# Business Continuity for Containerized Applications in a Hybrid Cloud Environment

Using a Hitachi VSP 5200 storage system, Red Hat OpenShift Cluster, and Kasten K10

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# **About This Guide**

This reference architecture documents how to set up backup and restoration operations between two OpenShift clusters using Kasten K10 Multi-Cluster Manager and Hitachi Storage Plug-in for Containers. Additionally, the document includes test procedures to validate the resiliency of the solution, which you can leverage for your own proof-of-concept before deploying the solution.

#### **Intended Audience**

This document is intended for Hitachi Vantara staff and IT professionals of Hitachi Vantara customers and partners who are responsible for planning and deploying such solutions.

#### **Document Revisions**

Revision Number	Date	Author	Details
v1.0	September 2023	Hitachi Vantara LLC	Initial Release

#### References

- Red Hat OpenShift Container Platform Installing on AWS v4.11
- Red Hat OpenShift Container Platform Installing on vSphere v4.11https://access.redhat.com/documentation/enus/openshift\_container\_platform/4.11/html/installing/installing-on-vsphere
- Hitachi Storage Plug-in for Containers Quick Reference Guide v3.11.0
- Hitachi Virtual Storage Platform 5000 Series: System Administrator Guide
- Veeam Kasten K10 Guide

#### Comments

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Thank you.

# **Executive Summary**

This reference architecture documents the process of cloud-based migration of a containerized application with the Kubernetes volume snapshot function using Hitachi Storage Plugin for Containers (HSPC) and Kasten K10 Multi-Cluster Manager by Veeam when a Hitachi Virtual Storage Platform (VSP) storage system is used as a storage backend. HSPC leverages Thin Image (TI) point-in-time snapshots that are instantaneous and space efficient. Using the MySQL stateful application as an example, this document describes how to use HSPC for backup and restore, disaster recovery, and data mobility. In addition, it includes some real-world use cases. The environment used for this validation includes two Red Hat® OpenShift clusters, one at the near-cloud VMware environment and another in Amazon Web Services (AWS). For both the clusters, storage is provided from a VSP 5200 storage system located at the near-cloud data center. Keeping the application data in a centralized location has a number of benefits including costs, performance, and security. The near-cloud data center is a colocation operated by Equinix.

The Equinix colocation was selected because it offered high-speed and low latency connections to the major hyperscalers, such as AWS. Hitachi Vantara collaborated with Equinix to offer a near-cloud hybrid offering called **Hitachi Cloud Connect for Equinix**.

This offering allows clients to locate Hitachi products such as the VSP storage systems at Equinix International Business Exchange<sup>™</sup> (IBX) data centers worldwide. Moreover, there is an option for clients to procure this solution through one agreement and invoice, greatly simplifying and accelerating their time to market. By using Equinix IBX data centers and Equinix Fabric<sup>™</sup> to interconnect sources of data to applications, organizations can locate their data residing on VSP storage systems next to clouds to leverage hybrid- or multi-cloud capabilities while still maintaining physical control of the data.

If you want to discuss hosting these types of solutions at Equinix, contact your Hitachi Vantara sales team. For more information, visit the Hitachi Cloud Connect for Equinix webpage at: <u>https://hitachivantara.com/en-us/products/storage/flash-storage/cloud-connect-for-equinix.html</u>.

# Introduction

Red Hat OpenShift is a hybrid-cloud application platform that leverages the power of Kubernetes and combines reliable and proven services to make the process of developing, modernizing, deploying, running, and managing applications more streamlined. OpenShift ensures a uniform user experience, whether applications are deployed on public-cloud, on-premises, hybrid-cloud, or edge architecture.

The installation program of OpenShift Container Platform offers flexibility to deploy on a wide range of platforms. You can deploy OpenShift Container Platform on bare metal, AWS, Azure, GCP, VMware vSphere, and so on.

You can install OpenShift Container Platform using either installer-provisioned (IPI) or user-provisioned infrastructure (UPI) methods. In this solution, Red Hat OpenShift cluster version 4.11.25 was deployed using the installer-provisioned method.

The Hitachi Storage Plug-in for Containers is a software component comprising of libraries, settings, and commands that enable you to create a container for running stateful applications. The software enables stateful applications to persist and maintain data after the lifecycle of the container has ended. HSPC provides persistent volumes (PV) from Hitachi storage systems.

Kasten K10 is an enterprise grade robust data management platform by Veeam that helps organizations to back up and restore container-based applications on Kubernetes/OpenShift. The capabilities include automating and orchestrating data backup, recovery, disaster recovery, and application mobility across multiple Kubernetes clusters and cloud environments. Kasten K10 offers support for a variety of Kubernetes distributions, as well as public and private cloud providers and storage solutions.

The environment used for this validation includes a Red Hat OpenShift cluster, at the near-cloud data center, and a Red Hat OpenShift cluster in AWS. Both clusters share the same VSP 5200 storage system located in the near-cloud data center for persistent volume requirement for stateful applications. Keeping the data at the near-cloud location ensures data availability to any cloud vendor at close proximity and avoids cloud locking. The near-cloud data center is a colocation operated by Equinix.

To summarize, our hybrid cloud environment consists of the following two domains. The relationship between the two sites is shown in *Figure 1*.

- A near-cloud Equinix colocation data center (named SV5), located in San Jose, California.
- A cloud hosted by AWS in Northern California.



Figure 1: Hybrid Cloud Environment

**Note**: The information shared here is specific to our requirements. It can be used as a guideline or a starting point; however, you can conduct a proof-of-concept in a non-production, isolated test environment matching your production environment before implementing this solution.

#### **Solution Overview**

HSPC integrates the OpenShift Container Platform with the Hitachi storage system by using the Container Storage Interface (CSI). Integrating backup software Kasten K10 with HSPC enables protection from data loss and on demand application mobility in the OpenShift Container Platform by using the Hitachi storage system functions (such as Thin Image snapshots and ShadowImage clones).

In addition, implementing HSPC enables the availability of high-performance and high-reliability persistent volumes.

#### **Benefits**

The following lists the benefits of business continuity solution using Red Hat OpenShift Cluster, Hitachi storage system, and Kasten K10 Multi-Cluster:

- The solution allows business to resume operations quickly when a disaster brings down a cluster environment.
- On-demand application mobility: Provides the flexibility to quickly snap data copies in multiple environments for on-demand analytics, data mining, DR testing, development testing, and similar use cases.
- The backup and restore operation of Kubernetes clusters in a hybrid cloud environment can be centralized with a single pane of glass UI provided by Kasten K10 Multi-Cluster manager.
- Recover against ransomware attacks: Granular, schedule-based snapshots with immutability (using Data Retention Utility) enables the administrator to recover from a point-in-time snapshot before the attack.
- The substantial reduction in cloud egress costs can be achieved by sharing the same near-cloud storage between AWS and the near-cloud cluster.

#### **Key Components**

The following lists the major components of the solution. For specifications, see the Hardware and Software section.

- Red Hat OpenShift Container Platform: This solution involved two Red Hat OpenShift Clusters. The first cluster consisted of
  three Control Plane nodes and two Worker nodes that were configured in the VMware environment at the near-cloud data
  center. The second cluster consisted of three Control Plane nodes and two Worker nodes; however, this was configured in
  AWS. Some of the key components of Red Hat OpenShift Container Platform are:
  - OpenShift Control Plane node: Runs services required for controlling the OpenShift Container Platform cluster and manages node workloads.
  - OpenShift Worker node: Responsible for running containerized workloads, managing resources, and communicating
    with the control plane to ensure that the desired state of the cluster is maintained.
  - Namespace: Provides a way to organize and isolate resources within a cluster, making it easier to manage and secure workloads
  - Persistent Volume and Persistent Volume Claim (PVC): A part of the storage of the cluster that is statically provided by the cluster administrator or dynamically provided by using the "StorageClass" object.
- HSPC: A CSI plugin from Hitachi used to provision persistent volume from the Hitachi storage system to Red Hat OpenShift or Kubernetes cluster to preserve and maintain data after the container life cycle ends.
  - CSI-controller: Mainly incorporates the CSI controller service for storage operation. This service is deployed as "Deployment" and is run only on the control plane.
  - CSI-node: Mainly incorporates the CSI node service that manages volumes in each node. This service is deployed as "DaemonSet". This component is required for all nodes.
- Veeam Kasten K10 Multi-Cluster Manager: Kasten K10 provides a user-friendly data management platform to perform backup or restore, disaster recovery, and mobility of containerized applications. The K10 Multi-Cluster manager provides a platform for K10 operations across multiple OpenShift clusters in a hybrid-cloud environment.
- VSP Storage System: A VSP 5200 storage system was used for persistent volume in Red Hat OpenShift clusters deployed in near-cloud and AWS for stateful application.
- Network Switch: Cisco Nexus 9000 Series switch was used to connect to AWS Direct Connect. The following accessories are required for establishing a WAN between the two sites:
  - 10/25Gbase-LR-S Optics: Long Range transceivers are required to connect long distances.
  - Single-Mode Fiber Cables: Required for long-distance communications.
- Equinix Fabric: Connected equipment at the Equinix near-cloud data center to AWS cloud.

• AWS Cloud: Equipment at Equinix was connected to AWS cloud using a 10 Gbps Direct Connect link. On AWS, a Virtual Private Cloud was created in the region us-west-1. Some of the key services used in AWS cloud are EC2, S3, Route53, Classic load balancer, and Network load balancer.

# Validation

This section describes the method, test environment, hardware and software, and test scenarios used in the validation.

#### Validation Method

This solution consists of the following test cases.

Test case 1 involves setting up the environment, which includes two Red Hat OpenShift Container Platform clusters - one in near-cloud and the other in AWS.

To validate test case 2, a persistent volume was allocated from the VSP 5200 storage system located in near-cloud to deploy a stateful MySQL application in both Red Hat OpenShift Container Platforms in near-cloud and AWS.

To validate test case 3, fresh data was inserted into the MySQL application, and after restoring the backup, the database records were verified at the AWS location to ensure the data consistency. The Kasten K10 Multi-Cluster user interface was used to perform this use case. A Global Location Profile was created with AWS S3 bucket as the storage provider, followed by creating Global Policies to automate the workflows for managing data (such as snapshot and restore). The subsequent step was to add Distributions, which defines the clusters where K10 resources must be allocated. Finally, snapshot and restore operations were carried out using the Global Policies.

Instead of Kasten K10 Multi-Cluster, a manual approach with Kubernetes commands was used to validate test case 4. Before performing the backup operation, fresh data was inserted into the MySQL application. A snapshot of the persistent volume was created with Kubernetes Volume Snapshot function with HSPC. In the target cluster, a PVC of the snapshot volume was created and used as a source to create a clone volume. The stateful MySQL application was restored using this cloned PVC in the target cluster.

Test case 5 shows how business continuity can be performed if a ransomware attack corrupts the application data. To validate this test case, a stateful MySQL application was used and the Data Retention Utility (DRU) feature was set on the snapshot volume to restrict read and write. If a ransomware attack corrupts the application's data, the data can be restored from the snapshot. You can perform the recovery process in either of the Red Hat OpenShift Container Platform clusters (near-cloud or AWS). The process involves creating a PVC of the DRU-enabled snapshot, creating a snap-on-snap copy of that PVC, and then restoring the stateful MySQL application using the cloned PVC in the target cluster.

# **High Level Diagrams**

Figure 2 shows the test environment used to run the validation.







Figure 3: Test Environment for Kasten K10 Multi-Cluster

## Hardware and Software

Table 1 provides the hardware specifications for the equipment used in this validation.

Image: Property of the propert		Item	Description	Version	Function
Hitachi Advanced Server DS220(2) 18-core Intel Xeon Gold 6140 @ 2.3 GHz 128 GB cache (1) Intel Ethernet Network Adapter XXV710BMC 4.70.06 BIOS S5BH3B22.H004-node vSphere cluster used to deploy 5-nodes near-cloud Red Hat OpenShift cluster.Cisco Nexus C93180YC-FXCisco Nexus C93180YC-FX 10 GbE SwitchNXOS 9.3(4)Network switch at the data center that serviced the Direct Connect to AWS.AWS EC2(4) Intel Xeon Platinum 8000 series processor, 16 GB RAMInstance type: t3.xlarge AMI Name: rhcos-5-nodes Red Hat OpenShift cluster in the cloud.	ata Center	Hitachi VSP 5200	1 TB cache (2) 20-core MPUs (4) RAID6 6D+2P parity groups (1) 10 GbE iSCSI port	SVOS RF 9.8.6 90-09-01-00/01	Storage system used to store application data.
VitigCisco Nexus C93180YC-FXCisco Nexus C93180YC-FX 10 GbE SwitchNXOS 9.3(4)Network switch at the data center that serviced the Direct Connect to AWS.AWS EC2(4) Intel Xeon Platinum 8000 series processor, 16 GB RAMInstance type: t3.xlarge AMI Name: rhcos-5-nodes Red Hat OpenShift cluster in the cloud.	Near-Cloud D	Hitachi Advanced Server DS220	<ul> <li>(2) 18-core Intel Xeon Gold</li> <li>6140 @ 2.3 GHz</li> <li>128 GB cache</li> <li>(1) Intel Ethernet Network</li> <li>Adapter XXV710</li> </ul>	BMC 4.70.06 BIOS S5BH3B22.H00	4-node vSphere cluster used to deploy 5-nodes near-cloud Red Hat OpenShift cluster.
AWS EC2       (4) Intel Xeon Platinum 8000 series processor, 16 GB RAM       Instance type: t3.xlarge       5-nodes Red Hat OpenShift         AMI Name: rhcos-       cluster in the cloud.	Equinix	Cisco Nexus C93180YC-FX	Cisco Nexus C93180YC-FX 10 GbE Switch	NXOS 9.3(4)	Network switch at the data center that serviced the Direct Connect to AWS.
See       411.86.202212072103-         0-x86_64       AMI ID: ami-         0298a5395cfd69001       0298a5395cfd69001	AWS	AWS EC2	(4) Intel Xeon Platinum 8000 series processor, 16 GB RAM	Instance type: t3.xlarge AMI Name: rhcos- 411.86.202212072103- 0-x86_64 AMI ID: ami- 0298a5395cfd69001	5-nodes Red Hat OpenShift cluster in the cloud.
AWS S3     (1) Standard S3 bucket     N/A     Kasten K10 Multi-Cluster       Global Location profile.		AWS S3	(1) Standard S3 bucket	N/A	Kasten K10 Multi-Cluster Global Location profile.

Table 1: Hardware Components

Table 2 provides the software specifications used in this validation.

Item	Version	Function
VMware vSphere	7.0 U2 (17867351)	Hypervisor operating system
VMware vCenter Server Appliance	7.0 U3 (18700403)	Management interface for vSphere cluster
Red Hat OpenShift Cluster	4.11.25	Red Hat OpenShift Cluster deployed in near-cloud and AWS.
Red Hat Enterprise Linux CoreOS (RHCOS)	4.11	RHCOS is the Operating System for Control Plane and Worker nodes.
Hitachi Storage Plug-in for Containers	3.11	HSPC plugin integrates Kubernetes or OpenShift with Hitachi storage systems using Container Storage Interface.
Kasten K10 Multi-Cluster	5.5.8	Kasten K10 Multi-Cluster Manager is a data management platform from Veeam which provides backup operation, disaster recovery, and application mobility for OpenShift applications across multiple clusters.
MySQL	5.7.41	A stateful database application used to validate data consistency on both Equinix and AWS.

Table 2: Software Components

#### **Test Scenarios**

Table 3 lists the test scenarios performed in the validation.

#	Description	Success Criteria
1	<ol> <li>Prepare the environment:         <ol> <li>Deploy two Red Hat OpenShift Clusters: One in a VMware environment in near- cloud and another in AWS.</li> <li>Define storage, network, and iSCSI connection.</li> <li>Use one Dynamic Provisioning (DP) pool to provision persistent volume for stateful application in near-cloud and AWS.</li> <li>Deploy HSPC in both clusters.</li> <li>Deploy Kasten K10 and K10 Multi-Cluster in both clusters.</li> <li>Discover AWS cluster from Kasten K10 Multi-Cluster Manager deployed in near- cloud.</li> </ol> </li> </ol>	Environment is set up as per specifications.
2	<ul> <li>Deploy a stateful application in the RHOCP clusters. This test case is performed in near- cloud as well as in AWS. The persistent volume is provisioned to both the Red Hat OpenShift Container Platform clusters from the same Hitachi VSP 5200 storage system located in near-cloud.</li> <li>Define the storage class for the VSP 5200 storage system with the required settings.</li> <li>Deploy MySQL database as a stateful application on Red Hat OpenShift Container Platform with persistent volume claim.</li> <li>Create a new table and ingest new records.</li> </ul>	Persistent volume from the VSP storage system is provisioned in Red Hat OpenShift Container Platform cluster in near- cloud as well as AWS successfully. Stateful application is deployed successfully.
3	<ol> <li>Migrate a stateful application across OpenShift clusters using Kasten K10 Multi-Cluster:</li> <li>Ingest data into MySQL application in near-cloud.</li> <li>Create an S3 bucket in AWS.</li> <li>Create a global location profile using this bucket.</li> <li>Create a global snapshot policy.</li> <li>Create a global distribution for snapshot policy and add both clusters.</li> <li>Run the snapshot policy for the MySQL application to take the backup.</li> <li>Create a global distribution for restore.</li> <li>Create a global distribution for import policy and add both clusters.</li> <li>Run the policy to restore the application in the target cluster.</li> <li>Verify that the MySQL application is being restored and the ingested data is visible to the target MySQL environment.</li> </ol>	Backup taken in near-cloud Red Hat OpenShift Container Platform cluster can be restored in Red Hat OpenShift Container Platform cluster in AWS using Kasten K10 Multi- Cluster.
4	<ul> <li>Migrate a stateful application across OpenShift Clusters using HSPC (this test case is performed manually instead of Kasten K10):</li> <li>1. Ingest data into MySQL application in near-cloud.</li> <li>2. Create a Kubernetes volume snapshot.</li> <li>3. Create PV and PVC of the snapshot volume.</li> <li>4. Create a clone PVC using the PVC created in step 3 as the source PVC.</li> <li>5. Use the clone as a volume source to deploy MySQL stateful application in the Red Hat OpenShift Container Platform cluster on AWS.</li> <li>6. Verify that the ingested data is visible to the target MySQL environment.</li> </ul>	Snapshot created in near- cloud Red Hat OpenShift Container Platform cluster can be manually restored in the Red Hat OpenShift Container Platform cluster in AWS.
5	<ol> <li>Kecover from ransomware attack: This test case is performed manually instead of Kasten K10. The Data Retention Utility feature is set on the snapshot volume to protect the backup from any write operations and define the data retention term for the protected volumes.</li> <li>Ingest data into MySQL application in near-cloud.</li> <li>Create a Kubernetes volume snapshot.</li> <li>Set DRU attribute in the snapshot volume using Command Control Interface (CCI).</li> <li>Assume that application is affected by ransomware in near-cloud and must restore the data from the snapshot taken in step 2.</li> <li>Create a Kubernetes volume snapshot volume created in step 2.</li> <li>Create a Kubernetes volume snapshot (snap-on-snap) of the PVC created in step 5. This creates a cascaded snapshot volume.</li> <li>Create a clone PVC using the PVC created in step 7 as the source PVC.</li> </ol>	Nevert to clean stateful MySQL application from snapshot data with DRU.

#	Description	Success Criteria
	<ol> <li>Use the clone PVC as a volume source to deploy MySQL stateful application in the Red Hat OpenShift Container Platform cluster in AWS.</li> <li>Verify that the ingested data is visible to the target MySQL environment.</li> </ol>	
	Table 3: Test Scenarios	

# **Guidelines and Recommendations**

This section describes the lessons learned from this validation, along with guidelines and recommendations.

- While installing a Red Hat OpenShift cluster in a private environment (for example, in an existing Amazon Virtual Private Cloud with a specific AWS Identify and Access Management user), use "*CredentialMode*" to set as "Manual" in the install-config.yaml file. The default mode is "Mint", which assumes that you have administrative privileges.
- While running the OpenShift installation, install-config.yaml file is used by the installer. You must keep a backup of this file. If the installation fails and must be re-run, copy the OpenShift installer and install-config.yaml to a new directory and then run from there. You must not re-use the same directory, or else X.509 certificate error occurs.
- Prepare a separate node outside the cluster for cluster deployment and install OpenShift CLI (oc) command to interact with OpenShift Container Platform for administration.
- While migrating an application using Kasten K10 across clusters, a location profile is mandatory. Without the location profile, import policy would not generate, and restoration is not possible to other clusters. However, to restore an application in the same cluster, a location profile is not required.
- While building a POD with persistent volume, HSPC automatically performs a series of tasks such as provisioning the volume, creating an iSCSI target (or FC host group), attaching the volume to it, discovering the volume on the target node, and then attaching the volume as a block device or creating a file system on it.
- In Kubernetes environment, a "VolumeSnapshot" object cannot be attached to a POD because it is not a persistent volume. To access the snapshot data, create a clone volume and then attach the clone volume to a POD.
- Retention time cannot be reduced while DRU setting is active on a volume.

# **Validation Results**

This section shows the steps and screenshots for each test scenario.

#### **Test 1: Prepare the Environment**

This test case describes the configuration of the components used in the validation.

The test environment consists of two multi-node Red Hat OpenShift Clusters deployed using IPI method in a near-cloud VMware environment and AWS. You must configure the following components for validation of test cases:

- Configure physical LAN and iSCSI connections for OpenShift clusters.
- Provision DP pool to be used for persistent volume from VSP 5200 storage system.
- Deploy two Red Hat OpenShift Clusters: One in near-cloud VMware environment and another in AWS.
- Install HSPC.
- Deploy Kasten K10 Multi-Cluster.

#### Deploy Red Hat OpenShift Cluster in Near-Cloud

In this configuration, the cluster is installed using the IPI method in a VMware environment.

#### Prerequisites

Note that the following prerequisites are outside the scope of this document, so we do not describe them in detail. For more information, see: <u>https://docs.openshift.com/container-platform/4.11/installing/installing\_vsphere/installing-vsphere-installer-provisione</u>.

- The OpenShift Container Platform installer requires access to port 443 on the vCenter and ESXi hosts. Verify that port 443 is accessible.
- In OpenShift Container Platform 4.11, internet access is required to install the cluster using IPI method.
- Use DHCP for the network and ensure that the DHCP server is configured to provide persistent IP addresses to the cluster machines. All nodes must be in the same VLAN.
- The installation in vSphere requires two static IP addresses:
  - The API IP address is used to access the cluster API.
- The Ingress IP address is used for cluster ingress traffic. You must create DNS records for these two static IP addresses in the appropriate DNS server.
- Use a separate Red Hat Enterprise Linux virtual machine to trigger the OpenShift deployment. This node is also used as the Kubernetes admin node.
- Install OpenShift CLI (oc) on the admin node to interact with OpenShift Container Platform from a command-line interface.

#### Add vCenter Root CA Certificates

The installation program requires access to vCenter API; therefore, you must add vCenter trusted root CA certificates in the admin node system trust before installing the OpenShift Container Platform cluster.

```
# wget https://vcsa.juno.com/certs/download.zip
```

```
# unzip download.zip
# cp certs/lin/* /etc/pki/ca-trust/source/anchors
cp: overwrite `/etc/pki/ca-trust/source/anchors/f67dd544.0'? y
cp: overwrite `/etc/pki/ca-trust/source/anchors/f67dd544.r0'? y
# update-ca-trust extract
```

#### Generate a Key Pair for Cluster Node SSH Access

```
1. To generate a key pair, run the following command:
    # ssh-keygen -t ed25519 -N '' -f ~/.ssh/id_ed25519
    # eval "$(ssh-agent -s)"
    Agent pid 1199721
```

2. To view the public SSH key, run the following command:

\$ cat ~/.ssh/id\_ed25519.pub

#### **Obtain the Installation Program**

You can download the latest OpenShift Installer from the Red Hat OpenShift Cluster Manager site. To download older versions such as v4.11.25, see: <u>https://mirror.openshift.com/pub/openshift-v4/clients/ocp/4.11.25/</u>.

- 1. Open the Infrastructure Provider page on the Red Hat OpenShift Cluster Manager site.
- 2. Navigate to download OpenShift Installer.
- 3. Pull secret and OpenShift command line interface.

Clusters > Cluster Type > VMware vSphere > Installer-provisioned infrastructure

# Install OpenShift on vSphere with installer-provisioned infrastructure

openonintinista	ller	
Download and extr where you will stor available for Linux	ract the install program fo e the installation configur and macOS at this time.	or your operating system and place the file in the directory ration files. Note: The OpenShift install program is only
Linux	▼ x86_64	Download installer
Developer Preview	Download pre-release bu	uilds
Pull secret		
Download or copy	your pull secret. You'll be	prompted for this information during installation.
Download or copy	your pull secret. You'll be ecret Dopy pull sec	prompted for this information during installation. cret
Download or copy Download pull se Command line ir	your pull secret. You'll be ecret Dopy pull sec	prompted for this information during installation. cret
Download or copy Download pull so Command line ir Download the Ope	your pull secret. You'll be ecret Copy pull sec nterface enShift command-line too	prompted for this information during installation. cret ols and add them to your PATH.

#### Create an Install Config File

To install the OpenShift Cluster, prepare the install config file as follows:

```
# ./openshift-install create install-config --log-level=debug
DEBUG OpenShift Installer 4.11.25
DEBUG Built from commit b1b244444835f9a3fd2c5e6717db9ba6d18607be
? Platform vsphere
? vCenter vcsa.juno.com
? Username administrator@vsphere.local
? Password [? for help] **********
INFO Connecting to vCenter vcsa.juno.com
? Datacenter SV10
INFO Defaulting to only available cluster: DR
? Default Datastore vsp-5200-lun-fef0
? Network VM Network
? Virtual IP Address for API 172.23.31.180
? Virtual IP Address for Ingress 172.23.31.181
```

DEBUG Generating Base Domain ... ? Base Domain juno.com ? Cluster Name ocpcluster DEBUG Generating Pull Secret... ? Pull Secret [? for help] DEBUG Generating Install Config... INFO Install-Config created in: . (Command output is truncated) # cat install-config.yaml apiVersion: v1 baseDomain: juno.com compute: - architecture: amd64 hyperthreading: Enabled name: worker platform: {} replicas: 2 controlPlane: architecture: amd64 hyperthreading: Enabled name: master platform: {} replicas: 3 metadata: creationTimestamp: null name: ocpcluster networking: clusterNetwork: - cidr: 10.128.0.0/14 hostPrefix: 23 machineNetwork: - cidr: 10.0.0/16 networkType: OpenShiftSDN serviceNetwork: - 172.30.0.0/16 platform: vsphere: apiVIP: 172.23.31.180 cluster: DR datacenter: SV10 defaultDatastore: vsp-5200-lun-fef0 ingressVIP: 172.23.31.181 network: VM Network password: password1 username: administrator@vsphere.local vCenter: vcsa.juno.com publish: External pullSecret: '{"auths":{"cloud.openshift.com":{"auth":"b3BlbnNoaWZ0LXJlbGVhc2UtZGV2K2hkc19pbGFiX2tvbDFkZXV jbHJsbmV3c2N5bmgwMn10Y31sMWVhbTpKOTNZSUpWVkFWMVRRNDBCNDRMSjdNREFSTU81VUNZNjRSV0JGTDZaWV1WRDRK ==","email":"abc1.xz@hds.com"}} sshKey: | ssh-ed25519 AAAAC3NzaC11ZDI1NTE5AAAAIDgf0Kgeb0X/IGyLR9N3NCVzPmPEdhN0XOt2/ScIloNm root@linuxnfscl2 (Command output is truncated)

#### **Create a Cluster**

Navigate to the directory that contains the installation program and run the following openshift-install command:

# ./openshift-install create cluster -log-level=debug

×

#### After installation, access the console from: https://console-openshift-console.apps.ocpcluster.juno.com.

$\leftrightarrow$ $\rightarrow$ C (1	Not secure   https://www.secure   https://www.secure   https://www.secure   https://www.secure.com//www.secure   https://www.secure.com//www.secure   https://www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com///www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com///www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com//www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com//www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com///www.secure.com////www.secure.com///www.secure.com////www.secure.com////////////////////////////////////	//console-openshift-con	isole.apps.ocpcl	uster.juno.com/k8s/clus	ter/nodes				Q		
E Cope	<b>l Hat</b> enShift								<b>III 🌲</b> 8	•	kube:admin <del>•</del>
Search	<b>^</b>			You are logged	d in as a temporary	administrative user. Update the	e <u>cluster OAuth configu</u>	r <u>ation</u> to allow others to	log in.		
API Explorer Events		Nodes									
Operators	>	▼ Filter ▼ Na	ame 👻 Sea	ch by name 7							
Workloads	>	Name 1	Status 💲	Role 1	Pods 1	Memory 1	CPU 1	Filesystem 1	Created 1	Instance typ	e 1
Networking	>	N ocpcluster- bnwlq- master-0	Ready	master	46	6.37 GIB / 15.64 GIB	1.672 cores / 4 cores	13.23 GiB / 119.8 GiB	Feb 1, 2023, 7:25 AM	-	ŧ
Storage	>	ocpcluster- bnwlq- master-1	Ready	master	63	8.31 GiB / 15.64 GiB	1.971 cores / 4 cores	10.92 GiB / 119.8 GiB	Feb 1, 2023, 7:25 AM	-	:
Observe	>	N ocpcluster- bnwlq- master-2	🕏 Ready	master	37	5.18 GIB / 15.64 GIB	1.308 cores / 4 cores	11.04 GiB / 119.8 GiB	Feb 1, 2023, 7:25 AM	-	i
Compute Nodes	~	N ocpcluster- bnwlq- worker-289lj	Ready	worker	21	3.5 GiB / 15.5 GiB	0.776 cores / 4 cores	7.46 GiB / 119.8 GiB	Feb 1, 2023, 7:36 AM	-	
Machines MachineSets		N ocpcluster- bnwlq- worker-m26vf	🕏 Ready	worker	18	3.24 GIB / 15.5 GIB	0.687 cores / 4 cores	7.03 GIB / 119.8 GIB	Feb 1, 2023, 7:36 AM	-	i

#### Install Hitachi Storage Plug-in for Containers

After successfully deploying the OpenShift cluster, install the HSPC software.

#### **Deploy HSPC using OperatorHub**

To deploy the HSPC plugin in OpenShift using OperatorHub, complete the following steps:

- 1. Log in to Red Hat OpenShift console and select **Operators** and click on **OperatorHub**.
- 2. Search "Hitachi Storage Plug-in for Containers" in All Items option and click on "Hitachi Storage Plug-in for Containers" displayed in the search result.
- 3. In Hitachi Storage Plug-in for Containers page, click on Install.

```
HITACHI Hitachi Storage Plug-in for Containers
```

1.11.0 provided by Hitachi

![](_page_17_Picture_13.jpeg)

- 4. In the Install Operator window, enter the following information and click Install.
  - Installation mode: Select A specific namespace on the cluster.
  - Installed Namespace: Namespace where you want to install HSPC. Select the kube-system namespace.
  - Update approval: Select Manual.

![](_page_17_Picture_18.jpeg)

 Wait until the installed operator status is ready to use. From the Red Hat OpenShift console, navigate to Operators and click **Installed Operators**. The following screenshot shows the status of the operator after a successful installation.
 Project: kube-system

Installe	d Operators				
Installed Ope	erators are represented by ClusterSer	viceVersions within this Namespace. For more in	formation, see the Understanding Operators d	ocumentation g. Or create an Operator and ClusterServiceVe	rsion using the Operator S
Name 👻	Search by name /				
Name	I	Managed Namespaces 1	Status	Last updated	Provided /
HTACHI Ingle (In Sec)	Hitachi Storage Plug-in for Containers 1.11.0 provided by Hitachi	KS kube-system	Succeeded Up to date	Feb 7, 2023, 7:23 AM	HSPC

6. From the console, navigate to Workloads, click **Pods**, and ensure that the status of the operator pod is running.

		h.		You are logged in as a temp	orary administrative use	r. Update the <u>cluster OAuth configuration</u> to allo	w others to log in.		
↔ Administrator	Ľ.	Project: kube-system 👻							
Home	>								
		Pods							
Operators	<u> </u>								
Workloads	~	▼ Filter ▼ Name	Search by name      I						
Pods		Name 1	Status 1	Ready 1	Restarts 1	Owner 1	Memory 1	CPU 1	Created 1
Deployments		hspc-operator-contro fr4Edb47f_cf0p7	ller-manager- 🏾 🎗 Running	1/1	0	hspc-operator-controller-manager-	36.9 MiB	0.002 cores	Feb 7, 2023, 7:23 AM

7. Create an HSPC Instance. From the console, navigate to Operators and click **Installed Operators**. Open the Operator details window and click **Create instance**.

, Events	Project: kube-system 🔹		
Events	Installed Operators > Operator details		
Operators 🗸	Hitachi Storage Plug-in for Containers 1110 provided by Hitachi		Actions 💌
OperatorHub			
Installed Operators	Details YAML Subscription Events HSPC		
Workloads >	Provided APIs	<b>Provider</b> Hitachi	
Networking >	(ISPC) HSPC	Created at Feb 1, 2023, 10:45 AM	
Storage 🗸	HSPC is the Schema for the hspcs API	Links	
PersistentVolumes PersistentVolumeClaims	O Create instance	Knowledge Base https://knowledge.hitachivantara.com/Docu ters_and_Drivers/Storage_Adapters_and_D ners IX	uments/Adap Irivers/Contai
		-	

8. From the Create HSPC window, enter any name and click Create.

Configure via: O YAML view YAML view	
1 Note: Some fields may not be represented in this form view. Please select "YAML view" for full control.	HSPC provided by Hitachi
Name *	HSPC is the Schema for the hspcs A
hspc	
abels	
app=frontend	
controller	>
Controller overwrite parameters of the deployment hspc-csi-controller.	
magePullSecrets	>
magePullSecrets for pulling images from RedHat registries	
lode	>
Node overwrite parameters of the daemonset hspc-csi-node.	

# 9. Verify that the Ready status of HSPC is **true**.

# oc get hspc -n kube-system
NAME READY AGE
hspc true 3m42s

#### Create Storage Class and Volume SnapshotClass

After installing the HSPC plugin, create Storage Class to provision persistent volume from the VSP 5200 storage system. A Volume SnapshotClass is required to take point in time snapshot. Complete the following steps:

- 1. Create a secret for HSPC.
  - a. From the Red Hat OpenShift console, navigate to Workloads, click **Secret**, and then click **Create** to open a **YAML** window.
  - b. Enter the storage URL, username, and password in base64 format and click **Create** to generate secret. The following shows a sample secret YAML:

```
apiVersion: v1
kind: Secret
metadata:
   name: secret-vsp5200
   namespace: default
type: Opaque
data:
   url: aHR0cHM6Ly8xNzIuMjMuMzAuMTA=
   user: a3ViZXJuZXRlcw==
   password: a3ViZXJuZXRlcw==
```

Status of the secret from the Red Hat OpenShift console: Secrets

Name secret-vsp5200 X Clear all filters				
Name 1	Namespace 1	Туре 💲	Size 1	Created 1
S secret-vsp5200	NS default	Opaque	3	Feb 7, 2023, 10:19 AM

- 2. Create a storage class for the VSP 5200 storage system.
  - a. From the Red Hat OpenShift console, navigate to Storage, click **StorageClasses**, and then click **create StorageClass**.
  - b. Enter the storage information (Pool ID, Port Number, and so on) and click **Create**. The following shows a sample storage class YAML:

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
 name: sc-vsp5200
  annotations:
    kubernetes.io/description: Hitachi Storage Plug-in for Containers
provisioner: hspc.csi.hitachi.com
reclaimPolicy: Delete
volumeBindingMode: Immediate
allowVolumeExpansion: true
parameters:
  serialNumber: "40028"
 poolID: "0"
 portID : CL1-C
 connectionType: iscsi
  csi.storage.k8s.io/fstype: ext4
  csi.storage.k8s.io/node-publish-secret-name: "secret-vsp5200"
  csi.storage.k8s.io/node-publish-secret-namespace: "default"
  csi.storage.k8s.io/provisioner-secret-name: "secret-vsp5200"
  csi.storage.k8s.io/provisioner-secret-namespace: "default"
  csi.storage.k8s.io/controller-publish-secret-name: "secret-vsp5200"
  csi.storage.k8s.io/controller-publish-secret-namespace: "default"
  csi.storage.k8s.io/node-stage-secret-name: "secret-vsp5200"
  csi.storage.k8s.io/node-stage-secret-namespace: "default"
  csi.storage.k8s.io/controller-expand-secret-name: "secret-vsp5200"
  csi.storage.k8s.io/controller-expand-secret-namespace: "default"
```

Status of the storage class:

StorageClasses		
Name 👻 Search by name /		
Name 1	Provisioner 1	Reclaim policy 1
SC sc-vsp5200 - Default	bsoc csi bitachi com	Delete

- 3. Create a volume snapshot class for the VSP 5200 storage system.
  - a. From the Red Hat OpenShift console, navigate to Storage, click VolumeSnapshotClass, and then click create VolumeSnapshotClass.
  - b. Populate "VolumeSnapshotClass" YAML with the required information and click **Create**. The following shows a sample YAML:

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshotClass
metadata:
   name: snapshotclass-sample
driver: hspc.csi.hitachi.com
deletionPolicy: Delete
```

parameters:
poolID: "0"
<pre>csi.storage.k8s.io/snapshotter-secret-name: "secret-vsp5200"</pre>
<pre>csi.storage.k8s.io/snapshotter-secret-namespace: "default"</pre>

#### Status of the VolumeSnapshotclass:

VolumeSnapshotClasses						
Name   Search by name  X						
Name 1	Driver 1	Deletion policy 1				
VSC snapshotclass-sample	hspc.csi.hitachi.com	Delete				

#### Install Kasten K10 in Red Hat OpenShift Cluster

This section describes the process of deploying Kasten K10 in the near-cloud OpenShift cluster. Kasten K10 is integrated with HSPC plugin to provision backup and restore target. When the installation is complete, additional steps are performed to enable Multi-Cluster on Kasten K10.

- 1. Install the Helm package manager.
  - a. To deploy Kasten K10, your client machine in the OpenShift Container Platform must have access to the helm command. To download the script for installing Helm, run the curl command:

[root@linuxnfscl2 sv	w3]# curl	-fsSL -o get	helm.sh http	s://raw.githubuser	content.com/helm/h	elm/main/scripts/get-helm-3
[root@linuxnfscl2 st	w3]#					
[root@linuxnfscl2 st	w3]# chmod	700 get_helm	n.sh			

b. Run the script.

[root@linuxnfscl2 sw3]# ./get_helm.sh
Downloading https://get.helm.sh/helm-v3.11.1-linux-amd64.tar.gz
/erifying checksum Done.
Preparing to install helm into /usr/local/bin
nelm installed into /usr/local/bin/helm
[root@linuxnfscl2 sw3]#

2. Configure Helm chart repositories: Add a Helm chart repository to obtain the Kasten K10 chart.

```
[root@linuxnfscl2 sw3]# helm repo add kasten https://charts.kasten.io/
WARNING: Kubernetes configuration file is group-readable. This is insecure. Location: /sw5/auth/kubeconfig
"kasten" has been added to your repositories
[root@linuxnfscl2 sw3]#
```

- 3. Add an annotation to "VolumeSnapshotClass".
  - a. Add the Kasten K10 annotation as follows:

[root@linuxnfscl2 sw3]# oc annotate volumesnapshotclass snapshotclass-sample k10.kasten.io/is-snapshot-class=true volumesnapshotclass.snapshot.storage.k8s.io/snapshotclass-sample annotated [root@linuxnfscl2 sw3]#

b. Verify the status after adding the Kasten K10 annotation.

[root@linuxnfscl2	sw3]# oc describe volumesnapshotclass snapshotclass-sample
Name:	snapshotclass-sample
Namespace:	
Labels:	<none></none>
Annotations:	k10.kasten.io/is-snapshot-class: true
API Version:	<pre>snapshot.storage.k8s.io/v1</pre>
Deletion Policy:	Delete
Driver:	hspc.csi.hitachi.com
Kind:	VolumeSnapshotClass

(Output is truncated)

- 4. Create a namespace (kasten-io) for installing Kasten K10.
- 5. Set the storage class sc-vsp5200 as default for installing Kasten K10.

Status of the Storage Class before:

[root@linuxnfscl	2 sw3]# oc get storageclass				
NAME	PROVISIONER	RECLAIMPOLICY	VOLUMEBINDINGMODE	ALLOWVOLUMEEXPANSION	AGE
sc-vsp5200	hspc.csi.hitachi.com	Delete	Immediate	true	5d201
thin (default)	kubernetes.io/vsphere-volume	Delete	Immediate	false	11d
thin-csi	csi.vsphere.vmware.com	Delete	WaitForFirstConsumer	true	11d
[root@linuxnfscl	2 sw3]#				

To set the storage class sc-vsp5200 as default, run the following oc patch command:

[root@linuxnfscl2 sw3]	# oc patch storageclass sc-vsp5:	200 -p '{"metada	ta": {"annotations": {"	storageclass.kubernetes	.io/is-default-class": "true"}}}'
storageclass.storage.k	8s.io/sc-vsp5200 patched				
[root@linuxnfscl2 sw3]	<del>1</del>				
[root@linuxnfscl2 sw3]	# oc get storageclass				
NAME	PROVISIONER	RECLAIMPOLICY	VOLUMEBINDINGMODE	ALLOWVOLUMEEXPANSION	AGE
sc-vsp5200 (default)	hspc.csi.hitachi.com	Delete	Immediate	true	5d20h
thin (default)	kubernetes.io/vsphere-volume	Delete	Immediate	false	11d
thin-csi	csi.vsphere.vmware.com	Delete	WaitForFirstConsumer	true	11d
[					

- 6. Before installing Kasten K10, run a Pre-Flight Checks script.
  - a. To verify whether the Kubernetes settings meet the Kasten K10 requirements, run Pre-Flight Checks before installing Kasten K10 in Red Hat OpenShift container environment. Pre-Flight checks verify the following items:
    - Whether available "StorageClass" is cataloged.
    - Whether a CSI provisioner exists and basic verification is conducted.
  - b. For Pre-Flight checks, run the following command:

```
# curl https://docs.kasten.io/tools/k10 primer.sh | bash
  % Total
           % Received % Xferd Average Speed Time
                                                       Time
                                                               Time Current
                                Dload Upload Total
                                                       Spent
                                                               Left Speed
                            0 31615
100 7967 100 7967 0
                                         0 --:--: -- --: -- --: -- 31615
Namespace option not provided, using default namespace
Checking for tools
 --> Found kubectl
 --> Found helm
 --> Found jq
(Output is truncated)
Validating Provisioners:
hspc.csi.hitachi.com:
 Is a CSI Provisioner - OK
 Missing/Failed to Fetch CSIDriver Object
  Storage Classes:
   sc-vsp5200
     Valid Storage Class - OK
  Volume Snapshot Classes:
   k10-clone-snapshotclass-sample
    snapshotclass-sample
     Has k10.kasten.io/is-snapshot-class annotation set to true - OK
     Has deletionPolicy 'Delete' - OK
```

```
(Output is truncated)
```

serviceaccount "k10-primer" deleted
clusterrolebinding.rbac.authorization.k8s.io "k10-primer" deleted
job.batch "k10primer" deleted

c. To verify the snapshot behavior, run the following command by specifying storage class with "-s" option. Verify that the command does not return any error.

```
# curl -s https://docs.kasten.io/tools/k10_primer.sh | bash /dev/stdin -c "storage
csi-checker -s sc-vsp5200 --runAsUser=1000"
Namespace option not provided, using default namespace
Checking for tools
--> Found kubectl
--> Found helm
--> Found jq
(Output is truncated)
```

```
Running K10Primer Job in cluster with command-
     ./k10tools primer storage csi-checker -s sc-vsp5200 --runAsUser=1000
serviceaccount/k10-primer created
(Output is truncated)
Creating application
 -> Created pod (kubestr-csi-original-podj7glq) and pvc (kubestr-csi-original-
pvcvnk5t)
Taking a snapshot
 -> Created snapshot (kubestr-snapshot-20230504121654)
Restoring application
 -> Restored pod (kubestr-csi-cloned-podhc245) and pvc (kubestr-csi-cloned-
pvcfpcv8)
Cleaning up resources
CSI Snapshot Walkthrough:
 Using annotated VolumeSnapshotClass (snapshotclass-sample)
 Successfully tested snapshot restore functionality. - OK
serviceaccount "k10-primer" deleted
clusterrolebinding.rbac.authorization.k8s.io "k10-primer" deleted
job.batch "k10primer" deleted
```

d. Verify that a snapshot and clone are correctly created on the Storage Navigator.

Сору Туре: ТІ	•									IE
TI History (Page.1)										
AFilter ON OFF										
	Primary Volume		Secondary Volume		Mirror			Description		
Date and Time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	Pool ID	Diff Compare Volume	Code	Description	
2023/02/13 09:57:09	00:01:BE	DP	00:01:BF	DP	3	0	-	2021	SMPL END	
2023/02/13 09:57:08	00:01:BE	DP	00:01:BF	DP	3	0		2020	SMPL START	
2023/02/13 09:57:00	00:01:BF	DP	00:01:C0	DP	3	0		2092	CLONE END	
2023/02/13 09:56:33	00:01:BF	DP	00:01:C0	DP	3	0		2091	CLONE START	Clone
2023/02/13 09:56:32	00:01:BF	DP	00:01:C0	DP	3	0		2001	PAIR	
2023/02/13 09:56:21	00:01:BE	DP	00:01:BF	DP	3	0		2011	PSUS	Snapshot
2023/02/13 09:56:18	00:01:BE	DP	00:01:BF	DP	3	0	*	2001	PAIR	

7. Install Kasten K10. To deploy Kasten K10 in OpenShift using OperatorHub, complete the following steps:

- a. Log in to Red Hat OpenShift console, select Operators, and click **OperatorHub**.
- b. Under All Items, search for "Kasten" and click Kasten K10 (Enterprise Term).
- c. In the Kasten K10 (Enterprise Term) page, click Install, which opens the Install Operator window.
- d. In the Install Operator window, enter the following information and click Install.
  - Installation mode: Select A specific namespace on the cluster.
  - Installed Namespace: Namespace where the Kasten K10 must be installed. Select kasten-io.

Jpdate channel * 💿	Kasten K10 (Enterprise - Term)	
stable	provided by Kasten by Veeam, kasten.io	
nstallation mode *	Ki0restore	<b>(</b> ) K10
All namespaces on the cluster (default)		
I his mode is not supported by this Operator	in case of a variety of disasters such as	management system for all your
Operator will be available in a single Namespace only.	the accidental deletion of K10, failure of	persistence enabled container-based
	underlying storage that K10 uses for its	applications.
installed Namespace *	destruction of the Kubernetes cluster on	**Note: The complete list of values
Operator recommended Namespace: PR kasten-io	which K10 is	supported by the K10 spec field in the "YAMI. View" are documented
A 44		
Namespace aiready exists Namespace kasten-io already exists and will be used. Other users can already have access to this n	amespace	
Select a Namesoace		
Selecta Namespace		
Update approval * 💿		
Automatic		

 e. Wait until the installed operator status is ready to use. In the Red Hat OpenShift console, navigate to Operators and click Installed Operators.
 Installed Operators

motane	a operators					
Installed Ope	erators are represented by Cluste	erServiceVersions within this Namespace. For r	nore information, see the Understanding Ope	rators documentation 🖉. Or create an Operati	or and ClusterServiceVersion using the Operat	or SDK 🗗.
Name 👻	Kasten					
Name Kas	ten X Clear all filters					
Name	1	Namespace 👔	Managed Namespaces 1	Status	Last updated	Provided API
	Kasten K10 (Enterprise – Term) 5.5.8 provided by Kasten by	NS kasten-io	🚯 kasten-io	Succeeded Up to date	✤ Apr 22, 2023, 2:13 AM	K10restore K10

Status of Kasten K10 Operator from CLI:

<pre>[root@linuxnfscl2 sw3]# kubectl get podsnamespace kasten-io</pre>				
NAME	READY	STATUS	RESTARTS	AGE
k10-kasten-operator-term-rhmp-controller-manager-6bbf4d7d6k6rn9	2/2	Running		13m
[nost 0] in un facily av 2] #				

- f. From the Red Hat OpenShift console, select **Operators** and click **Installed Operators**.
- g. From the Installed Operators menu, click Kasten K10 (Enterprise Term).
- h. From the Kasten K10 (Enterprise Term) page, click Create Instance which opens a Create K10 window.

i. Enter a Name, specify the Storage class name, and click **Create**.

Project: kasten-io 🔻				
Lreate KIU				
reate by completing the form. Default values may be provided by the Operator authors.				
ionfigure via: 💿 Form view O YAML view				
	-f-hi-st-			
Note: Some fields may not be represented in this form. Please select YAML View for full control.	of object crea	ation.		
Name *				
kio				
abels				
app=frontend				
Enable Basic Authentication				
False				
	Authenticatior	Details (htpassw	vd) or Secret Name	
Table Teles Based Authentication				
Faise				
Optional - Configure Token based authentication for the K10 dashboard				
Enable K10 dashboard to be exposed via route				
False				
Dotional - Configure Route for the K10 dashboard				
puona configure notice foi ale no admodula				
Specify StorageClassName to be used for PVCs				
sc-vsp5200				
Optional - Defaults to the default StorageClass of the cloud provider. (gp2 on AWS, standard on GKE, AWS &	OpenStack)			
size of a volume for catalog service. For e.g. 2001				
Optional - Defaults to global size of volumes for K10 persistent services. Controlled by `global.persistence.siz	e`			
Control metric and license reporting				
Create				
erify whether the relevant Kasten K10 components are running.				
postflipuwnfagl2 gy2l# kybegtl got pedg				
ME	READY	STATUS	RESTARTS	AGF
gregatedapis-svc-f4bfc797-5wpgs	1/1	Running	0	108
th-svc-84479b86c-rm5hx	1/1	Running		109
talog-svc-5c7595c74b-zqd2n	2/2	Running		108
ontrollermanager-svc-68ff5957-4dd9v	1/1	Running		109
ypto-svc-5bd747dcd9-9fshj	4/4	Running		108
shboardbff-svc-57595d7bcc-mhxwq	2/2	Running	0	109
ecutor-SVC-bCIDI45/CI-/ltn2	2/2	Running	0	108
ecutor-svc-6cfbf457cf-kmilc	2/2	Running	0	108
contend-svc=55b4c48dfd=mnp5p	1/1	Running		100
teway-9867fb979-cm5j2	1/1	Running	0	100
bs-svc-788c49585-vqqh4	1/1	Running		108
0-grafana-6b85fb7-ndqp9	0/1	Running		43
0-kasten-operator-term-rhmp-controller-manager-6bbf4d7d6k6rn9	2/2	Running		35r
mister-svc-7759c5cc48-gzqx9	1/1	Running		108
gging-svc-7f87bc97db-9qz81	1/1	Running		108
tering-svc-785459bcf7-2vmmz	1/1	Running		108
ometheus-server-bab45/b46C-21XX6	2/2	Running		109
Lale-SVC-J914C/843C-24K6/	212	Running		108

j.

k. Run the following command and then access the Kasten K10 dashboard:

![](_page_26_Picture_3.jpeg)

. Access the Kasten K10 dashboard (http://127.0.0.1:8080/k10/#/) from the browser. Accept the end-user license agreement and log in.

![](_page_26_Picture_5.jpeg)

The Applications option on the Kasten K10 dashboard contains a list of applications that were automatically detected and registered.

by Veeam		© Docs ◎ Settings ≗ k10-admin ∨ ♀
Applications Discovered in this system	Policies Managing resources	Usage & Reports Total Backup Data O.O B
<ul><li>0 Compliant</li><li>0 Non-Compliant</li></ul>	Backup Policies     Import Policies	Snapshots Object Storage

- 8. Install Kasten K10 Multi-Cluster Manager in OpenShift cluster at near-cloud.
  - a. Download the Kasten Multi-Cluster tool from: <u>https://github.com/kastenhq/external-tools/releases</u>.
    - b. Set the OpenShift cluster at near-cloud as Primary.

```
[root@linuxnfscl2 sw7]# ./k10multicluster setup-primary --name ocpcluster
Bootstrapping Primary Cluster...
Getting Primary Cluster Config...
Verifying cluster parameters: ocpcluster
Setting up primary multicluster configuration: ocpcluster
Setting up Primary Cluster Complete!
[root@linuxnfscl2 sw7]#
```

The K10 dashboard changed to K10 Multi-Cluster dashboard. Access the Kasten K10 Multi-Cluster dashboard using the same URL mentioned in step 7.

![](_page_27_Picture_2.jpeg)

#### Deploy Red Hat OpenShift Cluster in AWS

The following links describe the OpenShift installation procedure with IPI method in AWS.

For prerequisites, see <u>https://docs.openshift.com/container-platform/4.11/installing/installing\_aws/preparing-to-install-on-aws.html</u>.

If you do not have an AWS administrator account, you can deploy as an IAM user. See section 5.2.3 in: <a href="https://access.redhat.com/documentation/en-us/openshift">https://access.redhat.com/documentation/en-us/openshift</a> container <a href="https://access.redhat.com/documentation/en-us/openshift">platform/4.11/https://access.redhat.com/documentation/en-us/openshift</a> container <a href="https://access.redhat.com/documentation/en-us/openshift">https://access.redhat.com/documentation/en-us/openshift</a> container <a href="https://access.re

To obtain the installation media and pull secret, see <u>Deploy Red Hat OpenShift Cluster in Near-Cloud: Obtain the Installation</u> <u>Program</u>.

1. Prepare an "install-config.yaml" file for installing OpenShift Cluster as follows:

```
credentialsMode: Manual
apiVersion: v1
baseDomain: hvcloudconnect.com
compute:
- architecture: amd64
  hyperthreading: Enabled
  name: worker
  platform:
    aws:
      rootVolume:
        size: 200
        type: gp2
      type: t3.xlarge
      zones:
      - us-west-la
  replicas: 2
controlPlane:
  architecture: amd64
  hyperthreading: Enabled
  name: master
  platform:
    aws:
      zones:
      - us-west-la
      rootVolume:
        size: 200
        type: gp2
      type: t3.xlarge
  replicas: 3
metadata:
  creationTimestamp: null
  name: awscluster
networking:
```

```
clusterNetwork:
  - cidr: 10.128.0.0/14
   hostPrefix: 23
  machineNetwork:
  - cidr: 10.77.28.128/25
  networkType: OpenShiftSDN
  serviceNetwork:
  - 172.30.0.0/16
platform:
  aws:
    region: us-west-1
    subnets:
    - subnet-074541383711fd230
publish: Internal
pullSecret:
'{"auths":{"cloud.openshift.com":{"auth":"b3BlbnNoaWZ0LXJlbGVhc2UtZGV2K2hkc19pbGFiX2tvbDFk
ZXVfrgf==","email":"abc1.xz@hds.com"}}}'
sshKey: |
  ssh-rsa +uXAPvCfwTuiWu2+/GgGMBTUGwKLjcGYwdngSZW8e3C0Y5i/v root@ip-10-77-24-140.us-west-
1.compute.internal
```

2. Create the cluster. Change to the directory that contains the installation program and run the following openshift-install command:

#./openshift-install create cluster -log-level=debug

3. When the installation is complete, obtain the console URL from: https://console-openshift-

console.apps.awscluster.hvcloudconnect.com. C A Not secure Https://console-openshift-console.apps.awscluster.hvcloudconnect.com/k8s/cluster/nodes 🔍 🛧 🔲 🌧 Incognito 🛛 Updat Red Hat OpenShift III 🔺 3 🖸 🚱 kube:admin 🔻 You are logged in as a temporary administrative user. Update the cluster OAuth configuration to allow others to log in. Workloads > Nodes Networking ▼ Filter ▼ Name ▼ Search by name... Storage Name 1 Status 1 Role 1 Pods 1 Memory 1 CPU 1 Filesystem 1 Created 1 Instance type 1 Builds 🚺 ip-10-77-28- 🛛 🛇 Ready 64 10.5 GiB / 15.46 GiB 0.920 cores / 4 13.3 GiB / 199.8 GiB 🚯 Mar 9, 2023, 7:40 t3.xlarge master ÷ cores AM Observe 1.compute.inte ~ Compute 🚱 Mar 9, 2023, 7:40 t3.xlarge 🚺 ip-10-77-28- 🛛 🔮 Ready 46 8.05 GiB / 15.46 GiB 0.807 cores / 4 23.15 GiB / 199.8 : master 152.us-west cores GiB AM 1.compute.inte 🚺 ip-10-77-28- 🛛 🖉 Ready 27 4.39 GiB / 15.46 GiB 0.603 cores / 4 11.18 GiB / 199.8 GiB 🚯 Mar 9, 2023, 7:40 t3.xlarge ÷ master 37.us-west cores AM 1.compute.inte MachineAutoscalers MachineHealthChecks 🚺 ip-10-77-28- 🛛 🛇 Ready 4.22 GIB / 15.46 GIB 0.506 cores / 4 13.19 GiB / 199.8 GiB 🚯 Mar 9, 2023, 7:45 t3.xlarge 25 ÷ worker 45.us-west-AM cores MachineConfigs 1.compute.inte rnal MachineConfigPools 🚺 ip-10-77-28- 🛛 🛇 Ready 8.14 GiB / 199.8 GiB 🚱 Mar 9, 2023, 7:45 t3.xlarge ÷ worker 20 2.83 GiB / 15.46 GiB 0.226 cores / 4 . 247.us-west AN User Management 1.compute.inte

The automated installation creates two load balancers in AWS. One Classic Load Balancer for Ingress traffic and one Network Load Balancer for API traffic.

Name 🗢	DNS name	$\bigtriangledown$	State $\triangledown$	VPC ID 🛛 🗸	Availability Zones 🔻	Туре
a1609fb6b6c184ab 8b6bb92155ca1192	internal-a1609fb6b6c184ab8b6bb92155ca1192-627184225.us-west-1.elb.amazonaws.com	ı	-	vpc- 07fed8ae29 5819772	us-west-1a (usw1- az3)	classic
awscluster-vbvwz- int	awscluster-vbvwz-int-4505eb3a44635dc4.elb.us-west-1.amazonaws.com		⊘ Active	vpc- 07fed8ae29 5819772	us-west-1a (usw1- az3)	network

A Route53 private hosted zone entry is automatically created with the baseDomain and cluster name set in "installconfig.yaml" file.

	Hosted zone name	•	Туре	$\nabla$	Create	▽	Record ▼		Description	$\nabla$	Hosted zone ID
$\bigcirc$	awscluster.hvcloudconnect.com		Private		Route 53		5		Managed by Terraform		Z030164026DWTCVV189BM
In the	In the host, zone 3 records are added and API requests are redirected to the Network Load Balancer.										
	Record name	•	Type ⊽	Ro	utin 🔻	Di	▼ Alias	⊽	Value/Route traffic to		
	api-int.awscluster.hvcloudconnect.co	om	А	Sin	ıple	-	Yes		awscluster-vbvwz-int-4505	eb3a44	635dc4.elb.us-west-1.amazonaws.com.
	api.awscluster.hvcloudconnect.com		А	Sin	nple	-	Yes		awscluster-vbvwz-int-4505	eb3a44	635dc4.elb.us-west-1.amazonaws.com.
A	Il other requests are for	ware	ded to th	e Cla	assic Loa	ad Ba	alancer.				
	Record name		Type 🔻	Rou	tin 🔻	Differe	e 🔻 🛛 Alias		▼ Value/Route traffic to		
	*.apps.awscluster.hvcloudconnect.com	n	А	Sim	ple	-	Yes		internal-a1609fb6b6c1	84ab8b	6bb92155ca1192-627184225.us-west-
Verifv	the nodes, cluster vers	ion.	and Ope	enSh	ift URL a	as fol	lows:				

[root@ip-10-77-28-159 sw\_ocp18]# oc get nodes NAME STATUS ROLES AGE ip-10-77-28-161.us-west-1.compute.internal Ready master 69m ip-10-77-28-167.us-west-1.compute.internal Ready worker 64m

ip-10-77-28-206.us-west-1.compute.internal	Ready	master	68m	v1.24.6+5658434
ip-10-77-28-223.us-west-1.compute.internal	Ready	master	68m	v1.24.6+5658434
ip-10-77-28-231.us-west-1.compute.internal	Ready	worker	60m	v1.24.6+5658434
[root@ip-10-77-28-159 sw ocp18]#				

[root@ip-10-77-28-159 sw\_ocp18]# oc get clusterversion
NAME VERSION AVAILABLE PROGRESSING SINCE STATUS
version 4.11.25 True False 75m Cluster version is 4.11.25
[root@ip-10-77-28-159 sw\_ocp18]#

[root@ip-10-77-28-159 sw\_ocp18]# oc cluster-info
Kubernetes control plane is running at https://api.awscluster.hvcloudconnect.com:6443
To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.
[root@ip-10-77-28-159 sw ocp18]#

#### Install HSPC in Red Hat OpenShift Cluster in AWS

To install HSPC in Red Hat OpenShift Cluster in AWS, see Install Hitachi Storage Plug-in for Containers.

#### Install Kasten K10 in Red Hat OpenShift Cluster in AWS

To install Kasten K10 in Red Hat OpenShift Cluster in AWS, see Install Kasten K10 in Red Hat OpenShift Cluster.

#### Access Kasten K10 Dashboard

Kasten K10 dashboard URL is similar to that of near-cloud (<u>http://127.0.0.1:8080/k10/#/</u>), and is not externally published by default. To publish the K10 dashboard externally, run the following command:

# helm upgrade --force k10 kasten/k10 --namespace=kasten-io \
> --reuse-values \
> --set externalGateway.create=true \

> --set auth.tokenAuth.enabled=true

The command creates a service of type "LoadBalancer".

[root@ip-10-7	7-28-159 sw ocp	18]# oc get svo	c gateway-extnamespace kasten-io -o wide			
NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT (S)	AGE	SELECTOR
gateway-ext	LoadBalancer	172.30.77.1	a0dlcfba50e234755b8d89fda0461b3e-798909474.us-west-1.elb.amazonaws.com	80:32479/TCP	36d	service=gateway
[root@ip-10-7	7-28-159 sw ocp	181#				

VERSION

v1.24.6+5658434

v1.24.6+5658434

4.

LoadBalancer service provisions a Classic Load Balancer in AWS.

EC2 > 1	Load balancers										
Load Elastic	<b>I balancers</b> (3) : Load Balancing scales you	ur load	I balancer capacity automatically in response to changes in incoming traffic.				C	Actions <b>v</b>	Creat	e load balan	cer
Q	Filter by property or value									< 1 >	۲
	Name	$\nabla$	DNS name	State	$\bigtriangledown$	VPC ID	$\nabla$	Availability Zones	$\nabla$	Туре	$\bigtriangledown$
	a0d1cfba50e234755b8 89fda0461b3e	Bd	add1cfba50e234755b8d89fda0461b3e-798909474.us-west-1.elb.amazonaws.com	-		vpc- 07fed8ae295819772		us-west-1a (usw1-az	:3)	classic	

#### Install Kasten K10 Multi-Cluster Manager in Red Hat OpenShift Cluster in AWS

Download and untar the Kasten K10 Multi-Cluster tool from: https://github.com/kastenhg/external-tools/releases.

#### Context Configuration

The default name "kasten-io/api-awscluster-hvcloudconnect-com:6443/system:admin" may cause confusion to know which cluster we are managing, that is why changed the name to make it clearer.

#### 1. List the available Kubernetes context.

# oc config get-contexts
CURRENT NAME
AUTHINFO NAMESPACE
admin awscluster
admin
\* kasten-io/api-awscluster-hvcloudconnect-com:6443/system:admin
\* kasten-io/api-awscluster-hvcloudconnect-com:6443 kasten-io

#### 2. Rename the kasten-io context as development.

# oc config rename-context kasten-io/api-awscluster-hvcloudconnect-com:6443/system:admin
development
Context "kasten-io/api-awscluster-hvcloudconnect-com:6443/system:admin" renamed to

Context "kasten-10/ap1-awscluster-nvcloudconnect-com:6443/system:admin" renamed to "development".

#### After renaming:

```
# oc config get-contexts
CURRENT NAME CLUSTER AUTHINFO
NAMESPACE
admin awscluster
* development api-awscluster-hvcloudconnect-com:6443 system:admin/api-
awscluster-hvcloudconnect-com:6443 kasten-io
```

 Use the Kasten K10 Multi-Cluster tool to generate a modified kubeconfig file of Red Hat OpenShift Cluster in AWS (development). This is required during discovery of this cluster as secondary cluster from the near-cloud Kasten K10 Multi-Cluster instance.

```
# k10multicluster kubeconfig prepare --context development
Preparing context development...
```

(Output is truncated)

#### Discover Development Cluster from Kasten K10 Multi-Cluster in Near-Cloud

- 1. Add the secondary cluster (development) from near-cloud Kasten K10 UI by uploading kubeconfig file.
- 2. Navigate to the Kasten K10 Multi-Cluster dashboard and click Add Clusters.
- 3. In the Add Clusters window, enter the following information and click Add Cluster.
  - a. Paste the content of kubeconfig of the development cluster generated using the k10multicluster tool.
  - b. In the select cluster dialog box, select the development cluster from the list of available clusters.
  - c. Provide Ingress URL of the K10 instance in AWS. For Ingress URL, see Access Kasten K10 Dashboard.

d. For K10 namespace, select kasten-io.

# **Add Clusters**

abeeoning mes contain mo	mation needed to c	ommunicate with your cluste	ers. Use the
<pre>k10multicluster tool to gener</pre>	ate a modified kube	config which can be used to	add additional clusters.
Example: k10multicluster kul	peconfig prepareo	context [CONTEXT_NAME]	
Paste the contents of your kul	econfig here		
<ul> <li>apiL_Jd6xVuS_zNJ736bTyKYdiM</li> <li>blNLzOKW3jttyDNGAJPSJuZp72NMr</li> <li>vxsxY197tyqscSh5qtP7Vj7CmINKv</li> <li>uEIdTX9_3t00Nmq28IT_Msl1jKU5z</li> </ul>	_19gf2_1k4mO-VLV3d6H6f cMmLCrNafMnYGFS- yCUX_paLRXSnmRKRznUbMc Y-WGmGMWHW-54-	0MxbscHG8YVu0Ue_YLjix- HS6qOBuzBtODUs_H-Lp0Qo5EL80C71z	rfødxo-
lzIvytyzR4tYFt3iCXyRrUdh418uG tAO0kF7HgMTOc4b134RKhvc013Gar	v1QlpHPEeCMkDTyFv_Te4F 16bDlR4RFvu_2p_i00UORM	Rdvbp0ZhpdJT47UiOxejaD3SVtpE7Ce IQ8OkMfG9k0577QRgqgQJAowNSgEmY46	e-pX93ffyzh7Fvol- 5qzGQ
Or select your kubeconfig file		Successful Import	
Choose file	Browse	Found 1 cluster contex	ts in this kubasanfig
Select Clusters			
elect clusters you wish to ac	ld to this multi-clust	er deployment.	
cicci ciusici s you wisii to at			

Ingress URL URL for the K10 instance deployed in this cluster
http://a0d1cfba50e234755b8d89fda04
Helm Release Name
In most cases, this is <b>k10</b> , but if it has been changed
on this cluster, edit it here.
k10

Status of the newly added cluster "development" in Kasten K10 dashboard:

Cluste	ers										
↓ <del>=</del> A-Z		Filter by Name	2 clusters				Completed Succes	ssfully 🧲		$\oplus$	Add Clusters
		CLUS	TER		APPLICATIO	ONS	POLICIES	A	TIONS •	1D	
٢	developm dist.kio.kasten.	io/cluster-type:secondary		64	0	0 64	0	0	0	0	•
primary	dist.kio.kasten.	er io/cluster-type:primary		65	0	0 65	2	0	0	0	•

#### Test 2: Deploy a Stateful Application in Red Hat OpenShift Cluster

This test case describes the process of deploying MySQL Stateful application in Red Hat OpenShift cluster in near-cloud as well as AWS using persistent volume from the VSP 5200 storage system located in near-cloud. HSPC plugin enables the application to use a persistent volume from the VSP 5200 storage system.

#### **Deploy in Near-Cloud**

- 1. Deploy a Stateful MySQL application using the mysqlsts.yaml manifest file.
  - a. Create a namspace for the MySQL application. # oc create namespace productionmysql
  - b. Create a mysqlsts.yaml manifest file for MySQL service and POD. For creating storage class sc-vsp5200, see Install Hitachi Storage Plug-in for Containers: Create Storage Class and Volume SnapshotClass.

```
apiVersion: v1
kind: Service
metadata:
    namespace: productionmysql
    name: mysqlapp
    labels:
       app: mysqlapp
spec:
    ports:
    - port: 3306
     name: mysqlapp
    clusterIP: None
    selector:
       app: mysqlapp
____
apiVersion: apps/v1
kind: StatefulSet
metadata:
   namespace: productionmysql
    name: mysqlapp
spec:
  selector:
   matchLabels:
     app: mysqlapp
  serviceName: "mysglapp"
  podManagementPolicy: Parallel
  replicas: 1
  template:
    metadata:
      labels:
       app: mysqlapp
    spec:
      terminationGracePeriodSeconds: 30
      containers:
      - name: mysqlapp
        image: mysql:5.7
        args:
          - "--ignore-db-dir=lost+found"
        env:
        - name: MYSQL ROOT PASSWORD
          value: pass123
        - name: MYSQL DATABASE
          value: wordpress
        - name: MYSQL USER
          value: admin
        - name: MYSQL PASSWORD
          value: secret
        ports:
```

```
- containerPort: 3306
    name: mysql
    volumeMounts:
    - name: mysql-vol
    mountPath: /var/lib/mysql
volumeClaimTemplates:
- metadata:
    name: mysql-vol
spec:
    storageClassName: sc-vsp5200
    accessModes: [ "ReadWriteOnce" ]
    resources:
    requests:
    storage: 30Gi
```

c. To create MySQL service and POD using the YAML file, run the following oc command:

```
# oc create -f mysqlsts.yaml
```

d. Check the status of the MySQL service as follows:

# oc get :	svc -n produc	ctionmysql			
NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
mysqlapp	ClusterIP	None	<none></none>	3306/TCP	25s

e. Verify whether the pod is created and the status is running.

# oc get pod	-n produ	ıctionmysq	T	
NAME	READY	STATUS	RESTARTS	AGE
mysqlapp-0	1/1	Running	0	38s

f. Verify whether pvc is created from the VSP 5200 storage system as per the manifest file. Using storage class dynamically provisions a persistent volume in the VSP 5200 storage system.

```
# oc get pvc -n productionmysql
NAME
                     STATUS
                             VOLUME
                                                                        CAPACITY
ACCESS MODES STORAGECLASS AGE
mysql-vol-mysqlapp-0 Bound pvc-a3864ef6-23cf-4e39-889f-9829779762eb
                                                                       30Gi
             sc-vsp5200
RWO
                            45s
# oc get pv |grep productionmysql
pvc-a3864ef6-23cf-4e39-889f-9829779762eb 30Gi
                                                   RWO
                                                                 Delete
Bound productionmysql/mysql-vol-mysqlapp-0
                                                                 sc-vsp5200
```

#### 2. Access the MySQL application.

a. Log in to pod MySQL and verify whether the 30 GB persistent volume is created and mounted in /var/lib/mysql.

[root@linuxnfscl2 sw k10mc]# oc -n productionmysql rsh mysqlapp-0 sh-4.2\$ df -h Filesystem Size Used Avail Use% Mounted on 120G 19G 102G 16% / overlay tmpfs 64M 0 64M 0% /dev 7.8G 7.8G 0% /sys/fs/cgroup tmpfs shm 64M 64M 0% /dev/shm 7.8G 47M 7.8G 1% /etc/passwd tmpfs /dev/sda4 120G 19G 102G 16% /etc/hosts /dev/sdf 30G 255M 28G 1% /var/lib/mysql

b. Log in to MySQL database using "*mysql -u root -p*".

c. Verify whether the "wordpress" database is created.

d. Select the "wordpress" database.

![](_page_35_Picture_3.jpeg)

e. Create a table "employee" and ingest some records to the table.

<pre>mysql&gt; SELECT * FROM employees;</pre>												
emp_no   birth	date   first_name	last_name	gender	joining_date								
10001   1988-	12-03   Ajay	-+   Kumar	+	2018-07-18								
10002   1989-:   10003   1985-:	12-03   Amit 12-06   Robert	Kumar   Callahan	M   M	2018-09-18     2018-07-18								
10004   1985-:	12-06   Anne	Buchanan	F	2018-07-18								
10005   1989-	12-19   Ravi	Reddy	M   M	2018-07-18								
10007   1980-	12-06   Satish	J	M	2018-07-18								
10008   1989-	08-19   Raj	Singh	M	2018-07-18								
10010   1990-	11-06   Rabin	RD	M   M	2018-07-18								
++	+	-+	+	++								
10 rows in set ()	U.UI sec)											
mysql>												

f. HSPC automatically creates an iSCSI target on port 1-C of the storage system. Verify whether the 30 GB volume was created in the VSP 5200 storage system from Storage Navigator.

ISCSI Target A	lias	5	pc-e35b97e6397ee576a	5c4f8bd9aad (04)	:4f8bd9aad (04)		Host Mode			00 [Standard]		
iSCSI Target N	ame	i	qn.1994-04.jp.co.hitachi:	rsd.r90.t.40028.1c00	)4	Port Security		Enabled			Enabled Comply with Host Setting	
Port ID		(	CL1-C			Authentication Method		Method	thod Com;			
Virtual Storage Machine		3	VSP 5200, 5600 / 40028				1	Mutual CHAP		Disabled		
								User Name				
-								_	_	_		
Add LUN Path	Copy LUN Paths	Edit Co	mmand Devices More	Actions 🔻	_	_		_	_	0	ptions 👻 🕅 He	
Add LUN Path	S Copy LUN Paths	Edit Co	mmand Devices More	Actions	Emulation	Capacity				O Used Capaci	ptions 👻 🕅 🗺	
Add LUN Path	s Copy LUN Paths OFF Select All Page LUN ID LDEV I	Edit Co les Colun D 1 V	mmand Devices More	Pool Name (ID)	Emulation Type	Capacity Total	Reserved	Used	Used (%)	Used Capaci	ptions 👻 🎼 ty Tier 2	

#### **Deploy in AWS**

- 1. Deploy a stateful MySQL application in "devclustermysql" namespace with a 200 GB persistent volume.
- 2. Create a manifest file and deploy the application. See <u>Test 2: Deploy a Stateful Application in Red Hat OpenShift Cluster:</u> <u>Deploy in Near-Cloud</u>.
- 3. Access the stateful MySQL application.

```
a. Verify whether the pod is running.
# oc get pod -n devclustermysql
NAME READY STATUS RESTARTS AGE
```

- mysqlappdev-0 1/1 Running 0
- b. Log in to pod MySQL and verify that the 200 GB persistent volume is mounted in "/var/lib/mysql".

[root@ip-10-77-2	28-159	sw oo	cp18]#	oc -r	n devclustermysql	rsh mysqla	ppde <b>v</b> -0
sh-4.2\$ df -h							
Filesystem	Size	Used	Avail	Use%	Mounted on		
overlay	200G	31G	169G	16%	/		
tmpfs	64M	0	64M	0%	/dev		
tmpfs	7.8G	0	7.8G	0응	/sys/fs/cgroup		
shm	64M	0	64M	0응	/dev/shm		
tmpfs	7.8G	52M	7.7G	18	/etc/passwd		
/dev/nvme0n1p4	200G	31G	169G	16%	/etc/hosts		
/dev/sdi	197G	271M	187G	1%	/var/lib/mysql		

47s

- c. Log in to MySQL database using "mysql -u root -p".
- d. Verify that "persistantdb" database is created as mentioned in the manifest file.
- e. Select the "persistantdb" database.

mysql> show databases;
++   Database
++   information schema
mysql
performance_schema     persistantdb
sys
5 rows in set (0.00 sec)
mysql> use persistantdb;
Database changed

f. Create a table "student" and ingest some new records to the table.

mysql> SELECT * FRO	OM student; +		+	+	+4
registration_no	birth_date	first_name	last_name	gender	admision_date
+   70001 - 70002	++   1988-12-03     1000 12 03	Ramesh	   Kumar	+   M   M	2018-07-18
I 70002	1985-12-03     1985-12-06	Robert	Callahan	M   M	2018-09-18
70004   70005	1985-12-06     1989-12-19	Anne David	Buchanan   Hussain	F   M	2018-07-18   2018-07-18
70006   70007	1990-12-06     1980-12-06	Ananda	Muller   J	M   M	2018-07-18   2018-07-18
70008   70009	1989-08-19     1990-06-06	RN Ad	Prasad   Bolt	M   M	2018-07-18 2018-07-18
70010   70011	1980-11-06     1985-10-02	Rabin Raj	RD   MOHAN	M   M	2018-07-18
70012	1985-10-02	Priayam	Ajad	M 	2019-07-18
12 rows in set (0.0	00 sec)				

mysql>

g. HSPC automatically creates an iSCSI target on port 1-C of the storage system. Verify whether the 200 GB volume was created in the VSP 5200 storage system from Storage Navigator.

iSCSI Target Alia	IS	spc-883646	666e69015b02bd6e93f1ef	fd (0B)	Host Mode		00 [Stand	dard]			
iSCSI Target Nar	ne	iqn.1994-0	4.jp.co.hitachi:rsd.r90.t.40	0028.1c00b	Port Security		Enabled				
Port ID		CL1-C		CL1-C Authentication Method		Method	Comply w	Comply with Host Setting			
Virtual Storage Machine		VSP 5200, 5600 / 40028			Mutual CHAP	Disabled					
						User Name					
Add LUN Paths	Copy LUI	Dathe Edit									
	_	a Pacits Edic	Command Devices Mo	ore Actions				Selecte	d: 0 of		
SFilter ON	OFF Sele	t All Pages Co	lumn Settings	ore Actions			Options 👻 🖡	Selecte	ed:0 of /1 →		
Set ID	OFF Sele	tt All Pages Co	lumn Settings	Pool Na	me Emulatio	Capacity	Options 👻 🖡	Selecte	:d: 0 of /1 →		
Filter ON	LUN ID	t All Pages Co	LDEV Name	Pool Na (ID)	me Emulatio Type	Capacity Total 1V	Options 👻 🖡 Reserved	Selecte	d: 0 of / 1 → Used (%		

#### Test 3: Migrate Stateful Applications Across OpenShift Clusters Using Kasten K10 Multi-Cluster

This test case describes the process of migrating a stateful application by performing backup and restoration operations between two OpenShift clusters using Kasten K10 Multi-Cluster Global policy and HSPC. To illustrate this, we captured the snapshot of a stateful MySQL application running on Red Hat OpenShift cluster in near-cloud and then restored it on a secondary cluster in AWS. The entire process is performed from Kasten K10 Multi-Cluster UI. The VSP 5200 storage system serves the persistent volume required for stateful MySQL applications in both clusters.

#### **Snapshot Operation**

Before performing snapshot operation of an application, create the following:

- Global Location Profile: Profiles define credentials and locations required to move the data in and out of the cluster. In this scenario, an Amazon S3 bucket is used.
- Global Policy: Policies are used to automate your data management workflows. To achieve this, they combine actions you want to take (such as snapshot), a frequency or schedule for how often you want to take that action, and a label-based selection criteria for the resources you want to manage.
- Distribution: Distributions define which K10 resources belong to which clusters.

To perform snapshot operation of an application using Kasten K10, complete the following steps:

- 1. Verify that the application created in near-cloud as shown in <u>Test 2: Deploy a Stateful Application in Red Hat OpenShift</u> <u>Cluster: Deploy in Near-Cloud</u> is registered in the Kasten K10 UI.
- 2. Navigate to Kasten K10 Multi-Cluster dashboard and check the available clusters and registered applications. Clusters

↓≕ A-Z	Filter by Name 2 clusters		Completed Succe	ssfully 🕑	+ Add Clusters
	CLUSTER	APPLICATIONS	POLICIES	ACTIONS • 1D	
٢	development dist. Kio kasten loktuster-type secondery	67 0 0 67	0	0 0	•
primary	ocpcluster dist.klo.kasten.lo/cluster-type.primary	63 0 0 68	0	1 0 (	• •

 Navigate to Clusters, select ocpcluster (primary), and view the registered applications. Kasten K10 registers detected namespaces as an application. The following screenshot shows that the "productionmysql" namespace created in <u>Test 2:</u> <u>Deploy a Stateful Application in Red Hat OpenShift Cluster: Deploy in Near-Cloud</u> is detected.

pplications			
v details or perform actions o	n applications.		
Filter by Status	prod 2 applica	tions 88 HE	Page 1 ( )
productionmysql			
productionmysql			
productionmysql Not Protected by Policies     f Create a Policy >			
productionmysql Not Protected by Policies f Create a Policy > 0.0.0.08 @1 4 1 @1 @8			
productionmysql Not Protected by Policies f Create a Policy > 00.0 GB © 1 40 1 © 1			

Cluster-Scoped Resources M Latest snapshot was Today, 8:14am + Create a Policy >

4. Create a Global Cloud Location Profile.

a. In the K10 Global Resources section of the K10 Multi-Cluster dashboard, click Global Profile.

![](_page_39_Figure_3.jpeg)

In this scenario, an Amazon AWS S3 bucket named "**rhocp-k10**" is created and designated as the destination for Global Location Profile. For instructions to create an S3 bucket, see the User Guide section on the Amazon AWS S3 website.

Buckets (26) Info Buckets are containers for data st	C Copy ARN Empty Del		
Q rhocp-k10	X 1 match		
Name		▼ Access	▽ Creation date
O rhocp-k10	US West (N. California) us-west-1	Objects can be public	March 27, 2023, 12:57:11 (UTC+05:30)

b. In Global K10 Resources window, click New Profile.

c. Enter the required information (such as Profile Name, Storage Provider, AWS region, Bucket Name, AWS Access Key, Secret Key, and so on) and then click **Save Profile**.

rhocp-global-profile  orage Provider  Amazon S3  Google Cloud Storage  S3 Compatible  Veeam Repositor  WS Access Key  AKIAYSF765GGGRV2NJY275G711	re Y
torage Provider   Amazon S3  Azure Storage  S3 Compatible  Veeam Repositor  S3 Compatible  KIAYSF765GGGRV2NJY275G711  S5 Correct	re y
Armazon S3     Azure Storage     Google Cloud Storage     S3 Compatible     Veeam Repositor     S4 Access Key     AKIAYSF76SGGGRV2NJY275G711	re 'y
Google Cloud Storage     NFS FileSto     S3 Compatible     Veeam Repositor WS Access Key AKIAYSF76SGGGRV2NJY275G711	re 'Y
S3 Compatible     Veeam Repositor WS Access Key AKIAYSF76SGGGRV2NJY275G711 WE Forcet	y
WS Access Key AKIAY5F765GGGRV2NJY275G711	
AKIAY5F76SGGGRV2NJY275G711	
NS Socrat	
WS Secret	
	0
agion he geography in which the bucket is located	
US West (N. California) • us-west-1	•
ucket he bucket must be created beforehand and the region must atch.	t
rhocp-k10	

d. Verify that the profile is created.

@ GLOI	BAL PROFILE Belong	s to the distributions <b>redhat-ocp-restore-dis</b>	tribution, redhat-ocp-snapshot-distribution			
	LOCATION PROFILE	profile 🛛		< <b>/&gt;</b> yami	⊡2 edit	delete
	CLOUD PROVIDER AWS S3	REGION US West (N. California) • us-west-1	BUCKET NAME rhocp-k10			

- 5. Create a Global Snapshot Policy.
  - a. From the K10 Global Resources page, click **Global Polices** and then click **New Policy**.
  - b. Enter the snapshot related information (such as Policy Name, Backup Frequency, target application, application resources, and so on).

c. Select **Enable Backup via Snapshot Exports**, select the location profile that you created, and click **Create Policy**. This is required to generate an import policy while restoring the application.

New Policy				
Name				
redhat-ocp-snapshot-policy				
Comments				
Action		1		
The action that should be taken wher Snapshot	this policy is executed	Import		
Backup Frequency				
O Hourly	O Daily	O Weekly		
O Monthly	O Yearly	On Demand		
Storage class exceptions  Advanced Export Settin  Select Applications  Choose which application namespace label.	ngs es this policy should target. S	elect applications by name or by		
By Name	O By Labels	O None		
Choose one or more applications to t	arget with this policy. 🌘			
productionmysql x		-		
Select Application Resources Optionally create filters to include/ex	clude specified application re	esources.		
All Resources		Filter Resources		
Snapshot Cluster-Scoped These include non-namespaced Custom Resource Definitions, Cl	Resources resources that are not captur lusterRoles, and ClusterRoleBi	ed in application snapshots, such as ndings.		
Create	Policy (> YAML	Cancel		

d. Verify that the policy is created.

⊕ G	OBAL	POLICY Not yet added to distribution.	+ Create a Distribution
R	POL re	dhat-ocp-snapshot-policy 🛛	년 edit
	۲	productionmysql ( luster-scoped resources	>yami
		Snapshot <i>on-demand</i>	delete
	₽	Export onDemand snapshots using the export profile rhocp-global-profile	
		Export volume data for durable backups	

- 6. Create a distribution.
  - a. From the K10 Global Resources page, click **Distributions** and then click **New Distribution**.
  - b. In the Add Distribution window, enter the required information (such as Distribution Name, specify both nearcloud and AWS clusters), specify the two resources you created (Global Location Profile and Global Snapshot Policy), and then click **Add Distribution**.

Add Distribution					
<b>Name</b> The display name for the distri	bution. Must be Kube	rnetes-compatible (lowercase, dots, d	dashes)		
redhat-ocp-snapshot-distr	ibution				
<b>Clusters</b> Jsing labels, specify the cluste Multiple labels will be unioned	rs to which you want (OR). Any cluster that	to distribute resources. : matches any label will be targeted.			
Cluster - ocpcluster X	Cluster - develop	oment ×			
Resources Select the global K10 resources Available Options (0) No Unselected Options	s to distribute to clust Select All	ers. Selected (2) <b>R</b> redhat-ocp-snapshot- Snapshot + export policy dep	Deselect All policy ends on		
		profile rhocp-global-profile.	8		

c. Verify that the distribution is added.

[]]	טודעושטדוטא redhat-ocp-snapshot-distribution		C force sync	< <b>/&gt;</b> yaml	🖻 edit	delete
	CLUSTERS	RESOURCES	île			
	STATUS ✓ Synced 2 minutes ago					

d. Navigate to the Kasten K10 dashboard and verify that the global policy is distributed to both clusters. Clusters

it A-Z	Filter by Name 2 clusters		Completed Succes	ssfully 🕑	Add Clusters
	CLUSTER	APPLICATIONS	POLICIES	ACTIONS +	D
۲	development dist Ko kaster initiatier-type secondary	69 0 67	0	0 0	•
primary ©	ocpcluster dist is issue of see - oper primery	60 0 0 68	0	0 0	• •

- 7. Collect a snapshot of the registered application using the Global Snapshot Policy.
  - a. From the K10 Multi-Cluster dashboard, click Cluster "ocpcluster" and then click Policies.
  - b. Verify that the Global snapshot on-demand policy (created in <u>Test 3: Migrate Stateful Applications Across</u> <u>OpenShift Clusters Using Kasten K10 Multi-Cluster: Snapshot Operation</u>) is available under **Polices**.

8	redhat-ocp-snapshot-policy	revalidate
	Valid  Productionmysql  Cluster-scoped resources	() yami
	Snapshot on-demand	run once
	Export onDernand snapshots using the export profile rhocp-global-profile Export volume data for durable backups	
	Show import details	

c. Click **run once**, which opens a Run Once window. To start the snapshot, click **Yes, Continue**. **Run Once** 

This will immediately execute the actions in the policy redhat-ocpsnapshot-policy. Continue?

Snapshot Expiration (Optional)
If specified the snapshot will be deleted after the selected date and time.

Yes, Continue
Cancel d. Open the Kasten K10 Multi-Cluster dashboard and check the status of the policy in the [Actions] window. To check the phase in progress, click the related action.

total actions 23	completed actions	failed actions	skipped actions O	avg duration 113 sec	live artifacts 3,982	retired artifacts
Actions (10)			187 Filter			Page 1 🔇 🕥
40% Policy Run policy-run-7h6v2	rouer ⊇ redhat-ocp-snapshot- policy					statt Today, 4:52pm

e. Verify that the phase has changed to Completed Successfully. Click the relevant action to confirm that no error is present.

< Clusters < ocp	cluster 🗸						
	completed SUCCESSFULLY redhat-ocp-snapshot policy-run-7höv2 Show Details	START Today, 4:52pm APPLICATIONS	END Today, 4:57pm nysql	DURATION 5 mins, 14 secs			
Actions 💿	1				ŶåŶ Filta	er Actions	~
COMPLETED Export policy-run-7h6v	HNSS     Exporting Metadata     Monitoring Actions     All phases completed successfully.	PROTECTED OBJECT none originating Policy redhat-ocp-snapshot	ARTIFACTS none t-policy		START Today DURATI S mini	, 4:52pm <sub>N</sub> s, 25 secs	
COMPLETED Export scheduled-f7zs	Exporting RestorePoint     All phases completed successfully.	PROTECTED OBJECT none ORIGINATING POLICY redhat-ocp-snapshot	ARTIFACTS 617 @ s t-policy	spec	START Today DURATI 2 secs	, 4:52pm N	
COMPLETED Export scheduled-bzm	PHAGES © Exporting RestorePoint © All phases completed successfully.	PROTECTED OBJECT productionmysql ORIGINATING POLICY redhat-ocp-snapshot	ARTIFACTS 1 @ ka 19 @ sp	anister Dec	start Today Duran 1 min	, 4:54pm <sup>NN</sup> 47 secs	
COMPLETED Backup scheduled-bzm95	Huss:           Snapshotting Application Components           Snapshotting Application configuration           G           Snapshotting Vorkload mystapp           All phases completed successfully.	PROTECTED OBJECT productionmysql originating POLICY redhat-ocp-snapshot	ARTIFACTS 1 @ sn t-policy	napshot - 30 GiB pec	START Today Dusam 2 min:	, 4:52pm N 5, 22 secs	
COMPLETED Backup scheduled-f7zsw	Snapshotting Cluster-Scoped Resources     All phases completed successfully.	PROTECTED OBJECT none originating policy redhat-ocp-snapshot	ARTIFACTS 617 💮 s t-policy	spec	START Today DURATI 3 secs	, 4:52pm <sup>NN</sup>	

f. Integrating Kasten K10 with HSPC creates a Thin Image snapshot and splits the pair. In Storage Navigator, confirm the pair's status.

TI History (Page.1) &Filter ON OFF			_						
	Primary Volume		Secondary Volume		Mirror	0	Diff of the bull	Description	
Date and time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	Pool ID	Diff Compare Volume	Code	Description
2023/03/27 16:56:10	00:01:DB	DP	00:01:DC	DP	3	0		2011	PSUS
2023/03/27 16:56:07	00:01:DB	DP	00:01:DC	DP	3	0	-	2001	PAIR

#### **Restore Operation**

You can restore an application from snapshot across clusters from Kasten K10 Multi-Cluster. Restoring operation consists of the following high-level steps:

· Copying the Import data.

Canu Tunas T

- Creating a Restore policy.
- Apply the Restore Policy.
- 1. To copy the Import data from the K10 Multi-Cluster dashboard, click the production Cluster "**ocpcluster**" and then click **Policies**.

2. In the Polices window, select the Global Snapshot Policy created earlier, click **Show Import data**, and then click **Copy to clipboard**.

Policies Policies are used to automate y want to take (e.g., snapshot), a label-based selection criteria fo	our data management workflows. T frequency or schedule for how ofte r the resources you want to manag	o achieve this, they combine actions you n you want to take that action, and a e.	
		Importing Data	×
① Create New Policy	Filter by Name ×	The encoded text below contains import data needed by the receiving cluster. You'll be asked to paste this text when you create an import policy on the receiving cluster.	
GLOBAL POLICY Redhat-ocp-snapsh	ot-policy 🖪	Visit the Policies Page at any time to see this information.	
Valid		Copy to Clipboard	
productionmysql     (	Cluster-scoped resources	bIzAPpoanmE3zRF58wlj1JVZR0VIEhe75j+C5kQYZJcmPvJ/j165e6CVf/Lbpc4mLSm/zKuNGU+u7	7
🗑 Snapshot <i>on-dema</i>	nd	Dismiss	
Export onDemand export profile rhocp	snapshots using the -global-profile		
Export volume data	for durable backups		
Show import details			

- 3. Create a restore policy.
  - a. From the K10 Global Resources page, click Polices and then click New Policy.
  - b. In the New Policy window, enter a Policy Name, and select Import Frequency as On Demand.
  - c. In Config Data for Import section, paste the import policy copied in step 2.
  - d. Select **Restore after Import** and select the Global Location in Profile for Import.

>

e. Click Create Policy.

	New Policy	
lame		
he display name for this policy		
redhay-ocp-restore-policy		
omments		
<b>ction</b> he action that should be taken wi	hen this policy is executed	
O Snapshot		Import
Restore After Import     Automatically restore after i	mporting	
Data-Only Restore     Restore only the volume di	ata and exclude other artifac	ts such as config files.
Don't wait for workloa Specifies whether the reste StatefulSets or Deploymen	ids to be ready ore action should skip waitin tConfigs) to be ready before	g for all workloads (Deployments, completing.
Restore cluster-scoper	i resources	
If the restore point contain	is cluster-scoped (non-name	spaced) resources, they will not be
of this cluster's resources.	ct this option. This helps pro	vent against unintended overwriting
Apply transforms to	restored resources	
On restore, change the co	ontents of spec resources. This	may be useful when migrating
names.	or everyor, you carrying a	onde entret of entretenties unde
Select Application Resour	ces	
Select Application Resour Optionally create filters to Incl	ces ude/exclude specified applic	ation resources.
Select Application Resour Optionally create filters to Incl	ces ude/exclude specified applic	ation resources.
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Select Application Resour Optionally create filters to Incl All Resour Pre and Post-Restore Acti Optional blueprint actions to B Before After - On Success After - On Success After - On Failure moort Frequency Hourly Monthly onfig Data for Import aste the toxit that was presented user. Policy must like of Success bit dypoint Like (stavder) bit dypoint Like (stavder) roffie for Import set the profile that defines the I Crop-global-profile didvanced Settings prore Exceptions and Contin	rees ude/exclude specified applic ces ion Hooks se run before or after restore Daily Daily Yearly to you when the restore pails to you when the restore pails to you when the restore pails to second the restore pails to second the restore pails to use the restore pails to restore paints, present to contain for importing data.	ation resources.  Filter Resources  s complete  Meekly  On Demand  twas exported from the source in the source cluster at the time of  cestSay exulClus77cL11779rhaderg81 7y80

f. Verify that the policy is created.

#### **Policies**

Policies are used to automate your data management workflows. To achieve this, they combine actions you want to take (e.g., snapshot), a frequency or schedule for how often you want to take that action, and a label-based selection criteria for the resources you want to manage.

① Create New Policy	Filter by Name	
GLOBAL POLICY	Not yet added to distribution.	🕀 Create a Distribution
POLICY	e-policy 🛛	edit.
i Import <i>on-deman</i>	<i>d</i> and <b>restore after import</b> using the import profile <b>rhocp-global-profile</b> .	yami
		[ii] delete

- 4. Create a Distribution.
  - a. From the K10 Global Resources page, click **Distributions** and then click **New Distribution**.
  - b. In the Add Distribution window, enter the name, specify both clusters, select the restore policy and location profile in Resources, and then click **Add Distribution**.

Add Distribution  Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add Distribution Add D						
Name The display name for the distribution. Must be Kub	ernetes-compatible (lowercase, dots, dashes)					
redhat-ocp-restore-distribution						
Clusters Jsing labels, specify the clusters to which you wan Multiple labels will be unioned (OR). Any cluster tha	to distribute resources. It matches any label will be targeted.					
Cluster - development X Cluster - ocp	cluster ×					
elect the global K10 resources to distribute to clus wallable Options (1) Select All <b>redhat-ccp-snapshot-policy</b> Snapshot + export policy depends on profile index-global-profile	ters. Selected (2) Deselect All R redhat-ocp-restore-policy Import + restore policy depends on profile rhoop global profile.					
	S3, us-west-1, "rhocp-k10"					
Add Distribu	tion Cancel					

c. Verify that the distribution is added.

[]]	DISTRIBUTION redhat-ocp-restore-distribution		C force sync	>yaml	년 edit	i delete
	CLUSTERS	RESOURCES Policy redhat-ocp-restore-policy Profile rhocp-global-profile				
	STATUS ✓ Synced 2 minutes ago					

5. Navigate to the K10 Multi-Cluster dashboard and verify whether the global policy is distributed to both clusters.

ļ≡ <mark>A-</mark> Z	Filter by Name 2 clusters	Cor	npleted Su	Add Clusters
	CLUSTER	APPLICATIONS	POLICIES	ACTIONS • 1D
٢	development dist. Kis kasten Jorduster-type secondary	67 0 0 67	0	• • • •
primary	ocpcluster           dist No kasten lolduster-type primary	68 0 0 68	8	200 🔍

- 6. Run the restore operation.
  - a. From the K10 Multi-Cluster dashboard, click development (the secondary cluster) and then click Policies.
  - b. Verify whether the Global restore on-demand policy created in <u>Test 3: Migrate Stateful Applications Across</u> <u>OpenShift Clusters Using Kasten K10 Multi-Cluster: Restore Operation</u> section is available under Polices.

R	GLOBAL POLICY redhat-ocp-restore-policy	✓ revalidate
	Valid	>yaml
	import <i>on-demand</i> and <b>restore after import</b> using the import profile <b>rhocp-global-profile</b> .	パ run once
	we are which as we the Due One window To start the metals will Ver Orations	

c. Click run once, which opens the Run Once window. To start the restore, click Yes, Continue.

	Run Once		
	This will immediately execute the <b>restore-policy</b> . Continue?	actions in the policy <b>redhat-ocp-</b>	
	Yes, Continue	Cancel	
d.	Open the K10 Multi-Cluster	dashboard and check the	e status of the policy in the [Actions] window. To check the

![](_page_48_Picture_12.jpeg)

e. Verify that the phase has changed to Completed Successfully. To confirm that no error is present, click the related action.

$\bigcirc$	COMPLETED SUCCESSFULLY redhat-ocp-restore-po policy-run-g4md7 Show Details	START Today, 5:17pm Applications	END Today, 5:19pm	DURATION 2 mins, 13 secs		
Actions 2					해 Filter Actions	~
COMPLETED Restore scheduled-zfpj6	Restoring Application Components     All phases completed successfully.	TARGET NAMESPACE productionmysql originating policy redhat-ocp-restore-	ARTIFACTS none policy		START Today, 5:18pm DURATION 1 min, 6 secs	
COMPLETED Import scheduled-q57xz	Importing RestorePoint     All phases completed successfully.	PROTECTED OBJECT none ORIGINATING POLICY redhat-ocp-restore-	ARTIFACTS 1 @ kar 636 @ sp policy	nister Jec	START Today, 5:17pm Duration 29 secs	

f. From the K10 Multi-Cluster dashboard, navigate to cluster Development and verify that application "productionmysql" is restored.

pplications ew details or perform actions on ap	plications.				@ (	Cluster-Scoped Resources Mi atest snapshot was Today, 4:52pm
የሬየ Filter by Status 🗸 proc	4	2 applications 88 IE	Page 1 🔇 🕥			
productionmysql Not Protected by Policies						
Latest snapshot was Today, 4:54pm						
80.0 G/B 🗐 1 🕂 1 🎯 1 🔘 8						
snapshot	<b>O</b> restore	B→ export	II details			

- 7. Verify that the data is available.
  - a. Log in to the pod mysqlapp-0 in productionmysql namespace in the development cluster and verify whether the 30 GB persistent volume is mounted.

-									
[root@ip-10-	77-28	-159	sw kl	10]#	oc get	c p	od	-n	productionmysql
NAME	READ	Y S	STATUS	5	RESTAR	RTS	5	AGE	6
mysqlapp-0	1/1	F	Runnir	ng	0			10n	n
[root Ain 10	77 20	150	err lei	101#					
[root@ip-10-77-	-28-159	sw_ki	L0]# od	c -n j	producti	onm	nysq	l rs	sh mysqlapp-0
sh-4.2\$ df -h									
Filesystem	Size	Used	Avail	Use%	Mounted	l or	ı		
overlay	200G	22G	178G	11%					
tmpfs	64M	0	64M	0응	/dev				
tmpfs	7.8G	0	7.8G	0%	/sys/fs	/cg	grou	р	
shm	64M	0	64M	08	/dev/sł	m			
tmpfs	7.8G	49M	7.7G	1%	/etc/pa	ISSW	<b>v</b> d		
/dev/nvme0n1p4	200G	22G	178G	11%	/etc/ho	sts	5		
/dev/sdc	30G	255M	28G	1%	/var/li	b/m	nysa	1	

b. Log in to MySQL and verify whether database wordpress and employee table is available.

```
mysql> use wordpress;
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A
Database changed
mysql>
mysql> show tables;
+-----+
| Tables_in_wordpress |
+-----+
| employees |
+-----+
1 row in set (0.00 sec)
```

c. Verify whether the ingested data in Primary cluster "ocpcluster" (as shown in <u>Test 2: Deploy a Stateful</u> <u>Application in Red Hat OpenShift Cluster: Deploy in Near-Cloud</u>) is available in "development" cluster in AWS.

mysql> SEI +	LECT * FROM er	nployees; +		+	+
emp_no	birth_date	first_name	last_name	gender	joining_date
+   10001   10002   10003   10004   10005   10006   10007   10008   10009   10010	1988-12-03 1989-12-03 1985-12-06 1985-12-06 1989-12-19 1990-12-06 1980-12-06 1989-08-19 1990-06-06	   Ajay   Amit   Robert   Anne   Ravi   Carlos   Satish   Raj   Andrew   Rabin	Kumar Kumar Callahan Buchanan Reddy Fuller J Singh Muller RD	+	2018-07-18   2018-09-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18
+	+	++		++	++
10 1005 11	1 500 (0.00 50				

During restoration a clone volume "00:01:DD" was created from the snapshot volume "00:01:DC". The following screenshot shows the creation of the clone volume:

☆Filter ON OFF									
Date and Time	Primary Volume		Secondary Volume		Mirror	Pool ID	Diff. On second Values	Description	Description
Date and Time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	POOLID	Dim Compare Volume	Code	Description
2023/03/27 16:57:51	00:01:DC	DP	00:01:DD	DP	3	0	-	2092	CLONE END
2023/03/27 16:56:56	00:01:DC	DP	00:01:DD	DP	3	0		2091	CLONE START
2023/03/27 16:56:56	00:01:DC	DP	00:01:DD	DP	3	0	-	2001	PAIR

Clone volume "00:01:DD" was assigned to the restored application in the development cluster in AWS, as shown

# in the following screenshot:

spc-5638cdf0327f3e4538	c-5638cdf0327f3e4538f4ba7100d0 (07)						
<u>VSP-5200-SV10(S/N:40028)</u> >	Ports/Host Groups/iSCSI Targets > <u>CL1-C</u> > spc-5638c	df0327f3e4538f4ba7	'100d0				
Volume Migration 🔻							
iSCSI Target Alias	spc-5638cdf0327f3e4538f4ba7100d0 (07)	Host Mode		00 [Standard]			
iSCSI Target Name	iqn.1994-04.jp.co.hitachi:rsd.r90.t.40028.1c007	Port Security		Enabled			
Port ID	CL1-C	Authentication	Method	Comply with Host Setting			
Virtual Storage Machine	VSP 5200, 5600 / 40028		Mutual CHAP	Disabled			
			User Name				

Host	ts LUNs	Host Mo	de Options 🛛 🤇	HAP Users	^						
Ad	dd LUN Path	s Copy Ll	JN Paths Edit	Command Devices M	ore Actions					Selected: 0	of :
<b>\$</b>	Filter ON	OFF Sel	ect All Pages Co	lumn Settings				Optio	ns 🔻 候 🗧	1 / 1	>
			100110	1.5.5.1.1	Pool Name Err (ID) Ty	Eroulation	Capacity				Use
	Port ID	LUN ID	LDEV ID	LDEV Name		Туре	Total	Reserved	Used	Used (%)	Tier
	CL1-C	6	00:01:CE	spc-6462997a53	dr_pool(0)	OPEN-V CVS	20.00 GB	0.00 GB	1.39 GB	6	
	CL1-C	<b>1</b> 250	00:01:CD	spc-1d632c1644	dr_pool(0)	OPEN-V CVS	8.00 GB	0.00 GB	3.69 GB	46	
	CL1-C	<b>Ø</b> <u>253</u>	00:01:DD	spc-7734c34e9e	dr_pool(0)	OPEN-V CVS	30.00 GB	0.00 GB	2.00 GB	6	

#### Test 4: Migrate a Stateful Application Across OpenShift Cluster Manually

Test 3 describes the applications migration process with Kasten K10 Multi-Cluster Manager. This test case, instead of using Kasten K10, describes the Kubernetes commands with the help of HSPC plugin that can be used for migrating a stateful application from OpenShift cluster in near-cloud to AWS. The VSP 5200 storage system provides the persistent volume required for stateful MySQL application in both clusters.

#### **Snapshot Operation**

Complete the following steps in OpenShift Cluster in near-cloud:

- Create a new namespace "prodmysql" and deploy a Stateful MySQL application with a 250 GB persistent volume from the VSP 5200 storage system, as shown in <u>Test 2: Deploy a Stateful Application in Red Hat OpenShift Cluster: Deploy in</u> <u>Near-Cloud</u>.
- 2. Access the stateful MySQL application.
  - a. Log in to pod MySQL and verify that the 250 GB persistent volume is mounted in "/var/lib/mysql", as per the manifest file.

[root@linuxnfsc: sh-4.2\$ df -h	12 ~]#	oc -r	n prodr	nysql	rsh prodmysqlapp-0
Filesystem	Size	Used	Avail	Use%	Mounted on
overlay	120G	20G	100G	17%	/
tmpfs	64M	0	64M	08	/dev
tmpfs	7.8G	0	7.8G	0%	/sys/fs/cgroup
shm	64M	0	64M	0%	/dev/shm
tmpfs	7.8G	48M	7.8G	1%	/etc/passwd
/dev/sda4	120G	20G	100G	17%	/etc/hosts
/dev/sdj	246G	271M	234G	1%	/var/lib/mysql

b. Log in to MySQL database using "*mysql -u root -p*" and verify that database "prodmysqldb" is created as per the manifest file.

my	ysql> show databases;
+	Database
+-	information_schema
	performance_schema
	sys
+- 5	rows in set (0.01 sec)

c. Create a table "employees" and ingest some new records to the table.

mysql	mysql> SELECT * FROM employees;										
emp	_no	birth_date	first_name	last_name	gender	joining_date					
+   50   50	001   002   003   004   005   006   008   009   010	1988-12-03 1989-12-03 1985-12-06 1985-12-06 1989-12-19 1990-12-06 1989-08-19 1990-06-06 1980-11-06	Ramesh Amit Robert Md Jagdish Carlos Raj Andrew Rabin	+   Kumar   Fernandez   Riaz   Reddy   Fuller   Singh   Muller   RD	+   M   M   M   M   M   M   M   M	2018-07-18   2018-09-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18   2018-07-18					
50	012	1985-10-02	David	H	M   M	2019-07-18					
+	ws in	set (0.00 se	+ ≥c)	+	+	++					

d. HSPC automatically creates an iSCSI target on port 1-C of the storage system. Verify whether a dynamically provisioned volume (00:01:EB) of 250 GB was created in the VSP 5200 from storage system.

iSCSI Target Alias	spc-e35b97e6397ee576a5c4f8bd9aad (	04) Host Mode					
iSCSI Target Name	iqn.1994-04.jp.co.hitachi:rsd.r90.t.4002	1994-04.jp.co.hitachi:rsd.r90.t.40028 Port Security Enabled					
Port ID	CL1-C	Authentication	Method	thod Comply with Host S			
/irtual Storage Machine	VSP 5200, 5600 / 40028		Mutual CHAP	Disabled			
			User Name				
osts LUNs Host Mo	de Options CHAP Users	Actions		Selec	ted: 0 of :		
osts LUNs Host Mo	de Options CHAP Users	Actions		Selec	ted: 0 of 8		
Add LUN Paths Copy L Add LUN Paths Copy L AFilter ON OFF Sel	de Options CHAP Users JN Paths Edit Command Devices Mor et All Pages Column Settings	2 Actions	Optic	Selec	ted: 0 of 1		
Add LUN Paths Copy LI	de Options CHAP Users UN Paths Edit Command Devices Mor ect All Pages Column Settings UDEV ID 1 LDEV Name	: Actions	Optic Pool Name	Selectons VIE Constant	ted: 0 of : /1 → Capacity		
OSTS LUNS HOST MO Add LUN Paths Copy Li SFilter ON OFF Sel Port ID LUN ID	de Options CHAP Users JN Paths Edit Command Devices Mor ect All Pages Column Settings LDEV ID 1 V LDEV Name	Actions 🔻	Pool Name (ID)	Select Select Select Select Emulation Type	ted: 0 of / 1 🎐 Capacity Total		

- 3. Create a snapshot.
  - a. Create VolumeSnapshotClass. See Install Hitachi Storage Plug-in for Containers.
  - b. Create a manifest file to collect snapshot of the persistent volume created in step 2.

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
   name: mysql-manual-snapshot
   namespace: prodmysql
spec:
   volumeSnapshotClassName: snapshotclass-sample
   source:
      persistentVolumeClaimName: prod-vol-prodmysqlapp-0
```

c. Run the oc command using manifest file to create the snapshot.

# oc create -f volumesnapshot-mysql-manual.yaml

#### d. Verify that the snapshot is created.

```
# oc get VolumeSnapshot -n prodmysql
NAME READYTOUSE SOURCEPVC
SOURCESNAPSHOTCONTENT RESTORESIZE SNAPSHOTCLASS SNAPSHOTCONTENT
CREATIONTIME AGE
mysql-manual-snapshot true prod-vol-prodmysqlapp-0
250Gi snapshotclass-sample snapcontent-ba8ddcf5-38b9-4581-b3c3-
```

84bdc386ef07 14d 14d

e. From Storage Navigator, verify that the snapshot volume (00:01:EC) is created successfully.

Copy Type: TI	•								
TI History (Page.1)									
A Filter ON OFF									
Data and Time	Primary Volume		Secondary Volume		Mirror	Deal ID	Diff Company Maluma	Description	Description
Date and Time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	P00110	bin compare volume	Code	Description
2023/04/17 06:17:47	00:01:EB	DP	00:01:EC	DP	3	0		2011	PSUS
2023/04/17 06:17:44	00:01:EB	DP	00:01:EC	DP	3	0	-	2001	PAIR

#### **Restore Operation**

Complete the following steps in the OpenShift cluster in AWS:

- Identify the volume handle string for the snapshot secondary volume 00:01:EC. Volume handle string for this LDEV is "60060e80089c5c0000509c5c000001ec—spc-208715bccc". In the string, LDEV ID is "01ec" and LDEV Name is "spc-208715bccc". LDEV name is automatically assigned by HSPC.
- 2. Create PV and PVC using volume (00:01:EC) with the pre-defined volume handle string.
  - a. Create a namespace in the OpenShift cluster in AWS.
    - # oc create namespace devmysql
  - b. Create a manifest file for PV and PVC. Use the volume handle string for PV manifest. This way, storage class does not dynamically create a new volume; instead, it uses the existing volume to preserve the snapshot data.

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: devmysqlpv
 namespace: devmysql
spec:
  capacity:
    storage: 250Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  storageClassName: sc-vsp5200
  csi:
    driver: hspc.csi.hitachi.com
    volumeHandle: 60060e80089c5c0000509c5c000001EC--spc-208715bccc
  claimRef:
    name: devmysqlpvc
    namespace: devmysql
___
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: devmysqlpvc
  namespace: devmysql
spec:
  accessModes:
  - ReadWriteOnce
  resources:
        requests:
          storage: 250Gi
  volumeName: devmysqlpv
  storageClassName: sc-vsp5200
```

c. To create PV and PVC using manifest, run the following oc command:

<sup>#</sup> oc create -f devmysqlpvc.yaml

d. Verify that PV and PVC are created as per manifest.

[root@ip-10-77-28-159 devmysqlpv [root@ip-10-77-28-159	sw_k10]# oc get ; sw_k10]#	pv  grep devmysqlpv 250Gi RWO	Retain	Bound	devmysql/dev	mysqlpvc	sc-vsp5200	
[root@ip-10-	77-28-159		ret pvc -n	devmvsal				
NAME	STATUS	VOLUME	CAPACITY	ACCESS	MODES	STORAGECLASS	AGE	
devmvsalpvc	Bound	devmvsalpv	250Gi	RWO		sc-vsp5200	10s	

3. Create a manifest file to create a clone PVC using the "devmysqlpvc" PVC as data source.

```
a. Create a manifest.
```

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: devmysqlclone
 namespace: devmysql
spec:
  storageClassName: sc-vsp5200
  dataSource:
    name: devmysqlpvc
    kind: PersistentVolumeClaim
    apiGroup: ""
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 250Gi
```

- b. To create the clone PVC, run the following oc command using manifest:
  - # oc create -f devmysqlclone.yaml
- c. HSPC dynamically provisions a PV from the VSP 5200 storage system. Verify the PVC and PV.

```
# oc get pvc -n devmysql
               STATUS
                        VOLUME
                                                                  CAPACITY
NAME
ACCESS MODES
              STORAGECLASS
                            AGE
devmysqlclone Bound
                       pvc-cd4a340d-538d-41cd-991d-963a3d9605fd
                                                                  250Gi
                                                                             RWO
sc-vsp5200
              60s
# oc get pv |grep devmysql/devmysqlclone
pvc-cd4a340d-538d-41cd-991d-963a3d9605fd 250Gi
                                                    RWO
                                                                   Delete
        devmysql/devmysqlclone
                                                                         4m20s
                                                  sc-vsp5200
Bound
```

![](_page_55_Figure_11.jpeg)

Filter ON OFF	_					_		_	
Arriter On Orr	Primary Vol	ume	Secondary \	Secondary Volume				Description	
Date and Time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	P001 1D	Diff Compare Volume	Code	n Description
2023/04/17 07:24:12	00:01:EC	DP	00:01:ED	DP	3	0	-	2092	CLONE END
2023/04/17 07:19:33	00:01:EC	DP	00:01:ED	DP	3	0	-	2091	CLONE START
2023/04/17 07:19:32	00:01:EC	DP	00:01:ED	DP	3	0		2001	PAIR

- 4. Restore the MySQL application in the AWS cluster. In the volume section, use the claim "devmysqlclone" created in step 3, which ensures that MySQL application uses the clone PVC for persistent data.
  - a. Create a manifest.

```
apiVersion: v1
kind: Service
metadata:
namespace: devmysql
name: prodmysqlapp
```

```
labels:
       app: prodmysqlapp
spec:
    ports:
    - port: 3306
     name: prodmysqlapp
    clusterIP: None
    selector:
      app: prodmysqlapp
___
apiVersion: apps/v1
kind: StatefulSet
metadata:
    namespace: devmysql
   name: prodmysqlapp
spec:
  selector:
    matchLabels:
     app: prodmysqlapp
  serviceName: "prodmysqlapp"
  podManagementPolicy: Parallel
  replicas: 1
  template:
    metadata:
      labels:
        app: prodmysqlapp
    spec:
      terminationGracePeriodSeconds: 30
      containers:
      - name: prodmysqlapp
       image: mysql:5.7
        args:
          - "--ignore-db-dir=lost+found"
        env:
        - name: MYSQL_ROOT_PASSWORD
         value: pass123
        - name: MYSQL DATABASE
          value: prodmysgldb
        - name: MYSQL USER
          value: admin
        - name: MYSQL PASSWORD
          value: secret
        ports:
        - containerPort: 3306
         name: mysql
        volumeMounts:
        - name: prod-vol
         mountPath: /var/lib/mysql
      volumes:
      - name: prod-vol
        persistentVolumeClaim:
          claimName: devmysqlclone
```

#### b. To create MySQL pod and service, run the following oc command using manifest:

```
# oc create -f prodmysqlapp-sts.yaml
```

c. Verify that MySQL pod and service are created as per manifest.

			-			
[root@ip-10-77-2	8-159 sw	k10]# oc g	get svc -n	devmysql		
NAME T	YPE	CLUSTER-	-IP EXTER	NAL-IP	PORT (S)	AGE
prodmysqlapp C	lusterIP	None	<none< td=""><td>&gt;</td><td>3306/TCP</td><td>16s</td></none<>	>	3306/TCP	16s
[root@ip-10-77-2	8-159 sw	k10]# oc g	get pod -n	devmysql		
NAME	READY	STATUS	RESTARTS	AGE		
prodmysglapp-0	1/1	Running	0	27s		

d. Log in to the pod prodmysqlapp-0 and verify whether the 250 GB persistent volume is mounted on "/var/lib/mysql".

[root@ip-10-77-	28-159	sw_kl	L0]# od	c −n (	devmysql rsh prodmysqlapp-0
sh-4.2\$ df -h					
Filesystem	Size	Used	Avail	Use%	Mounted on
overlay	200G	30G	171G	15%	/
tmpfs	64M	0	64M	0%	/dev
tmpfs	7.8G	0	7.8G	0%	/sys/fs/cgroup
shm	64M	0	64M	0%	/dev/shm
tmpfs	7.8G	50M	7.7G	1%	/etc/passwd
/dev/nvme0n1p4	200G	30G	171G	15%	/etc/hosts
/dev/sdf	246G	271M	234G	1%	/var/lib/mysql

e. Log in to MySQL and verify whether the database "prodmysqldb" is available.

```
mysql> show databases;
+-----+
| Database |
+----+
| information_schema |
| mysql |
| performance_schema |
| prodmysqldb |
| sys |
+----+
5 rows in set (0.01 sec)
```

f. Verify whether the ingested data from Primary cluster "ocpcluster" is available.

mysql> SEI	/sql> SELECT * FROM employees;											
emp_no	birth_date	first_name	last_name	, gender	joining_date							
50001	1988-12-03	Ramesh	Kumar	м М	2018-07-18							
50002	1989-12-03	Amit	Kumar	M	2018-09-18							
50003	1985-12-06	Robert	Fernandez	M	2018-07-18							
50004	1985-12-06	Md	Riaz	M	2018-07-18							
50005	1989-12-19	Jagdish	Reddy	M	2018-07-18							
50006	1990-12-06	Carlos	Fuller	M	2018-07-18							
50008	1989-08-19	Raj	Singh	M	2018-07-18							
50009	1990-06-06	Andrew	Muller	M	2018-07-18							
50010	1980-11-06	Rabin	RD	M	2018-07-18							
50011	1985-10-02	Firoz	Ali	M	2019-07-18							
50012	1985-10-02	David	H	M	2019-07-18							
+	++		+	+	+							
11 rows in	n set (0.00 se	ec)										
		-,										
wysol>												

# HSPC automatically creates an iSCSI target on port 1-C of the storage system and assigns the volume to the appropriate worker node.

iSCSI Target Alias	spc-5638cdf0327f3e4538f4ba7100d0 (07)	Host Mode		00 [Standard]
iSCSI Target Name	iqn.1994-04.jp.co.hitachi:rsd.r90.t.40028	Port Security		Enabled
Port ID	CL1-C	Authentication	Method	Comply with Host Setting
Virtual Storage Machine	VSP 5200, 5600 / 40028		Mutual CHAP	Disabled
			User Name	
	^			

losts	LUNs	Host Mod	e Options CH	AP Users							
Add	add LUN Paths Copy LUN Paths Edit Command Devices More Actions 🔻										
<b>☆</b> Fil	ter ON C	Sele	ct All Pages Colu	mn Settings		(	Options 🔻	€€	1 / 1		
	Dout ID				Pool Name	Emulation	Capacity				
<u> </u>	PORTD	LON ID	LDEV ID	LUEV Name	(ID)	Type	Total	1 🔻	Reserved		
	CL1-C	<b>Ø</b> <u>243</u>	00:01:ED	spc-1166399016	dr_pool(0)	OPEN-V CVS	250	.00 GB	0.00 G		

#### **Test 5: Recover from a Ransomware Attack**

This test case demonstrates how a VSP snapshot combined with immutability feature from Data Retention Utility program product can be used to recover a stateful application affected by a ransomware attack. Assume that application is affected by a ransomware attack and we must restore clean data from the snapshot. This recovery process can be carried out either in the near-cloud or in AWS cluster.

Recovering from a ransomware attack consists of the following high-level steps:

- Creating PVC with the snapshot volume (where the DRU attribute Write Disabled is set).
- Creating a cascaded snapshot of this volume because write is disabled.
- Using the cascaded snapshot (snap-on-snap) to recover the application data in any cluster.
- Creating a clone PVC and using that PVC as data volume to restore the MySQL application because snapshot volumes must not be directly used in a POD.
- Verifying that the data ingested from near-cloud cluster is available.

#### **Snapshot Operation**

Complete the following steps in the near-cloud OpenShift cluster:

- Create a new namespace "drusnapshot" and deploy a Stateful MySQL application with a persistent volume of 250 GB from a VSP 5200 storage system, as shown in <u>Test 2: Deploy a Stateful Application in Red Hat OpenShift Cluster: Deploy</u> <u>in Near-Cloud</u>.
- 2. Access the stateful MySQL application.
  - a. Log in to the pod mysqldru-0 and verify whether the 250 GB persistent volume is mounted on "/var/lib/mysql".

[root@linuxnfsd	:12 ~]#	oc -1	n drusr	napsho	ot rsh mysqldru-0
sh-4.2\$ df -h					
Filesystem	Size	Used	Avail	Use응	Mounted on
overlay	120G	20G	101G	17%	
tmpfs	64M	0	64M	0%	/dev
tmpfs	7.8G	0	7.8G	08	/sys/fs/cgroup
shm	64M	0	64M	0%	/dev/shm
tmpfs	7.8G	48M	7.8G	18	/etc/passwd
/dev/sda4	120G	20G	101G	17%	/etc/hosts
/dev/sdi	246G	271M	234G	18	/var/lib/mysql
tmpfs	15G	20K	15G	18	/run/secrets/kubernetes.io/serviceaccount
tmpfs	7.8G	0	7.8G	0응	/proc/acpi
tmpfs	7.8G	0	7.8G	0응	/proc/scsi
tmpfs	7.8G	0	7.8G	08	/sys/firmware

b. Log in to MySQL and verify whether the database "drusnapshotdb" is created.

my ⊥	<pre>ysql&gt; show databases;</pre>
	Database
+-   	information schema
	mysql
	performance_schema   sys
+- 5	rows in set (0.00 sec
	10.00 10.000 (0.000 500

mysql> SELECT * FRO	OM student;			1.	
<pre>+   registration_no +</pre>	birth_date	first_name	last_name	   gender	
1         70001           1         70002           1         70003           1         70004           1         70005           1         70006           1         70007           1         70008           1         70009           1         70009           1         70010	<pre>1988-12-03   1989-12-03   1985-12-06   1985-12-06   1989-12-19   1990-12-06   1980-12-06   1980-12-06   1989-08-19   1990-06-06   1980-11-06   1980-11-06   1980-11-06   </pre>	Promad Ji Robert Amy Nader Aleberto Amit Rakesh Amanto Kramsa	Kumar Lehman Heiman Wildsmith Hussain D Jain Singh Pator Taro	+   M   M   M   F   M   M   M   M   M	1       2018-07-18                 2018-09-18                 1       2018-07-18                 2018-07-18                 1       2018-07-18                 2018-07-18                         2018-07-18                         1       2018-07-18                 1       2018-07-18                 1       2018-07-18                 1       2018-07-18                 1       2018-07-18                 2018-07-18                         2018-07-18                         1       2018-07-18
70011   70012 +	1985-10-02     1985-10-02   ++	Abnay Priyanka	Mushary   Timungpi +	M   F +	2019-07-18     2019-07-18   ++
12 rows in set (0.0	00 sec)				

c. Create a table "student" and ingest some new records to the table.

3. Create a snapshot.

a. Create a manifest to take volume snapshot of the MySQL application PVC.

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
 name: mysqldrusnapshotnew1
 namespace: drusnapshot
spec:
  volumeSnapshotClassName: snapshotclass-sample
 source:
    persistentVolumeClaimName: dru-vol-mysqldru-0
```

b. To create the snapshot, run the following oc command using manifest:

[root@linuxnfscl2 ~]# oc create -f volumesnapshot-mysqldrunew1.yaml volumesnapshot.snapshot.storage.k8s.io/mysqldrusnapshotnew1 created [root@linuxnfscl2 ~]#

c. Verify that the snapshot is created as per manifest.

```
# oc get volumesnapshot -n drusnapshot
                     READYTOUSE SOURCEPVC
NAME
                                                     SOURCESNAPSHOTCONTENT
RESTORESIZE SNAPSHOTCLASS
                                 SNAPSHOTCONTENT
CREATIONTIME AGE
                    true
mysqldrusnapshotnew1
                                dru-vol-mysqldru-0
          snapshotclass-sample snapcontent-4e643b81-4260-4a49-b306-
250Gi
52aa04f77960 <invalid>
                                 64s
```

d. In Storage Navigator, verify that snapshot volume (00:01:E6) is created successfully.

TI History (Page.1)	_		_	_	_	_		_	
<b>☆</b> Filter ON OFF									
	Primary Vol	ume	Secondary Volume		Mirror	0	Diff Ormer Malers	Description	Description
Date and Time	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	P001 1D	Diff Compare Volume	Code	Description
2023/04/13 07:28:40	00:01:E3	DP	00:01:E6	DP	5	0		2011	PSUS
2023/04/13 07:28:40	00:01:E3	DP	00:01:E6	DP	5	0	-	2001	PAIR

4. Set DRU attribute (write disable) to snapshot volume 486 (00:01:E6).

[root@linuxnfscl2 ~] # raidvchkdsp	) -g grp0 -fd -v gflag -I1
Group PairVol Device_File	Seq# LDEV# GI-C-R-W-S PI-C-R-W-S R-Time
grp0 pair0 Unknown	540028 486 EEEEE EEEEE 0
[root@linuxnfscl2 ~]#	
[root@linuxnfscl2 ~]# raidvchkset	; -g grp0 -vg wtd 5 -I1
[root@linuxnfscl2 ~] # raidvchkdsp	) −g grp0 −fd −v gflag −I1
Group PairVol Device_File	Seq# LDEV# GI-C-R-W-S PI-C-R-W-S R-Time
grp0 pair0 Unknown	540028 486 EEEDE EEE <mark>D</mark> E 5
[root@linuxnfscl2 ~]#	

#### **Restore Operation**

The section shows the restoration procedure when an application in near-cloud is affected by ransomware.

- 1. Create PV and PVC for the snapshot volume (00:01: E6).
  - a. Identify the volume handle string for the snapshot volume (00:01:E6). The volume handle string for this LDEV is "60060e80089c5c0000509c5c000001e6--spc-439ad69acd". In the string, the LDEV ID is "01e6" and the LDEV name is "spc-439ad69acd". The LDEV name is automatically assigned by HSPC.

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: drusnapshotpv
  namespace: drusnapshot
spec:
  capacity:
    storage: 250Gi
  accessModes:
    - ReadWriteOnce
  persistentVolumeReclaimPolicy: Retain
  storageClassName: sc-vsp5200
  csi:
    driver: hspc.csi.hitachi.com
    volumeHandle: 60060e80089c5c0000509c5c000001e6--spc-439ad69acd
  claimRef:
    name: drusnapshotpvc
    namespace: drusnapshot
___
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: drusnapshotpvc
  namespace: drusnapshot
spec:
  accessModes:
  - ReadWriteOnce
  resources:
        requests:
          storage: 250Gi
  volumeName: drusnapshotpv
  storageClassName: sc-vsp5200
```

b. To create PV and PVC, run the following oc command using manifest:

```
# oc create -f drusnapshotpvpvc.yaml
```

c. Verify that PV and PVC are created.

#	OC	ge	et	pvc	-n	drusnapshot	
NZ	AME					STATUS	VOLUME
A	CCES	SS	MC	DES	S	STORAGECLASS	AGE

CAPACITY

```
250Gi
drusnapshotpvc
                 Bound
                           drusnapshotpv
RWO sc-vsp5200
                           17s
# oc get pv -n drusnapshot
NAME
                                       CAPACITY ACCESS MODES RECLAIM POLICY
STATUS
                                                              STORAGECLASS
      CLAIM
REASON
      AGE
drusnapshotpv
                                       250Gi
                                                 RWO
                                                              Retain
Bound drusnapshot/drusnapshotpvc
                                                              sc-vsp5200
41s
```

- 2. Create a cascaded snapshot (snapshot of S-VOL "00:01:E6").
  - a. To create a cascaded snapshot, use the following manifest:

```
apiVersion: snapshot.storage.k8s.io/v1
kind: VolumeSnapshot
metadata:
   name: drusnaponsnap
   namespace: drusnapshot
spec:
   volumeSnapshotClassName: snapshotclass-sample
   source:
      persistentVolumeClaimName: drusnapshotpvc
```

b. To create a new snapshot, run the following oc command using manifest. A new S-VOL "00:01:E9" will be created.

```
# oc create -f drusnaponsnap.yaml
```

c. Verify that the new volumesnapshot is created.

```
# oc get volumesnapshot -n drusnapshot
NAME READYTOUSE SOURCEPVC SOURCESNAPSHOTCONTENT
RESTORESIZE SNAPSHOTCLASS SNAPSHOTCONTENT
CREATIONTIME AGE
drusnaponsnap true drusnapshotpvc
250Gi snapshotclass-sample snapcontent-43548d17-0c0a-4d37-b1ec-
146b0f2e7cff <invalid> 9s
```

d. In Storage Navigator, verify that the snapshot volume ("00:01:E9") is created successfully.

Copy Type: TI 🛛

Date and Time Secondary Volume Mirror Pool ID Diff Compare Volume Descri	stion
Date and time Unit Diff Compare Volume Code	Dennishing
LDEV ID Provisioning Type LDEV ID Provisioning Type	Description
2023/04/14 06:54:54 00:01:E6 DP 00:01:E9 DP 4 0 - 2011	PSUS
2023/04/14 06:54:54 00:01:E6 DP 00:01:E9 DP 4 0 - 2001	PAIR

- 3. To create a clone volume for restoring an application, use the snap-on-snap volume.
  - a. Create a namespace "drusnaponsnap".

root@linuxnfscl2 etc]#

b. Create a manifest to create PV and PVC from the snap-on-snap volume (00:01:E9). Mentioning the volume handle string prevents storage class from dynamically creating a new volume; instead, use an existing volume to preserve the snapshot data.

```
apiVersion: v1
kind: PersistentVolume
metadata:
name: drusnaponsnappv
namespace: drusnaponsnap
```

```
spec:
 capacity:
   storage: 250Gi
 accessModes:
   - ReadWriteOnce
 persistentVolumeReclaimPolicy: Retain
  storageClassName: sc-vsp5200
  csi:
   driver: hspc.csi.hitachi.com
   volumeHandle: 60060e80089c5c0000509c5c000001e9-spc-2bdf56bb18
  claimRef:
   name: drusnaponsnappvc
   namespace: drusnaponsnap
   ___
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
 name: drusnaponsnappvc
 namespace: drusnaponsnap
spec:
 accessModes:
  - ReadWriteOnce
  resources:
        requests:
          storage: 250Gi
  volumeName: drusnaponsnappv
  storageClassName: sc-vsp5200
```

- c. To create PV and PVC, run the following oc command using manifest:
  - # oc create -f drusnaponsnappvc.yaml
- d. Verify that PVC and PV are created.

```
[root@ip-10-77-28-159 sw k10] # oc get pvc -n drusnaponsnap
NAME
                                  VOLUME
                                                                      ACCESS MODES
                                                                                         STORAGECLASS
                       STATUS
                                                         CAPACITY
                                                                                                            AGE
drusnaponsnappvc
                                  drusnaponsnappv
                                                                      RWO
                                                                                         sc-vsp5200
[root@ip-10-77-28-159 sw k10]#
   t@ip-10-77-28-159 sw_k10]# oc get pv

    n drusnap
    CAPACITY

                                          CESS MODES
                                                                STATUS
Bound
```

e. Create a clone PVC using the snapshot PVC.

```
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: drusnaponsnapclone
  namespace: drusnaponsnap
spec:
  storageClassName: sc-vsp5200
  dataSource:
    name: drusnaponsnappvc
    kind: PersistentVolumeClaim
    apiGroup: ""
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 250Gi
```

- f. To create the clone PVC, run the following oc command using manifest:
  - # oc create -f drusnaponsnapclone.yaml

g. Verify that the PVC is created.

# oc get pvc -:	n drusnaponsnap		
NAME	STATUS	VOLUME	CAPACITY
ACCESS MODES	STORAGECLASS	AGE	
drusnaponsnapc.	lone Bound	pvc-b3981ce6-c788-44fd-a169-11febdff2782	250Gi
RWO	sc-vsp5200	18d	

h. In Storage Navigator, verify that the clone volume (00:01:EA) is created successfully.

TI History (Page.1)									
&Filter ON OFF									
Date and Time	Primary Volume		Secondary Volume		Mirror	Deel ID	Diff Company Molume	Description	Description
	LDEV ID	Provisioning Type	LDEV ID	Provisioning Type	Unit	Pool ID	Diff Compare Volume	Code	Description
2023/04/14 08:20:30	00:01:E9	DP	00:01:EA	DP	3	0		2092	CLONE END
2023/04/14 08:15:50	00:01:E9	DP	00:01:EA	DP	3	0	-	2091	CLONE START
2023/04/14 08:15:49	00:01:E9	DP	00:01:EA	DP	3	0	() • (	2001	PAIR

- 4. Restore the MySQL application using the clone PVC.
  - a. Create a manifest of stateful MySQL application using the clone PVC ("drusnaponsnapclone").

```
apiVersion: v1
kind: Service
metadata:
    namespace: drusnaponsnap
    name: mysqldruapp
    labels:
       app: mysqldruapp
spec:
    ports:
    - port: 3306
     name: mysqldruapp
    clusterIP: None
    selector:
      app: mysqldruapp
___
apiVersion: apps/v1
kind: StatefulSet
metadata:
    namespace: drusnaponsnap
    name: mysqldruapp
spec:
  selector:
    matchLabels:
      app: mysqldruapp
  serviceName: "mysqldruapp"
  podManagementPolicy: Parallel
  replicas: 1
  template:
    metadata:
      labels:
        app: mysqldruapp
    spec:
      terminationGracePeriodSeconds: 30
      containers:
      - name: mysqldruapp
        image: mysql:5.7
        args:
          - "--ignore-db-dir=lost+found"
        env:
        - name: MYSQL ROOT PASSWORD
         value: pass123
        - name: MYSQL DATABASE
         value: drusnapshotdb
        - name: MYSQL_USER
```

```
value: admin
- name: MYSQL_PASSWORD
value: secret
ports:
- containerPort: 3306
name: mysql
volumeMounts:
- name: dru-vol
mountPath: /var/lib/mysql
volumes:
- name: dru-vol
persistentVolumeClaim:
claimName: drusnaponsnapclone
```

- b. To create MySQL pod and service, run the following oc command using manifest:
   # oc create -f mysqldruapp.yaml
- c. Verify that pod and MySQL service are created as per manifest.

```
# oc get svc -n drusnaponsnap
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
mysqldruapp ClusterIP None <none> 3306/TCP 18d
# oc get pod -n drusnaponsnap
NAME READY STATUS RESTARTS AGE
mysqldruapp-0 1/1 Running 0 18d
```

d. Log in to the pod "mysqldruapp-0"and verify whether the 250 GB persistent volume is mounted on "/var/lib/mysql".

[root@ip-10-77-2	28-159	sw ki	L0] <b>#</b> od	c -n (	drusnaponsnap rsh mysqldruapp-0
sh-4.2\$ df -h					
Filesystem	Size	Used	Avail	Use%	Mounted on
overlay	200G	31G	170G	16%	
tmpfs	64M	0	64M	08	/dev
tmpfs	7.8G	0	7.8G	08	/sys/fs/cgroup
shm	64M	0	64M	08	/dev/shm
tmpfs	7.8G	52M	7.7G	18	/etc/passwd
/dev/nvme0n1p4	200G	31G	170G	16%	/etc/hosts
/dev/sdl	246G	271M	234G	18	/var/lib/mysql
tmpfs	15G	20K	15G	18	/run/secrets/kubernetes.io/serviceaccount
tmpfs	7.8G	0	7.8G	08	/proc/acpi
tmpfs	7.8G	0	7.8G	0응	/proc/scsi
tmpfs	7.8G	0	7.8G	08	/sys/firmware

e. Log in to MySQL and verify whether the database "drusnapshotdb" is available.

<pre>mysql&gt; show databases;</pre>	
++   Database	
information_schema     drusnapshotdb	
mysql	
performance_schema	
sys	
5 rows in set (0.01 sec	:)

f. Verify whether the ingested data before taking snapshot is available after restoring.

-					
<pre>mysql&gt; show tables; +</pre>	;				
Tables in drusnap	shotdb				
+	+				
student					
+	+				
1 row in set (0.00	sec)				
mysql> SELECT * FRO	OM student;				
l registration no	birth date	first name	last name	r	+
+	+				+
70001	1988-12-03	Promad	Kumar	M	2018-07-18
70002	1989-12-03	Ji	Lehman	M	2018-09-18
70003	1985-12-06	Robert	Heiman	M	2018-07-18
70004	1985-12-06	Amy	Wildsmith	F	2018-07-18
70005	1989-12-19	Nader	Hussain	M	2018-07-18
70006	1990-12-06	Aleberto	D	M	2018-07-18
70007	1980-12-06	Amit	Jain	M	2018-07-18
70008	1989-08-19	Rakesh	Singh	M	2018-07-18
70009	1990-06-06	Amanto	Pator	M	2018-07-18
70010	1980-11-06	Kramsa	Taro	M	2018-07-18
70011	1985-10-02	Abhay	Mushary	M	2019-07-18
70012	1985-10-02	Priyanka	Timungpi	F	2019-07-18
+	++	+		+	++
12 rows in set (0.0	)0 sec)				

g. Verify whether HSPC automatically created an iSCSI target on port 1-C and whether the clone volume "01:01:EA" is mounted.

iSCSI Target Alias	spc-88364666e69015b02bd6e93f1efd (OB)	Host Mode		00 [Standard]	
iSCSI Target Name	iqn.1994-04.jp.co.hitachi:rsd.r90.t.40028	Port Security		Enabled	
Port ID	CL1-C	Authentication	Method	Comply with Host Setting	
Virtual Storage Machine	VSP 5200, 5600 / 40028		Mutual CHAP	Disabled	
			User Name		

os	osts LUNs Host Mode Options CHAP Users												
Add LUN Paths Copy LUN Paths Edit Command Devices More Actions 🔻													
*	Filter ON C	(	Options 👻 Ѥ 🗲	1 / 1									
Port	Port ID		LDEV ID LDEV Name	LDEV Name	Pool Name	Emulation	Capacity						
	LON ID	LON ID		(ID)	Type	Total 1	Reserved						
	CL1-C	<b>8</b> 63	00:01:EA	spc-876fed1c72	dr_pool(0)	OPEN-V CVS	250.00 GB	0.00 G					

#### h. Delete the snap-on-snap PV and PVC created in step 3b.

```
[root@ip-10-77-28-159 sw_k10]# oc delete pvc drusnaponsnappvc -n drusnaponsnap
persistentvolumeclaim "drusnaponsnappvc" deleted
[root@ip-10-77-28-159 sw_k10]#
```

```
[root@ip-10-77-28-159 sw_k10]# oc delete pv drusnaponsnappv
persistentvolume "drusnaponsnappv" deleted
```