

IBM® Storage

Business Continuity Solution with Red Hat OpenShift and IBM Spectrum Virtualize for Public Cloud on Microsoft Azure

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Overview

The focus of this Blueprint is to facilitate the deployment of the hybrid cloud business continuity solution with Red Hat OpenShift Container Platform (RHOCP) on Microsoft Azure Cloud and Container Storage Interface (CSI) driver plug-in for IBM Block Storage and IBM® Spectrum Virtualize for Public Cloud (SV4PC) on Microsoft Azure Cloud.

This solution is designed to protect the data by using IBM Storage-based Global Mirror Replication, and the “volume replication” feature from IBM block storage CSI driver for IBM Storage.

For demonstration purposes, MySQL containerized database is installed on the persistent volume (PV) that is created on the on-premises IBM FlashSystem® Storage. This storage is connected to the RHOCP cluster in the vSphere environment.

CSI driver plug-in for IBM Block Storage (FS9100) and SV4PC on Azure is installed on Red Hat OCP on Azure and On-premises Red Hat OCP.

The volume or logical unit number (LUN) from on-premises IBM FlashSystem Storage (FS9100) is replicated to IBM SV4PC on Microsoft Azure Cloud by using the IBM storage global mirror replication feature and the IBM CSI volume replication feature.

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Executive summary

In today's environment, many organizations use some form of cloud services, whether private, public, or hybrid multi-cloud. Storage infrastructure is a part of these services and deployments.

For the RHOCP that is deployed on Microsoft Azure Cloud, the RHOCP installation program offers you flexibility. You can use the installation program to deploy a cluster on infrastructure that the installation program provisions and the cluster maintains. You also can deploy a cluster on infrastructure that you prepare and maintain.

IBM released its open source CSI driver, which allows dynamic storage provisioning for containers on Kubernetes and RHOCP on Azure. The IBM Spectrum Virtualize family and IBM Spectrum Virtualize for Public Cloud (SV4PC on Azure) support clients in their IT architectural transformation and migration toward the cloud service model. This transformation enables hybrid cloud strategies while maintaining the benefits and advanced functions of sophisticated storage systems.

With IBM Spectrum Virtualize and IBM Spectrum Virtualize For Public Cloud on Azure, organizations can have multi-cloud environments with data replication between the following components:

- On-premises or private cloud to public cloud (Azure Cloud)
- Two public clouds (Azure Cloud)

IBM Spectrum Virtualize for Public Cloud enables data on heterogeneous storage systems to be replicated or migrated between on-premises and Azure or AWS.

IBM Spectrum Virtualize and IBM Spectrum Virtualize for Public Cloud together support mirroring between on-premises and cloud data center or between cloud data center.

These functions can be used to:

- Migrate data between on-premises and public cloud data center or between a public cloud data center. Data management is consistent between on-premises storage and the public cloud.
- Implement disaster recovery strategies between on-premises and public cloud data center.
- Enable cloud-based DevOps with easy replication of data from on-premises sources.

Scope

The focus of this document is to provide a business continuity solution for the containerized MySQL database running on RHOCP at on-premises data centers. The MySQL PV or LUN from the on-premises IBM FlashSystem Storage (FS9100) is replicated by using IBM Global mirror to the PV or LUN that is created on the IBM SV4PC on Microsoft Azure Cloud. The PV or LUN is created from IBM SV4PC on Microsoft Azure Cloud by using the IBM Block Storage CSI driver plug-ins on the RHOCP that is deployed on Microsoft Azure Cloud.

This document also describes a brief procedure about how to use IBM Block CSI driver volume replication function to create volume relationships between on-premises PV to the SV4PC PV. Configuration steps also are included for enabling hybrid cloud connectivity between the on-premises data center to Microsoft Azure Cloud

The solution that is described in this document relies on the following software components and related document links for the configuration:

- RHOCP 4.x on Microsoft Azure cloud and on-premises RHOCP.
- IBM Block Storage CSI driver for IBM Storages.
- IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Cloud.
- IBM FlashSystem Storage FS9100 (on-premises).
- Hybrid Cloud connectivity on-premises to Azure Cloud with Virtual Private Network (VPN).
- MySQL containerized database on RHOCP.
- IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Cloud implementation guide.
- Technical configuration steps for building an end-to-end solution.
- VPN connectivity, on-premises to public cloud. For more information, see *Solutions for Hybrid Cloud Networking Configuration Version 1 Release1*, REDP-5542.

Customers are encouraged to suitable proper data consistency mechanisms for the respective databases to ensure that consistent data is available across sites.

The use-case that is presented in this document is a sample disaster recovery scenario in the Hybrid Cloud environment.

This blueprint does not:

- Provide scalability and performance analysis from a user perspective
- Replace any official manuals and documents that are issued by IBM
- Describe the installation of RHOCP in the on-premises data center

Introduction

Combining the capabilities of Red Hat OCP and IBM SV4PC on Microsoft Azure Cloud with IBM Block Storage CSI driver for IBM Storages enables enterprises to build business continuity solutions. These solutions address various use cases and enables data on heterogeneous storage systems to be replicated or migrated between on-premises and Azure or AWS. IBM Spectrum Virtualize and IBM Spectrum Virtualize for Public Cloud together support mirroring between on-premises and the cloud data center or between two public cloud data center.

IBM Block Storage CSI driver

IBM block storage CSI driver is used by Kubernetes PVs to dynamically provision for block storage used with stateful containers.

IBM block storage CSI driver is based on an open source IBM project (CSI driver), which is included as a part of IBM storage orchestration for containers. IBM storage orchestration for containers enables enterprises to implement a modern, container-driven hybrid multi-cloud environment that can reduce IT costs and enhance business agility, while continuing to derive value from existing systems.

By using CSI drivers for IBM storage systems, Kubernetes PVs can be dynamically provisioned for block or file storage to be used with stateful containers, such as database applications (IBM Db2®, MongoDB, PostgreSQL, and so on) running in Red Hat OCP or Kubernetes clusters.

Storage provisioning can be fully automatized with more support of cluster orchestration systems to automatically deploy, scale, and manage containerized applications. For more information, see [IBM Documentation web page](#).

IBM Spectrum Virtualize for Public Cloud on Microsoft Azure

IBM Spectrum Virtualize for Public Cloud is now available on Microsoft Azure. With IBM Spectrum Virtualize for Public Cloud 8.4.3 users, can deploy a highly available, two-node cluster running IBM Spectrum Virtualize for Public Cloud on supported Microsoft Azure virtual machines (VMs). This all-inclusive, bring your own license (BYOL) software offering virtualizes, optimizes, and provisions supported Azure Managed Disks to applications that require the performance of block storage in the cloud with the added efficiencies that IBM Spectrum Virtualize for Public Cloud brings to native infrastructure as a service (IaaS) provided by Microsoft Azure.

For more information, see *Implementation Guide for IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Version 8.4.3*, [SG24-8510](#).

For more information about product positioning, software requirements, and limitations, see the IBM Canada Software Announcement: *IBM Spectrum Virtualize for Public Cloud 8.4.3 on Microsoft Azure*, [A21-0596](#).

Installing Red Hat OpenShift Container Platform on Azure

OpenShift Container Platform is used for developing and running containerized applications. It is designed to allow applications and the data centers that support them to expand from a few machines and applications to thousands of machines that serve millions of customers.

With its foundation in Kubernetes, OpenShift Container Platform incorporates the same technology that serves as the engine for massive telecommunications, streaming video, gaming, banking, and other applications. Its implementation in open Red Hat technologies lets you extend your containerized applications beyond a single cloud to on-premises and multi-cloud environments. For more information, see this [Red Hat Documentation web page](#). Also, see the [Red Hat OCP installation procedure](#) for installing a cluster on Azure into a VNet.

Prerequisites

This section outlines prerequisites for the solution.

This blueprint assumes that the person who is implementing this solution has the basic knowledge of or access to the following information:

- IBM Spectrum Virtualize for Public Cloud on Microsoft Azure. For more information, see the following resources:
 - *Implementation Guide for IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Version 8.4.3*, [SG24-8510](#)
 - This [IBM Documentation web page](#)
- IBM Storage Remote Replication (IBM Global Mirror). For more information, see this [IBM Documentation web page](#).
- IBM Block Storage CSI driver plug-ins and RHOCP and Kubernetes.
- iSCSI basics and connectivity with IBM Storage. For more information, see this [iBM Documentation web page](#).
- Microsoft Azure Cloud portal login and required user rights and billing and cost approval.
- RHOCP 4.x on Microsoft Azure Cloud and on-premises RHOCP. For more information, see this [Red Hat Documentation web page](#).
- Red Hat login credentials to download binaries, pull secret, tools. For more information, see this [Red Hat Documentation web page](#) (login required).
- VPN connectivity between on-premises data-center to Microsoft Azure Cloud. For more information, see the following resources:
 - This [Microsoft Build tutorial](#)
 - This [VyOS Documentation web page](#)
- Containerized MySQL database deployment on RHOCP.
- Bastion hosts on Microsoft Azure Cloud (Windows 2019 and Linux 7.x).
- User with administrator privileges and required roles that must be created on Microsoft Azure portal for creating resources on Azure and successful deployment.
- The firewall rules and network security groups that must be created on Microsoft Azure Cloud and on-premises data-centers for hybrid cloud connectivity and networking between various network components.
- Internet access from Microsoft Azure Cloud and on-premises data center for successful deployment of RHOCP.

Note: Consider the following points:

- Red Hat OpenShift installation on Azure and Azure Red Hat OpenShift (ARHO) feature different installation procedures. For more information, see this [Red Hat Documentation web page](#).
- VPN connectivity between on-premises data centers to Microsoft Azure Cloud depends on the VPN and gateways devices that are available at on-premises. In this document, we used [VyOS documentation](#).
- The yellow arrow that is outlined in blue in the figures in this document highlights areas for selecting options while configuring the solution.

Solution overview

The purpose of this document is to showcase the hybrid multi-cloud scenario for business continuity and data replication between on-premises IBM FlashSystem Storage FS9100 to IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Cloud connected with iSCSI protocol for host mapping.

For demonstration purposes, MySQL containerized database is installed on the PV or LUN that was created on the on-premises IBM FlashSystem Storage that is connected with iSCSI protocol to the RHOC (v4.8) worker nodes in the vSphere environment and by using the IBM block storage CSI driver (v1.8).

A 2-way IP partnership was created between the on-premises (FS9100) IBM FlashSystem Storage and IBM SV4PC on Azure Cloud. The VPN connectivity between the on-premises data center and Azure Cloud is created with the Site-to-Site VPN to Azure (BGP over IKEv2/IPsec).

The volume or LUN on IBM FlashSystem Storage FS9100 is replicated by IBM global mirror on IBM Spectrum Virtualize for Public Cloud on Azure. The replicated volume or PV is imported in the RHOC that is deployed on Azure Cloud. For more information about importing a volume, see this [IBM Documentation web page](#).

Figure 1 shows a typical infrastructure and the various components that are required and used to create a business continuity solution.

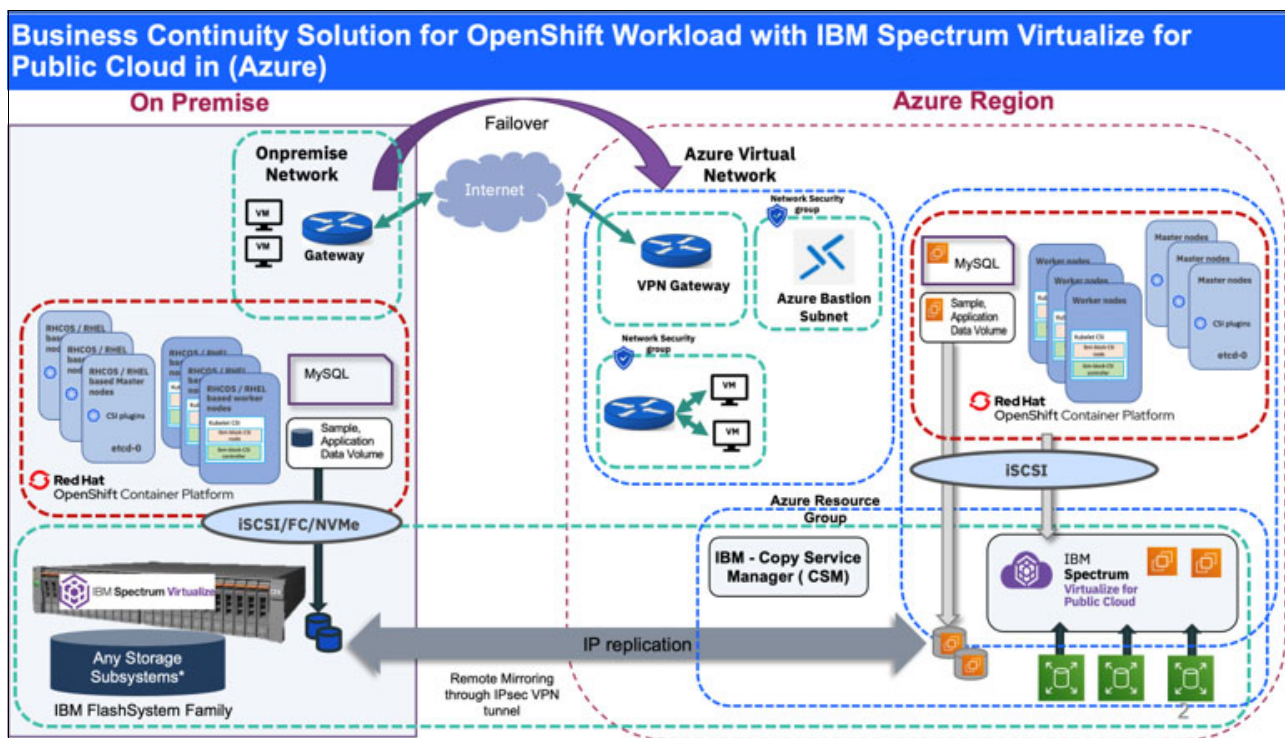


Figure 1 Solution overview

As part of the solution and the use case scenario and for data consistency, a sample database was created in the MySQL databases at the primary site (on-premises) and sample data is inserted in the table.

After the consistent copying status is completed to consistent synchronized, the consistency group is stopped and the replicated volume is opened for read/write access at the Azure Cloud. Also, the volume is imported by importing a volume in the RHODCP cluster and then, validating the sample data is available on the replicated volume to conclude the business continuity use-case.

Use cases demonstration methods

The following volume replication methods are described in this document for the use case demonstration:

- By using the IBM Storage global mirror feature
- By using IBM Block Storage CSI Volume Replication function

Lab setup

In this section, we describe the lab setup that was used for this use case.

Setting up Microsoft Azure Cloud and the on-premises data center

The following major components and software were deployed at the on-premises data center and Microsoft Azure Cloud for creating the lab setup:

- Microsoft Azure Cloud:
 - Red Hat OpenShift Container Platform v4.8 in the VNET
 - IBM Block Storage CSI driver v1.8 on RHOCP
 - IBM Spectrum Virtualize for Public Cloud v8.x with iSCSI connection
 - IBM Global mirror replication
 - Azure Cloud VPN Gateway device
 - Azure Site-Site VPN connection and local gateway
 - MySQL containerized database
 - Bastion hosts on Microsoft Azure (Windows 2019 and Linux 7.x)
 - SV4PC cluster IP: 40.10.1.4
 - Linux bastion host: hybrid-cloud-linux-bastion-vm
- On-premises data center:
 - Red Hat OpenShift Container Platform v4.8
 - IBM Block Storage CSI driver v1.8 on RHOCP
 - IBM FlashSystem Storage FS9100 with iSCSI connection
 - IBM Global mirror replication
 - On-premises VPN gateway devices (VyOS)
 - MySQL containerized database
 - RHOCP bastion hostname: gw-10
 - IBM FlashSystem storage IP: 10.0.240.30

Steps to be performed on Microsoft Azure Cloud

The following steps must be completed on Microsoft Azure Cloud:

1. Create virtual networks.

Log in to the Microsoft Azure portal at <https://portal.azure.com> and create a VNet by using the following settings (see Figure 2 - Figure 6 on page 12):

- Resource group: Hybrid-Cloud-with-IBM-SV4PC
- Name: Hybrid-Cloud-IBM-SV4PC-VNET
- Region: Germany West Central
- IPv4 address space: 40.10.0.0/16
- Subnet name: Hybrid-Cloud-IBM-SV4PC-Cluster-snet
- Subnet address space: 40.10.1.0/24
- Subnet address space: 40.10.2.0/26
- AzureBastionSubnet: 40.10.3.0/24

Microsoft Azure

Home > Virtual networks >

Virtual networks

IBM (ibm.onmicrosoft.com)

+ Create Manage view ...

Filter for any field...

Name ↑↓

- cicd-bastion-vnet
- CICD-vnet
- dev-imagebuilder-vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm8test-Vnet
- DevNr_T4test-Vnet
- Dhiraj_Vnet

Create virtual network

Basics IP Addresses Security Tags Review + create

Azure Virtual Network (VNet) is the fundamental building block for your private network in Azure. VNet enables many types of Azure resources, such as Azure Virtual Machines (VM), to securely communicate with each other, the internet, and on-premises networks. VNet is similar to a traditional network that you'd operate in your own data center, but brings with it additional benefits of Azure's infrastructure such as scale, availability, and isolation. [Learn more about virtual network](#)

Project details

Subscription * ⓘ Microsoft Azure Enterprise_ikky

Resource group * ⓘ (New) Hybrid-Cloud-With-IBM-SV4PC

Create new

Instance details

Name * Hybrid-Cloud-IBM-SV4PC-VNET

Region * Germany West Central

Figure 2 Creating virtual network: Basics

Microsoft Azure

Home > Virtual networks >

Virtual networks

IBM (ibm.onmicrosoft.com)

+ Create Manage view ...

Filter for any field...

Name ↑↓

- cicd-bastion-vnet
- CICD-vnet
- dev-imagebuilder-vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm8test-Vnet
- DevNr_T4test-Vnet
- Dhiraj_Vnet
- eswari_vnet
- ExistingVNET
- ibm_sushil_vnet
- jorgeAnuja-hybrid-vnet
- Madhu-doc-vnet

Create virtual network

Basics IP Addresses Security Tags Review + create

The virtual network's address space, specified as one or more address prefixes in CIDR notation (e.g. 192.168.1.0/24).

IPv4 address space

40.10.0.0/16 40.10.0.0 - 40.10.255.255 (65536 addresses)

The entered address ranges '40.10.0.0/16' may not work correctly. It is recommended to use address ranges within the private, non-routable address space defined in RFC 1918. [Learn more](#)

☐ Add IPv6 address space ⓘ

The subnet's address range in CIDR notation (e.g. 192.168.1.0/24). It must be contained by the address space of the virtual network.

+ Add subnet Remove subnet

Subnet name	Subnet address range	NAT gateway
<input type="checkbox"/> Hybrid-Cloud-IBM-SV4PC-Cluster-snet	40.10.1.0/24	-
<input type="checkbox"/> Hybrid-Cloud-IBM-SV4PC-quorum-snet	40.10.2.0/26	-

Use of a NAT gateway is recommended for outbound internet access from a subnet. You can deploy a NAT gateway and assign it to a subnet after you create the virtual network. [Learn more](#)

Figure 3 Creating VNet and adding subnet

Microsoft Azure

Home > Virtual networks >

Virtual networks

IBM (ibm.onmicrosoft.com)

+ Create ⚙️ Manage view ▾ ...

Filter for any field...

Name ↑↓

- cicd-bastion-vnet
- CICD-vnet
- dev-imagebuilder-vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm4test-Vnet
- Dev_Tm8test-Vnet
- DevNr_T4test-Vnet
- Dhiraj_Vnet
- eswari_vnet

Create virtual network

Basics IP Addresses **Security** Tags Review + create

BastionHost ☐ Disable ☒ Enable

Bastion name * AzureBastionSubnet ✓

AzureBastionSubnet address space * 40.10.3.0/26 ✓
40.10.3.0 - 40.10.3.63 (64 addresses)

Public IP address * (New) Hybrid-Cloud-IBM-SV4PC-Pub-vnet ▾
[Create new](#)

DDoS Protection Standard ☒ Disable ☐ Enable

Firewall ☒ Disable ☐ Enable

Figure 4 Creating VNet and AzureBastionSubnet

Microsoft Azure

Search resources, services, and docs (G+)

Home > Virtual networks >

Virtual networks

IBM (ibm.onmicrosoft.com)

Create

Manage view

Filter for any field...

Name

cicd-bastion-vnet

CICD-vnet

dev-imagebuilder-vnet

Dev_Tm4test-Vnet

Dev_Tm4test-Vnet

Dev_Tm4test-Vnet

Dev_Tm8test-Vnet

DevNr_T4test-Vnet

Dhiraj_Vnet

eswari_vnet

ExistingVNET

ibm_sushil_vnet

jorgeAnuja-hybrid-vnet

Madhu-doc-vnet

mudassar-bastion-vnet

Pankaj-Deshpande-Bastion--vNet

perf1-vnet

Perf_vnet

PerfAuto-vnet

prasad-vnet

eni_bastion_vnet

Create virtual network

Validation passed

Basics

IP Addresses

Security

Tags

Review + create

Basics

Subscription

Resource group

Name

Region

IP addresses

Address space

Subnet

Tags

Hemant

Security

BastionHost

DDoS protection plan

Firewall

Microsoft Azure Enterprise_ikky

(new) Hybrid-Cloud-With-IBM-SV4PC

Hybrid-Cloud-IBM-SV4PC-VNET

Germany West Central

40.10.0.0/16

Hybrid-Cloud-IBM-SV4PC-Cluster-snet (40.10.1.0/24),Hybrid-Cloud-IBM-SV4PC-quorum-snet (40.10.2.0/26),AzureBastionSubnet (40.10.3.0/26)

ISDL

Enabled

Basic

Disabled

Create

< Previous

Next >

Download a template for automation

Figure 5 Creating resource

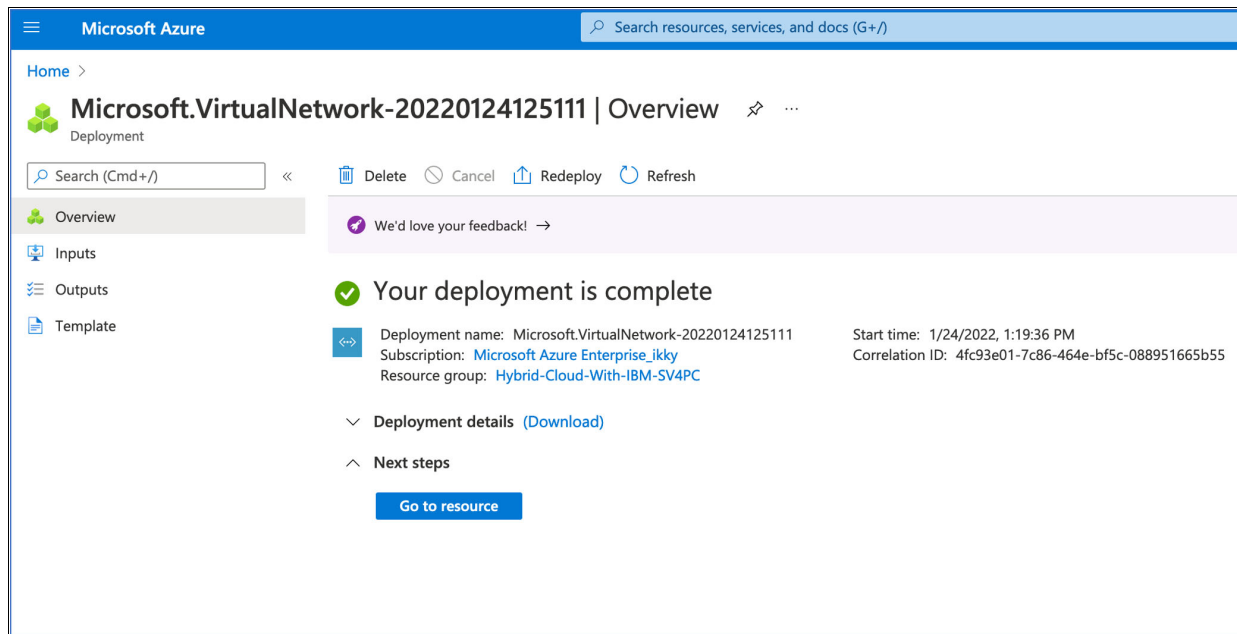


Figure 6 Checking deployment progress

2. Create the VPN gateway.

Log in to the Microsoft Azure portal at <https://portal.azure.com> and create a VPN Gateway by using the following settings (see Figure 7 on page 13 - Figure 11 on page 16):

- Name: Hybrid-Cloud-IBM-SV4PC-Vnet-gateway
- Region: Germany West Central
- Gateway type: VPN
- VPN type: Route-based
- SKU: VpnGw1
- Generation: Generation 1
- Virtual network: Hybrid-Cloud-IBM-SV4PC-VNET
- Gateway subnet address range: 40.10.0.0/24
- Public IP address: Create new
- Public IP address name: Hybrid-Cloud-IBM- SV4PC-Public-IP
- ASN: 65515

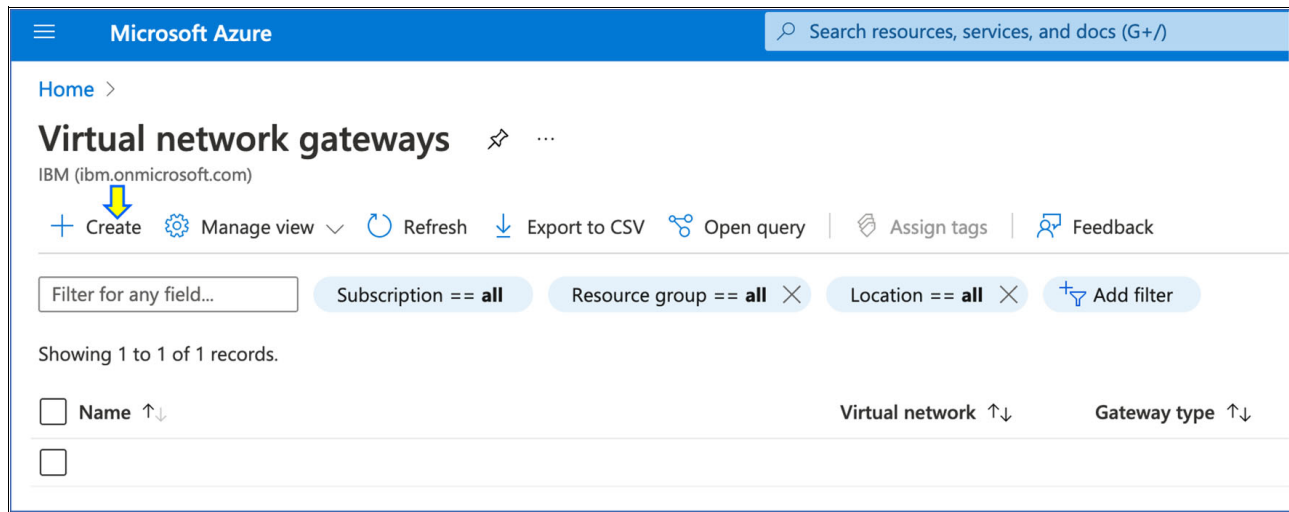


Figure 7 Selecting Create option

The screenshot shows the 'Create virtual network gateway' page in the Microsoft Azure portal. The 'Basics' tab is selected, and the page is divided into sections for configuration. The 'Project details' section includes 'Subscription' (set to 'Microsoft Azure Enterprise_ikky') and 'Resource group' (set to 'Hybrid-Cloud-With-IBM-SV4PC'). The 'Instance details' section includes 'Name' (set to 'Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway'), 'Region' (set to 'Germany West Central'), 'Gateway type' (set to 'VPN'), 'VPN type' (set to 'Route-based'), 'SKU' (set to 'VpnGw1'), and 'Generation' (set to 'Generation1'). Yellow arrows point to each of these fields, indicating the configuration steps.

Figure 8 Creating VPN gateway: Basics page Part 1

Microsoft Azure

Home > Virtual network gateways >

Virtual network ga...

IBM (ibm.onmicrosoft.com)

+ Create Manage view

Filter for any field...

Name ↑↓

VNGW1

Create virtual network gateway

SKU * ⓘ VpnGw1

Generation ⓘ Generation1

Virtual network * ⓘ Hybrid-Cloud-IBM-SV4PC-VNET
[Create virtual network](#)

Only virtual networks in the currently selected subscription and region are listed.

Gateway subnet address range * ⓘ 40.10.0.0/24
40.10.0.0 - 40.10.0.255 (256 addresses)

Public IP Address Type * ⓘ ☒ Basic ☐ Standard

Public IP address

Public IP address * ⓘ ☒ Create new ☐ Use existing

Public IP address name * Hybrid-Cloud-IBM-SV4PC-Public-IP

Public IP address SKU Basic

Assignment ☒ Dynamic ☐ Static

Enable active-active mode * ⓘ ☐ Enabled ☒ Disabled

Configure BGP * ⓘ ☒ Enabled ☐ Disabled

Autonomous system number (ASN) * ⓘ 65515

Custom Azure APIPA BGP IP address ⓘ

Peer Address

Azure recommends using a validated VPN device with your virtual network gateway. To view a list of validated devices and instructions for configuration, refer to Azure's [documentation](#) regarding validated VPN devices.

Figure 9 Creating VPN gateway: Basics page Part 2

Microsoft Azure

Search resources, services, and docs (G+)

Home > Virtual network gateways >

Virtual network ga...

IBM (ibm.onmicrosoft.com)

Create

Manage view

Filter for any field...

Name

VNGW1

Create virtual network gateway

Validation passed

Basics

Tags

Review + create

Basics

Subscription

Resource group

Name

Region

SKU

Generation

Virtual network

Subnet

Gateway type

VPN type

Enable active-active mode

Configure BGP

Autonomous system number (ASN)

Custom Azure APIPA BGP IP address

Public IP address

Microsoft Azure Enterprise_ikky

Hybrid-Cloud-With-IBM-SV4PC

Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway

Germany West Central

VpnGw1

Generation1

Hybrid-Cloud-IBM-SV4PC-VNET

GatewaySubnet (40.10.0.0/24)

Vpn

RouteBased

Disabled

Enabled

65515

None

Hybrid-Cloud-IBM-SV4PC-Public-IP

Tags

Hemant

ISDL

Page 1 of 1

Create

Previous

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Figure 10 Selecting Create option on Review + create page

15

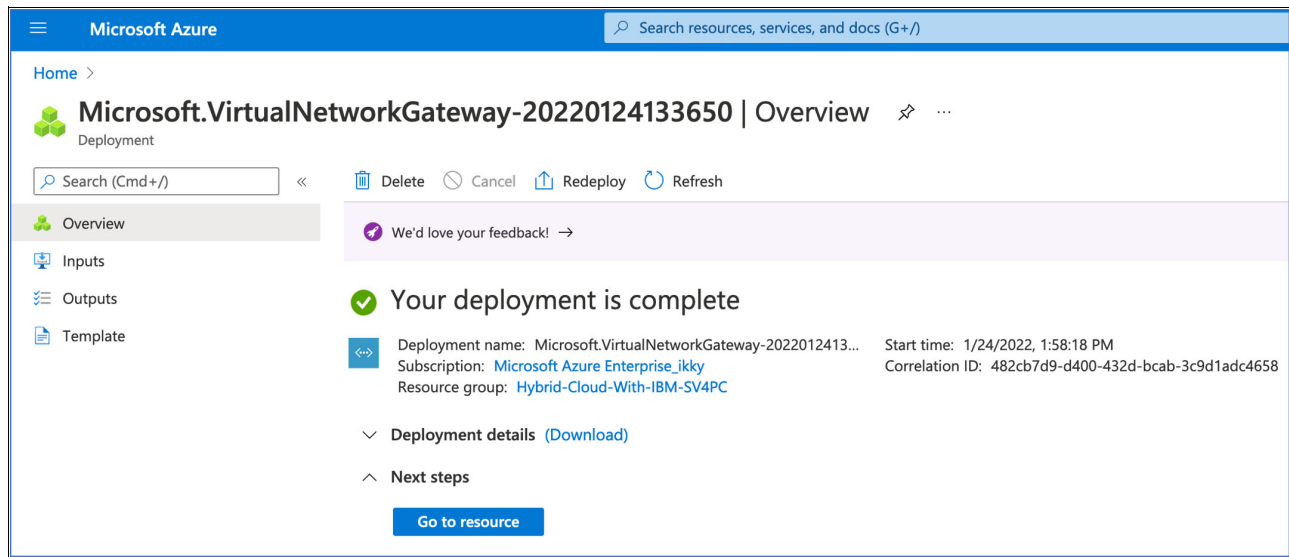


Figure 11 Checking that deployment is complete

3. Complete the following steps to create a site-to-site connection:
 - a. Log in to the Microsoft Azure portal at <https://portal.azure.com> and create a site-to-site connection by using the values that are shown in Figure 12 - Figure 17 on page 19.

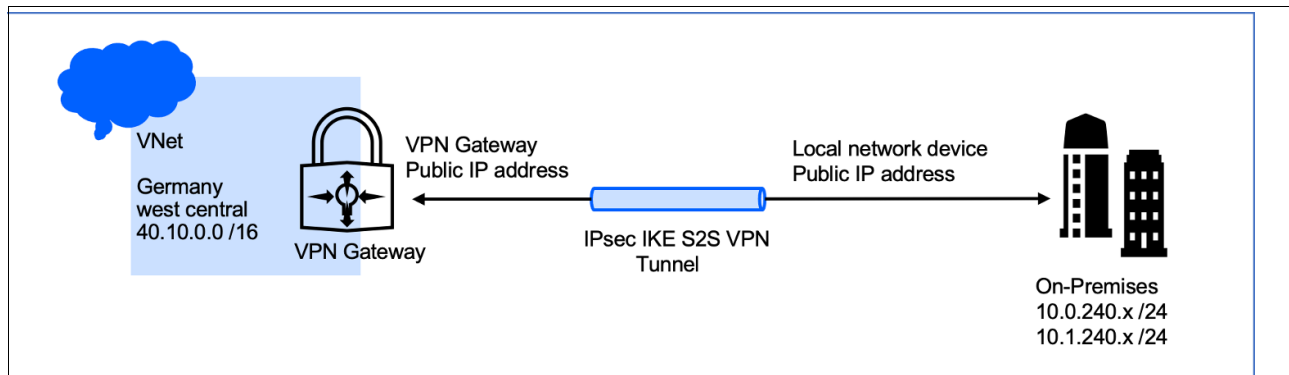


Figure 12 Hybrid cloud network connectivity

- b. Log in to the Microsoft Azure portal at <https://portal.azure.com> and create a Local Network Gateway to create a site-to-site connection. (A virtual network and VPN gateway were created in steps 1 and 2).

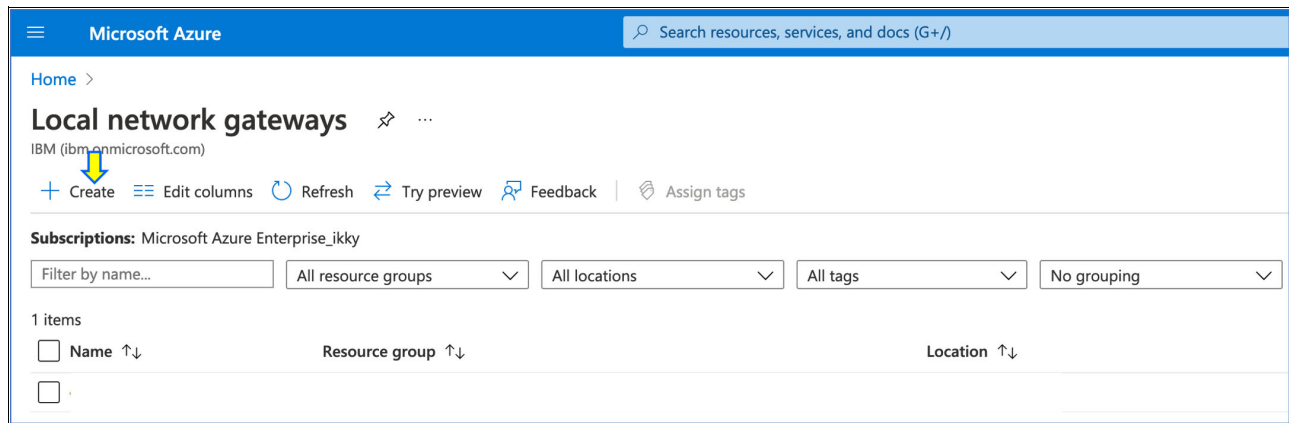


Figure 13 Selecting the Create option

The screenshot shows the 'Create local network gateway' page in the Microsoft Azure portal. The breadcrumb navigation is 'Home > Local network gateways > Create local network gateway'. The main heading is 'Create local network gateway'. Below the heading, there are three tabs: 'Basics', 'Advanced', and 'Review + create'. The 'Basics' tab is selected. A description states: 'A local network gateway is a specific object that represents an on-premises location (the site) for routing purposes. [Learn more.](#)'. Below the description, there are two sections: 'Project details' and 'Instance details'. In the 'Project details' section, there are two dropdown menus: 'Subscription' (set to 'Microsoft Azure Enterprise_ikky') and 'Resource group' (set to 'Hybrid-Cloud-With-IBM-SV4PC'). A yellow arrow points to the 'Subscription' dropdown. In the 'Instance details' section, there are four fields: 'Region' (set to 'Germany West Central'), 'Name' (set to 'Hybrid-Cloud-IBM-SV4PC-Local-net-Gateway'), 'Endpoint' (set to 'IP address'), and 'IP address' (set to '192.168.0.4'). A yellow arrow points to the 'Region' dropdown, another to the 'Name' field, and a third to the 'IP address' field. At the bottom, there's a section for 'Address space' with two input fields: '10.0.240.0/24' and '10.1.240.0/24'. A yellow arrow points to the 'IP address' field.

Figure 14 Create local network gateway: Basics page

Microsoft Azure

Home > Local network gateways >

Create local network gateway ...

Basics **Advanced** Review + create

Configure BGP settings Yes No

Autonomous system number (ASN) * ⓘ 65000

BGP peer IP address * 10.1.240.9

Figure 15 Create local network gateway: Advanced

Microsoft Azure

Home > Local network gateways >

Create local network gateway ...

Validation passed

Basics Advanced **Review + create**

Summary

Name	Hybrid-Cloud-IBM-SV4PC-Local-net-Gateway
Subscription	Microsoft Azure Enterprise_ikky
Resource group	Hybrid-Cloud-With-IBM-SV4PC
Region	Germany West Central
Endpoint	IP address
IP address	10.0.240.0/24, 10.1.240.0/24
Address space	65000
Autonomous system number (ASN)	10.1.240.9
BGP peer IP address	

Figure 16 Creating local network gateway: Review + create page

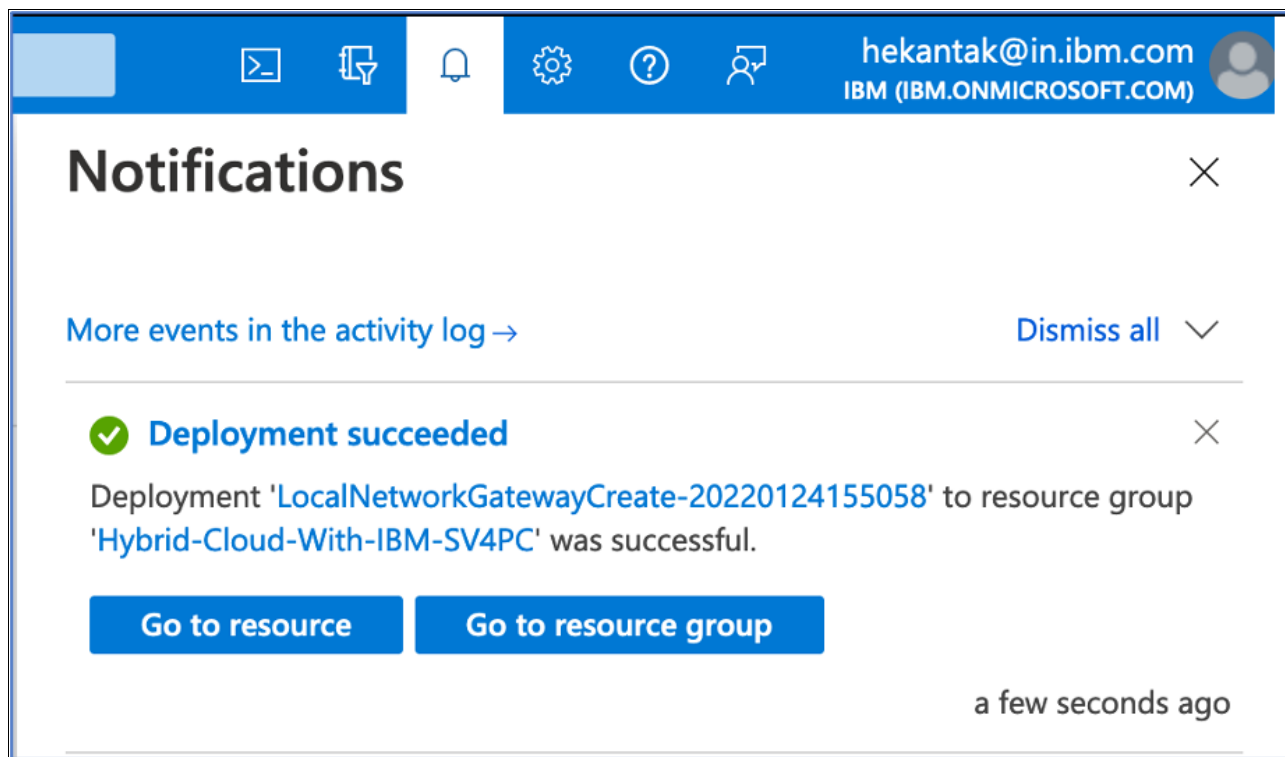


Figure 17 Deployment succeeded message

4. Configure the on-premises VPN gateway device.

Log in to the on-premises VPN gateway device and configure the device for site-to-site VPN to Azure; that is, BGP over IKEv2/IPsec (see Figure 18 - Figure 20 on page 21). For more information, see [this web page](#).

Configure the device with the values as described in Appendix 18, “Configuring on-premises VPN device” on page 19.

WAN Interface	eth0	←
On-premises address space	10.0.240.0/24	←
Azure address space	40.10.0.0	←
Vyos public IP	On-premises Public IP address	←
Vyos private IP	10.1.240.9	←
Azure VNet Gateway public IP	Azure Public IP address (Hybrid-Cloud-IBM-SV4PC-Public-IP)	←
Azure VNet Gateway BGP IP	40.10.0.254 (BGP peer IP address)	←
Pre-shared key	HybridCloudSV4PC	←
Vyos ASN	65000	←
Azure ASN	65515	←

Figure 18 Configuring on-premises VPN device

```

CONFIGURE ETHERNET INTERFACE
set interfaces ethernet eth0 address '10.1.240.9/24'
set interfaces ethernet eth0 description 'TRANSFER-NET'
set interfaces ethernet eth0 duplex 'full'
set interfaces ethernet eth0 hw-id 'e4:1f:13:6d:ea:58'
set interfaces ethernet eth0 smp_affinity 'auto'
set interfaces ethernet eth0 speed '1000'
set interfaces ethernet eth1 address '10.0.240.9/24'
set interfaces ethernet eth1 description 'YELLOW-ZONE'
set interfaces ethernet eth1 duplex 'full'
set interfaces ethernet eth1 hw-id 'e4:1f:13:6d:ea:5a|
set interfaces ethernet eth1 smp_affinity 'auto'
set interfaces ethernet eth1 speed '1000'
set interfaces loopback 'lo'

CONFIGURE THE IKE AND ESP SETTINGS TO MATCH A SUBSET OF THOSE SUPPORTED BY AZURE

set vpn ipsec esp-group AZURE compression 'disable'
set vpn ipsec esp-group AZURE lifetime '3600'
set vpn ipsec esp-group AZURE mode 'tunnel'
set vpn ipsec esp-group AZURE pfs 'dh-group2'
set vpn ipsec esp-group AZURE proposal 1 encryption 'aes256'
set vpn ipsec esp-group AZURE proposal 1 hash 'sha1'

set vpn ipsec ike-group AZURE dead-peer-detection action 'restart'
set vpn ipsec ike-group AZURE dead-peer-detection interval '15'
set vpn ipsec ike-group AZURE dead-peer-detection timeout '30'
set vpn ipsec ike-group AZURE key-exchange 'ikev1'
set vpn ipsec ike-group AZURE lifetime '28800'
set vpn ipsec ike-group AZURE proposal 1 dh-group '2'
set vpn ipsec ike-group AZURE proposal 1 encryption 'aes256'
set vpn ipsec ike-group AZURE proposal 1 hash 'sha1'

ENABLE IPSEC ON ETH0
set vpn ipsec ipsec-interfaces interface 'eth0'
set vpn ipsec nat-networks allowed-network '40.10.0.0/16'
set vpn ipsec nat-traversal 'enable'

```

Figure 19 Configuring on-premises VPN gateway device: Part 1

```

CONFIGURE A VTI WITH A DUMMY IP ADDRESS
set interfaces vti vti2 address '40.10.0.200/24'
set interfaces vti vti2 description 'Azure Tunnel'
set interfaces vti vti2 mtu '1436'

CONFIGURE THE VPN TUNNEL
set vpn ipsec site-to-site peer [Public IP address] authentication mode 'pre-shared-secret'
set vpn ipsec site-to-site peer [Public IP address] authentication pre-shared-secret 'HybridCloudSV4PC'
set vpn ipsec site-to-site peer [Public IP address] description 'AZURE PRIMARY TUNNEL'
set vpn ipsec site-to-site peer [Public IP address] ike-group 'AZURE'
set vpn ipsec site-to-site peer [Public IP address] local-address '10.1.240.9'
set vpn ipsec site-to-site peer [Public IP address] vti bind 'vti2'
set vpn ipsec site-to-site peer [Public IP address] vti esp-group 'AZURE'

CONFIGURE YOUR BGP SETTINGS
set protocols bgp 65000 neighbor 40.10.0.254 'disable-connected-check'
set protocols bgp 65000 neighbor 40.10.0.254 remote-as '65515'
set protocols bgp 65000 neighbor 40.10.0.254 soft-reconfiguration 'inbound'
set protocols bgp 65000 neighbor 40.10.0.254 timers holdtime '30'
set protocols bgp 65000 neighbor 40.10.0.254 timers keepalive '10'
set protocols bgp 65000 network '10.0.240.0/24'

ADD AN INTERFACE ROUTE TO REACH AZURE'S BGP LISTENER
set protocols static interface-route 40.10.0.254/32 next-hop-interface 'vti2'

```

Figure 20 Configuring on-premises VPN gateway device: Part 2

5. Add a connection to create the site-to-site VPN connection.

Log in to the Microsoft Azure portal at <https://portal.azure.com> and add a connection to the VPN gateway to create the site-to-site connection (see Figure 21 on page 22 - Figure 23 on page 23).

Microsoft Azure

Home > Virtual network gateways > Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway

Add connection

Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway

Name *
Hybrid-Cloud-IBM-SVPC-site-to-site ✓

Connection type ⓘ
Site-to-site (IPsec) ✓

*Virtual network gateway ⓘ
Hybrid-Cloud-IBM-SV4PC-Vnet-G... ✓

*Local network gateway ⓘ
Hybrid-Cloud-IBM-SV4PC-Local-n... ✓

Shared key (PSK) * ⓘ
HybridCloudSV4PC ✓

☐ Use Azure Private IP Address ⓘ

☒ Enable BGP ⓘ

Enable Custom BGP Addresses
☐

Custom BGP Addresses

IKE Protocol ⓘ
☒ IKEv1 ☐ IKEv2

Subscription ⓘ
Microsoft Azure Enterprise_ikky ✓

Resource group ⓘ
✓

Location ⓘ
Germany West Central ✓

OK

Figure 21 Adding connection

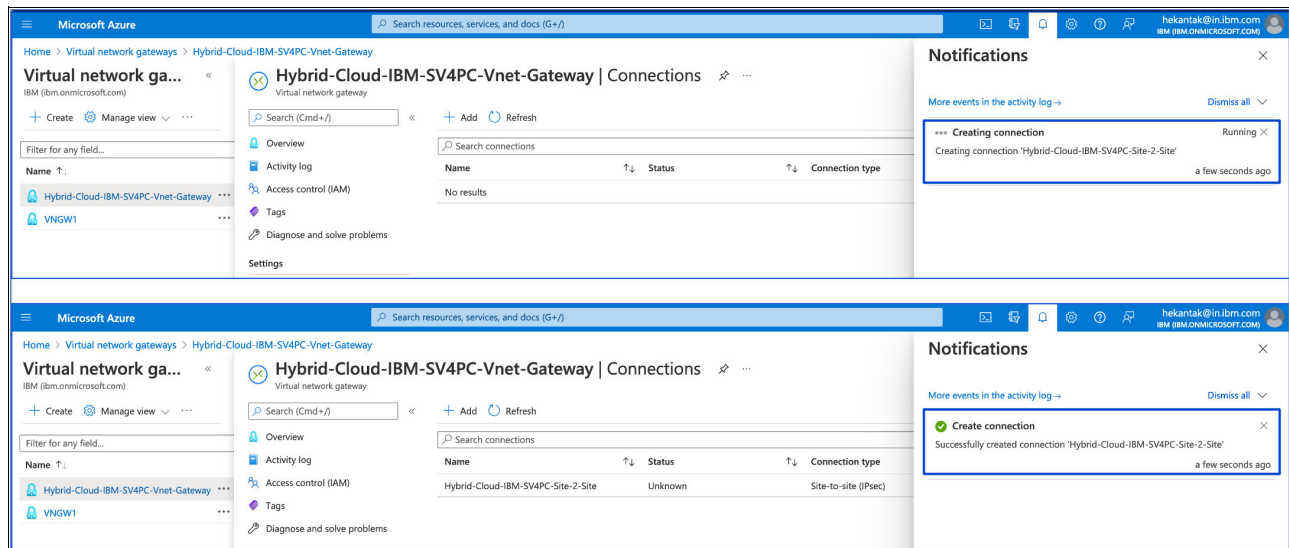


Figure 22 Checking the status of the deployment

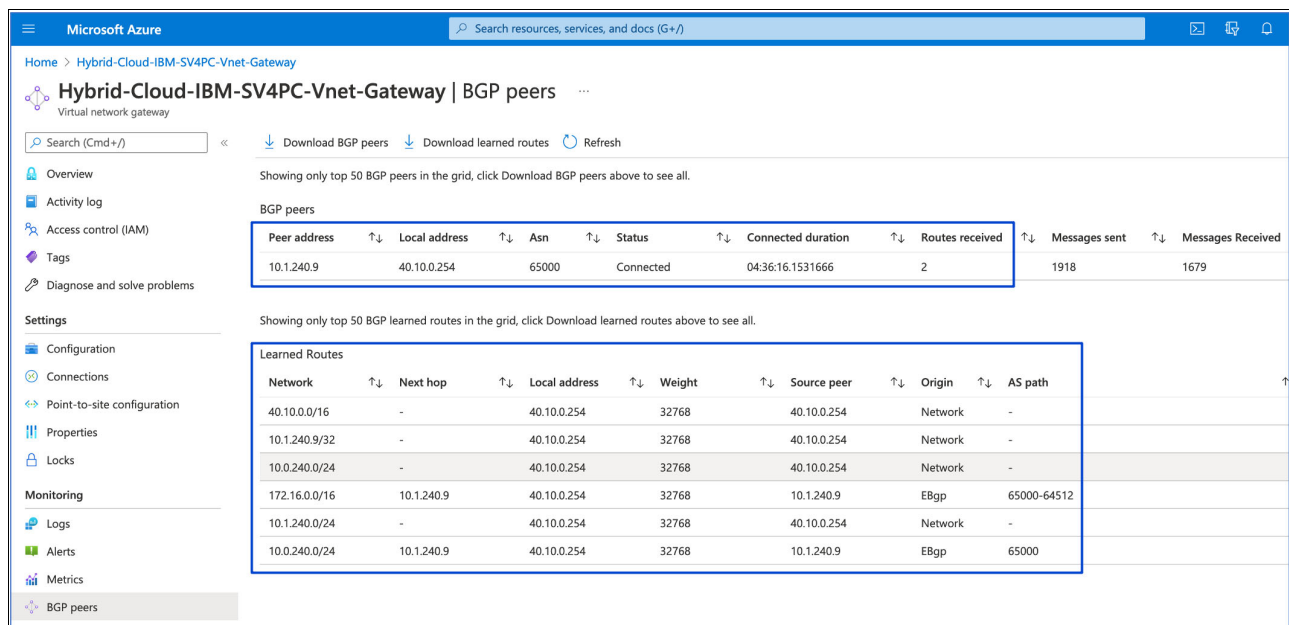


Figure 23 Checking the status of devices that are connected on-premises to Azure Cloud

6. Complete the following steps to install Linux VM as the Bastion host for the RHOCF cluster on Microsoft Azure Cloud:
 - a. Log in to the Microsoft Azure portal at <https://portal.azure.com> and create the Linux virtual machine (see Figure 24).
 - b. Enter the Disk, Networking, Management, Advance, Tags information.
 - c. Review and create the virtual machine.

Ensure that the existing Resource Group, which was configured with Virtual networks (VNET), was selected.

The screenshot shows the 'Create a virtual machine' page in the Microsoft Azure portal, specifically the 'Networking' tab. The page is divided into two main sections: 'Project details' and 'Instance details' on the left, and 'Network interface' on the right. Blue arrows point to specific configuration fields: Subscription, Resource group, Virtual machine name, Region, Availability options, Security type, Image, Azure Spot instance, Size, Virtual network, Subnet, Public IP, NIC network security group, Public inbound ports, and Select inbound ports. A warning message at the bottom states: 'This will allow all IP addresses to access your virtual machine. This is only recommended for testing. Use the Advanced controls in the Networking tab to create rules to limit inbound traffic to known IP addresses.'

Figure 24 Creating Linux virtual machine

7. Complete the following steps to install Red Hat OpenShift Container Platform on Microsoft Azure Cloud:
 - a. Log in to the Microsoft Azure portal at <https://portal.azure.com>.
 - b. Log in to the Linux VM by using azureuser and the SSH key that uses the Bastion service or by using SSH and configuring the Azure Account that is required for the RHOCF deployment (see this [Red Hat Documentation web page](#)), as shown in Figure 25 on page 25 - Figure 28 on page 26).

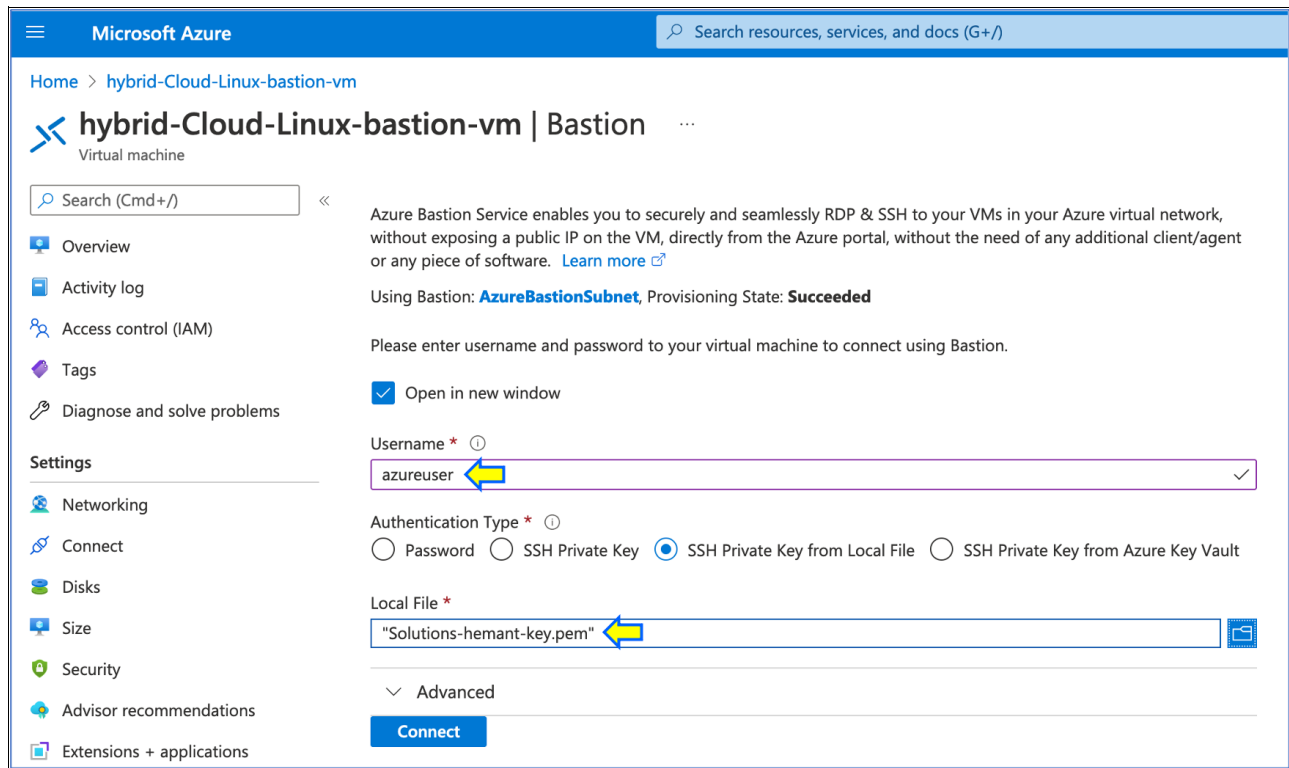


Figure 25 Logging in to Linux VM host



Figure 26 Creating Azure Account

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# az account show
{
  "environmentName": "AzureCloud",
  "homeTenantId": "6567857-5009-1ad4-98f8-ff6a61ad490",
  "id": "00100000-1000-1ad4-1701-1ad400000000",
  "isDefault": true,
  "managedByTenants": [],
  "name": "Microsoft Azure Enterprise_Italy",
  "state": "Enabled",
  "tenantId": "6567857-5009-1ad4-98f8-ff6a61ad490",
  "user": {
    "name": "hekantak@in.ibm.com",
    "type": "user"
  }
}
```

Figure 27 Azure account show

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# az ad sp create-for-rbac --role Contributor --name hybrid-cloud-service_principal
Creating 'Contributor' role assignment under scope '/subscriptions/794c6fdf-6182-4da4-b701-dad9da3c23a0'
The output includes credentials that you must protect. Be sure that you do not include these credentials in your code or check the credentials into your source control. For more information, see https://aka.ms/azadsp-cli
```

```
{
  "appId": "f386e929-e84c-4abb-ad68-3cf921bffaa9",
  "displayName": "hybrid-cloud-service_principal",
  "password": "[REDACTED]",
  "tenant": "fcf67057-50c9-4ad4-98f3-ffca64add9e9"
}
```

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# █
```

```
[root@hybrid-Cloud-Linux-bastion-vm ~]#
```

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# az ad role assignment create --role "User Access Administrator" --assignee-object-id $(az ad sp list --filter 'appId eq \'f386e929-e84c-4abb-ad68-3cf921bffaa9\'' | jq '.[0].objectId' -r)
```

RBAC service might reject creating role assignment without --assignee-principal-type in the future. Better to specify --assignee-principal-type manually.

```
{
  "canDelegate": null,
  "condition": null,
  "conditionVersion": null,
  "description": null,
  "id": "/subscriptions/994c6fdf-6182-4da4-b701-dad9da3c23a0/providers/Microsoft.Authorization/roleAssignments/bee77d02-d031-4a08-a479-7229e0ae0eb",
  "name": "bee77d02-d031-4a08-a479-7229e0ae0eb",
  "principalId": "86355021-591e-4e9f-91bb-083db774f57d",
  "principalType": "ServicePrincipal",
  "roleDefinitionId": "/subscriptions/994c6fdf-6182-4da4-b701-dad9da3c23a0/providers/Microsoft.Authorization/roleDefinitions/18d7d88d-d35e-4fb5-a5c3-7773c20a72d9",
  "scope": "/subscriptions/994c6fdf-6182-4da4-b701-dad9da3c23a0",
  "type": "Microsoft.Authorization/roleAssignments"
}
```

```
[root@hybrid-Cloud-Linux-bastion-vm ~]#
```

Figure 28 Adding role and assignment and creating service principal

8. Complete the following steps to create the Public DNS Zone in Microsoft Azure:
 - a. Log in to the Microsoft Azure portal at <https://portal.azure.com> and create the DNS zone (see Figure 29 on page 27 - Figure 32 on page 28).

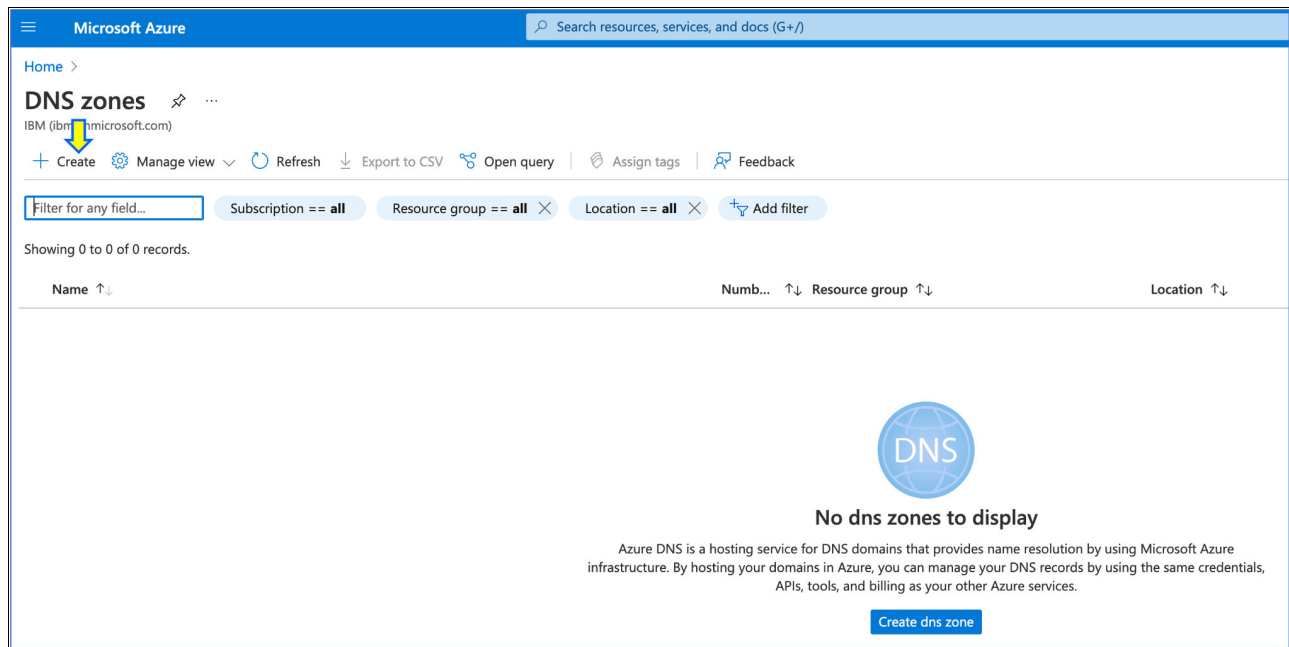


Figure 29 Selecting the Create option

Microsoft Azure

Search resources, services, and docs (G+)

Home > DNS zones >

Create DNS zone

Basics Tags Review + create

A DNS zone is used to host the DNS records for a particular domain. For example, the domain 'contoso.com' may contain a number of DNS records such as 'mail.contoso.com' (for a mail server) and 'www.contoso.com' (for a web site). Azure DNS allows you to host your DNS zone and manage your DNS records, and provides name servers that will respond to DNS queries from end users with the DNS records that you create. [Learn more.](#)

Project details

Subscription * Microsoft Azure Enterprise_ikky

Resource group * Hybrid-Cloud-SV4PC-ARHO-RG [Create new](#)

Instance details

☐ This zone is a child of an existing zone already hosted in Azure DNS ⓘ

Name * arhocclustersv4pc.net ✓

Resource group location ⓘ Germany West Central

Figure 30 Creating DNS zones: Basics page

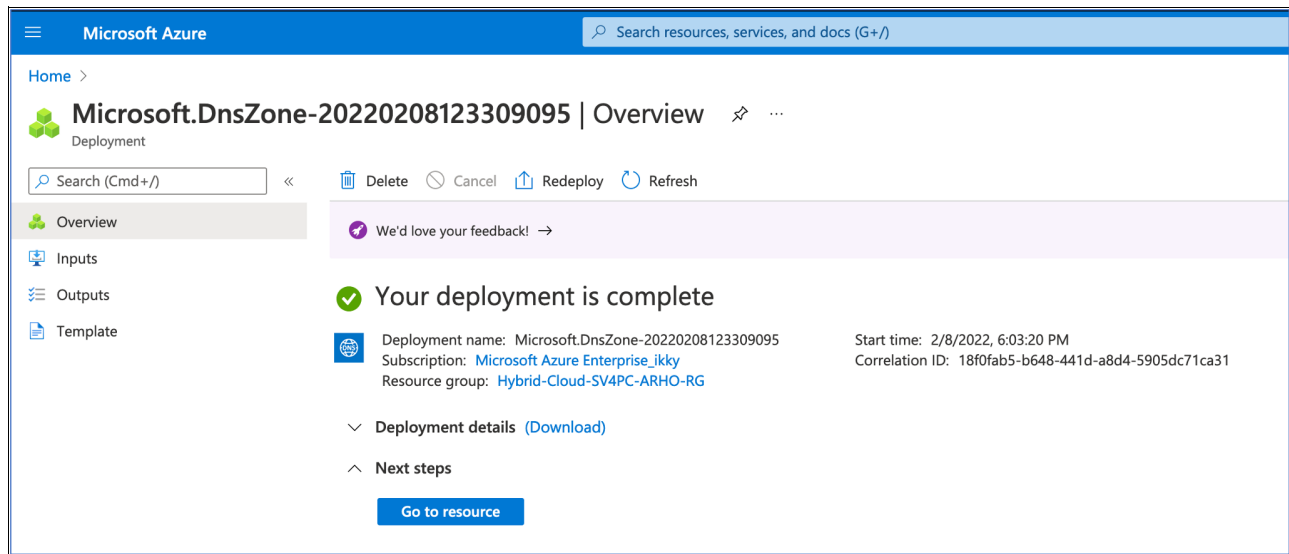


Figure 31 Checking the deployment

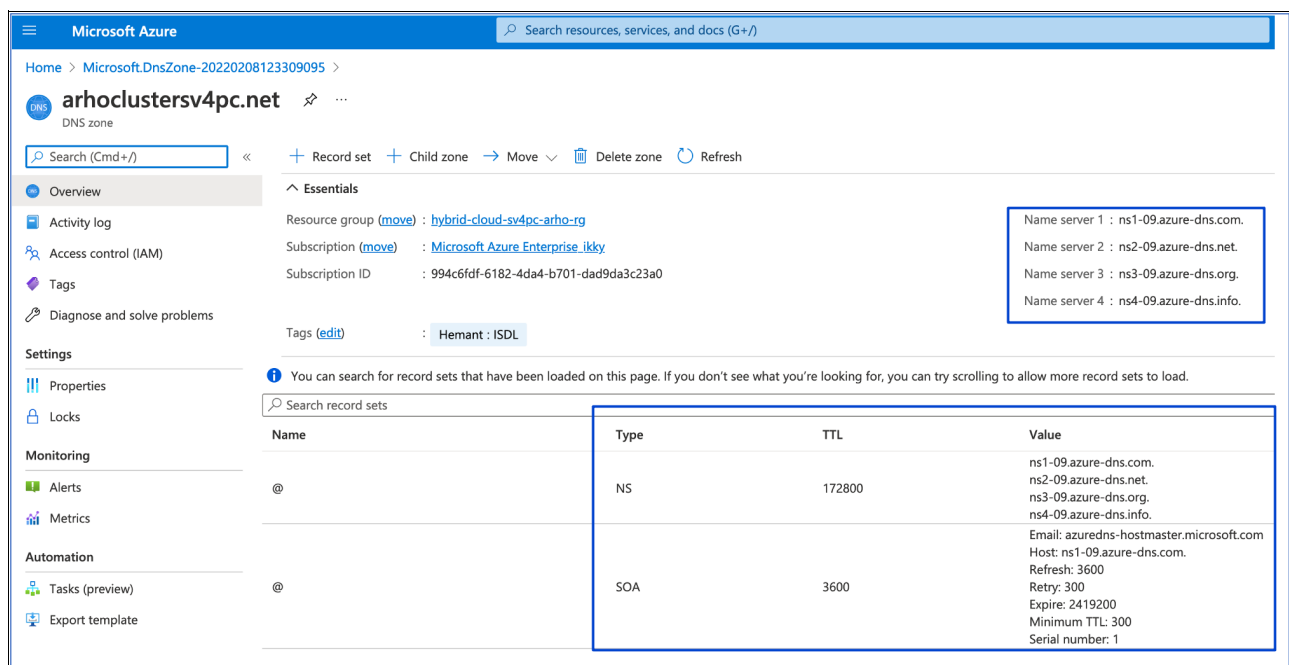


Figure 32 Checking the name server details

- b. Log in to the Microsoft Azure portal at <https://portal.azure.com>.
- c. Log in to the Linux VM by using azureuser and the SSH key.
- d. Create the install-config.yaml file and the RHOCP cluster (see Figure 33 on page 29 - Figure 37 on page 31).


```
[root@hybrid-Cloud-Linux-bastion-vm bin]#
[root@hybrid-Cloud-Linux-bastion-vm bin]#
[root@hybrid-Cloud-Linux-bastion-vm bin]# ./openshift-install create cluster --dir /root/ocp4.8/config/ --log-level=info
INFO Credentials loaded from file "/root/.azure/osServicePrincipal.json"
INFO Consuming Install Config from target directory
INFO Creating infrastructure resources...
INFO Waiting up to 20m0s for the Kubernetes API at https://api.arhocluster1sv4pc.arhoclustersv4pc.net:6443...
INFO API v1.21.6+bb8d50a up
INFO Waiting up to 30m0s for bootstrapping to complete...
INFO Destroying the bootstrap resources...
INFO Waiting up to 40m0s for the cluster at https://api.arhocluster1sv4pc.arhoclustersv4pc.net:6443 to initialize...
INFO Waiting up to 10m0s for the openshift-console route to be created...
INFO Install complete!
INFO To access the cluster as the system:admin user when using 'oc', run 'export KUBECONFIG=/root/ocp4.8/config/auth/kubeconfig'
INFO Access the OpenShift web-console here: https://console-openshift-console.apps.arhocluster1sv4pc.arhoclustersv4pc.net
INFO Login to the console with user: "kubeadmin", and password: "ii3B5-AbFPa-ujRfg-ntkYX"
INFO Time elapsed: 35m43s
[root@hybrid-Cloud-Linux-bastion-vm bin]#
```

Figure 35 Creating cluster

```
[root@hybrid-Cloud-Linux-bastion-vm auth]#
[root@hybrid-Cloud-Linux-bastion-vm auth]# export KUBECONFIG=/root/ocp4.8/config/auth/kubeconfig
[root@hybrid-Cloud-Linux-bastion-vm auth]#
[root@hybrid-Cloud-Linux-bastion-vm auth]# oc get nodes
NAME                                     STATUS    ROLES    AGE     VERSION
arhocluster1sv4pc-9w2gw-master-0       Ready     master   31m     v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-master-1       Ready     master   30m     v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-master-2       Ready     master   31m     v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 Ready     worker   22m     v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 Ready     worker   22m     v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral3-kk4rv Ready     worker   22m     v1.21.6+bb8d50a
[root@hybrid-Cloud-Linux-bastion-vm auth]#

[root@hybrid-Cloud-Linux-bastion-vm auth]#
[root@hybrid-Cloud-Linux-bastion-vm auth]# oc get nodes -o wide
NAME                                     STATUS    ROLES    AGE     VERSION    INTERNAL-IP    EXTERNAL-IP    OS-IMAGE
arhocluster1sv4pc-9w2gw-master-0       Ready     master   31m     v1.21.6+bb8d50a    40.10.4.6      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
arhocluster1sv4pc-9w2gw-master-1       Ready     master   31m     v1.21.6+bb8d50a    40.10.4.5      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
arhocluster1sv4pc-9w2gw-master-2       Ready     master   31m     v1.21.6+bb8d50a    40.10.4.7      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 Ready     worker   23m     v1.21.6+bb8d50a    40.10.5.4      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 Ready     worker   23m     v1.21.6+bb8d50a    40.10.5.5      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
arhocluster1sv4pc-9w2gw-worker-germanywestcentral3-kk4rv Ready     worker   23m     v1.21.6+bb8d50a    40.10.5.6      <none>         Red Hat Enterprise Linux
  CoreOS 48.84.202201241104-0 (Ootpa)  4.18.0-305.34.2.el8_4.x86_64    cri-o://1.21.4-9.rhaos4.8.gitaebb17b.el8
[root@hybrid-Cloud-Linux-bastion-vm auth]#
```

Figure 36 Logging in and checking the node status

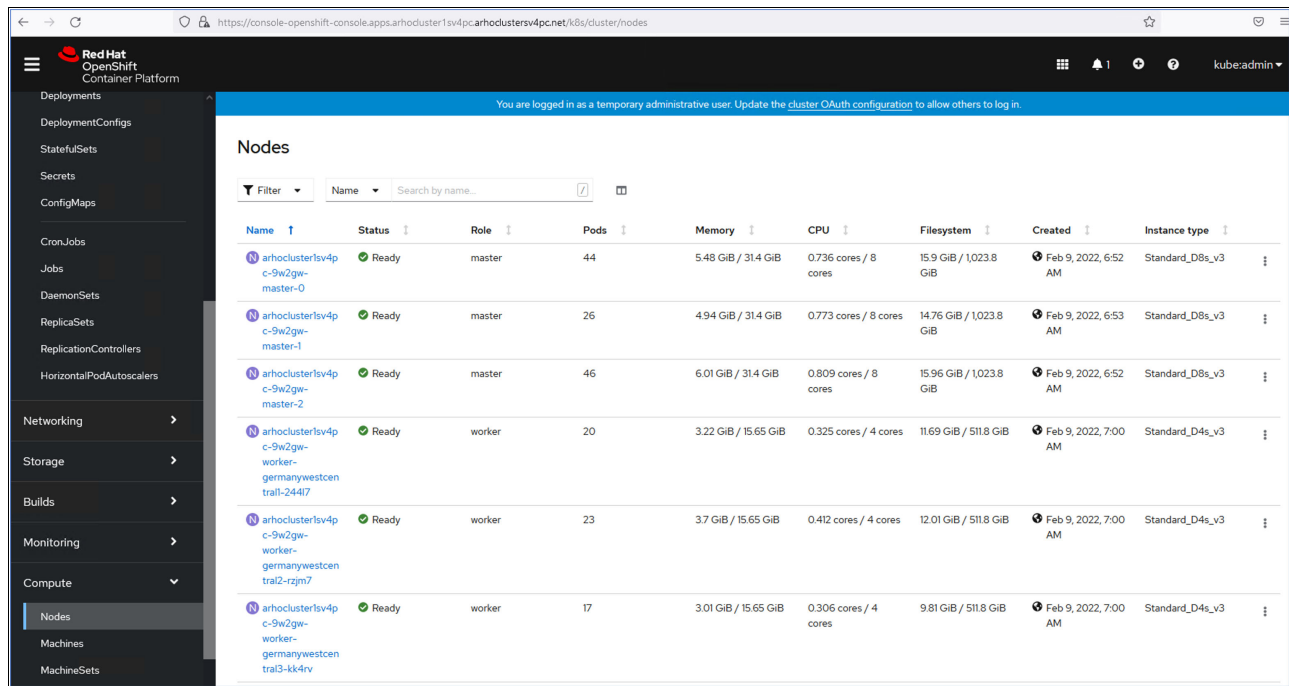


Figure 37 Checking the cluster status with web console

9. Install the IBM Block Storage CSI driver on RHOCP on Microsoft Azure Cloud.

As shown in Figure 38, Open the RHOCP console URL from the browsers of your choice and log in by using kubeadmin. Click the **Operator** hub and install the IBM Block Storage CSI driver. For more information, see this [IBM Documentation web page](#).

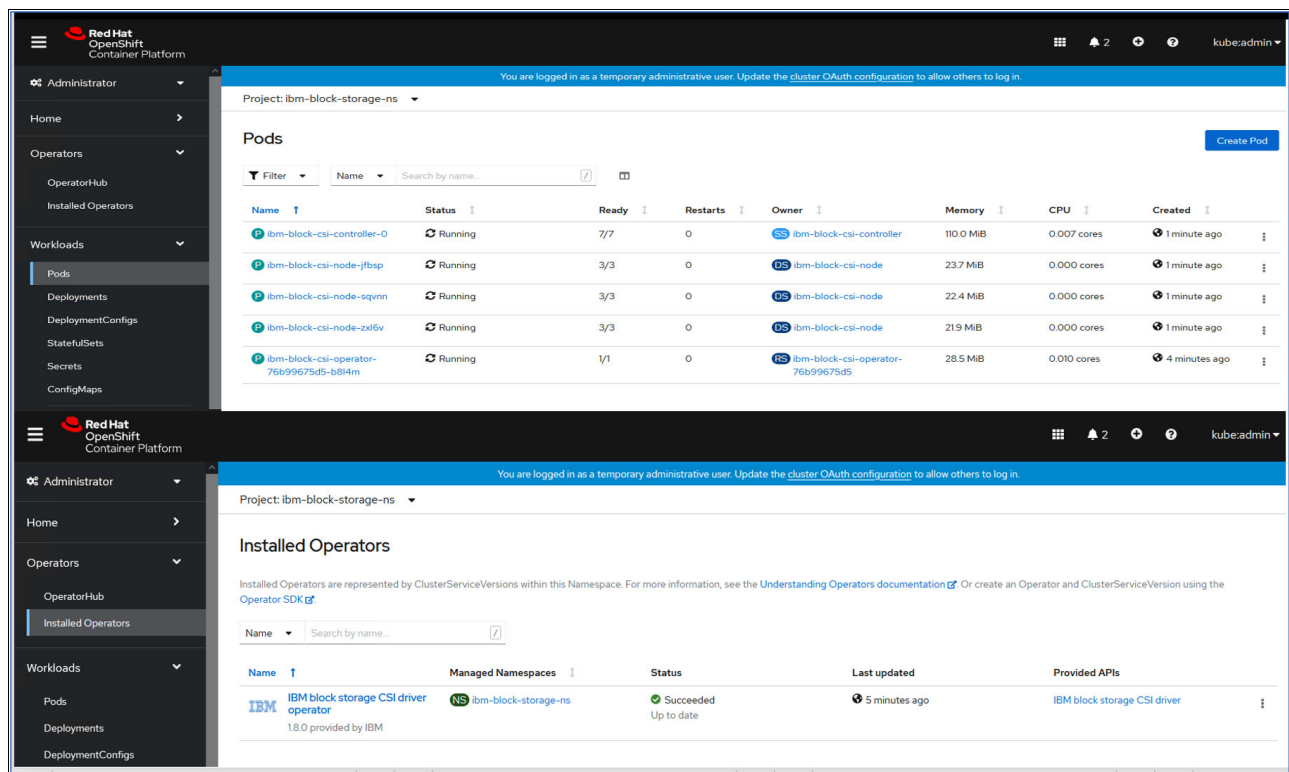


Figure 38 Installing IBM Block storage CSI driver

10. Complete the following steps to install IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Cloud:
- Log in to the Microsoft Azure portal at <https://portal.azure.com>.
 - Select **market place** → **Private Products** → **IBM Spectrum Virtualize for Public Cloud**.
 - Click **Create** (see Figure 39 - Figure 47 on page 38).

Microsoft Azure

Search resources, services, and docs (G+/)

Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) >

Create IBM Spectrum Virtualize for Public Cloud - Beta

Basics VM Selection Credentials Networking Storage Review + create

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription * ⓘ Microsoft Azure Enterprise_ikky

Resource group * ⓘ (New) Hybrid-Cloud-SV4PC-RG
[Create new](#)

Instance details

Region * ⓘ Germany West Central

Project Name

Tag to identify deployment in a resource group

Tag * ⓘ hybridsvpc

Rollback

Rollback on failure. ⓘ ☒

Figure 39 Basic product details

Microsoft Azure

Search resources, services, and docs (G+)

Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) >

Create IBM Spectrum Virtualize for Public Cloud - Beta

Basics **VM Selection** Credentials Networking Storage Review + create

IBM Spectrum Virtualize for Public Cloud is deployed in a 2 Node High Availability cluster consisting of 2 Azure VMs and a third VM that serves as a quorum node for the cluster. The following selection allows you to select from 3 different Azure VMs that are supported for running IBM Spectrum Virtualize for Public Cloud

[Learn more](#)

Spectrum Virtualize for Public Cloud Node * ⓘ	2x Standard D16s v3 16 vcpus, 64 GB memory Change size
Fixed Size Quorum Node * ⓘ	1x Standard B1ms 1 vcpu, 2 GB memory Change size

Figure 40 Selecting VM to create SV4PC on Azure

Microsoft Azure

Search resources, services, and docs (G+/)

Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) >

Create IBM Spectrum Virtualize for Public Cloud - Beta ...

Basics

VM Selection

Credentials

Networking

Storage

Review + create

Spectrum Virtualize is deployed in an Azure VNet across two subnets. The Spectrum Virtualize cluster VMs are deployed in cluster subnet and a quorum VM is deployed in quorum subnet. User may provide new CIDR block to create new VNet and new subnets or choose existing VNet and subnets in the same region
[Learn more](#)

Configure virtual networks

Virtual Network * ⓘ

Hybrid-Cloud-IBM-SV4PC-VNET

[Create new](#)

Cluster Subnet * ⓘ

Hybrid-Cloud-IBM-SV4PC-Cluster-snet (40.10.1.0/24)

[Manage subnet configuration](#)

Quorum Subnet * ⓘ

Hybrid-Cloud-IBM-SV4PC-quorum-snet (40.10.2.0/26)

[Manage subnet configuration](#)

Figure 42 Networking details

Microsoft Azure

Search resources, services, and docs (G+/)

Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) >

Create IBM Spectrum Virtualize for Public Cloud - Beta ...

Basics

VM Selection

Credentials

Networking

Storage

Review + create

Select the type of Azure Managed Disk to be used with IBM Spectrum Virtualize for Public Cloud for storage provisioning. A minimum of two volumes is required for initial cluster creation, and more can be added after installation.
[Check pricing details of Azure managed disks](#)

Azure Disk

Disk Type * ⓘ

Standard SSD (LRS)

Disk Size * ⓘ

512 GB

Figure 43 Storage details

Microsoft Azure

Search resources, services, and docs (G+/)

Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) >

Create IBM Spectrum Virtualize for Public Cloud - Beta ...

Validation Passed

Basics
VM Selection
Credentials
Networking
Storage
Review + create

PRODUCT DETAILS

IBM Spectrum Virtualize for Public Cloud - Beta

by IBM-Alliance-Global-Microsoft Partner-USA-NY-Armonk-HQ-IBMStorage-6201192

[Terms of use](#) | [Privacy policy](#)

TERMS

By clicking "Create", I (a) agree to the legal terms and privacy statement(s) associated with the Marketplace offering(s) listed above; (b) authorize Microsoft to bill my current payment method for the fees associated with the offering(s), with the same billing frequency as my Azure subscription; and (c) agree that Microsoft may share my contact, usage and transactional information with the provider(s) of the offering(s) for support, billing and other transactional activities. Microsoft does not provide rights for third-party offerings. See the [Azure Marketplace Terms](#) for additional details.

Basics

Subscription	Microsoft Azure Enterprise_ikky
Resource group	Hybrid-Cloud-SV4PC-RG
Region	Germany West Central
Tag	hybridsvpc

Figure 44 Review + create option

Microsoft Azure

Search resources, services, and docs (G+)

Home

>

Marketplace

>

IBM Spectrum Virtualize for Public Cloud - Beta (preview)

>

Create IBM Spectrum Virtualize for Public Cloud - Beta

Validation Passed

Basics

Subscription	Microsoft Azure Enterprise_ikky
Resource group	Hybrid-Cloud-SV4PC-RG
Region	Germany West Central
Tag	hybridsvpc

VM Selection

Spectrum Virtualize for Public Cloud No...	Standard_D16s_v3
Fixed Size Quorum Node	Standard_B1ms

Credentials

Password	*****
IBM Customer Number	0015567
Notification Email	hekantak@in.ibm.com
SSH public key	ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQgQCmNQkZZHHWfzUfMoUm2...

Networking

Virtual network	Hybrid-Cloud-IBM-SV4PC-VNET
Cluster Subnet	Hybrid-Cloud-IBM-SV4PC-Cluster-snet
Address prefix (Cluster Subnet)	40.10.1.0/24
Quorum Subnet	Hybrid-Cloud-IBM-SV4PC-quorum-snet
Address prefix (Quorum Subnet)	40.10.2.0/26

Storage

Disk Type	Standard SSD (LRS)
Disk Size	512 GB

Create

< Previous

Next

Download a template for automation

Figure 45 Creating SV4PC

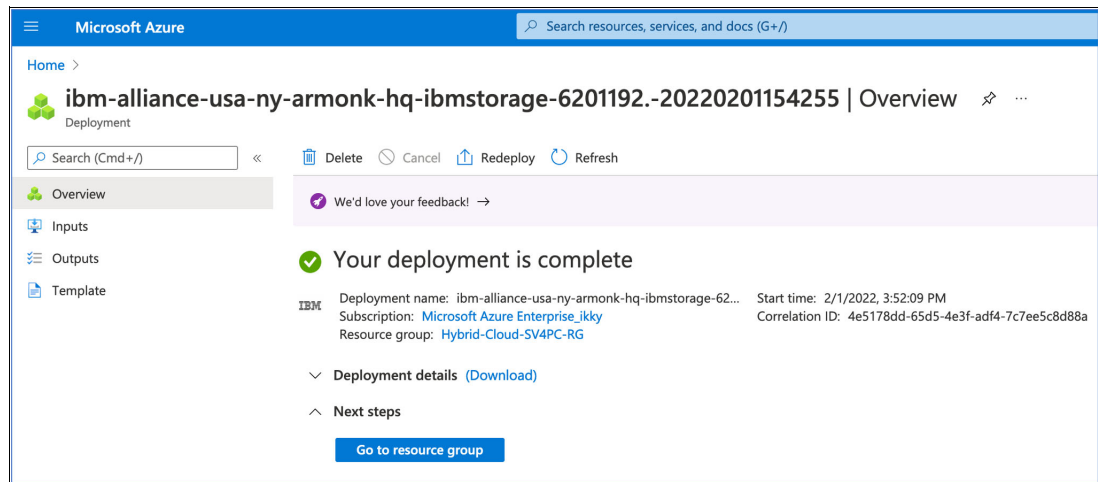


Figure 46 Checking the deployment

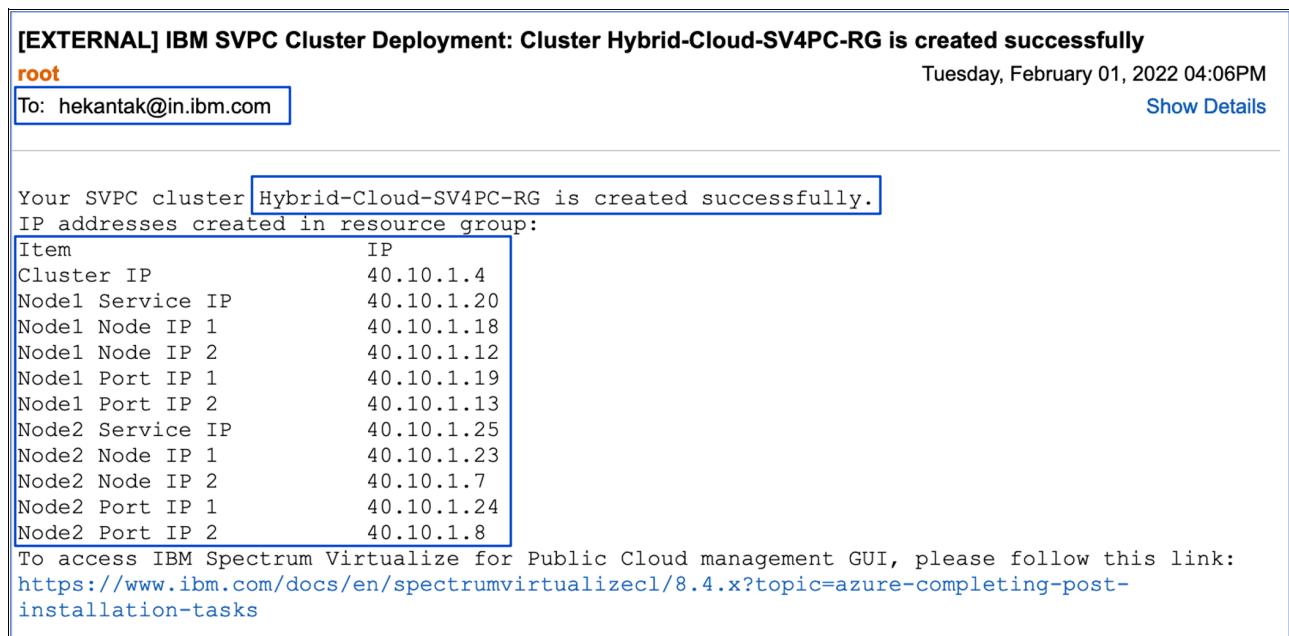


Figure 47 Checking email for cluster IP details

11. Create a Windows 2019 VM on Microsoft Azure Cloud or log in to the Windows VM from your on-premises Windows host and open the web browser of your choice to configure the newly deployed SV4PC storage on Azure Cloud.
12. Log in to the cluster IP at <https://40.10.1.4:8443/login> to complete the configuration for the newly deployed SV4PC (see Figure 47).
13. Click **Next**. Select **Agree with the terms in the License agreement**. Enter the password and then, click **Apply**. Then, click **Next**.
14. Enter the following information:
 - Name of the system
 - External Virtualization
 - Capacity in TB
 - DNS
 - Storage IBM Insight®

15. Click **Finish** to complete the setup.

16. Log in to the Storage at <https://40.10.1.4:8443/login> and check the status (see Figure 48).

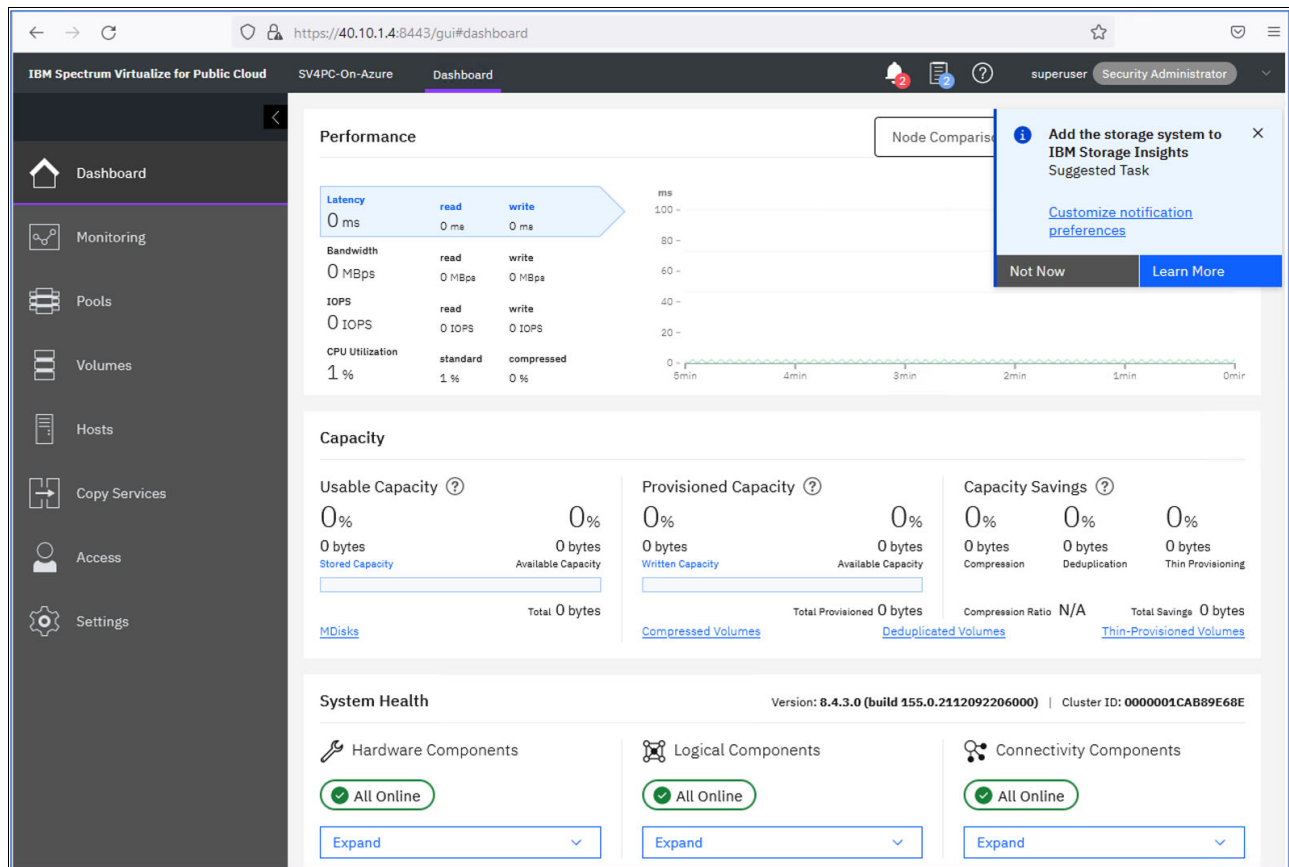


Figure 48 Checking the status of storage

17. Complete the following steps to create host mapping in SV4PC Storage for RHOCP Worker nodes with iSCSI connection:

- Log in to the Microsoft Azure portal at <https://portal.azure.com>.
- Log in to the Linux VM by using azureuser and the SSH key that uses the Bastion service or by using SSH and get the initiator name from the RHOCP worker nodes.
- Create the host mapping for the worker nodes, as shown in Figure 49 on page 40 - Figure 52 on page 41.
- Repeat the same procedure for all the worker nodes in the cluster. Then, run `iscsiadm` commands for the iSCSI login.

```
[root@hybrid-Cloud-Linux-bastion-vm yam1]#
[root@hybrid-Cloud-Linux-bastion-vm yam1]# oc get nodes
NAME                                     STATUS    ROLES    AGE      VERSION
arhocluster1sv4pc-9w2gw-master-0      Ready    master   6h22m    v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-master-1      Ready    master   6h21m    v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-master-2      Ready    master   6h22m    v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 Ready    worker   6h13m    v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 Ready    worker   6h13m    v1.21.6+bb8d50a
arhocluster1sv4pc-9w2gw-worker-germanywestcentral3-kk4rv Ready    worker   6h13m    v1.21.6+bb8d50a
[root@hybrid-Cloud-Linux-bastion-vm yam1]#
[root@hybrid-Cloud-Linux-bastion-vm yam1]# ssh core@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 cat /etc/iscsi
i/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:402e6796fb6e
[root@hybrid-Cloud-Linux-bastion-vm yam1]#
[root@hybrid-Cloud-Linux-bastion-vm yam1]# ssh core@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 cat /etc/iscsi
i/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:25dd27569eb1
[root@hybrid-Cloud-Linux-bastion-vm yam1]#
[root@hybrid-Cloud-Linux-bastion-vm yam1]# ssh core@arhocluster1sv4pc-9w2gw-worker-germanywestcentral3-kk4rv cat /etc/iscsi
i/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:113148c0f72e
[root@hybrid-Cloud-Linux-bastion-vm yam1]#
```

Figure 49 Getting iSCSI initiator name

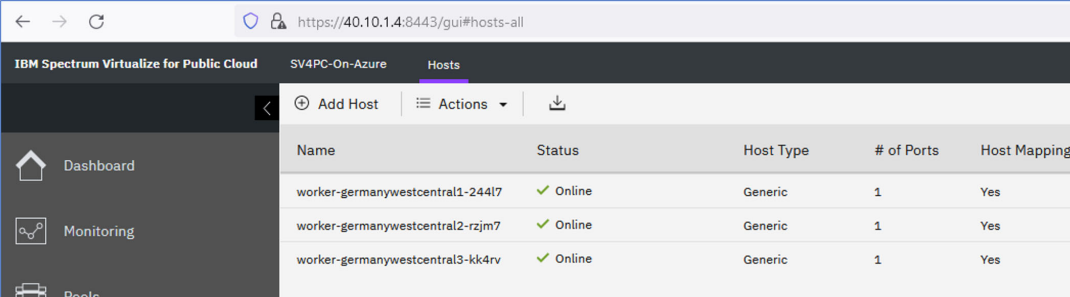
The screenshot shows the 'Add Host' dialog in the IBM Spectrum Virtualize for Public Cloud GUI. The dialog is titled 'Add Host' and has a close button (X) in the top right corner. Below the title, there is a blue information box stating 'NPIV Enabled' with a note: 'Because NPIV is enabled on this system, host traffic is only allowed over the storage system's virtual ports. Ensure that SAN zoning allows connectivity between virtual ports and the host.' Below this, the 'Name' field contains 'worker-germanywestcentral1-24417'. The 'Host Connections' section shows 'iSCSI (SCSI)' selected from a dropdown menu, and 'CHAP Authentication' is set to 'Off'. The 'Host Port (IQN)' field contains 'iqn.1994-05.com.redhat:402e6796fb6e'. The 'Host Type' dropdown is set to 'Generic'. At the bottom, there are 'Cancel' and 'Save' buttons. A blue arrow points to the 'Save' button.

Figure 50 Defining host mapping

```
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiadm -m discoverydb -t st -p 40.10.1.13:3260 --disc
over
40.10.1.19:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1
40.10.1.13:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiadm -m discoverydb -t st -p 40.10.1.8:3260 --discover
40.10.1.24:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2
40.10.1.8:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiadm -m node -p 40.10.1.13 --login
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1, portal: 40.10.1.13,3260]
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1, portal: 40.10.1.13,3260] successful.
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiadm -m node -p 40.10.1.8 --login
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2, portal: 40.10.1.8,3260]
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2, portal: 40.10.1.8,3260] successful.
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#

[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]#
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiadm -m discoverydb -t st -p 40.10.1.13:3260 --discover
40.10.1.19:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1
40.10.1.13:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiadm -m discoverydb -t st -p 40.10.1.8:3260 --discover
40.10.1.24:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2
40.10.1.8:3260,1 iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiadm -m node -p 40.10.1.13 --login
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node1, portal: 40.10.1.13,3260] successful.
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiadm -m node -p 40.10.1.8 --login
Login to [iface: default, target: iqn.1986-03.com.ibm:2145.sv4pc-on-azure.node2, portal: 40.10.1.8,3260] successful.
[root@arhoccluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]#
```

Figure 51 Running iscsiadm commands



Name	Status	Host Type	# of Ports	Host Mappings
worker-germanywestcentral1-24417	Online	Generic	1	Yes
worker-germanywestcentral2-rzjm7	Online	Generic	1	Yes
worker-germanywestcentral3-kk4rv	Online	Generic	1	Yes

Figure 52 Checking the host status

18. Complete the following steps to create the Storage secret and Storage class on RHOC on Microsoft Azure Cloud:

- Log in to the Microsoft Azure portal at <https://portal.azure.com>.
- Log in to the Linux VM by using azureuser and the SSH key that uses the Bastion service or by using SSH.
- Create the Storage secret and Storage class (see Figure 53 and Figure 54).

```
[root@hybrid-Cloud-Linux-bastion-vm yaml]# cat ibm-sv4pc-storage-secret.yaml
kind: Secret
apiVersion: v1
metadata:
  name: ibm-sv4pc-storage-secret
  namespace: ibm-block-storage-ns
type: Opaque
stringData:
  management_address: 40.10.1.4
  username: superuser
data:
  password: SWJtU3Y0cGNvbKkF6dXJlCg==
[root@hybrid-Cloud-Linux-bastion-vm yaml]#
[root@hybrid-Cloud-Linux-bastion-vm yaml]# oc create -f ibm-sv4pc-storage-secret.yaml
secret/ibm-sv4pc-storage-secret created
[root@hybrid-Cloud-Linux-bastion-vm yaml]#
[root@hybrid-Cloud-Linux-bastion-vm yaml]#
```

Figure 53 Creating Storage secret

```
[root@hybrid-Cloud-Linux-bastion-vm yaml]# cat ibm-sv4pc-storage-class.yaml
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: ibm-block-storage-class-sv4pc
  annotations:
    description: ibm-block-storage-class-sv4pc
provisioner: block.csi.ibm.com
parameters:
  pool: CloudPool0
  SpaceEfficiency: thin
  volume_name_prefix: SV4PC-AZ
  csi.storage.k8s.io/fstype: xfs
  csi.storage.k8s.io/secret-name: ibm-sv4pc-storage-secret
  csi.storage.k8s.io/secret-namespace: ibm-block-storage-ns
reclaimPolicy: Delete
allowVolumeExpansion: true
volumeBindingMode: Immediate
[root@hybrid-Cloud-Linux-bastion-vm yaml]# oc create -f ibm-sv4pc-storage-class.yaml
storageclass.storage.k8s.io/ibm-block-storage-class-sv4pc created
[root@hybrid-Cloud-Linux-bastion-vm yaml]#
```

Figure 54 Creating Storage class

19. Install the following components:

- Red Hat OpenShift container Platform. For more information, see the following resources:
 - *IBM Storage for Red Hat OpenShift*, [REDP-5565](#)
 - This [Red Hat Documentation web page](#)
- IBM Block storage CSI driver v1.8. For more information, see this [IBM Documentation web page](#).
- IBM FlashSystem Storage FS9100 and Create host mapping and iSCSI connection for on-premises RHOCP worker nodes and host, as described in Step 17 on page 39.

With these steps completed, the hardware, software, and hybrid cloud networking setup process is complete and the use case demonstration is available.

Use case demonstration

This use case demonstration shows how the on-premises data can be made available to remote sites and Microsoft Azure Cloud by using the following methods:

- Volume replication by using IBM Storage Global mirror
- Data replication by using IBM Block Storage CSI driver volume replication

These methods are described next.

Volume replication by using IBM Storage Global Mirror feature

Note: In this use case demonstration we did *not* use the Global Mirror with Change Volumes (GMCV) replication method. The customer can use this method if wanted.

The steps in this demonstration show how the on-premises data can be made available to remote sites and public clouds by using the components that are described in this Blueprint.

For more information about steps that can be taken to ensure database data consistency, see the specific product documentation.

Complete the following steps:

1. Log in to the on-premises RHOCP bastion hosts or the host from where the RHOCP cluster can be accessed by using `oc c1i` command tools.
2. Create the Storage secret and Storage class, as shown in Figure 55 on page 44 and Figure 56 on page 44.

```

[root@gw-10 yaml]#
[root@gw-10 yaml]# oc project
Using project "ibm-flashsystem-csi" on server "https://api.sha.spp-mcm.kb.stglabs.ibm.com:6443".
[root@gw-10 yaml]#
[root@gw-10 yaml]# ls -l
total 24
-rw-r--r--. 1 root root 212 Feb 12 07:51 01-ibm-block-storage-secret.yaml
-rw-r--r--. 1 root root 490 Feb 12 07:53 02-ibm-block-storageclass.yaml
-rw-r--r--. 1 root root 4135 Jan 27 04:01 install-config.yaml
-rw-r--r--. 1 root root 4135 Jan 27 04:07 install-config.yaml.orig
drwxr-xr-x. 2 root root 62 Jan 27 13:01 MySQL
[root@gw-10 yaml]# cat 01-ibm-block-storage-secret.yaml
apiVersion: v1
data:
  management_address: MTAuMC4yNDAuMzA=
  password: CGFzc3cwcmQ=
  username: c3VwZXJlc2Vy
kind: Secret
metadata:
  name: ibm-block-storage-secret
  namespace: ibm-flashsystem-csi
type: Opaque
[root@gw-10 yaml]# oc create -f 01-ibm-block-storage-secret.yaml
secret/ibm-block-storage-secret created
[root@gw-10 yaml]#
[root@gw-10 yaml]# oc get secrets ibm-block-storage-secret
NAME                                TYPE      DATA   AGE
ibm-block-storage-secret            Opaque    3        15s
[root@gw-10 yaml]#

```

Figure 55 Creating Storage secret

```

[root@gw-10 yaml]# oc project
Using project "ibm-flashsystem-csi" on server "https://api.sha.spp-mcm.kb.stglabs.ibm.com:6443".
[root@gw-10 yaml]#
[root@gw-10 yaml]# ls
01-ibm-block-storage-secret.yaml 02-ibm-block-storageclass.yaml install-config.yaml install-config.yaml.orig MySQL
[root@gw-10 yaml]#
[root@gw-10 yaml]# cat 02-ibm-block-storageclass.yaml
allowVolumeExpansion: true
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  annotations:
    description: ibm-block-storage-class
  name: ibm-block-storage-class
parameters:
  SpaceEfficiency: thin
  csi.storage.k8s.io/fstype: xfs
  csi.storage.k8s.io/secret-name: ibm-block-storage-secret
  csi.storage.k8s.io/secret-namespace: ibm-flashsystem-csi
  pool: SVPC Pool
  volume_name_prefix: hybrid
provisioner: block.csi.ibm.com
reclaimPolicy: Delete
volumeBindingMode: Immediate
[root@gw-10 yaml]#
[root@gw-10 yaml]# oc create -f 02-ibm-block-storageclass.yaml
storageclass.storage.k8s.io/ibm-block-storage-class created
[root@gw-10 yaml]#
[root@gw-10 yaml]# oc get sc
NAME                                PROVISIONER          RECLAIMPOLICY    VOLUMEBINDINGMODE    ALLOWVOLUMEEXPANSION    AGE
ibm-block-storage-class            block.csi.ibm.com     Delete           Immediate             true                    <invalid>
thin (default)                    kubernetes.io/vsphere-volume Delete           Immediate             false                   15d
[root@gw-10 yaml]#

```

Figure 56 Creating Storage class

3. Create a project and namespace and then, create the yaml files for the PV claim and MySQL deployment yaml file, as shown in Figure 57.

```
[root@gw-10 MySQL]# oc project
Using project "mysql" on server "https://api.sha.spp-mcm.kb.stglabs.ibm.com:6443".
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# ls
01-mysqlpvc.yaml 02-mysql-deployment.yaml
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# cat 01-mysqlpvc.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: mysql-pvc
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  storageClassName: ibm-block-storage-class
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc create -f 01-mysqlpvc.yaml
persistentvolumeclaim/mysql-pvc created
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc get pv,pvc

NAME                                     CAPACITY  ACCESS MODES  RECLAIM POLICY  STATUS  CLAIM                STORAGECLASS
REASON  AGE
persistentvolume/pvc-96a829c2-db25-48bc-8ad8-6d334e19323c  20Gi      RWO           Delete          Bound   mysql/mysql-pvc      ibm-block-storage-class
5s

NAME                                     STATUS  VOLUME                                     CAPACITY  ACCESS MODES  STORAGECLASS  AGE
persistentvolumeclaim/mysql-pvc          Bound   pvc-96a829c2-db25-48bc-8ad8-6d334e19323c  20Gi      RWO           ibm-block-storage-class  8s
[root@gw-10 MySQL]#
```

Figure 57 Creating PVC pvc for mysql

4. Confirm that the volume was created on the on-premises IBM FlashSystem storage FS9100, as shown in Figure 58.

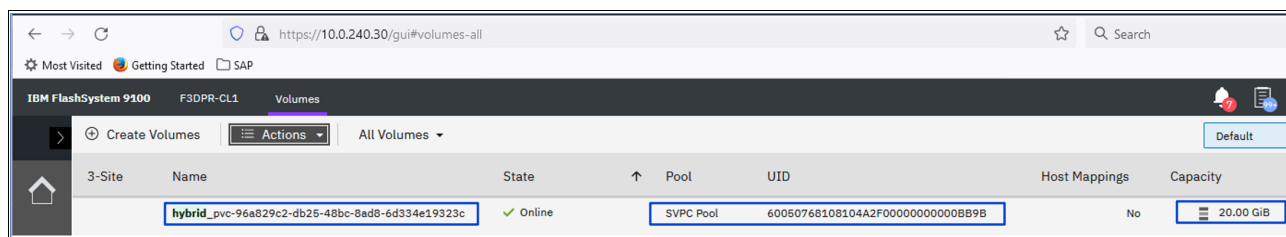


Figure 58 Checking that the volume and LUN are created on storage

5. Create the MySQL deployment yaml file and the MySQL containerized database, as shown in Figure 59 on page 46.

```

01-mysqlpvc.yaml 02-mysql-deployment.yaml
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# cat 02-mysql-deployment.yaml
---
apiVersion: v1
kind: Service
metadata:
  name: mysql
spec:
  ports:
    - port: 3306
  selector:
    app: mysql
  clusterIP: None
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
spec:
  selector:
    matchLabels:
      app: mysql
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
        - image: mysql:5.6
          name: mysql
          env:
            # Use secret in real usage
            - name: MYSQL_ROOT_PASSWORD
              value: password
          ports:
            - containerPort: 3306
              name: mysql
          volumeMounts:
            - name: mysql-persistent-storage
              mountPath: /var/lib/mysql
      volumes:
        - name: mysql-persistent-storage
          persistentVolumeClaim:
            claimName: mysql-pvc
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc create -f 02-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[root@gw-10 MySQL]#

```

Figure 59 Creating mysql yaml file and deploying mysql

6. Log in to the MySQL pod and check whether the MySQL deployment was successful, as shown in Figure 60.

```
[root@gw-10 ~]# oc project
Using project "mysql" on server "https://api.sha.spp-mcm.kb.stglabs.ibm.com:6443".
[root@gw-10 ~]#
[root@gw-10 ~]# oc get pods
NAME                                READY   STATUS    RESTARTS   AGE
mysql-6cb7cbd56d-s2682             1/1     Running   0           3m18s
[root@gw-10 ~]#
[root@gw-10 ~]# oc rsh mysql-6cb7cbd56d-s2682
$
$ mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1
Server version: 5.6.51 MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> █
```

Figure 60 Logging in to mysql pod

7. Create the sample database and table and then, insert data into table and show the table contents (see Figure 61).

```
mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql |
| performance_schema |
+-----+
3 rows in set (0.00 sec)

mysql> create database hybrid;
Query OK, 1 row affected (0.00 sec)

mysql> use hybrid;
Database changed
mysql> create table hybrid_sv4pc_table ( coll int );
Query OK, 0 rows affected (0.02 sec)

mysql> insert into hybrid_sv4pc_table values (1);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid_sv4pc_table values (2);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid_sv4pc_table values (3);
Query OK, 1 row affected (0.00 sec)

mysql> select * from hybrid_sv4pc_table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Create Sample data in MySQL DB

- Create Database
- Create table
- Insert sample data into table
- Show the table contents

➤ RESULTS – SAMPLE DATA on VOLUME

```
mysql> select * from hybrid_sv4pc_table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)
```

Figure 61 Creating database and insert sample data

The next part of the process involves replicating the on-premises storage volume or LUN with the equal sized volume or LUN on the SV4PC storage that is deployed on Microsoft Azure Cloud. The data replication is performed by using IBM Global mirror replication.

Complete the following steps:

1. Log in to the SV4PC storage on the Azure Cloud and the, create the 20Gi volume, as shown in Figure 62 and Figure 63 on page 50.

```
mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql |
| performance_schema |
+-----+
3 rows in set (0.00 sec)

mysql> create database hybrid;
Query OK, 1 row affected (0.00 sec)

mysql> use hybrid;
Database changed
mysql> create table hybrid_sv4pc_table ( coll int );
Query OK, 0 rows affected (0.02 sec)

mysql> insert into hybrid_sv4pc_table values (1);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid_sv4pc_table values (2);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid_sv4pc_table values (3);
Query OK, 1 row affected (0.00 sec)

mysql> select * from hybrid_sv4pc_table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Create Sample data in MySQL DB

- Create Database
- Create table
- Insert sample data into table
- Show the table contents

➤ RESULTS – SAMPLE DATA on VOLUME

```
mysql> select * from hybrid_sv4pc_table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)
```

Figure 62 Creating 20gi volume on sv4pc on Azure

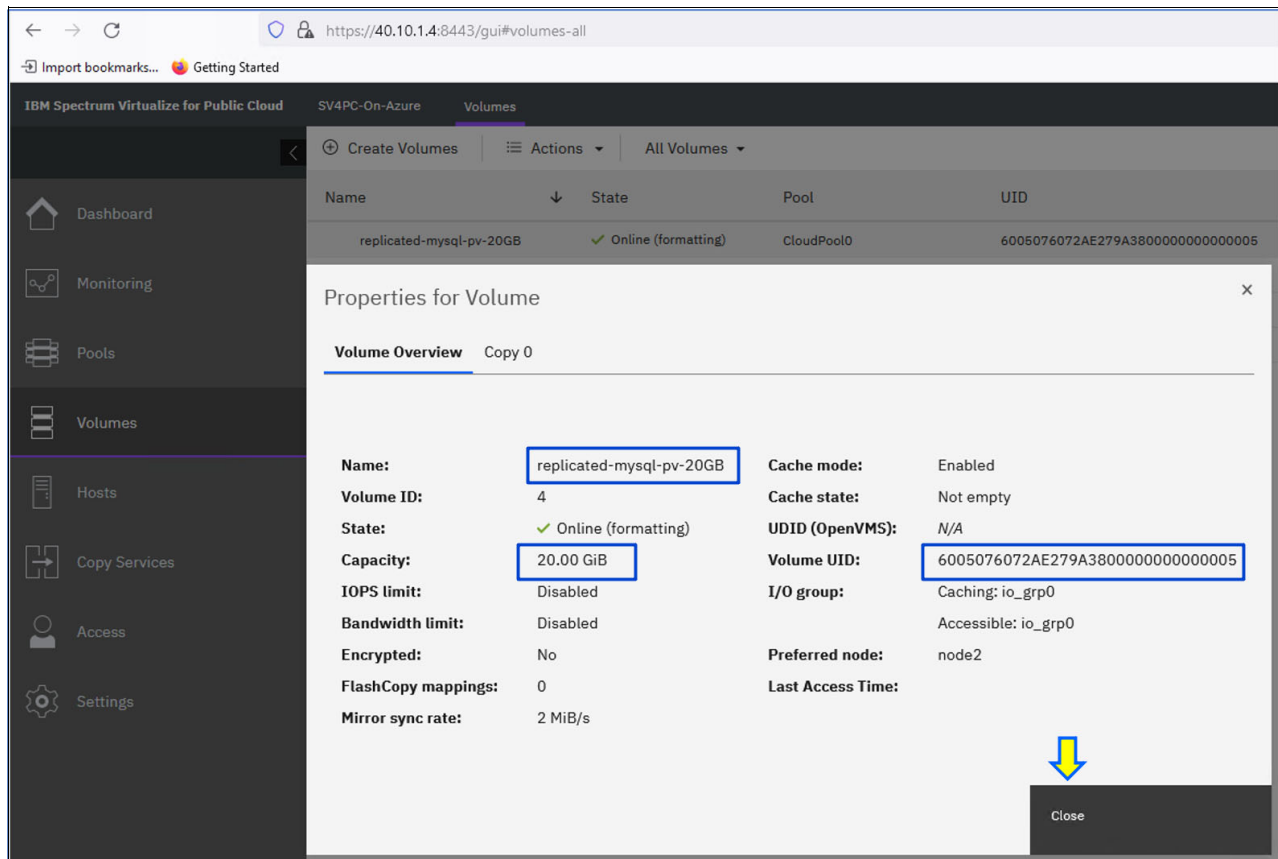


Figure 63 Checking the volume properties

2. Log in to the IBM FlashSystem FS9100 storage (on-premises) and SV4PC storage on Azure and complete the following steps to replicate the data on the volume, as shown in Figure 64 on page 51 - Figure 74 on page 55):
 - a. Create a partnership from on-premises storage.
 - b. Create a partnership from SV4PC storage on Azure Cloud.
 - c. Add a Consistency Group.
 - d. Create a relationship and start copying the data that is on the volume.
 - e. Stop the Remote-copy Consistency Group.

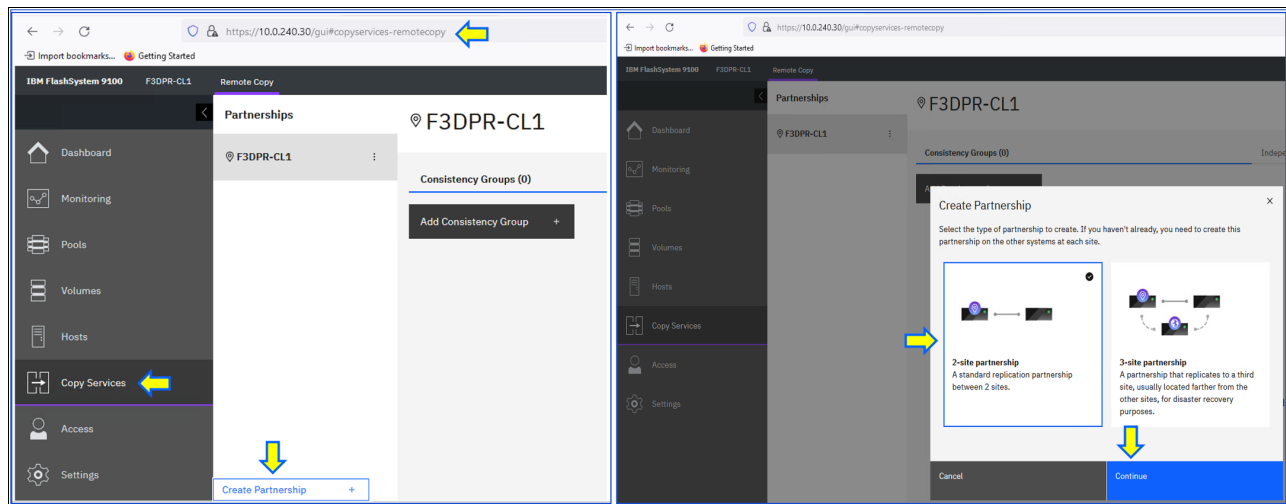


Figure 64 Creating partnership: On-premises storage, Part 1

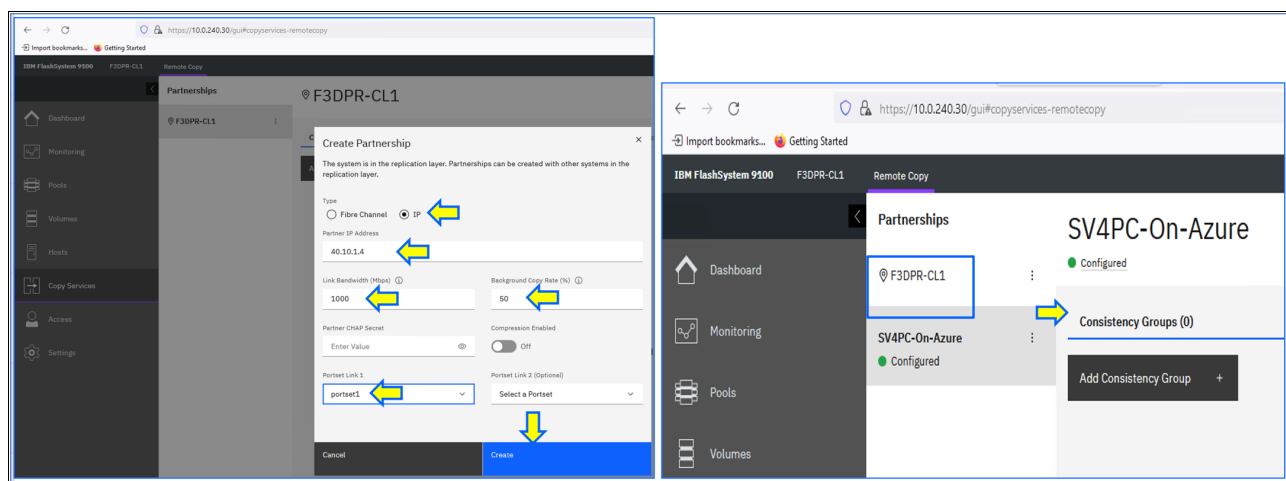


Figure 65 Creating partnership: On-premise storage, Part 2

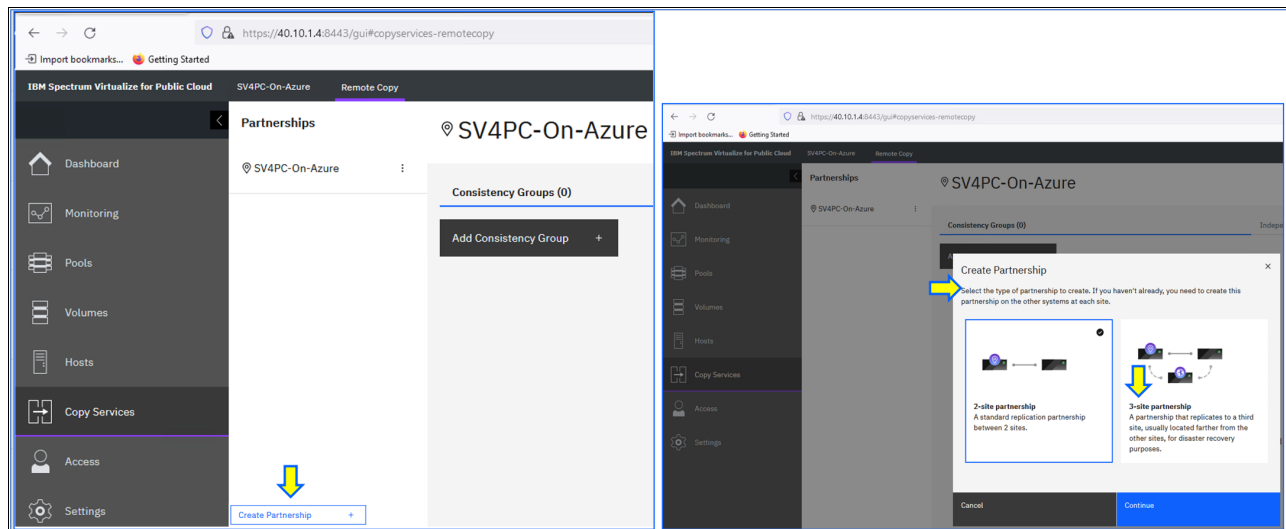


Figure 66 Creating partnership: sv4pc on Azure, Part 1

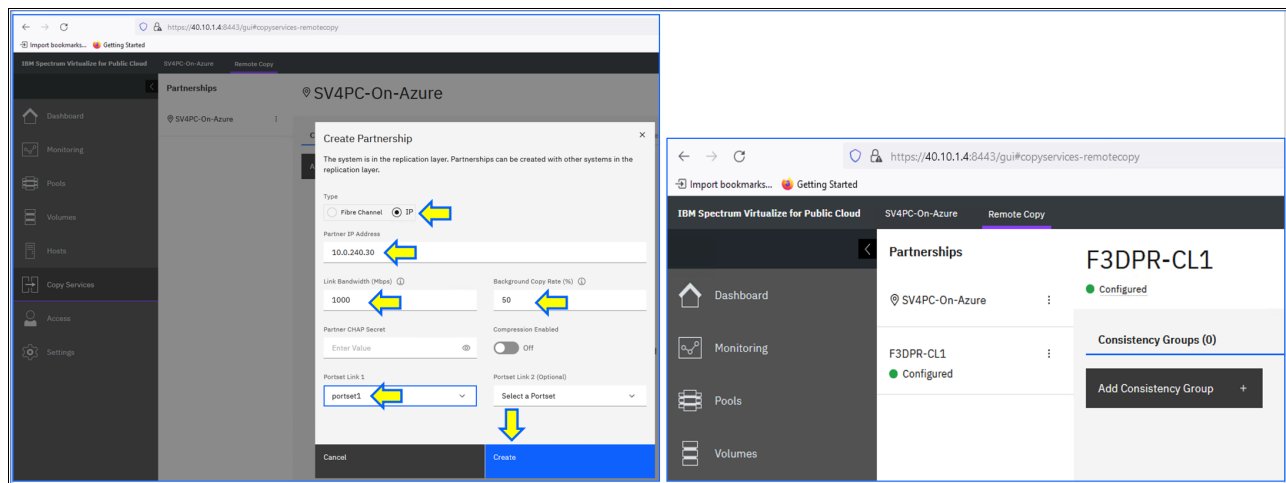


Figure 67 Creating partnership: sv4pc on Azure, Part 2

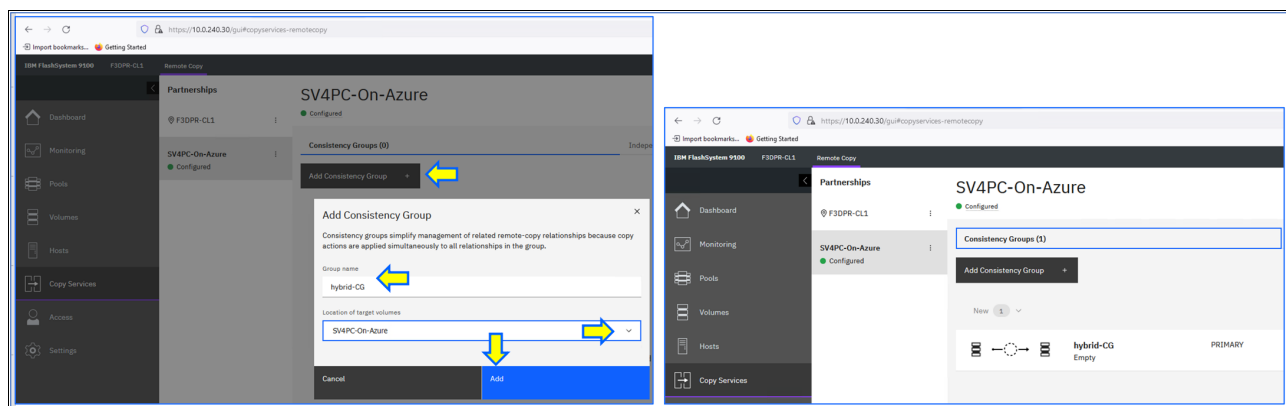


Figure 68 Adding consistency group: On-premises storage

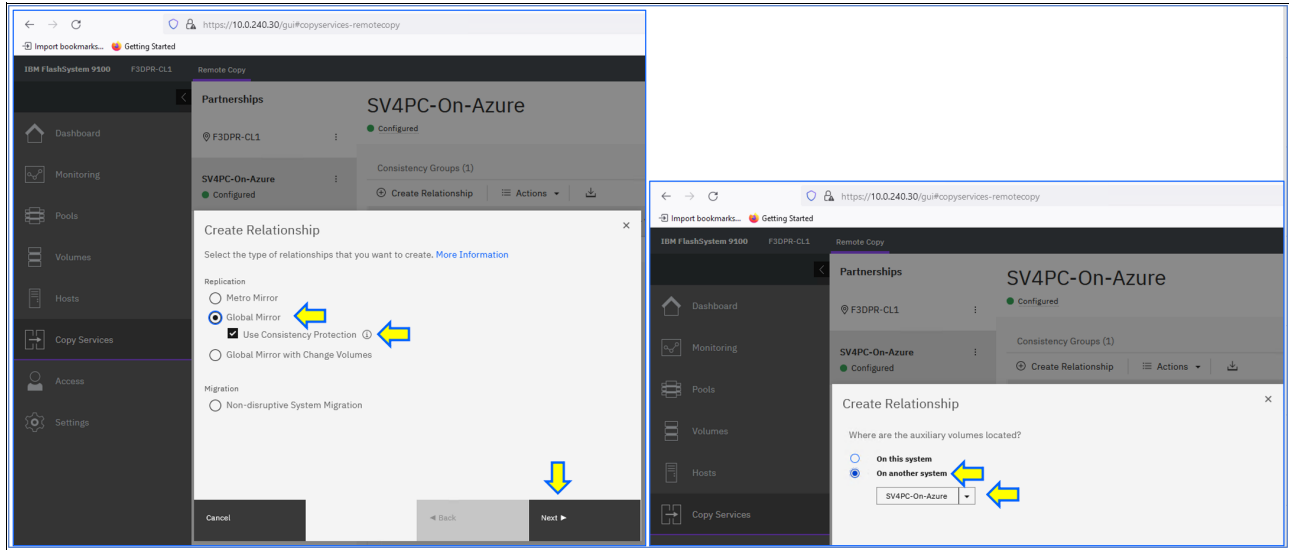


Figure 69 Creating relationship: On-premises storage Part 1

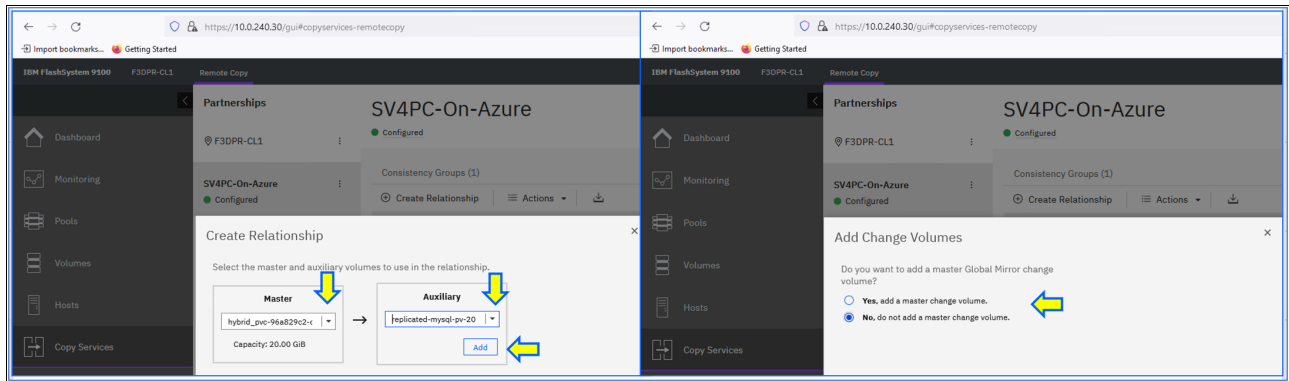


Figure 70 Creating relationship: On-premises storage Part 2

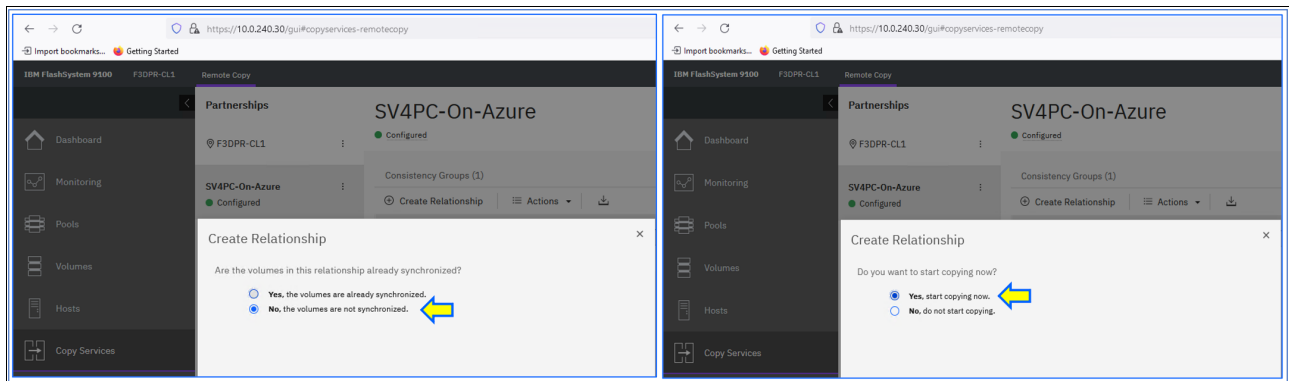


Figure 71 Creating relationship: On-premises storage Part 3

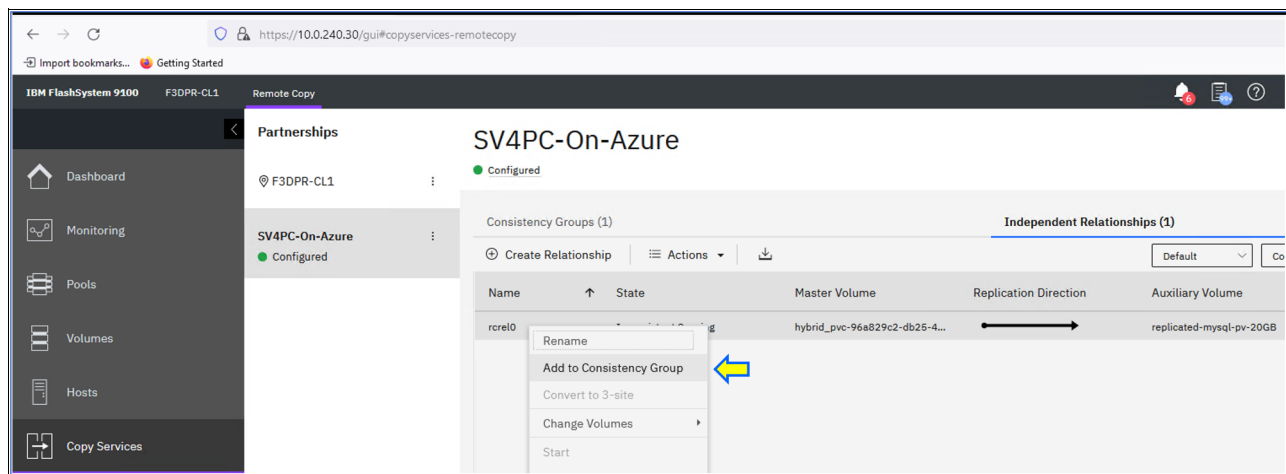


Figure 72 Adding consistency group: On-premises storage

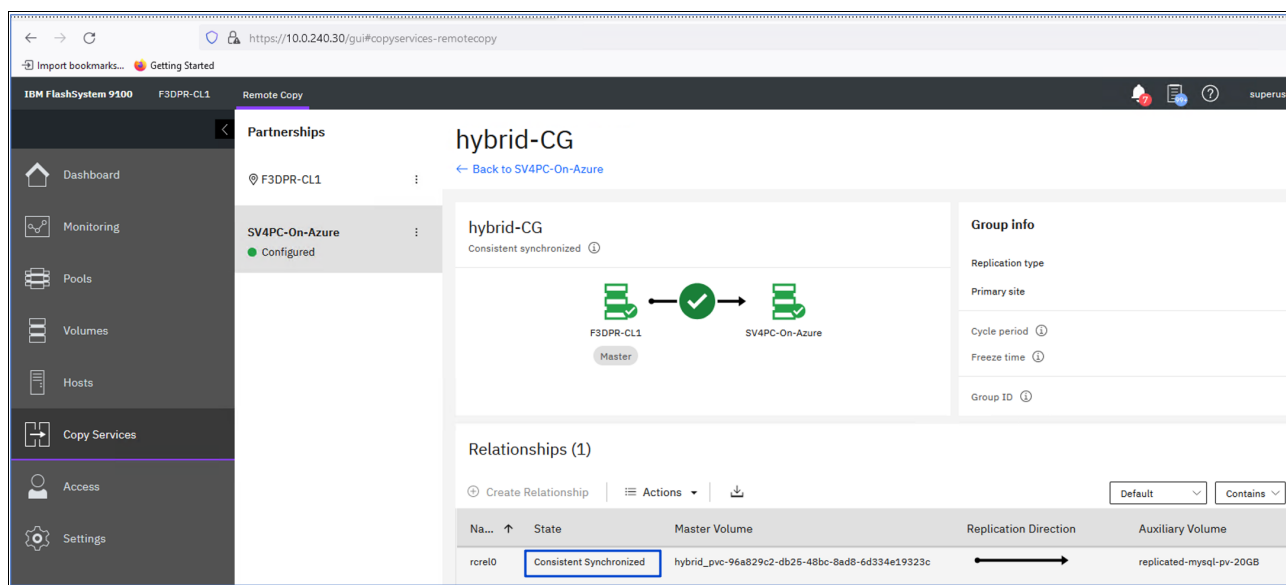


Figure 73 Checking status: Consistent synchronized

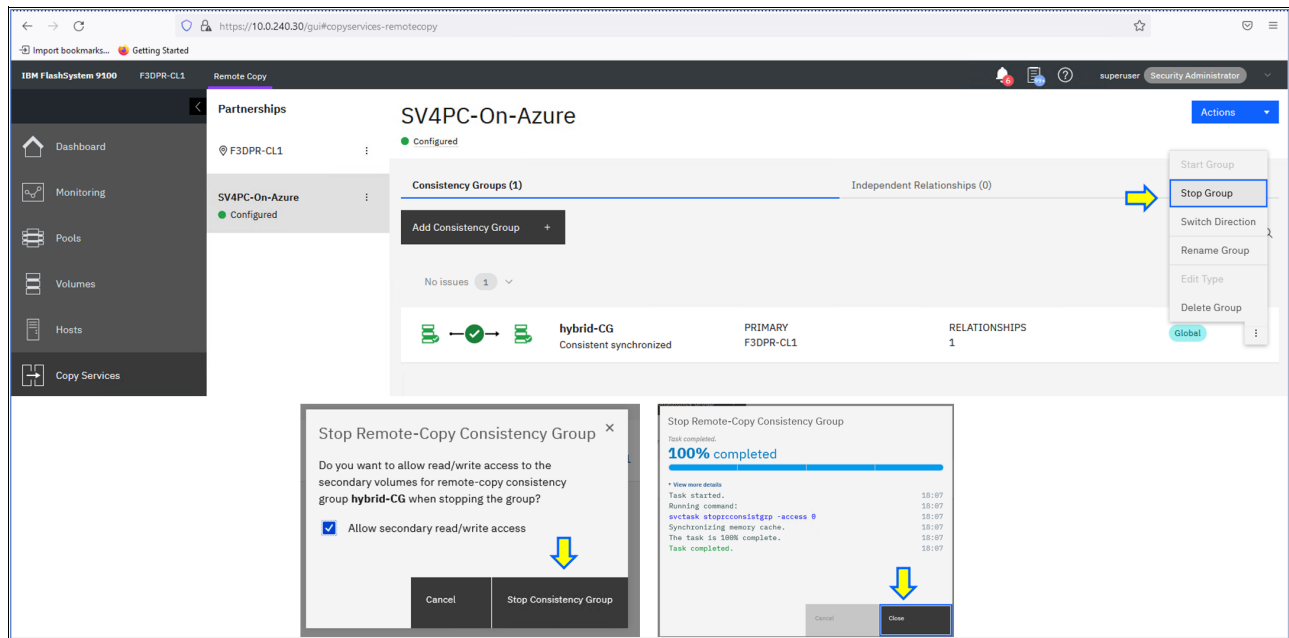


Figure 74 Stopping remote-copy consistency group

3. Log in to the Microsoft Azure portal at <https://portal.azure.com> and then, log in to the Linux VM by using azureuser and the SSH key that uses the Bastion service or by using SSH and creating the persistent volume claim (PVC) and PV by using the procedure that is described at this [IBM Documentation web page](#) (see Figure 75 on page 56 - Figure 82 on page 60).

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/MySQL
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc project mysql-cloud
Already on project "mysql-cloud" on server "https://api.arhocluster1sv4pc.arhoclustersv4pc.net:6443".
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# cat 01-replicated-existing-mysql-pv.yaml
apiVersion: v1
kind: PersistentVolume
metadata:
  annotations:
    pv.kubernetes.io/provisioned-by: block.csi.ibm.com
  finalizers:
    - kubernetes.io/pv-protection
    - external-attacher/block-csi-ibm-com
  name: replicated-mysql-pv-20gb
spec:
  accessModes:
    - ReadWriteOnce
  capacity:
    storage: 20Gi
  csi:
    controllerExpandSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    controllerPublishSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    driver: block.csi.ibm.com
    fsType: xfs
    nodePublishSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    nodeStageSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    volumeAttributes:
      array_address: 40.10.1.4
      pool_name: CloudPool0
      storage.kubernetes.io/csiProvisionerIdentity: 1644399157645-8081-block.csi.ibm.com
      storage type: SVC
      volume_name: replicated-mysql-pv-20gb
      volumeHandle: SVC:4;6005076072AE279A38000000000000005
      persistentVolumeReclaimPolicy: Delete
      storageClassName: ibm-block-storage-class-sv4pc
      volumeMode: Filesystem
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#

```

Figure 75 Creating a volume yaml file

```

[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc create -f 01-replicated-existing-mysql-pv.yaml
persistentvolume/replicated-mysql-pv-20gb created
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc get pv,pvc

```

NAME	STORAGECLASS	REASON	AGE	CAPACITY	ACCESS MODES	RECLAIM
persistentvolume/pvc-016db124-d744-4e5c-a74e-4919ee05ff28				5Gi	RWO	Delete
test-claim-on-sv4pc	ibm-block-storage-class-sv4pc		3d5h			
persistentvolume/replicated-mysql-pv-20gb				20Gi	RWO	Delete
	ibm-block-storage-class-sv4pc		5s			

```

[root@hybrid-Cloud-Linux-bastion-vm MySQL]#

```

Figure 76 Checking the status of pv,pvc

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/MySQL
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# cat 02-replicated-existing-mysql-pvc.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: replicated-mysql-pvc-20gb
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  storageClassName: ibm-block-storage-class-sv4pc
  volumeName: replicated-mysql-pv-20gb
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc create -f 02-replicated-existing-mysql-pvc.yaml

persistentvolumeclaim/replicated-mysql-pvc-20gb created
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc get pv,pvc

NAME                                     CAPACITY  ACCESS MODES  RECLAIM
POLICY  STATUS  CLAIM                                     STORAGECLASS  R
EASON  AGE
persistentvolume/pvc-016db124-d744-4e5c-a74e-4919ee05ff28  5Gi        RWO           Delete
Bound    ibm-block-storage-ns/test-claim-on-sv4pc  ibm-block-storage-class-sv4pc
3d5h
persistentvolume/replicated-mysql-pv-20gb  20Gi        RWO           Delete
Bound    mysql-cloud/replicated-mysql-pvc-20gb  ibm-block-storage-class-sv4pc
112s

NAME                                     STATUS  VOLUME                                     CAPACITY
ACCESS MODES  STORAGECLASS  AGE
persistentvolumeclaim/replicated-mysql-pvc-20gb  Bound   replicated-mysql-pv-20gb  20Gi
RWO        ibm-block-storage-class-sv4pc  7s
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#

```

Figure 77 Creating mysql pvc

```
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# cat 03-Cloud-mysql-deployment.yaml
---
apiVersion: v1
kind: Service
metadata:
  name: mysql
spec:
  ports:
    - port: 3306
  selector:
    app: mysql
  clusterIP: None
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
spec:
  selector:
    matchLabels:
      app: mysql
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
        - image: mysql:5.6
          name: mysql
          env:
            # Use secret in real usage
            - name: MYSQL_ROOT_PASSWORD
              value: password
          ports:
            - containerPort: 3306
              name: mysql
          volumeMounts:
            - name: mysql-persistent-storage
              mountPath: /var/lib/mysql
      volumes:
        - name: mysql-persistent-storage
          persistentVolumeClaim:
            claimName: replicated-mysql-pvc-20gb
```

Figure 78 Creating mysql yaml file

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/MySQL
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc create -f 03-Cloud-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc get all
NAME                                READY    STATUS              RESTARTS   AGE
pod/mysql-5cfb7b64c6-gv98r         0/1     ContainerCreating   0           15s

NAME                TYPE        CLUSTER-IP    EXTERNAL-IP    PORT(S)    AGE
service/mysql       ClusterIP   None          <none>         3306/TCP   15s

NAME                READY    UP-TO-DATE    AVAILABLE    AGE
deployment.apps/mysql 0/1      1             0            15s

NAME                                DESIRED    CURRENT    READY    AGE
replicaset.apps/mysql-5cfb7b64c6    1          1          0        15s
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc get pod
NAME                                READY    STATUS              RESTARTS   AGE
mysql-5cfb7b64c6-gv98r             1/1     Running          0           2m31s
[root@hybrid-Cloud-Linux-bastion-vm MySQL]#

```

Figure 79 Deploying mysql

```

[root@hybrid-Cloud-Linux-bastion-vm MySQL]#
[root@hybrid-Cloud-Linux-bastion-vm MySQL]# oc rsh mysql-5cfb7b64c6-gv98r
$
$ mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1
Server version: 5.6.51 MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| hybrid |
| mysql |
| performance_schema |
+-----+
4 rows in set (0.01 sec)

mysql>

```

Figure 80 Logging in to mysql pod

```
mysql>
mysql> use hybrid;
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> select * from hybrid sv4pc table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Figure 81 Validating the replicated data

On-premise, MySQL Volume data

```
mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql |
| performance_schema |
+-----+
3 rows in set (0.00 sec)

mysql> create database hybrid;
Query OK, 1 row affected (0.00 sec)

mysql> use hybrid;
Database changed
mysql> create table hybrid sv4pc table (coll int);
Query OK, 0 rows affected (0.02 sec)

mysql> insert into hybrid sv4pc table values (1);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid sv4pc table values (2);
Query OK, 1 row affected (0.00 sec)

mysql> insert into hybrid sv4pc table values (3);
Query OK, 1 row affected (0.00 sec)

mysql> select * from hybrid sv4pc table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

SV4PC on Azure, MySQL Volume data

```
mysql>
mysql> use hybrid;
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> select * from hybrid sv4pc table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Create Sample data in MySQL DB

- > Create Database
- > Create table
- > Insert sample data into table
- > Show the table contents

RESULTS – SAMPLE DATA on VOLUME

```
mysql> select * from hybrid sv4pc table;
+-----+
| coll |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)
```

Figure 82 Validating replicated data

Now, the volume replication and business continuity use case is complete by using IBM Storage Global Mirror.

Replication by using IBM Block Storage CSI driver volume replication

Complete the following steps:

1. Log in to the on-premises RHOCP bastion hosts or the host from where RHOCP cluster can be accessed by using `oc cli` command tools and deploy MySQL, as shown in Figure 83 - Figure 87 on page 63.

```
root@gw-10:~/cluster/yaml/CSI-Replication/MySQL
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# cat 01-mysqlpvc.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: mysql-pvc-csi-vreplication
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  storageClassName: ibm-block-storage-class
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc create -f 01-mysqlpvc.yaml
persistentvolumeclaim/mysql-pvc-csi-vreplication created
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc get pv,pvc

NAME                                     CAPACITY  ACCESS MODES  RECLAIM POLICY
STATUS  CLAIM                                STORAGECLASS  REASON  AGE
persistentvolume/pvc-b86b0900-575c-4e6b-96b0-a01acf3cbae3  20Gi
Bound  mysql/mysql-pvc-csi-vreplication  ibm-block-storage-class  <invalid>

NAME                                     CAPACITY  ACCESS MODES  STORAGECLASS  STATUS  VOLUME
persistentvolumeclaim/mysql-pvc-csi-vreplication  20Gi      RWO           ibm-block-storage-class  Bound   pvc-b86b0900-575c-4e6b-96b0-a01acf3cbae3
7s
[root@gw-10 MySQL]#
```

Figure 83 Creating mysql pvc yaml file

```
root@gw-10:~/cluster/yaml/CSI-Replication/MySQL
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# cat 02-mysql-deployment.yaml
---
apiVersion: v1
kind: Service
metadata:
  name: mysql
spec:
  ports:
    - port: 3306
  selector:
    app: mysql
  clusterIP: None
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
spec:
  selector:
    matchLabels:
      app: mysql
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
        - image: mysql:5.6
          name: mysql
          env:
            - $ Use secret in real usage
            - name: MYSQL_ROOT_PASSWORD
              value: password
          ports:
            - containerPort: 3306
          name: mysql
          volumeMounts:
            - name: mysql-persistent-storage
              mountPath: /var/lib/mysql
          volumes:
            - name: mysql-persistent-storage
              persistentVolumeClaim:
                claimName: mysql-pvc-csi-vreplication
[root@gw-10 MySQL]#

root@gw-10:~/cluster/yaml/CSI-Replication/MySQL
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc create -f 02-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc get pods

NAME                                     READY  STATUS             RESTARTS  AGE
mysql-d5f4bcd79-bb68r  0/1    ContainerCreating  0          <invalid>
[root@gw-10 MySQL]#

[root@gw-10 MySQL]# oc get all

NAME                                     READY  STATUS             RESTARTS  AGE
pod/mysql-d5f4bcd79-bb68r  1/1    Running            0          <invalid>

NAME                                     TYPE          CLUSTER-IP  EXTERNAL-IP  PORT(S)  AGE
service/mysql  ClusterIP     None        <none>        3306/TCP  15s

NAME                                     READY  UP-TO-DATE  AVAILABLE  AGE
deployment.apps/mysql  1/1    1           1          15s

NAME                                     DESIRED  CURRENT  READY  AGE
replicaset.apps/mysql-d5f4bcd79  1        1        1      <invalid>
[root@gw-10 MySQL]#
[root@gw-10 MySQL]# oc get pods

NAME                                     READY  STATUS             RESTARTS  AGE
mysql-d5f4bcd79-bb68r  1/1    Running            0          30s
[root@gw-10 MySQL]#
```

Figure 84 Deploying mysql

```
root@gw-10:~/cluster/yaml/CSI-Replication/MySQL
[root@gw-10 MySQL]# oc get pods
NAME                                READY   STATUS    RESTARTS   AGE
mysql-d5f4bcd79-bb68r              1/1     Running   0           <invalid>
[root@gw-10 MySQL]# oc rsh mysql-d5f4bcd79-bb68r
$ mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1
Server version: 5.6.51 MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
mysql>

mysql> show databases;
+-----+
| Database |
+-----+
| information_schema |
| mysql |
| performance_schema |
+-----+
3 rows in set (0.01 sec)

mysql> create database csi_replication_svpc;
Query OK, 1 row affected (0.00 sec)

mysql> use csi_replication_svpc;
Database changed
mysql> create table csi_rep_table ( coll int );
Query OK, 0 rows affected (0.02 sec)

mysql> insert into csi_rep_table values (10);
Query OK, 1 row affected (0.01 sec)

mysql> insert into csi_rep_table values (11);
Query OK, 1 row affected (0.00 sec)

mysql> insert into csi_rep_table values (12);
Query OK, 1 row affected (0.00 sec)

mysql> select * from csi_rep_table;
+-----+
| coll |
+-----+
| 10 |
| 11 |
| 12 |
+-----+
3 rows in set (0.00 sec)

mysql>
```

Figure 85 Logging in to the mysql pod and inserting sample data

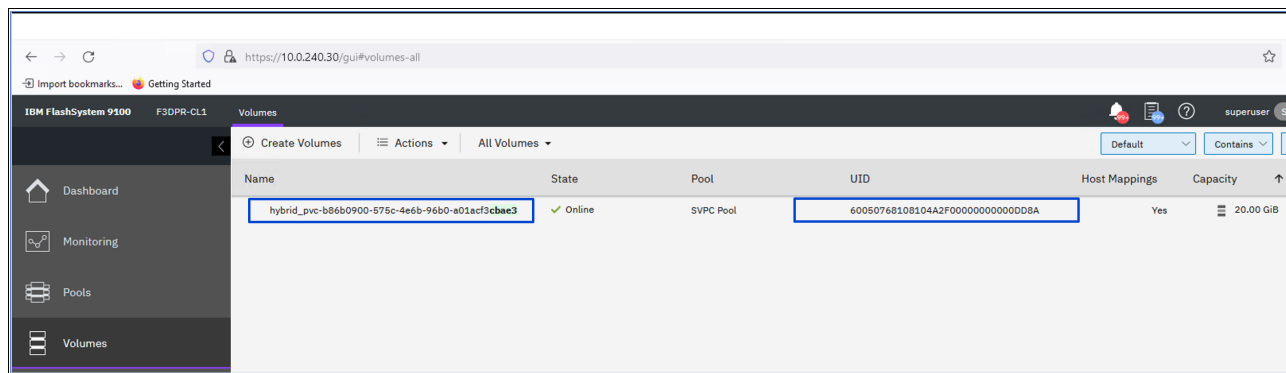


Figure 86 Checking that the volume is created in storage

2. Log in to the SV4PC on Azure and create equal-sized storage LUNs for CSI-based volume replication (see Figure 87).

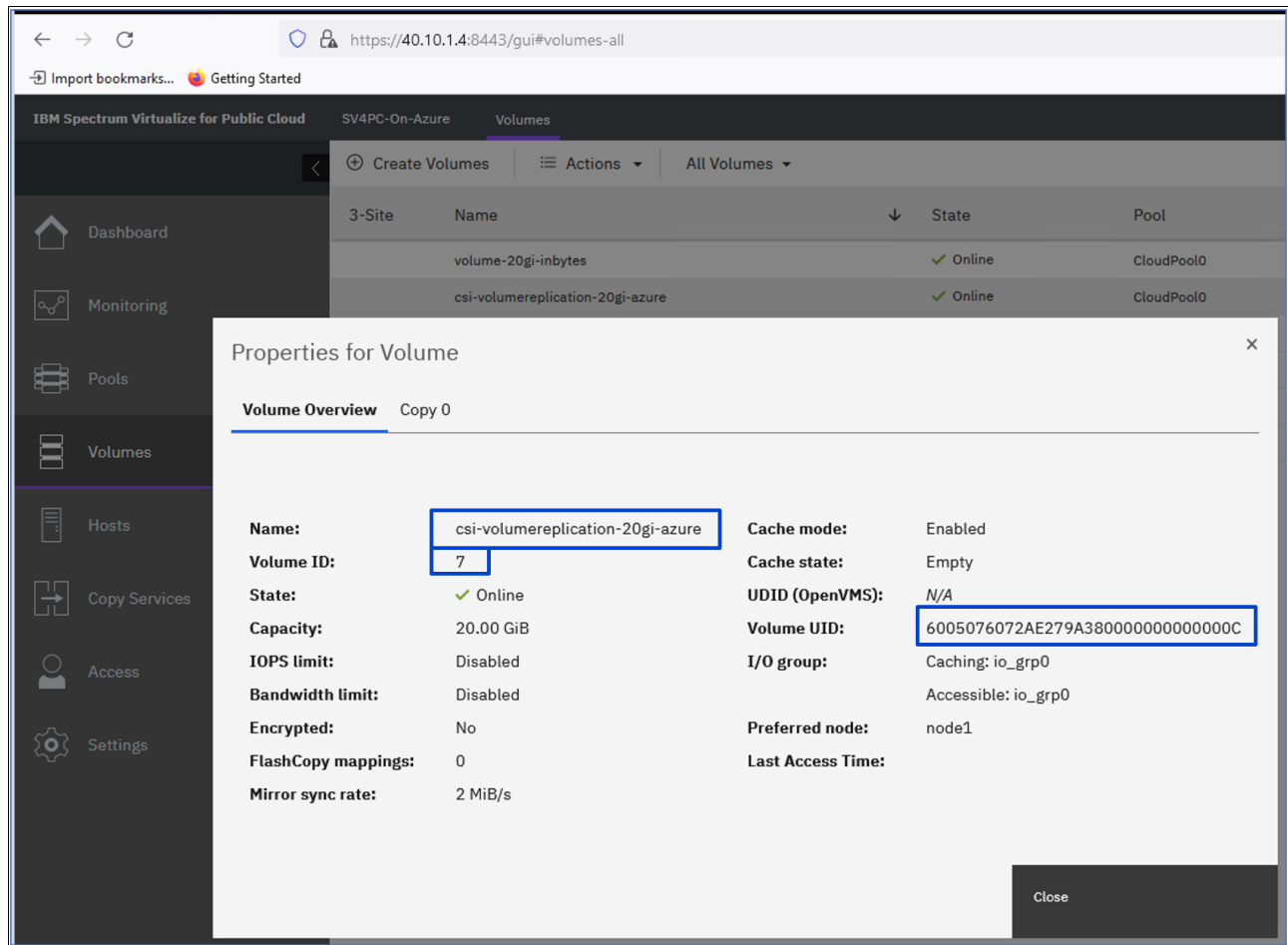


Figure 87 Creating a same size (20gi) volume on sv4pc storage

3. Using volume replication (remote copy function), enable support on your orchestration platform cluster and the storage system.

To enable support on your Kubernetes or Red Hat OpenShift cluster, install the following replication CRDs once per cluster as shown in Figure 88 on page 64 and Figure 90 on page 65.

Before the volume replication function is used, ensure that a partnership is created, and a consistency group is added to configure correctly.

```

[root@gw-10 CSI-Replication]# curl -O https://raw.githubusercontent.com/csi-addons/volume-replication-operator/v0.2.0/config/crd/bases/replication.storage.openshift.io_volumereplicationclasses.yaml
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 2747 100 2747    0     0  7027      0 --:--:-- --:--:-- --:--:--  7043
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc apply -f ./replication.storage.openshift.io_volumereplicationclasses.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplicationclasses.replication.storage.openshift.io configured
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# curl -O https://raw.githubusercontent.com/csi-addons/volume-replication-operator/v0.2.0/config/crd/bases/replication.storage.openshift.io_volumereplications.yaml
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 8935 100 8935    0     0 16291      0 --:--:-- --:--:-- --:--:-- 16275
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc apply -f ./replication.storage.openshift.io_volumereplications.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplications.replication.storage.openshift.io configured
[root@gw-10 CSI-Replication]#

```

Figure 88 Enabling volume replication support (on-premises)

4. Log in to the on-premises RHOC Bastion hosts or the host from where the RHOC cluster can be accessed by using `oc cli` command tools and create the volume replication class (see Figure 89). Ensure to add the correct `system_id` in the `yaml` file (see Figure 89).

```

root@gw-10:~/cluster/yaml/CSI-Replication
[root@gw-10 CSI-Replication]# cat 01-create-volumereplicationclass
apiVersion: replication.storage.openshift.io/v1alpha1
kind: VolumeReplicationClass
metadata:
  name: csi-volumereplicationclass
spec:
  provisioner: block.csi.ibm.com
  parameters:
    system_id: 0000001CAB89E68E
    copy_type: async # Optional. Values sync/async. The default is sync.

  replication.storage.openshift.io/replication-secret-name: ibm-block-storage-secret
  replication.storage.openshift.io/replication-secret-namespace: ibm-flashsystem-csi
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc create -f 01-create-volumereplicationclass
volumereplicationclass.replication.storage.openshift.io/csi-volumereplicationclass created
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc get volumereplicationclasses.replication.storage.openshift.io
NAME                                PROVISIONER
csi-volumereplicationclass         block.csi.ibm.com
[root@gw-10 CSI-Replication]#

```

Storage System ID
SV4PC on Azure

Figure 89 Creating volume replication class (on-premises)

```

[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# curl -O https://raw.githubusercontent.com/csi-addons/volume-replication-operator/v0.2.0/config/crd/bases/replication.storage.openshift.io_volumereplicationclasses.yaml
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total     Spent    Left     Speed
100 2747 100 2747    0     0 17974      0 --:--:-- --:--:-- --:--:-- 17954
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc apply -f ./replication.storage.openshift.io_volumereplicationclasses.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplicationclasses.replication.storage.openshift.io configured
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# curl -O https://raw.githubusercontent.com/csi-addons/volume-replication-operator/v0.2.0/config/crd/bases/replication.storage.openshift.io_volumereplications.yaml
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total     Spent    Left     Speed
100 8935 100 8935    0     0 61025      0 --:--:-- --:--:-- --:--:-- 61620
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc apply -f ./replication.storage.openshift.io_volumereplications.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplications.replication.storage.openshift.io configured

```

Figure 90 Enabling volume replication support (sv4pc on Azure)

5. Log in to the Microsoft Azure portal at <https://portal.azure.com>.
6. Log in to the Linux VM by using azureuser and the SSH key by using the Bastion service or use SSH and create the volume replication class (see Figure 91).

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# cat 04-create-volumereplicationclass
apiVersion: replication.storage.openshift.io/v1alpha1
kind: VolumeReplicationClass
metadata:
  name: csi-volumereplicationclass-sv4pc
spec:
  provisioner: block.csi.ibm.com
  parameters:
    system_id: 00000204204128BC
    copy_type: async # Optional. Values sync/async. The default is sync.

  replication.storage.openshift.io/replication-secret-name: ibm-sv4pc-storage-secret
  replication.storage.openshift.io/replication-secret-namespace: ibm-blockstorage-ns

[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc create -f 04-create-volumereplicationclass
volumereplicationclass.replication.storage.openshift.io/csi-volumereplicationclass-sv4pc created
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get volumereplicationclasses.replication.storage.openshift.io
NAME                                PROVISIONER
csi-volumereplicationclass-sv4pc    block.csi.ibm.com
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#

```

Storage System ID
- on-premise, IBM
FS9100 storage

Figure 91 Creating volume replication class (sv4pc on Azure)

7. Create the volume replication yaml file as shown in Figure 92. Then, create volume replication and check the status of volume replication.

```

root@gw-10:~/cluster/yaml/CSI-Replication
[root@gw-10 CSI-Replication]# cat 02-create-volumereplication.yaml
apiVersion: replication.storage.openshift.io/v1alpha1
kind: VolumeReplication
metadata:
  name: csi-volumereplication-20gi
  namespace: mysql
spec:
  volumeReplicationClass: csi-volumereplicationclass
  replicationState: primary
  replicationHandle: SVC:7;6005076072AE279A380000000000000C
  dataSource:
    kind: PersistentVolumeClaim
    name: mysql-pvc-csi-vreplication # Ensure that this is in the same namespace as VolumeReplication
.
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc create -f 02-create-volumereplication.yaml
volumereplication.replication.storage.openshift.io/csi-volumereplication-20gi created
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc get volumereplications.replication.storage.openshift.io
NAME                                AGE    VOLUMEREPLICATIONCLASS    PVCNAME                                DESIREDSTATE    CURRENTSTATE
csi-volumereplication-20gi         16m    csi-volumereplicationclass  mysql-pvc-csi-vreplication            primary         Primary
demo-volumereplication              20d    demo-volumereplicationclass  demo-pvc-file-system                   primary         Unknown

```

Figure 92 Creating volume replication (on-premises)

8. Log in to the on-premises storage and check the status of volume relationship (see Figure 93). The status should be consistent synchronized.

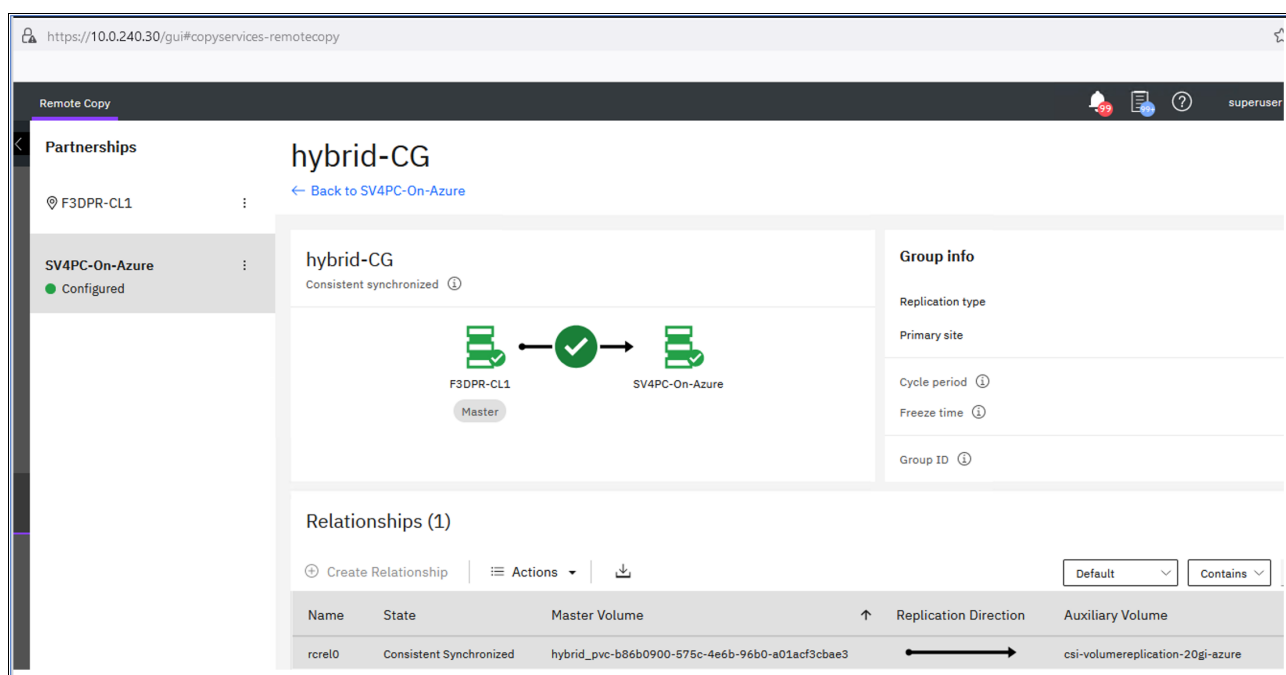


Figure 93 check status consistent synchronized

- Stop the Remote-copy consistency group and allow secondary read/write access (see Figure 94).

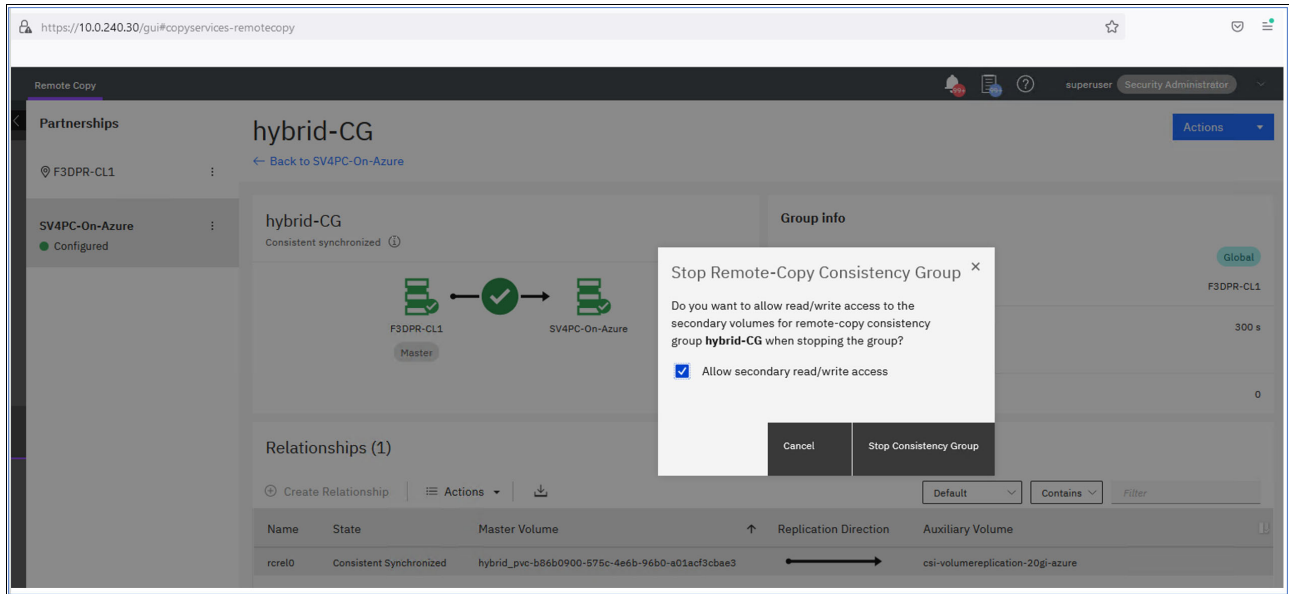


Figure 94 Stopping remote-copy consistency group

- Log in to the Microsoft Azure portal at <https://portal.azure.com>.
- Log in to the Linux VM by using azureuser and the SSH key that uses the Bastion service or by using SSH and deploying MySQL and validating the data (see Figure 95 - Figure 100 on page 71).

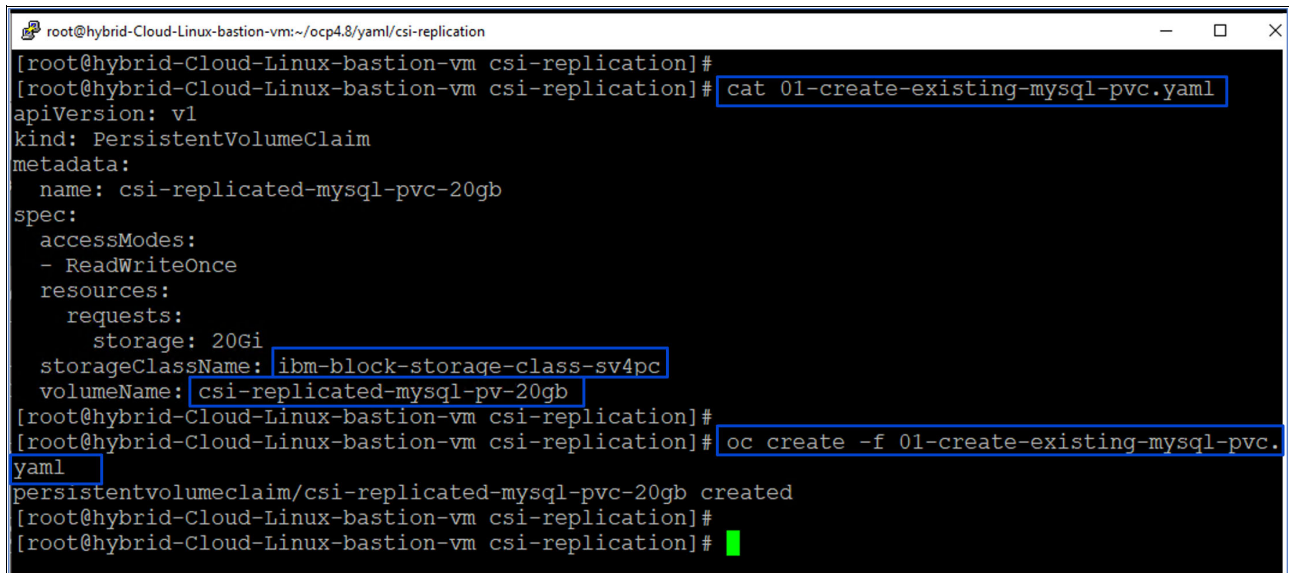
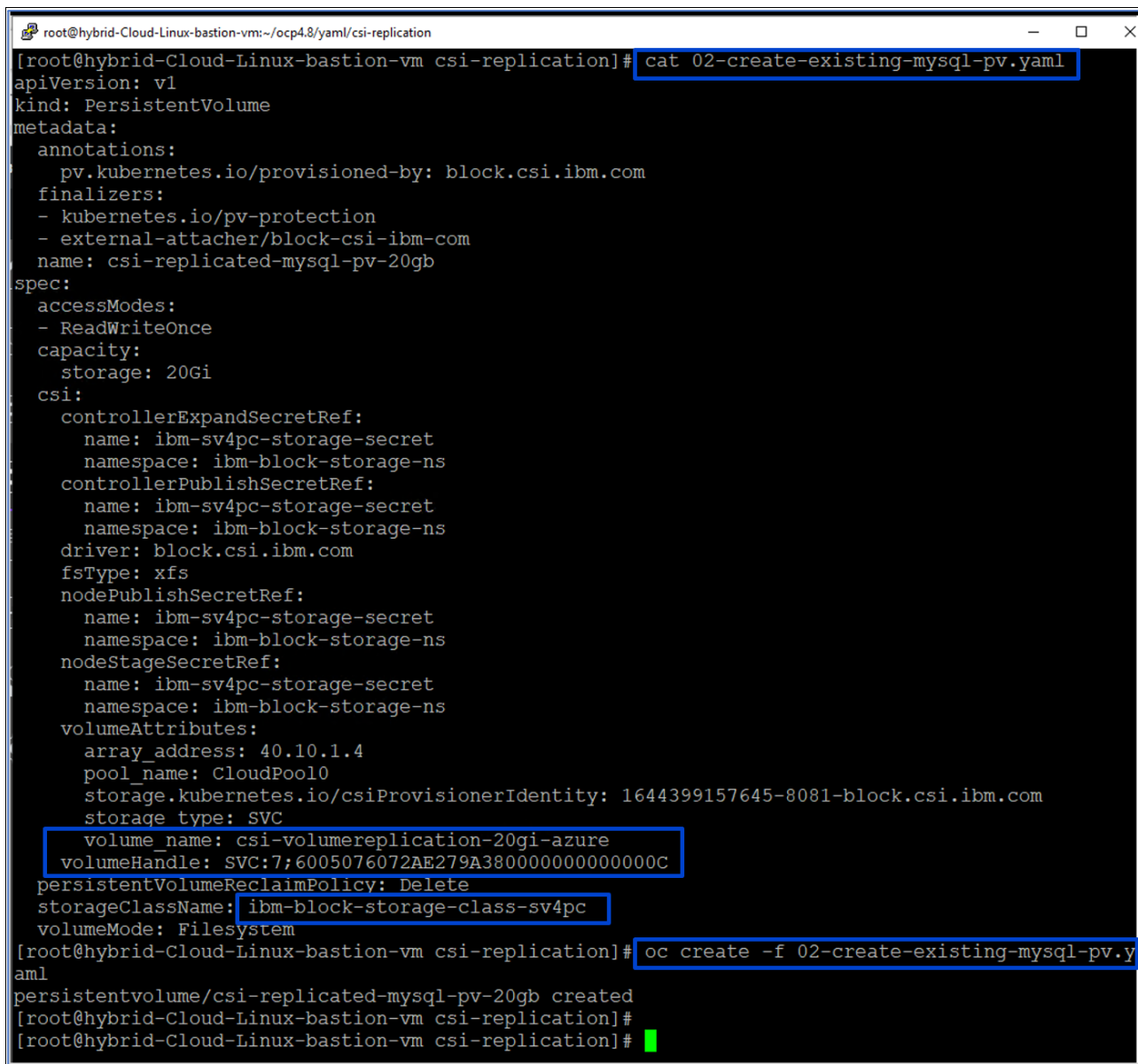


Figure 95 Creating mysql pvc

12. Create the PVC and PV by using the procedure that is described at this [IBM Documentation web page](#) (see Figure 96 and Figure 97).



```
root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# cat 02-create-existing-mysql-pv.yaml
apiVersion: v1
kind: PersistentVolume
metadata:
  annotations:
    pv.kubernetes.io/provisioned-by: block.csi.ibm.com
  finalizers:
  - kubernetes.io/pv-protection
  - external-attacher/block-csi-ibm-com
  name: csi-replicated-mysql-pv-20gb
spec:
  accessModes:
  - ReadWriteOnce
  capacity:
    storage: 20Gi
  csi:
    controllerExpandSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    controllerPublishSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    driver: block.csi.ibm.com
    fsType: xfs
    nodePublishSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    nodeStageSecretRef:
      name: ibm-sv4pc-storage-secret
      namespace: ibm-block-storage-ns
    volumeAttributes:
      array_address: 40.10.1.4
      pool_name: CloudPool0
      storage.kubernetes.io/csiProvisionerIdentity: 1644399157645-8081-block.csi.ibm.com
      storage type: SVC
      volume_name: csi-volumereplication-20gi-azure
      volumeHandle: SVC:7;6005076072AE279A3800000000000000c
    persistentVolumeReclaimPolicy: Delete
    storageClassName: ibm-block-storage-class-sv4pc
    volumeMode: Filesystem
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc create -f 02-create-existing-mysql-pv.y
aml
persistentvolume/csi-replicated-mysql-pv-20gb created
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
```

Figure 96 Importing a volume

```

[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get persistentvolume/csi-replicated-mys
ql-pv-20gb

```

NAME	CAPACITY	ACCESS MODES	RECLAIM POLICY	STATUS	CLAIM
csi-replicated-mysql-pv-20gb	20Gi	RWO	Delete	Bound	mysql-cloud/c
si-replicated-mysql-pvc-20gb	ibm-block-storage-class-sv4pc			3m15s	

```

[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get persistentvolumeclaim/csi-replicate
d-mysql-pvc-20gb

```

NAME	STATUS	VOLUME	CAPACITY	ACCESS MODES
csi-replicated-mysql-pvc-20gb	Bound	csi-replicated-mysql-pv-20gb	20Gi	RWO
ibm-block-storage-class-sv4pc	6m32s			

```

[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#

```

Figure 97 Checking the status of the volume

13. Create the MySQL deployment yaml file and the MySQL deployment (see Figure 98 on page 70 and Figure 99 on page 71).

```
root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# cat 03-Cloud-mysql-deployment.yaml
---
apiVersion: v1
kind: Service
metadata:
  name: mysql
spec:
  ports:
    - port: 3306
  selector:
    app: mysql
  clusterIP: None
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
spec:
  selector:
    matchLabels:
      app: mysql
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql
    spec:
      containers:
        - image: mysql:5.6
          name: mysql
          env:
            # Use secret in real usage
            - name: MYSQL_ROOT_PASSWORD
              value: password
          ports:
            - containerPort: 3306
              name: mysql
          volumeMounts:
            - name: mysql-persistent-storage
              mountPath: /var/lib/mysql
          volumes:
            - name: mysql-persistent-storage
              persistentVolumeClaim:
                claimName: csi-replicated-mysql-pvc-20gb
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
```

Figure 98 Deploying mysql

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc create -f 03-Cloud-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get pods
NAME                                READY   STATUS             RESTARTS   AGE
mysql-546f486f56-shgwq             0/1    ContainerCreating   0          6s

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc create -f 03-Cloud-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get pods
NAME                                READY   STATUS             RESTARTS   AGE
mysql-546f486f56-nglj7             1/1    Running            0          51s
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get all
NAME                                READY   STATUS             RESTARTS   AGE
pod/mysql-546f486f56-nglj7         1/1    Running            0          57s

NAME                TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)    AGE
service/mysql       ClusterIP   None         <none>        3306/TCP   57s

NAME                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/mysql 1/1      1            1          57s

NAME                DESIRED   CURRENT   READY   AGE
replicaset.apps/mysql-546f486f56 1         1         1       57s
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#

```

Figure 99 Creating mysql deployment

14. Log in to the MySQL pod and validate the data, as shown in Figure 100.

```

root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get pods
NAME                                READY   STATUS             RESTARTS   AGE
mysql-546f486f56-nglj7             1/1    Running            0          111s
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc rsh mysql-546f486f56-nglj7
$
$ mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 1
Server version: 5.6.51 MySQL Community Server (GPL)

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owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql>
mysql> show databases;
+-----+
| Database |
+-----+
| information schema |
| csi_replication_svpc |
| mysql |
| performance_schema |
+-----+
4 rows in set (0.00 sec)

mysql> use csi_replication_svpc;
Database changed
mysql> show tables;
+-----+
| Tables_in_csi_replication_svpc |
+-----+
| csi_rep_table |
+-----+
1 row in set (0.01 sec)

mysql>
mysql> select * from csi_rep table;
+-----+
| coll |
+-----+
| 10 |
| 11 |
| 12 |
+-----+
3 rows in set (0.00 sec)

mysql>
mysql>

```

Figure 100 validate the data

Now, the volume replication and business continuity use case that uses the IBM block storage CSI volume replication feature is complete.

Summary

This solution is designed to protect the data by using IBM Storage-based Global Mirror Replication and the volume replication feature from IBM block storage CSI driver for IBM Storage.

The use case that is described in this document is designed for the business continuity solution for containerized workload for Red Hat OpenShift on Microsoft Azure with IBM Spectrum Virtualize for Public Cloud on Azure.

The steps in this demonstration show how the on-premises data can be made available to remote sites and public clouds by using the components that are described in this Blueprint.

For more information about steps that can be taken to ensure database data consistency, see the specific product documentation.

Author

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Resources

For more information, see the following resources:

- IBM block storage CSI driver 1.8.0:
<https://www.ibm.com/docs/en/stg-block-csi-driver/1.8.0>
- Preparing to install on Azure:
https://docs.openshift.com/container-platform/4.8/installing/installing_azure/preparing-to-install-on-azure.html
- Microsoft tutorial: Create a site-to-site VPN connection in the Azure portal:
<https://docs.microsoft.com/en-us/azure/vpn-gateway/tutorial-site-to-site-portal>
- Route-Based Site-to-Site VPN to Azure (BGP over IKEv2/IPsec):
<https://docs.vyos.io/en/latest/configexamples/azure-vpn-bgp.html>
- *Implementation Guide for IBM Spectrum Virtualize for Public Cloud on Microsoft Azure Version 8.4.3*, SG24-8510:
<https://www.redbooks.ibm.com/Redbooks.nsf/RedpieceAbstracts/sg248510.html?Open>

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