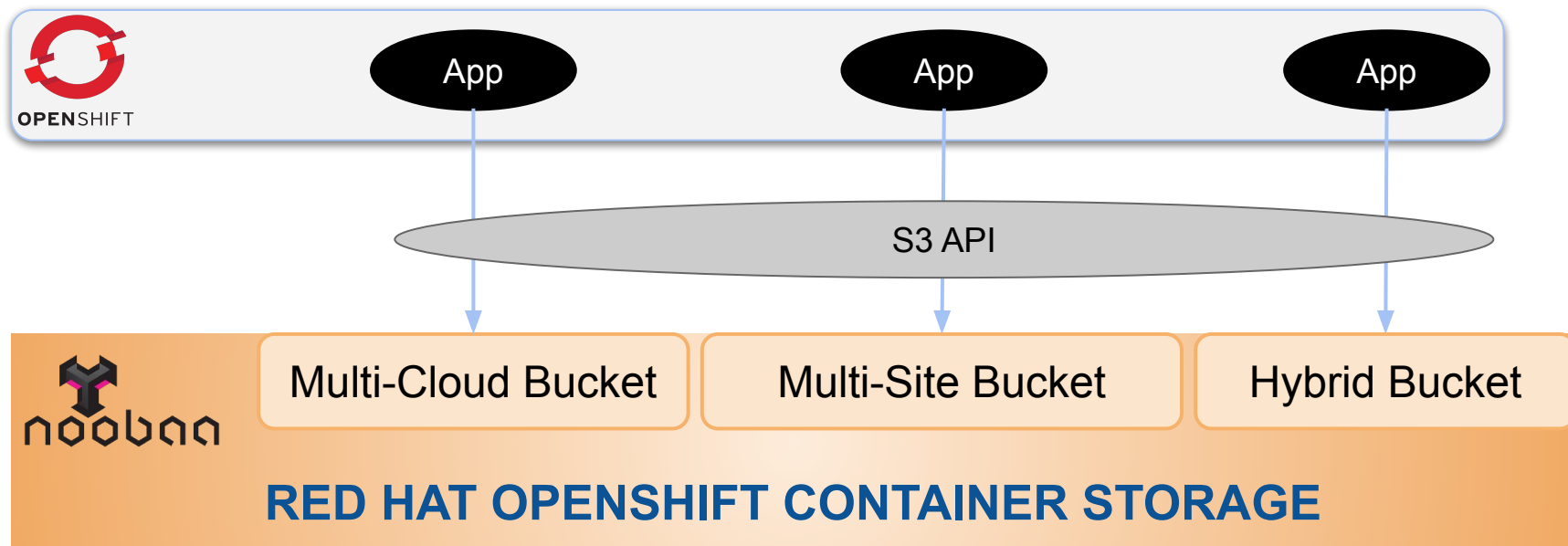
- **OCS MCG FUNCTIONALITY**

Multi Cloud Object Gateway: Active/Active read/write across different clouds.

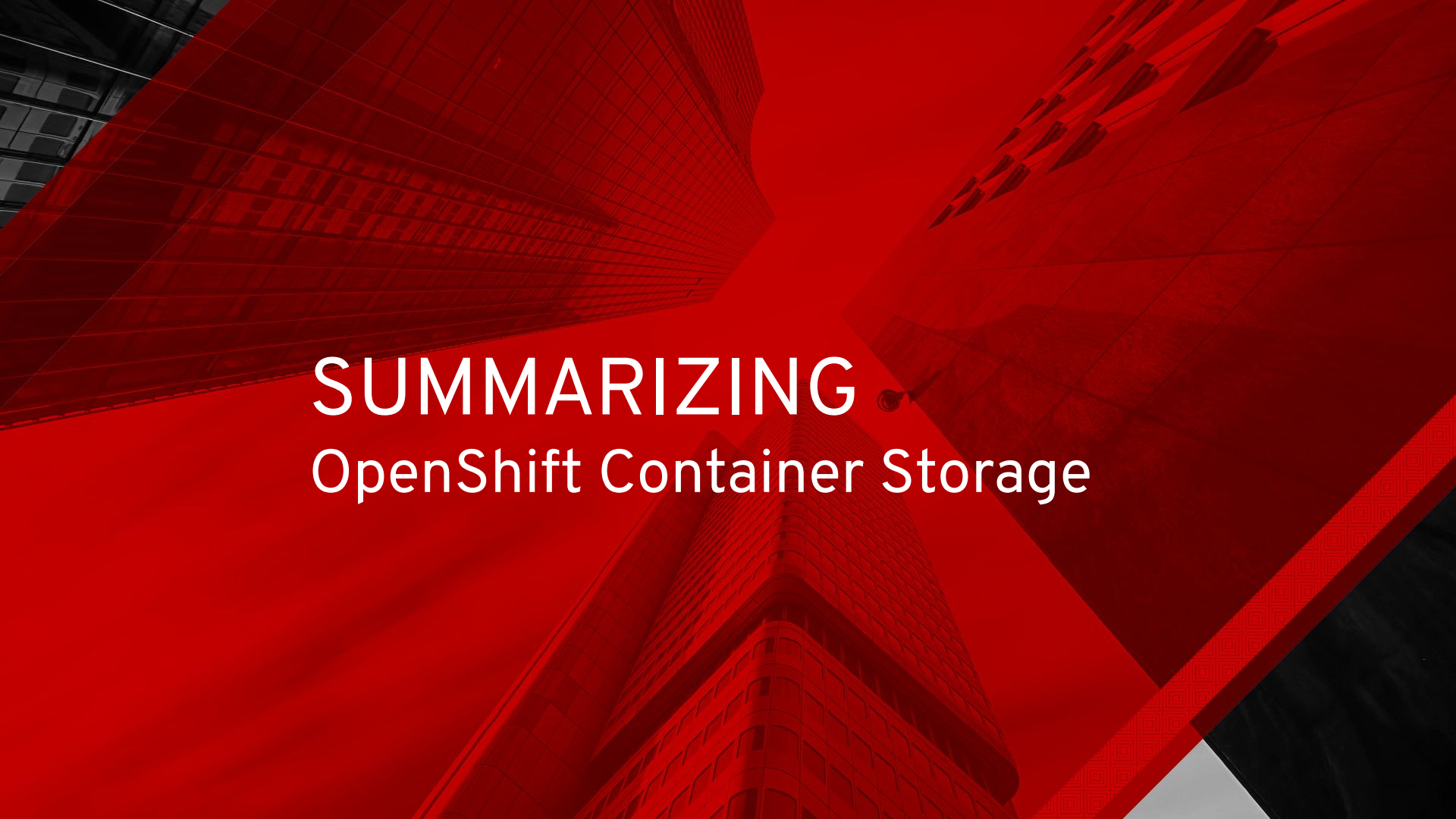
- **PRODUCTIZATION**

productized as RHOCS Multi-Cloud Gateway, starting with OCS 4.2 (NooBaa, is upstream only, downstream **OCS Multi-Cloud-Gateway**)

MULTI-CLOUD OBJECT GATEWAY



ACTIVE - ACTIVE MULTI CLOUD - READ/WRITE

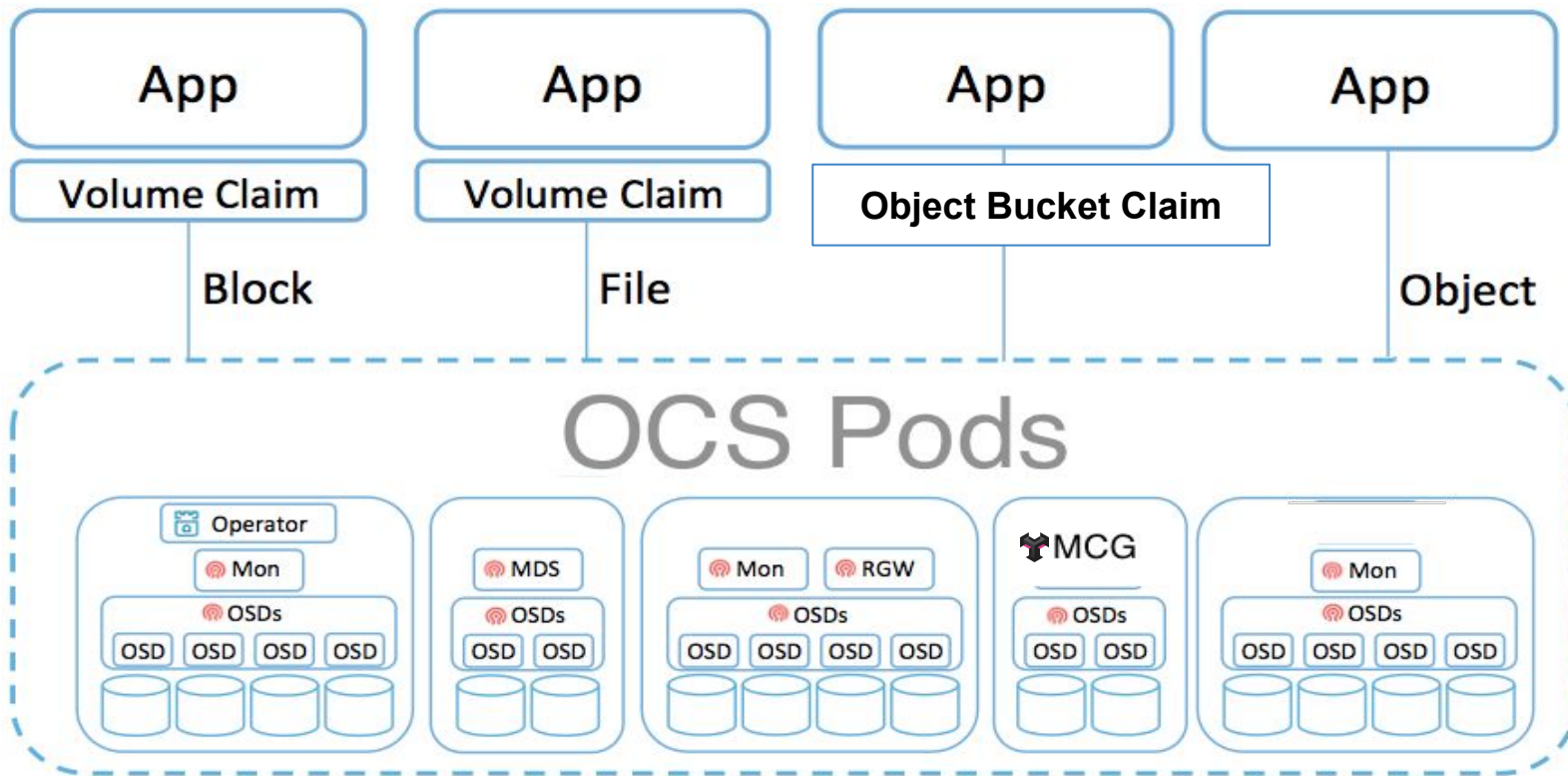
A low-angle, upward-looking perspective of several modern skyscrapers. The image is heavily stylized with a semi-transparent red overlay that covers most of the frame. The buildings' glass facades and structural lines are visible through the red. The text is centered in the middle of the image.

SUMMARIZING

OpenShift Container Storage

OCS 4.x Operator Install, Upgrade, Expansion

OCS Operator based on Rook.io with Operator Lifecycle Manager (OLM)

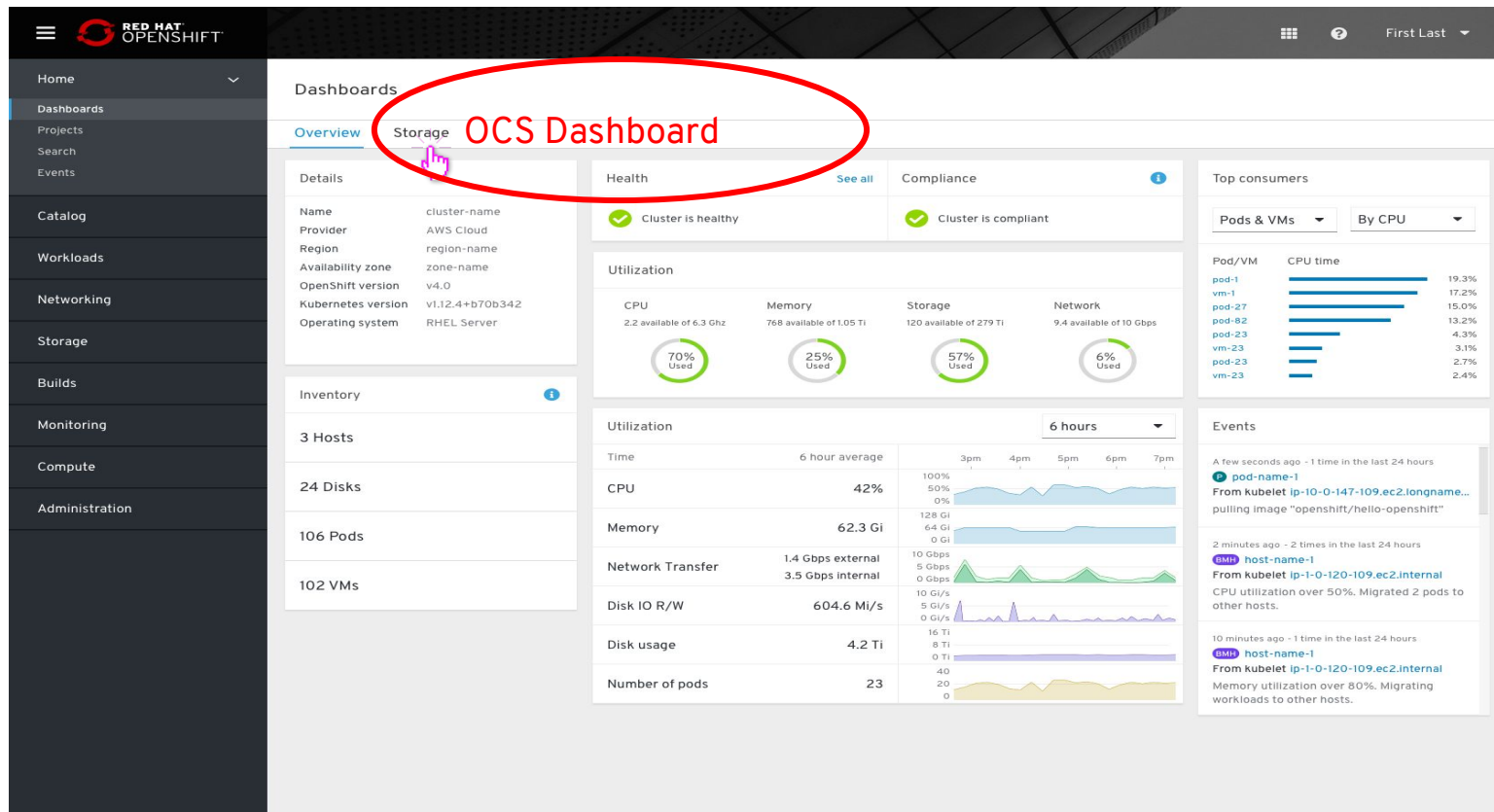


OCS 4.x Operator Driven Install from OperatorHub

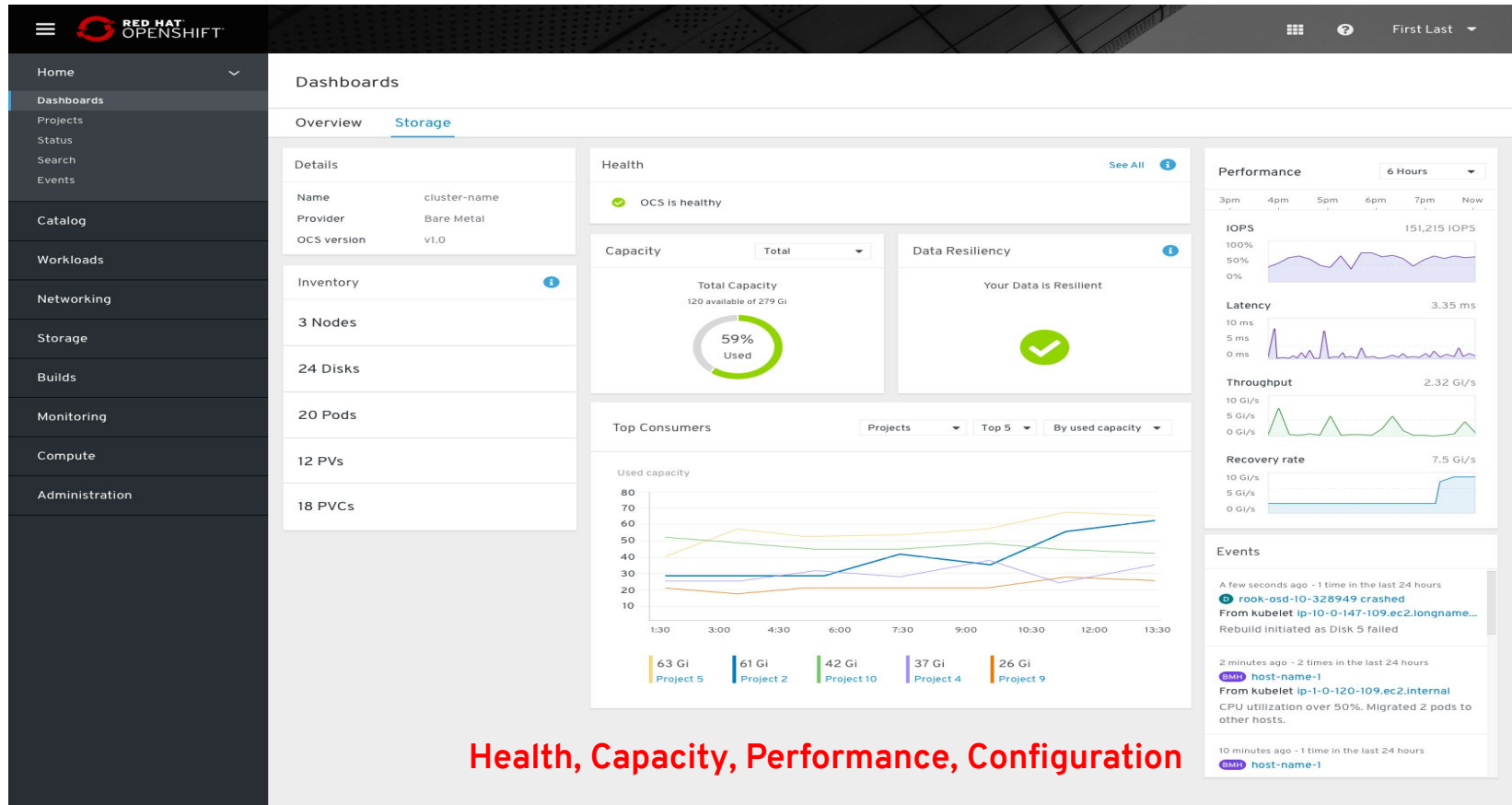
The screenshot displays the OpenShift OperatorHub interface. On the left is a dark sidebar with navigation links: Home, Catalog (expanded), Developer Catalog, Installed Operators, OperatorHub (selected), Operator Management, Workloads, Networking, Storage, Builds, Monitoring, Compute, and Administration. The main content area is titled 'OperatorHub' and includes a description of operators. Below this, there are filters for 'All Items' (25 items), 'Database', 'Integration & Delivery', 'Logging & Tracing', 'Monitoring', 'Networking', 'OpenShift Optional', 'Streaming & Messaging', and 'Other'. A 'Filter by keyword...' input field is present. The operators are listed in a grid, each with an icon, name, provider, and description. The 'OCS Operator' is highlighted with a red circle. The operators shown are: AMQ Streams (Red Hat), Automation Broker Operator (Red Hat), OpenShift Container Storage Dependent Mode (Red Hat), OpenShift Container Storage Independent Mode (Red Hat), CockroachDB (Helm Community), Couchbase Operator (Couchbase), Descheduler (Red Hat), Dynatrace OneAgent (Dynatrace LLC), and others.

OCS Operator

INTEGRATED MONITORING AND MANAGEMENT

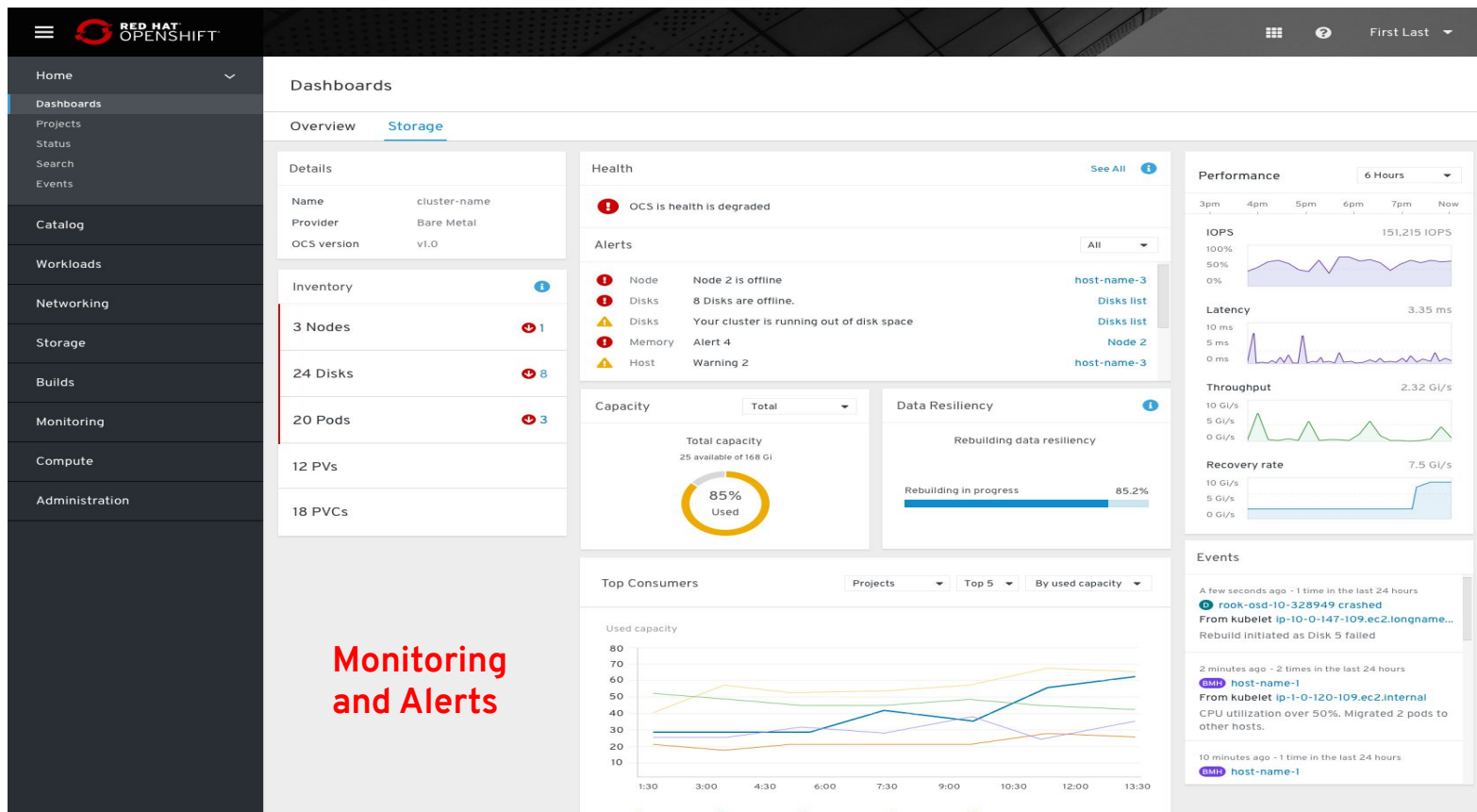


OCS INTEGRATED DASHBOARD



Health, Capacity, Performance, Configuration

OCS INTEGRATED DASHBOARD - ALERTS



FUNCTIONALITIES AND SUPPORTABILITY

- **FUNCTIONALITIES**

- OCS 4.2 has **FILE, BLOCK, and OBJECT** support
- OCS 4.2 supports **Prometheus**
- OCS 4.2 will be **FIPS** compliant

- **SUPPORTABILITIES**

- **VMWare**

storage provisioned from VMDKs and RDMs

- **PUBLIC CLOUD**

supported in all public cloud environments where OCS 3 is supported today, including AWS (OCS 4.2), Azure and Google Cloud (OCS 4.3)

ANY CLOUD, ANY APP, ONE STORAGE EXPERIENCE



RED HAT OPENSIFT CONTAINER STORAGE

BARE METAL

RED HAT
ENTERPRISE
LINUX



VIRTUAL

vm



CONTAINERS



OPENSIFT
ENTERPRISE
by Red Hat



PUBLIC CLOUD

AWS, AZURE, GCP

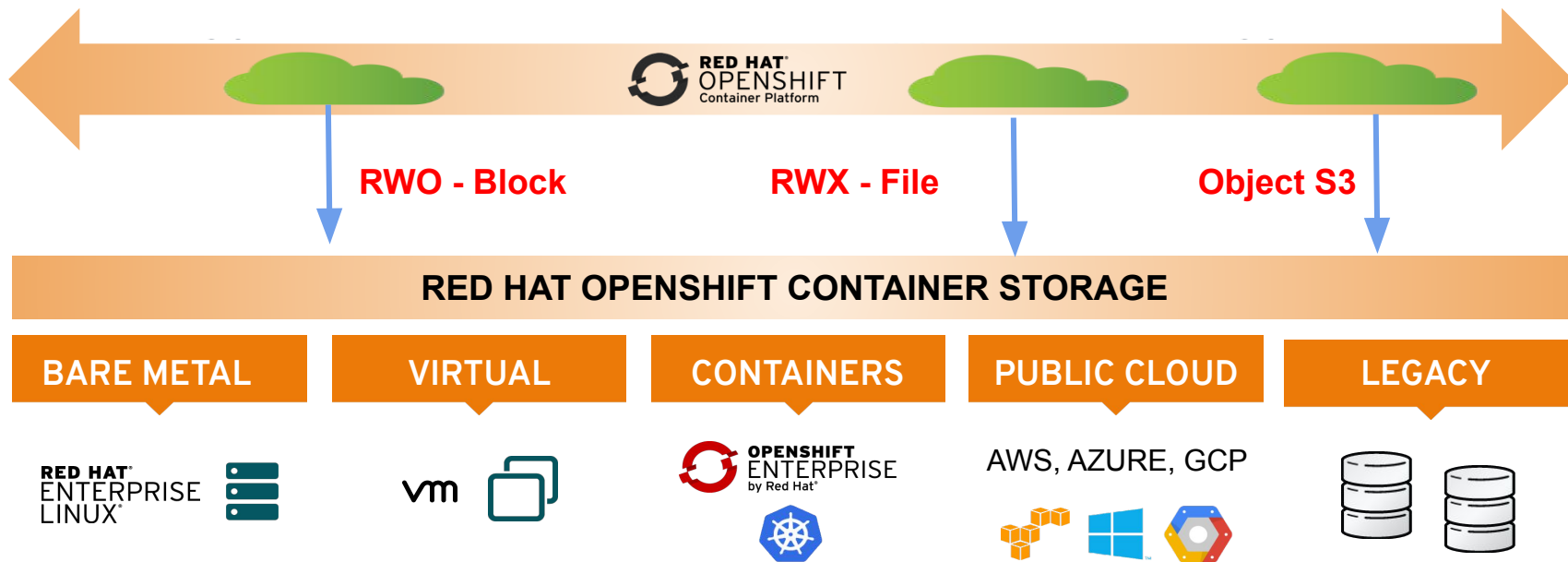


LEGACY



Consistent consumption, management, operations
Future Proof against cloud or infrastructure lock-in

COMPLETE STORAGE FOR CONTAINER PLATFORM



Provides Storage for All Apps and infrastructure Services
in their native interfaces

SKU's

- **NO SKU CHANGES**

OCS 3.X and OCS 4.x will have the same subscription model; there are no plans to change this.

Please note that customers will still be buying and consuming OCS (even though the underlying technology will be different) using the same SKUs that we have today which will provide access to the new Ceph-related content set.

THE FACTS - SUMMARY

- CONTAINERS ARE SYSTEM PROCESSES AND ARE VOLATILE BY DEFAULT
- CONTAINERS THEREFORE NEED PERSISTENT STORAGE
- **OCP 4 USES OPERATORS** TO MANAGE THE ENTIRE OCP CLUSTER
- RHOCS NOW CHANGES AND WILL NOW USE **CEPH** AND **NOOBAA** 'UNDER THE HOOD'
- **OCS 4.2** IS PLANNED TO BECOME GENERAL AVAILABLE STARTING AT **OCP 4.2**
- **OCS 4.2** WILL OFFER **FILE, BLOCK AND OBJECT** STORAGE
- **SKU** PROPOSITION WILL REMAIN THE SAME

Thank you

Red Hat is the world's leading provider of enterprise open source software solutions. Award-winning support, training, and consulting services make Red Hat a trusted adviser to the Fortune 500.



linkedin.com/company/red-hat



youtube.com/user/RedHatVideos



facebook.com/redhatinc



twitter.com/RedHat

REFERENCE HYPERLINKS

OCS Sales Enablement

<https://mojo.redhat.com/docs/DOC-1204753>

Velero Migration Tooling

<https://youtu.be/VvqsKjAvCx4>

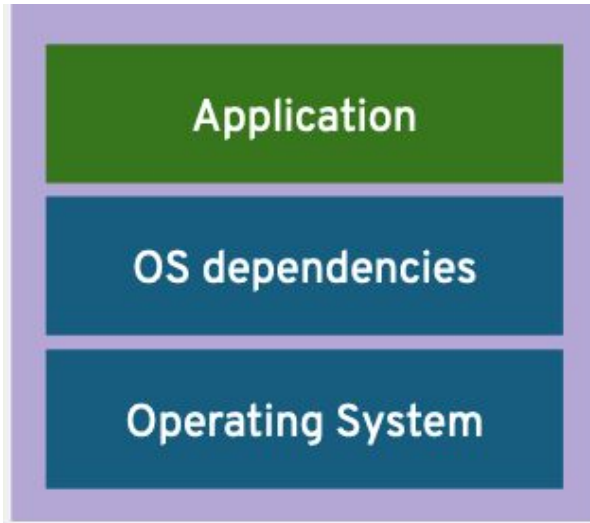
OpenShift Storage for Admins

<http://admin-labguides.6923.rh-us-east-1.openshiftapps.com/workshop/ocp-for-admins/lab/environment>

AGENDA - Part I

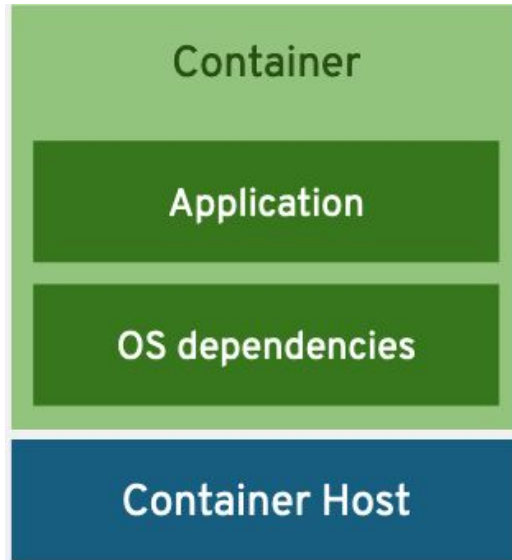
- APPLICATION PROPERTIES AND BEHAVIOUR
- TRANSITION FROM APPLICATION INTO MICROSERVICES
- TYPICAL PROPERTIES OF A MICROSERVICE
- APPLICATION STATE AND PERSISTENCE
- STORAGE PROVIDERS THAT CAN BE CONSUMED BY OPENSIFT
- STORAGE PROVISIONING OPTIONS
- THE FOUR STORAGE NEEDS IN OPENSIFT
- OCS: VALUE ADD TO THE BUSINESS
- FACTS

APPLICATION PROPERTIES AND BEHAVIOUR



TRADITIONAL APPLICATION

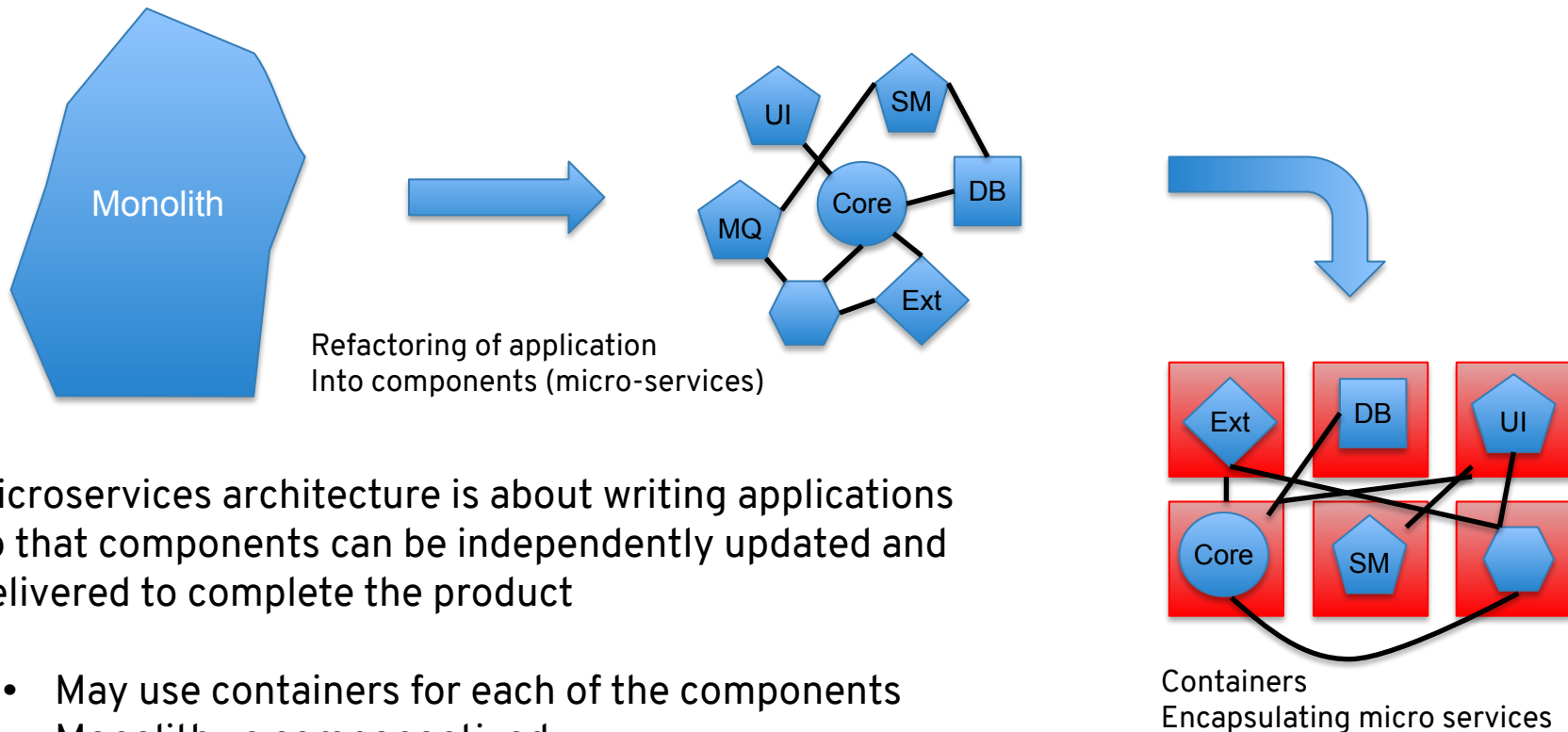
APPLICATION PROPERTIES AND BEHAVIOUR



MODERN APPLICATION

MICRO-SERVICES & CONTAINERS

Microservices architecture is different from containers

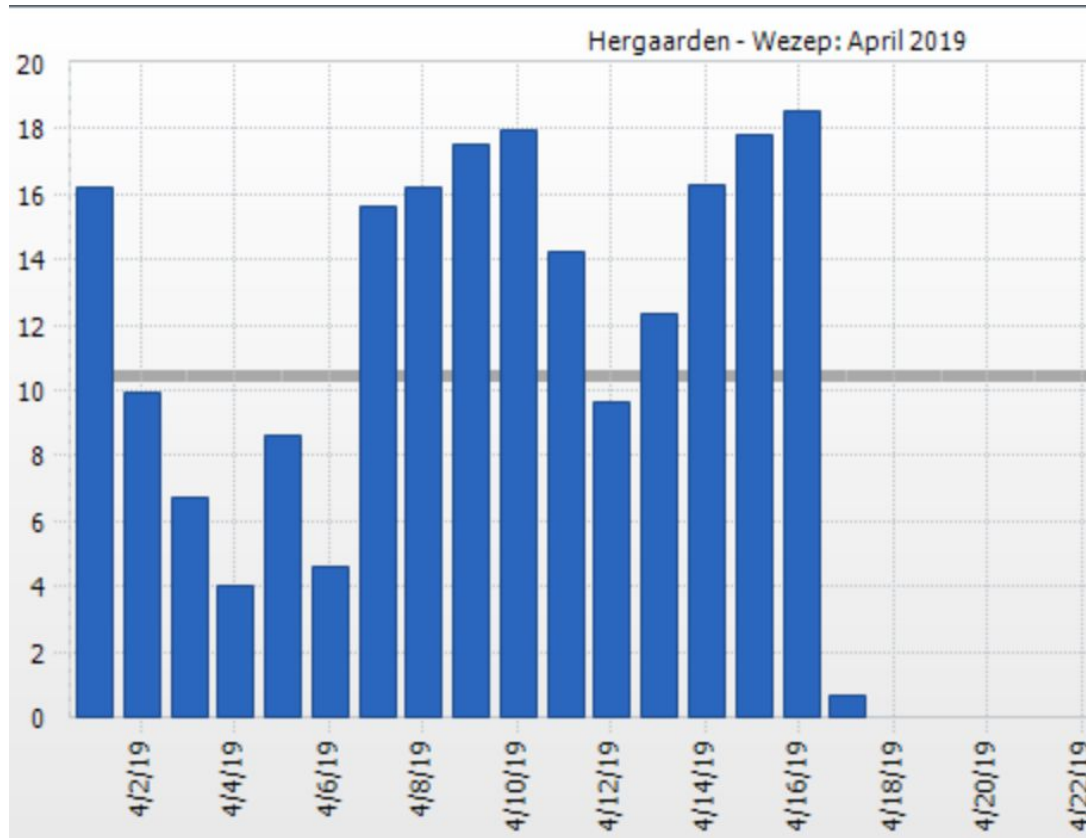


- Microservices architecture is about writing applications so that components can be independently updated and delivered to complete the product
 - May use containers for each of the components
 - Monolith vs componentized
 - Each component can evolve independently

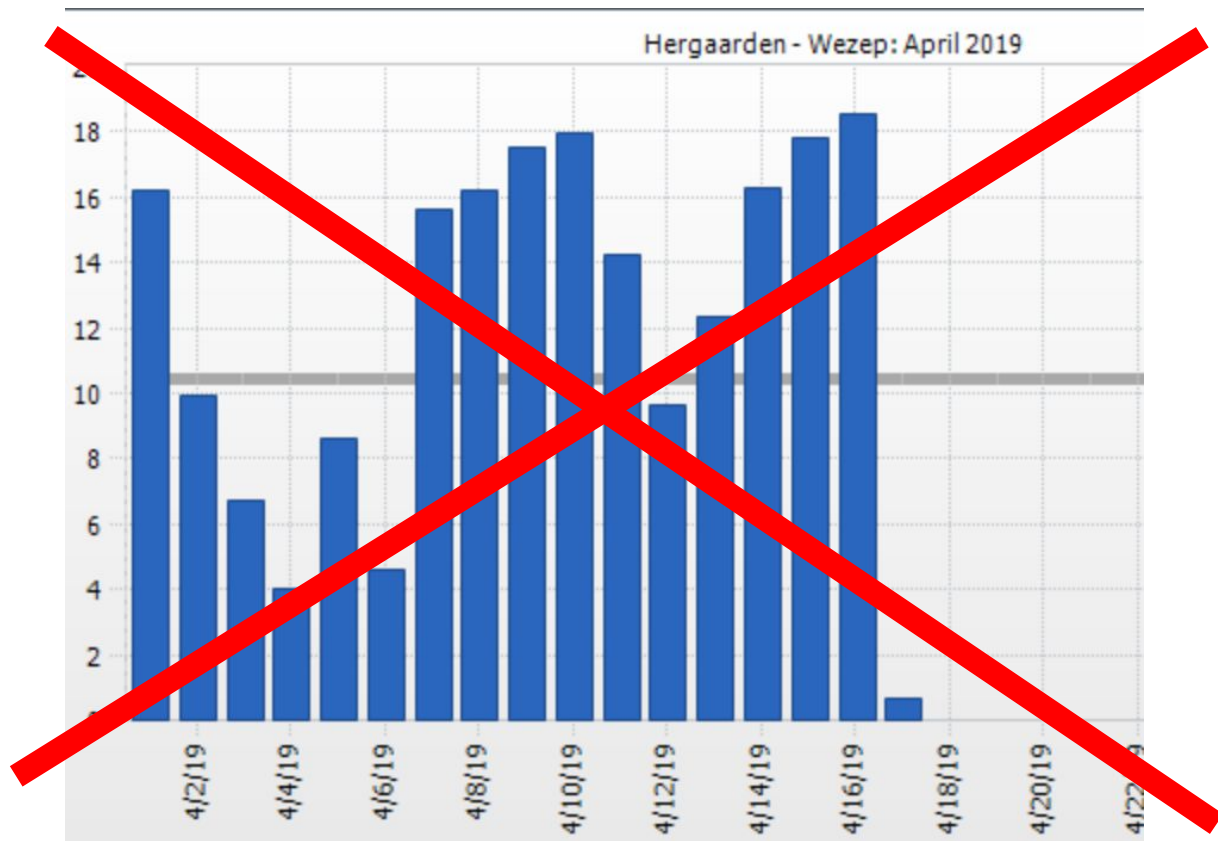
A CONTAINER IS A SYSTEM PROCESS

```
root      1998      1  0 Apr15 ?          00:00:06 /usr/sbin/nmbd -D
root      2017      1  0 Apr15 ?          00:00:01 /usr/sbin/smbd -D
root      2036     2017  0 Apr15 ?          00:00:00 /usr/sbin/smbd -D
104       2040      1  0 Apr15 ?          00:00:00 /usr/bin/dbus-daemon --system
root      2090      1  0 Apr15 ?          00:00:00 nginx: master process /usr/sbin/
www-data  2091     2090  0 Apr15 ?          00:00:00 nginx: worker process
www-data  2092     2090  0 Apr15 ?          00:00:21 nginx: worker process
www-data  2093     2090  0 Apr15 ?          00:00:22 nginx: worker process
www-data  2095     2090  0 Apr15 ?          00:00:21 nginx: worker process
ntp       2108      1  0 Apr15 ?          00:00:24 /usr/sbin/ntpd -p /var/run/ntpd.
root      2136      1  0 Apr15 ?          00:00:00 /usr/sbin/sshd
nobody    2161      1  0 Apr15 ?          00:00:02 /usr/sbin/thd --daemon --trigger
root      2176      1  0 Apr15 tty1        00:00:00 /sbin/getty --noclear 38400 tty1
root      2177      1  0 Apr15 tty2        00:00:00 /sbin/getty 38400 tty2
root      2178      1  0 Apr15 tty3        00:00:00 /sbin/getty 38400 tty3
root      2179      1  0 Apr15 tty4        00:00:00 /sbin/getty 38400 tty4
root      2180      1  0 Apr15 tty5        00:00:00 /sbin/getty 38400 tty5
root      2181      1  0 Apr15 tty6        00:00:00 /sbin/getty 38400 tty6
root      3704      2  0 04:17 ?          00:00:02 [kworker/u2:2]
root      3761      2  0 05:39 ?          00:00:00 [kworker/u2:0]
root      4051     2136  6 10:40 ?          00:00:00 sshd: pi [priv]
```

A SYSTEM PROCESS THAT PRODUCES STATE



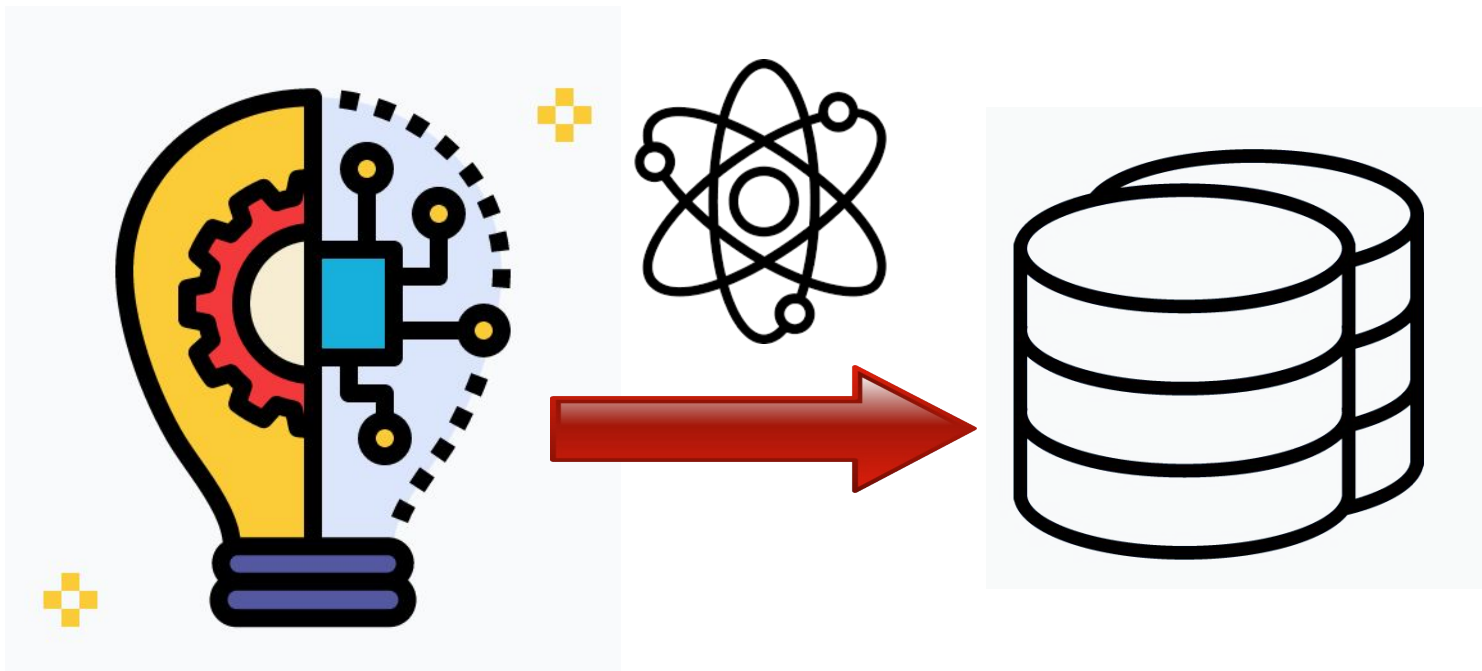
A STOPPED PROCESS CAUSES LOSS OF THAT STATE



NEED FOR PERSISTENT STORAGE

CONTAINERS NEED STORAGE

Containers are not persistent by default. App data is lost when containers die.



RED HAT SOLUTION: RHOCS

RED HAT OFFERS A FULLY INTEGRATED STORAGE SOLUTION FOR OPENSIFT

Objection: *“We don’t need your storage, we already have an existing storage solution present”*



LEVERAGE LEGACY STORAGE... WITH OPENSIFT CONTAINER STORAGE CONVERGED MODE

PERSISTENT VOLUMES PROVIDED BY OPENSIFT CONTAINER STORAGE

RED HAT
OPENSIFT
Container Storage



OPENSIFT
CONTAINER
STORAGE POD



BLOCK
DEVICE



OPENSIFT
CONTAINER
STORAGE POD



BLOCK
DEVICE



OPENSIFT
CONTAINER
STORAGE POD



BLOCK
DEVICE



OPENSIFT
CONTAINER
STORAGE POD



BLOCK
DEVICE



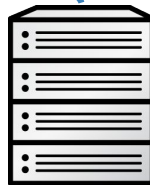
OPENSIFT
CONTAINER
STORAGE POD



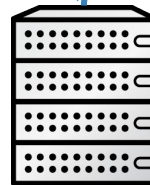
BLOCK
DEVICE



FIBRE-CHANNEL
ARRAY

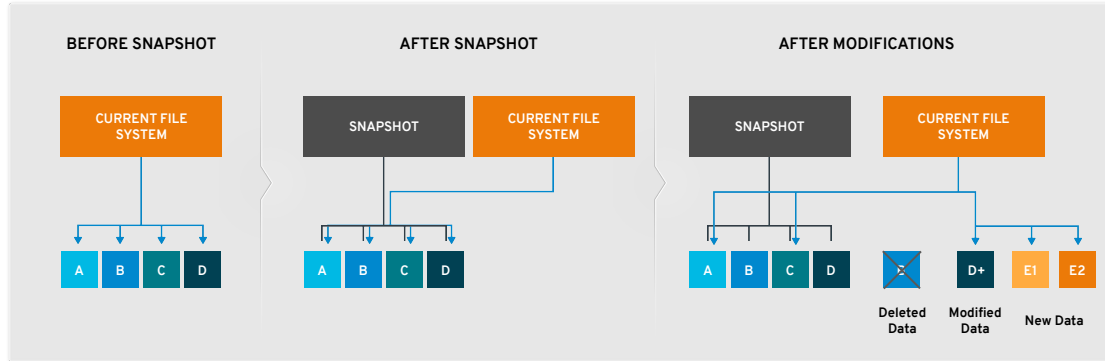
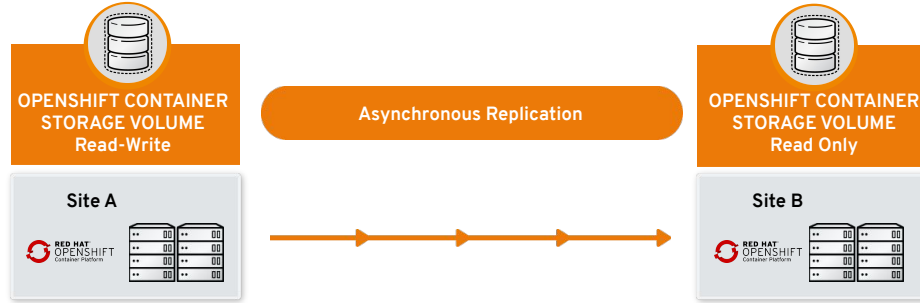


ISCSI SAN



SHARED SAS

SNAPSHOTS AND GEO-REPLICATION

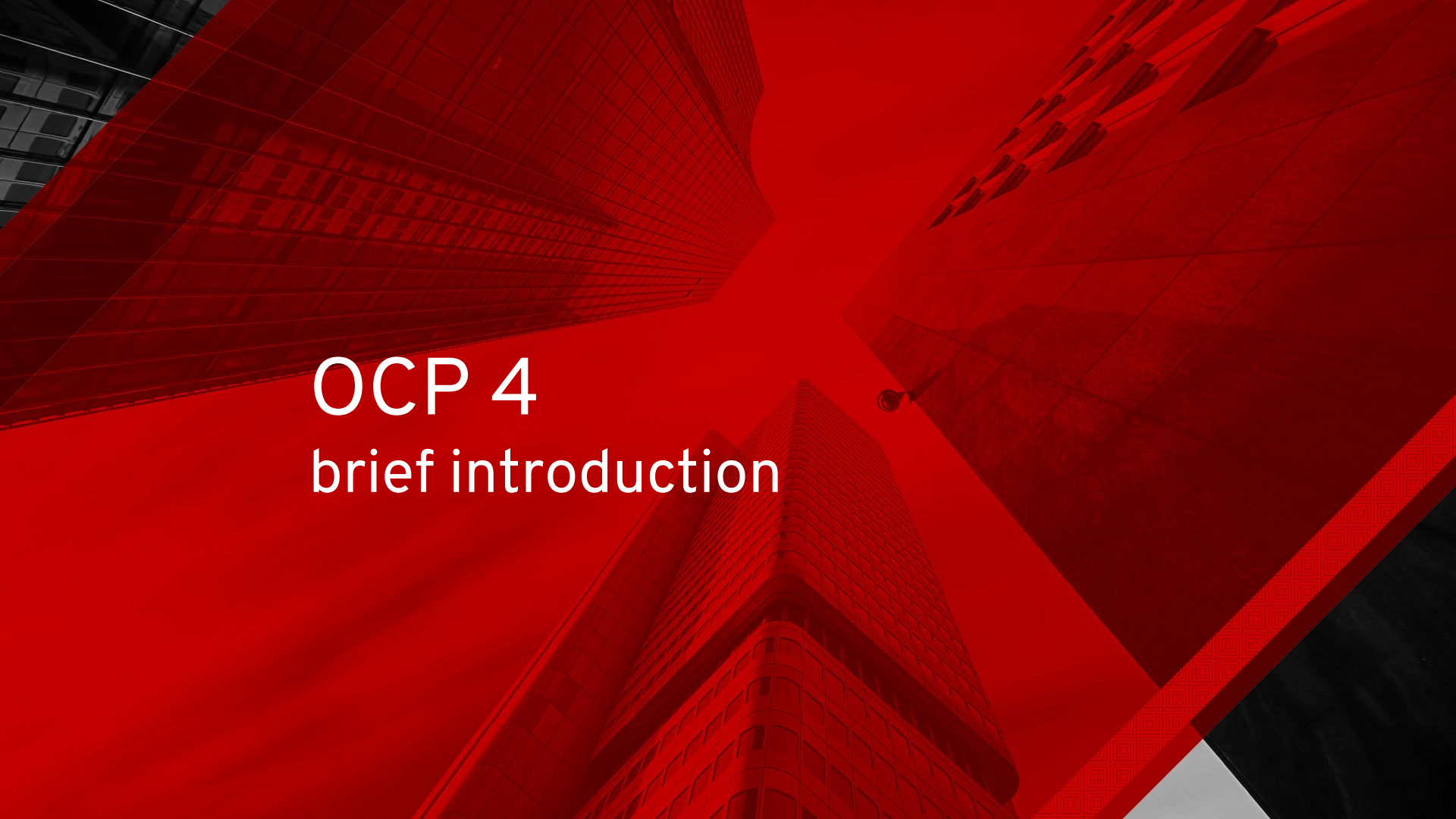


SUMMARY FACTS

- CONTAINERS ARE SYSTEM PROCESSES
- CONTAINER STATES ARE VOLATILE BY DEFAULT
- CONTAINERS THEREFORE NEED PERSISTENT STORAGE
- EXISTING STORAGE ENTITIES CAN BE USED IN CONJUNCTION WITH OPENSIFT
- EXISTING STORAGE ENTITIES OFTEN JUST ADDRESS ONE SINGLE PART OF THE 4 NEEDS
- PROVISIONING AND HANDLING OF CONTAINER STORAGE BECOMES COMPLEX SOON
- DIFFERENT STORAGE NEEDS IN OPENSIFT REQUIRE DIFFERENT SOLUTIONS
- RED HAT OFFERS **OCS** - NOT JUST ANOTHER STORAGE SOLUTION - A STORAGE MANAGER
- OCS: VALUE ADD TO THE BUSINESS - NO DIY PLUMBING OF EXISTING THINGS -

AGENDA - Part II

- OCP 4 - BRIEF INTRODUCTION
- INSTALLATION EXPERIENCES: IPI & UPI
- OPERATOR FRAMEWORK
- WHAT HAS CHANGED WITH RHOCS
- COMPONENTS: ROOK, CEPH & NOOBAA
- RED HAT ENTERPRISE SOLUTION
- FUNCTIONALITIES AND SUPPORTABILITY
- THE FACTS - SUMMARY

A low-angle, upward-looking photograph of several modern skyscrapers. The image is heavily stylized with a semi-transparent red overlay that covers most of the frame. The buildings' facades, with their grid-like window patterns, are visible through the red. The sky is a solid, bright red. The text "OCP 4" and "brief introduction" is centered in white. In the bottom right corner, there is a small black and white geometric shape.

OCP 4

brief introduction



TRUSTED ENTERPRISE KUBERNETES

- Trusted Host, Content, Platform
- Full Stack Automated Install
- Over the Air Updates & Day 2 Mgt

A CLOUD-LIKE EXPERIENCE, EVERYWHERE

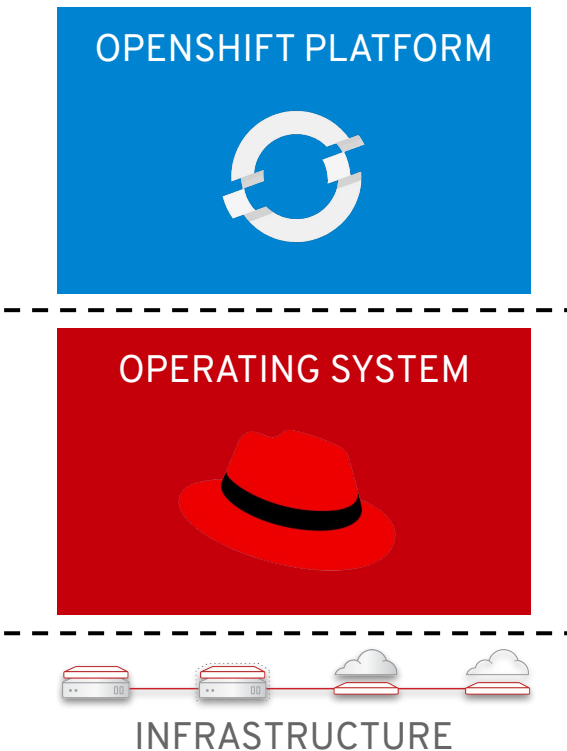
- Hybrid, Multi-Cluster Management
- Operator Framework
- Operator Hub & Certified ISVs

EMPOWERING DEVELOPERS TO INNOVATE

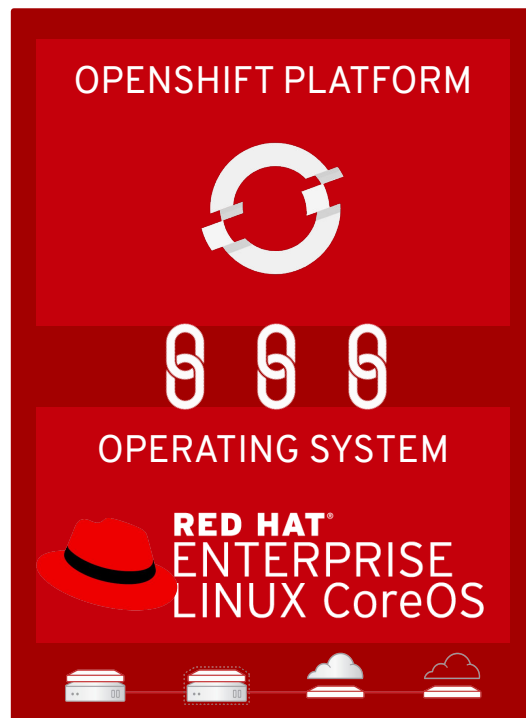
- OpenShift Service Mesh (Istio)
- OpenShift Serverless (Knative)
- CodeReady Workspaces (Che)

FULL STACK AUTOMATED INSTALL + UPGRADE

OPENSIFT 3



OPENSIFT 4



INSTALLATION EXPERIENCES

OPENSIFT CONTAINER PLATFORM

FULL STACK AUTOMATED

Simplified opinionated “Best Practices” for cluster provisioning

Fully automated installation and updates including host container OS.



PRE-EXISTING INFRASTRUCTURE

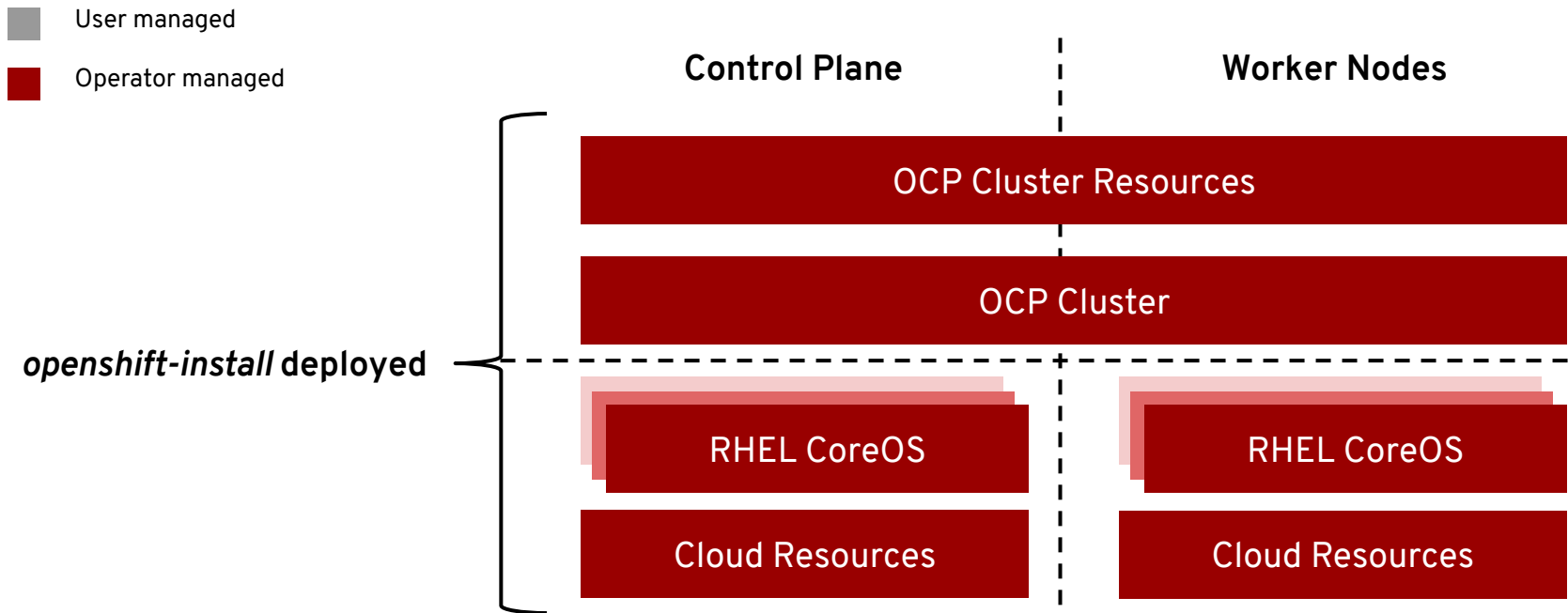
Customer managed resources & infrastructure provisioning

Plug into existing DNS and security boundaries



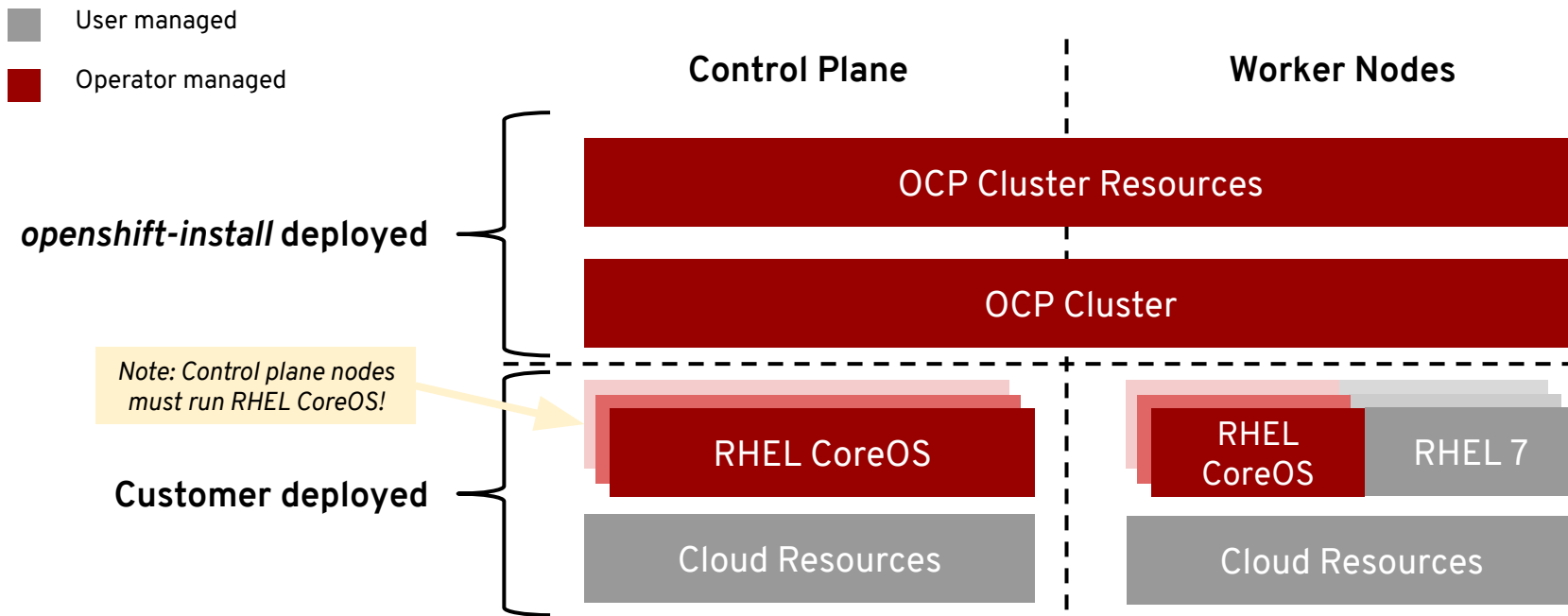
IPI: FULL STACK AUTOMATED DEPLOYMENT

Day 1: openshift-install - Day 2: Operators



UPI: DEPLOYING TO EXISTING INFRASTRUCTURE

Day 1: openshift-install - Day 2: Operators + Customer Managed Infra & Workers



RED HAT ENTERPRISE LINUX

RED HAT® ENTERPRISE LINUX®

General Purpose OS

BENEFITS

- 10+ year enterprise life cycle
- Industry standard security
- High performance on any infrastructure
- Customizable and compatible with wide ecosystem of partner solutions

WHEN TO USE

When customization and integration with additional solutions is required

RED HAT® ENTERPRISE LINUX CoreOS

Immutable container host

- Self-managing, over-the-air updates
- Immutable and tightly integrated with OpenShift
- Host isolation is enforced via Containers
- Optimized performance on popular infrastructure

When cloud-native, hands-free operations are a top priority

OPENSIFT OPERATOR FRAMEWORK



OPENSIFT OPERATOR FRAMEWORK

OpenShift 4 uses **OPERATORS** to manage EVERY ASPECT of the cluster.

This includes operators that manage **essential** Kubernetes project components like the api server, scheduler, and controller manager.

Additional operators for components like the cluster-autoscaler, cluster-monitoring, web console, dns, ingress, networking, node-tuning, and authentication are included to provide management of the entire platform.

Welcome to OperatorHub.io

OperatorHub.io is a new home for the Kubernetes community to share Operators. Find an existing Operator or list your own today.

CATEGORIES

AI/Machine Learning
Application Runtime
Big Data
Cloud Provider
Database
Developer Tools
Integration & Delivery
Logging & Tracing
Monitoring
Networking
OpenShift Optional
Security
Storage
Streaming & Messaging



PROVIDER

☐ Altinity (0)

8 ITEMS

VIEW ▾ SORT A-Z ▾



AWS S3 Operator
provided by Red Hat

Manage the full lifecycle of installing, configuring and managing AWS S3 Provisioning



NooBaa Operator
provided by NooBaa

NooBaa is an object data service for hybrid and multi cloud environments.



OpenEBS
provided by OpenEBS project

Creates and maintains OpenEBS Control Plane deployments



Portworx Enterprise
provided by Portworx

Cloud native storage solution for production workloads



Robin Storage
provided by Robin.io

Robin Storage operator enables advanced data



Rook-Ceph
provided by The Rook Authors

Install and maintain Ceph Storage cluster



Rook-EdgeFS
provided by The Rook Authors

Install and maintain EdgeFS Storage cluster



StorageOS
provided by StorageOS, Inc

Cloud-native, persistent storage for containers.