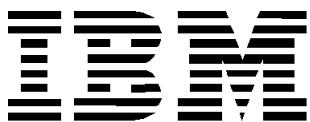


IBM® Storage

# **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 RHOCOP and Kubernetes.
- iSCSI basics and connectivity with IBM Storage. For more information, see this [hIBM Documentation web page](#).
- Microsoft Azure Cloud portal login and required user rights and billing and cost approval.
- RHOCOP 4.x on Microsoft Azure Cloud and on-premises RHOCOP. 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 RHOCOP.
- 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 RHOCP (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 RHOCP 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.

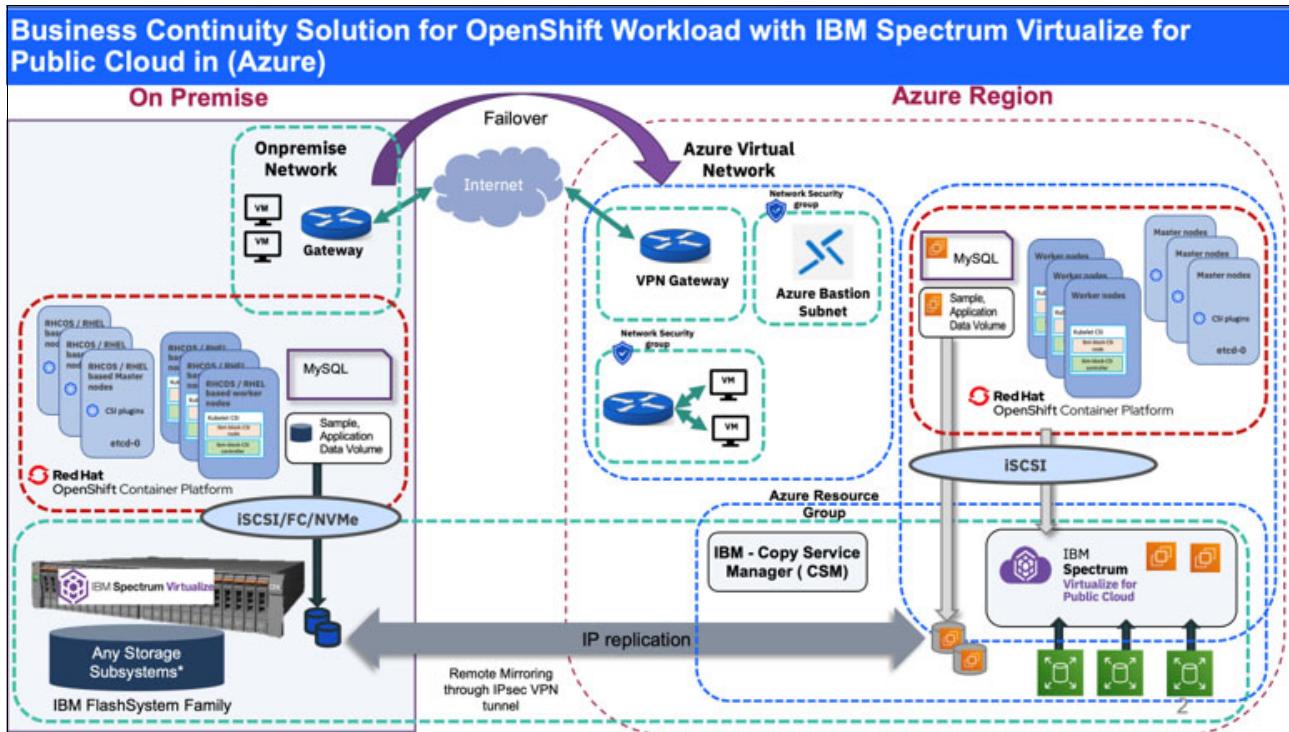


Figure 1 Solution overview

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 RHOCP 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 RHOC
  - 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 RHOC
  - IBM FlashSystem Storage FS9100 with iSCSI connection
  - IBM Global mirror replication
  - On-premises VPN gateway devices (VyOS)
  - MySQL containerized database
  - RHOC 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

**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 [Create new](#)

**Instance details**

Name \* [Hybrid-Cloud-IBM-SV4PC-VNET](#)

Region \* [Germany West Central](#)

Figure 2 Creating virtual network: Basics

**Create virtual network**

**IP Addresses** Basics 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) [Delete](#)

**Warning:** 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 [\(1\)](#)

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	-

**Info:** 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

**Create virtual network**

**Security**

BastionHost  Disable  Enable

Bastion name \*

AzureBastionSubnet address space \*  40.10.3.0 - 40.10.3.63 (64 addresses)

Public IP address \*  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	...
... creation vnet	...

Validation passed

### Create virtual network

Basics IP Addresses Security Tags Review + create

**Basics**

Subscription	Microsoft Azure Enterprise_ikky
Resource group	(new) Hybrid-Cloud-With-IBM-SV4PC
Name	Hybrid-Cloud-IBM-SV4PC-VNET
Region	Germany West Central

**IP addresses**

Address space	40.10.0.0/16
Subnet	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)

**Tags**

Hemant	ISDL
--------	------

**Security**

BastionHost	Enabled
DDoS protection plan	Basic
Firewall	Disabled

< Page 1 > **Create**  < Previous Next > Download a template for automation

Figure 5 Creating resource

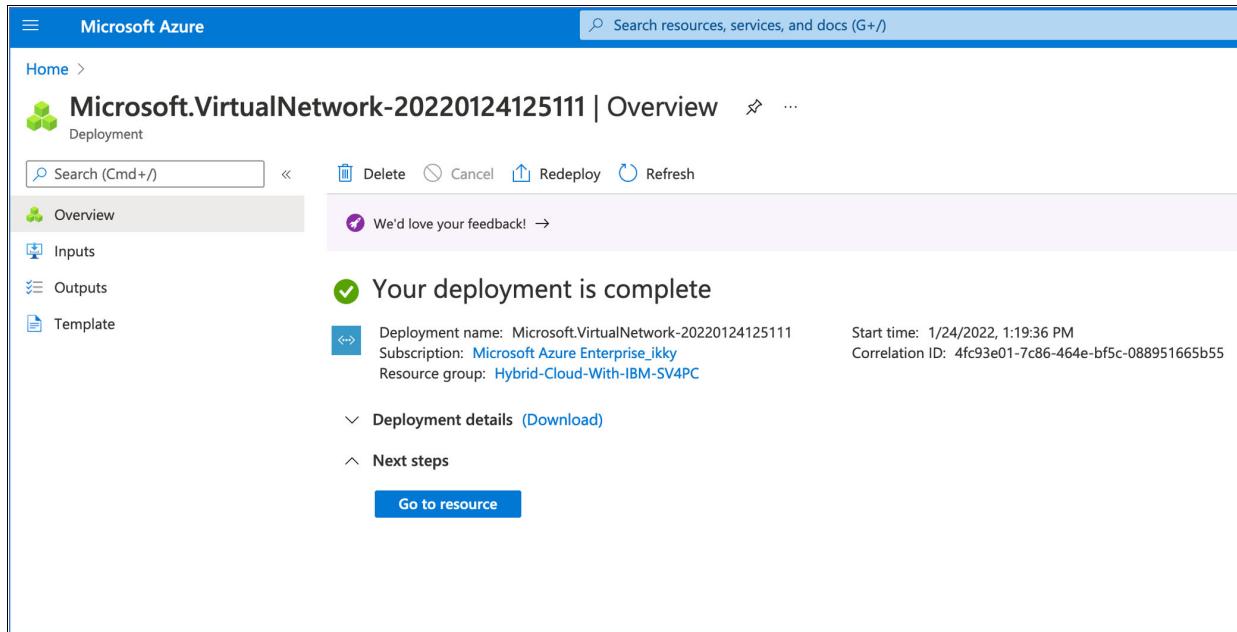


Figure 6 Checking deployment progress

## 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

Microsoft Azure

Home > Virtual network gateways

IBM (ibm.onmicrosoft.com)

**Create** Manage view Refresh Export to CSV Open query Assign tags Feedback

Filter for any field... Subscription == all Resource group == all Location == all Add filter

Showing 1 to 1 of 1 records.

Name	Virtual network	Gateway type

Figure 7 Selecting Create option

Microsoft Azure

Home > Virtual network gateways >

Virtual network ga...

IBM (ibm.onmicrosoft.com)

**Create** Manage view ...

Filter for any field...

Name ↑

VNGW1

**Basics** Tags Review + create

Azure has provided a planning and design guide to help you configure the various VPN gateway options. [Learn more.](#)

**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 Hybrid-Cloud-With-IBM-SV4PC (derived from virtual network's resource group)

**Instance details**

Name \* Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway

Region \* Germany West Central

Gateway type \*  VPN  ExpressRoute

VPN type \*  Route-based  Policy-based

SKU \* VpnGw1

Generation Generation1

Figure 8 Creating VPN gateway: Basics page Part 1

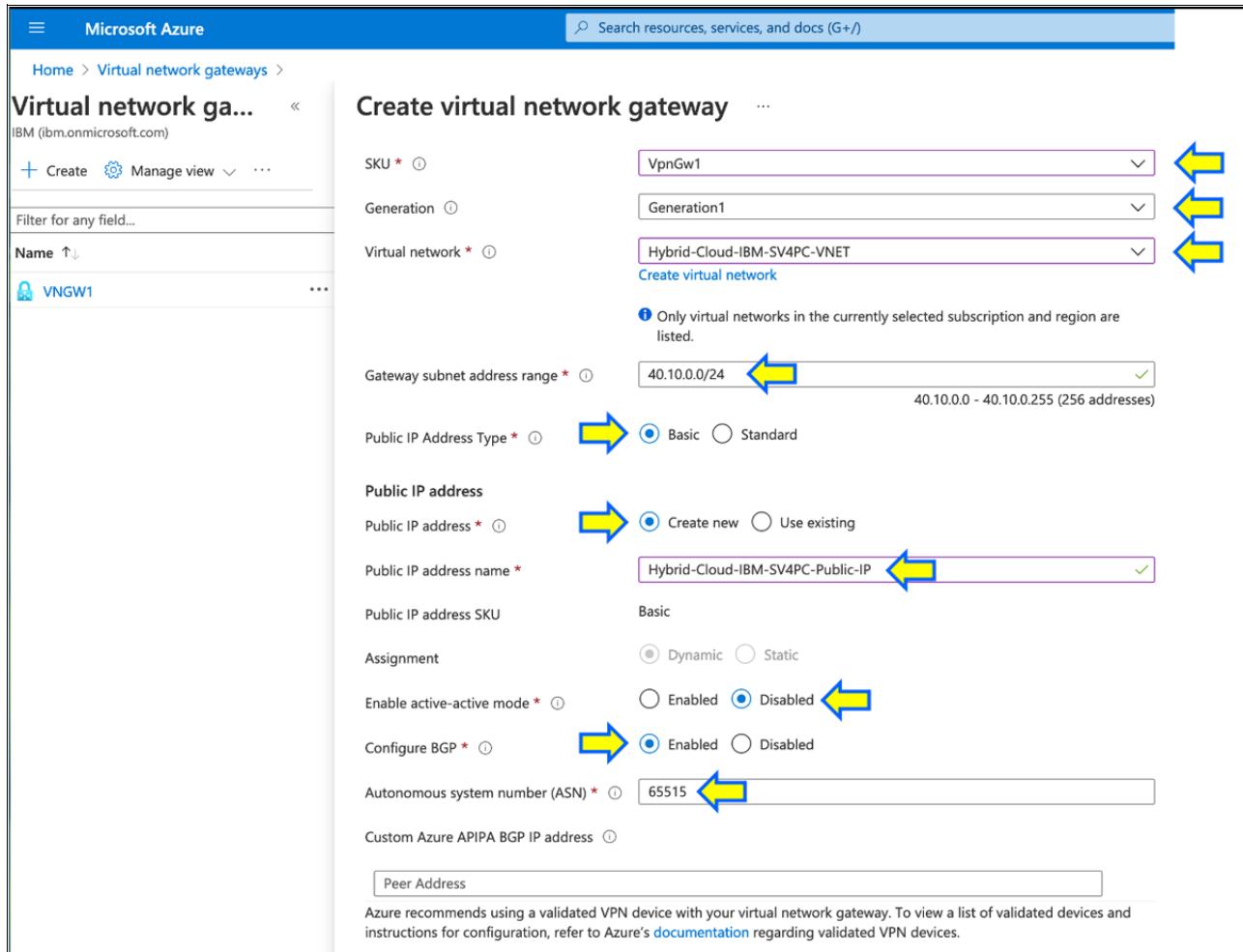


Figure 9 Creating VPN gateway: Basics page Part 2

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    ...

Validation passed

### Create virtual network gateway ...

Basics    Tags    Review + create

**Basics**

Subscription	Microsoft Azure Enterprise_ikky
Resource group	Hybrid-Cloud-With-IBM-SV4PC
Name	Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway
Region	Germany West Central
SKU	VpnGw1
Generation	Generation1
Virtual network	Hybrid-Cloud-IBM-SV4PC-VNET
Subnet	GatewaySubnet (40.10.0.0/24)
Gateway type	Vpn
VPN type	RouteBased
Enable active-active mode	Disabled
Configure BGP	Enabled
Autonomous system number (ASN)	65515
Custom Azure APIPA BGP IP address	None
Public IP address	Hybrid-Cloud-IBM-SV4PC-Public-IP

**Tags**

Hemant	ISDL
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< Page 1 > of 1    **Create**    Previous    Next    Download a template for automation



Figure 10 Selecting Create option on Review + create page

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.

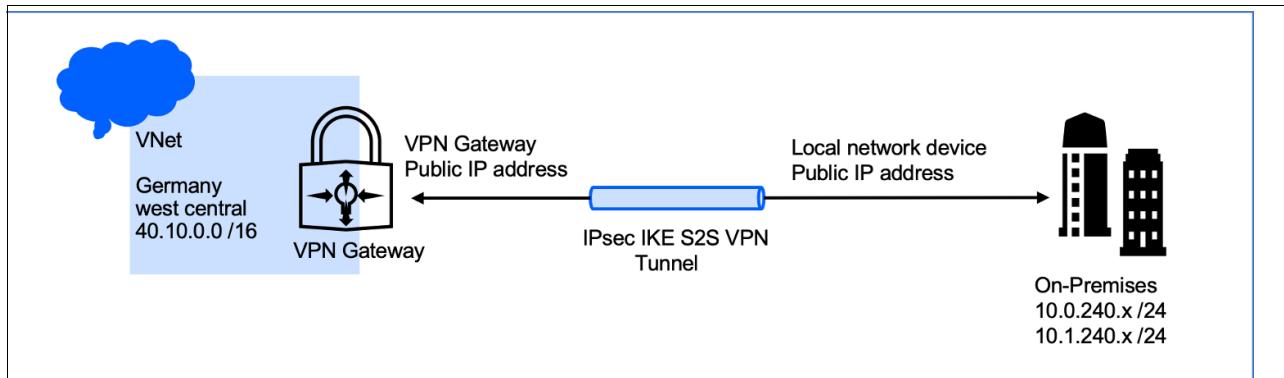


Figure 12 Hybrid cloud network connectivity

- 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).

The screenshot shows the Microsoft Azure portal interface. The top navigation bar has 'Microsoft Azure' and a search bar. Below it, the breadcrumb navigation shows 'Home > Local network gateways'. The main content area displays 'Local network gateways' with a subtitle 'IBM (ibm.onmicrosoft.com)'. A yellow arrow points to the '+ Create' button. Other buttons include 'Edit columns', 'Refresh', 'Try preview', 'Feedback', and 'Assign tags'. The 'Subscriptions' dropdown is set to 'Microsoft Azure Enterprise\_ikky'. Filter options like 'Filter by name...', 'All resource groups', 'All locations', 'All tags', and 'No grouping' are available. The table below shows one item: 'Name' (with a sorting arrow), 'Resource group' (sorted ascending), and 'Location' (sorted descending). A yellow arrow also points to the 'Name' column header.

Figure 13 Selecting the Create option

The screenshot shows the 'Create local network gateway' page in the Microsoft Azure portal. The top navigation bar has 'Microsoft Azure' and a search bar. The breadcrumb navigation shows 'Home > Local network gateways > Create local network gateway'. The main content area has tabs for 'Basics', 'Advanced', and 'Review + create', with 'Basics' selected. A descriptive text states: 'A local network gateway is a specific object that represents an on-premises location (the site) for routing purposes.' with a 'Learn more' link. 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 'Region \*' (set to 'Germany West Central'), 'Name \*' (set to 'Hybrid-Cloud-IBM-SV4PC-Local-net-Gateway'), 'Endpoint' (radio buttons for 'IP address' and 'FQDN' with 'IP address' selected), and 'IP address \*' (set to '192.168.0.04'). The 'Address space' section lists '10.0.240.0/24' and '10.1.240.0/24' with delete icons. A yellow arrow points to each of these highlighted fields.

Figure 14 Create local network gateway: Basics page

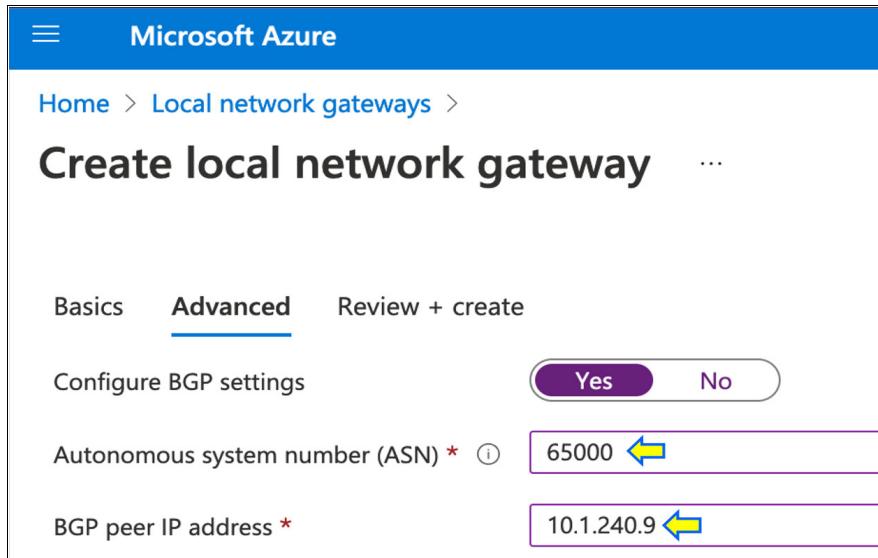


Figure 15 Create local network gateway: Advanced

The screenshot shows the 'Review + create' page for creating a local network gateway. A validation message 'Validation passed' is displayed. The 'Review + create' tab is selected. The summary table includes:

Setting	Value
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 [REDACTED]
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

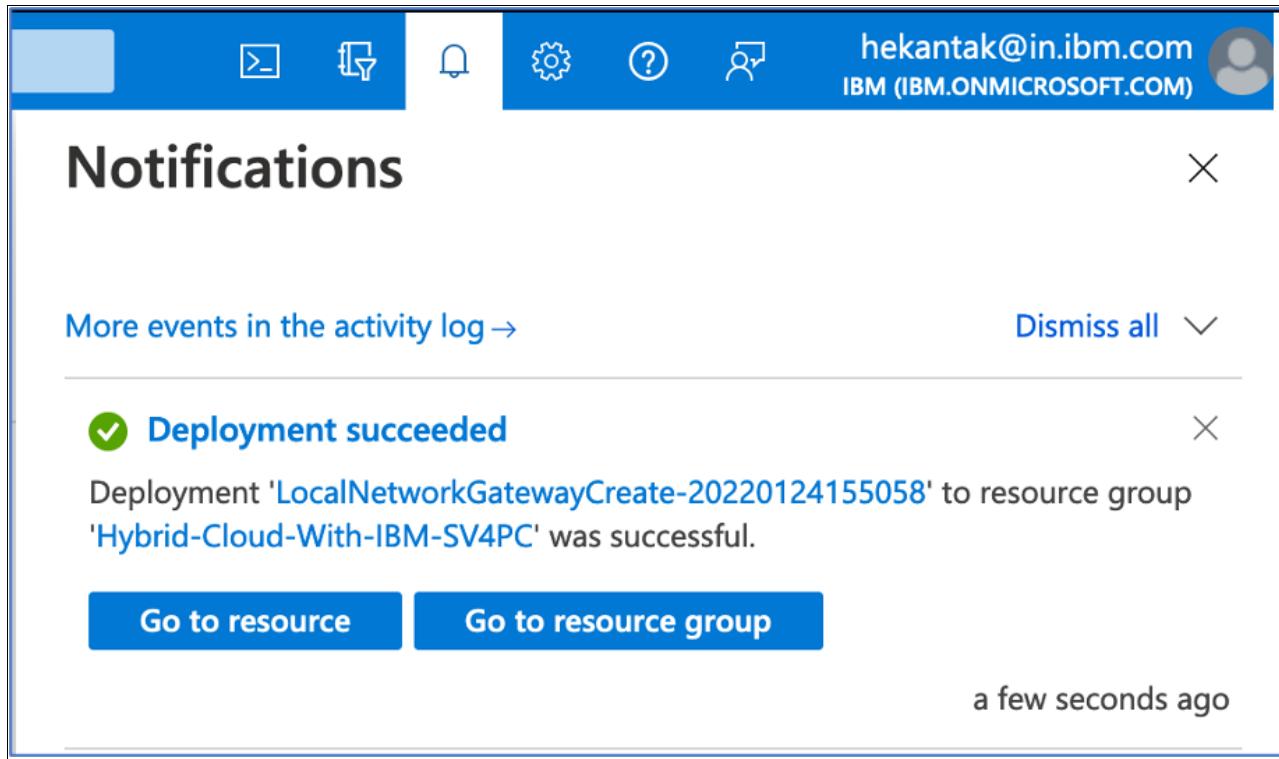


Figure 17 Deployment succeeded message

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.

This screenshot shows a configuration interface for an on-premises VPN device. The configuration parameters are listed on the left, and their corresponding values are on the right. Yellow arrows point from the parameter names to their respective values. The parameters and values are:

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).

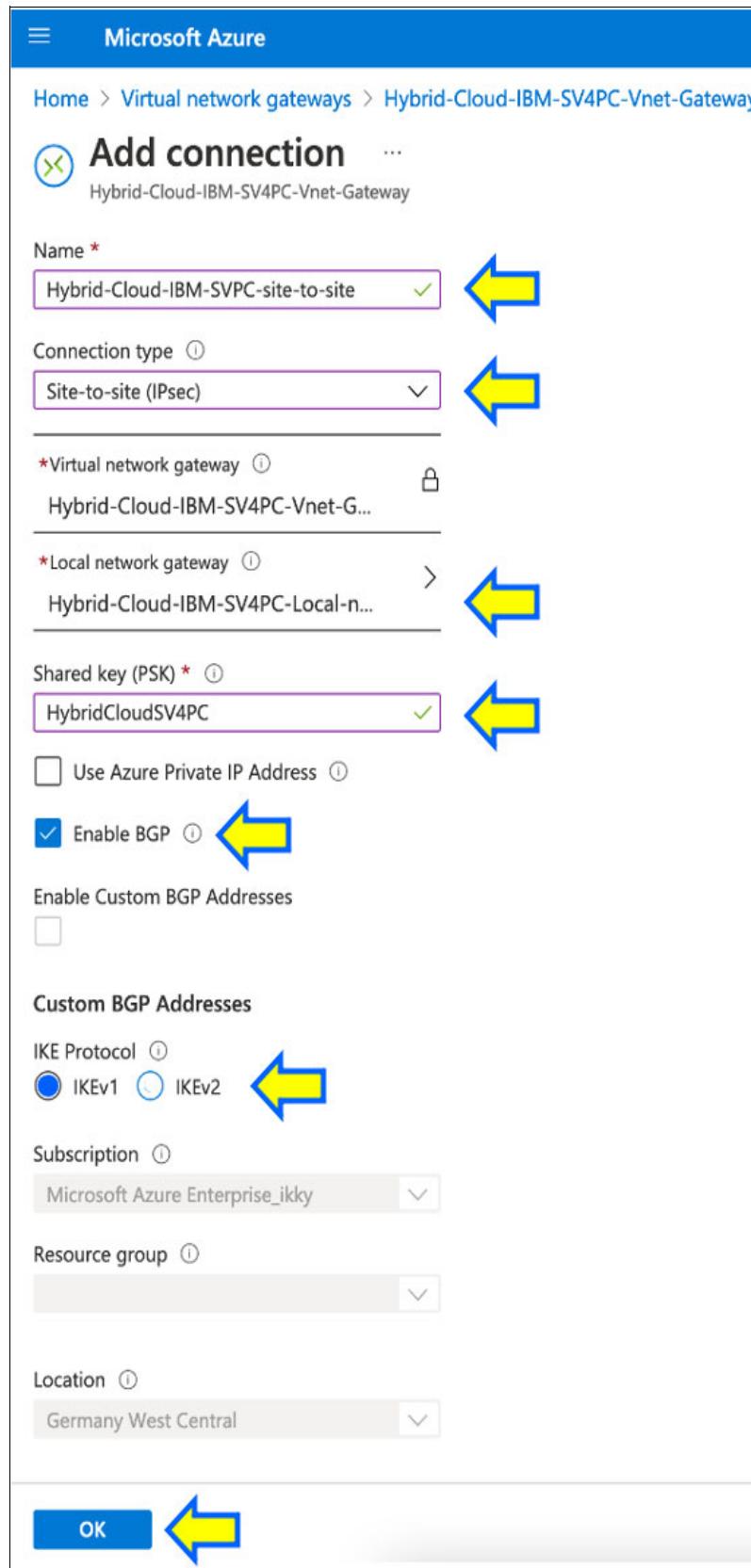


Figure 21 Adding connection

The figure consists of two side-by-side screenshots of the Microsoft Azure portal. Both screenshots show the 'Virtual network gateways' blade for a resource named 'Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway'. The left screenshot shows a 'Creating connection' notification in the 'Notifications' pane, indicating 'Creating connection 'Hybrid-Cloud-IBM-SV4PC-Site-2-Site'' with a status of 'Running' and a timestamp of 'a few seconds ago'. The right screenshot shows a 'Create connection' notification, indicating 'Successfully created connection 'Hybrid-Cloud-IBM-SV4PC-Site-2-Site'' with a status of 'Success' and a timestamp of 'a few seconds ago'.

Figure 22 Checking the status of the deployment

This screenshot shows the 'BGP peers' blade for the 'Hybrid-Cloud-IBM-SV4PC-Vnet-Gateway'. The left sidebar includes options like Configuration, Connections, Point-to-site configuration, Properties, Locks, Logs, Alerts, Metrics, and BGP peers (which is selected). The main area displays a table of BGP peers with one entry: Peer address 10.1.240.9, Local address 40.10.0.254, Asn 65000, Status Connected, Connected duration 04:36:16.1531666, Routes received 2, Messages sent 1918, and Messages Received 1679. Below this, a table of Learned Routes shows entries for networks 40.10.0.0/16, 10.1.240.9/32, 10.0.240.0/24, 172.16.0.0/16, 10.1.240.0/24, and 10.0.240.0/24, along with their respective next hops, local addresses, weights, source peers, origins, and AS paths.

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 RHOC 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 two side-by-side views of the Microsoft Azure 'Create a virtual machine' wizard. Both views are on the 'Networking' tab.

**Left View (Subscription):**

- Subscription: Microsoft Azure Enterprise\_ikky
- Resource group: Hybrid-Cloud-With-IBM-SV4PC
- Virtual machine name: hybrid-Cloud-Linux-bastion-vm
- Region: (Europe) Germany West Central
- Availability options: No infrastructure redundancy required
- Security type: Standard
- Image: Red Hat Enterprise Linux 7 (latest, LVM) - Gen1
- Azure Spot instance: Unchecked
- Size: Standard\_B2ms - 2 vcpus, 8 GiB memory (\$70.08/month)

**Right View (Networking):**

- Virtual network: Hybrid-Cloud-IBM-SV4PC-VNET
- Subnet: Hybrid-Cloud-IBM-SV4PC-Cluster-snet (40.10.0.0/24)
- Public IP: (new) hybrid-Cloud-Linux-bastion-vm-ip
- NIC network security group: Basic (radio button selected)
- Public inbound ports: HTTP (80), HTTPS (443), SSH (22)

A yellow callout box on the right side of the networking tab contains the note: "⚠ 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 RHOC deployment (see this [Red Hat Documentation web page](#)), as shown in Figure 25 on page 25 - Figure 28 on page 26).

Microsoft Azure

Search resources, services, and docs (G+)

Home > hybrid-Cloud-Linux-bastion-vm

## hybrid-Cloud-Linux-bastion-vm | Bastion

Bastion

Virtual machine

Search (Cmd+/)

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

**Settings**

Networking

Connect

Disk

Size

Security

Advisor recommendations

Extensions + applications

Azure Bastion Service enables you to securely and seamlessly RDP & SSH to your VMs in your Azure virtual network, without exposing a public IP on the VM, directly from the Azure portal, without the need of any additional client/agent or any piece of software. [Learn more](#)

Using Bastion: **AzureBastionSubnet**, Provisioning State: **Succeeded**

Please enter username and password to your virtual machine to connect using Bastion.

Open in new window

Username \*

Authentication Type \*  Password  SSH Private Key  SSH Private Key from Local File  SSH Private Key from Azure Key Vault

Local File \*

"Solutions-hemant-key.pem"

Advanced

Connect

Figure 25 Logging to Linux VM host

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# az login
To sign in, use a web browser to open the page https://microsoft.com/devicelogin and enter the code DDSQBZTJN to authenticate.
The following tenants don't contain accessible subscriptions. Use 'az login --allow-no-subscriptions' to have tenant level access.
7d684505-f7d4-4f7c-8f93-c8e54ea36510 'Microsoft Partner Events'
[{"id": "7d684505-f7d4-4f7c-8f93-c8e54ea36510", "name": "Microsoft Partner Events", "state": "Enabled", "tenantId": "7d684505-f7d4-4f7c-8f93-c8e54ea36510", "user": {"name": "hekantak@in.ibm.com", "type": "user"}, "isDefault": true, "managedByTenants": []}, {"id": "52000000-0000-0000-0000-000000000000", "name": "IBM Cloud", "state": "Enabled", "tenantId": "52000000-0000-0000-0000-000000000000", "user": {"name": "hekantak@in.ibm.com", "type": "user"}, "isDefault": false, "managedByTenants": []}][root@hybrid-Cloud-Linux-bastion-vm ~]#
```

Figure 26 Creating Azure Account

```
[root@hybrid-Cloud-Linux-bastion-vm ~]# az account show
{
  "environmentName": "AzureCloud",
  "homeTenantId": "fcf67057-50c9-4ad4-98f3-ffca64add9e9", ←
  "id": "00000000-0000-0000-0000-000000000000", ←
  "isDefault": true,
  "managedByTenants": [],
  "name": "Microsoft Azure", ←
  "state": "Enabled",
  "tenantId": "fcf67057-50c9-4ad4-98f3-ffca64add9e9", ←
  "user": {
    "name": "hekantak@in.ibm.com", ←
    "type": "user"
  }
}
[root@hybrid-Cloud-Linux-bastion-vm ~]#
```

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 onel scope /subscriptions/994c6fdf-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-cl
{
  "appId": "f386e929-e84c-4abb-ad68-3cf921bffa9",
  "displayName": "hybrid-cloud-service_principal",
  "password": "████████████████████████████████████████",
  "tenant": "fcf67057-50c9-4ad4-98f3-ffca64add9e9"
}
[root@hybrid-Cloud-Linux-bastion-vm ~]# █

[root@hybrid-Cloud-Linux-bastion-vm ~]# az role assignment create --role "User Access Administrator" --assignee-object-id $(az ad sp list
--filter "appId eq 'f386e929-e84c-4abb-ad68-3cf921bffa9'" | 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-a479-792
29e0ae0eb",
  "name": "bee77d02-d031-4a08-a479-79229e0ae0eb",
  "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).

The screenshot shows the Microsoft Azure DNS zones interface. At the top left, there's a breadcrumb navigation: Home > DNS zones. Below it, a search bar says 'Search resources, services, and docs (G+ /)'. On the left, there's a sidebar with the text 'IBM (ibm|microsoft.com)' and a 'Create' button, which is highlighted with a yellow arrow. The main content area shows a message 'Showing 0 to 0 of 0 records.' and a 'No dns zones to display' section with a blue globe icon containing the word 'DNS'. Below this, a descriptive text explains Azure DNS and a 'Create dns zone' button is visible.

Figure 29 Selecting the Create option

The screenshot shows the 'Create DNS zone' Basics page. At the top left, there's a breadcrumb navigation: Home > DNS zones > Create DNS zone. Below it, a search bar says 'Search resources, services, and docs (G+ /)'. The main content area has tabs for 'Basics', 'Tags', and 'Review + create', with 'Basics' being the active tab. It contains a descriptive text about DNS zones and a 'Learn more' link. The 'Project details' section includes a 'Subscription' dropdown set to 'Microsoft Azure Enterprise\_ikky' (highlighted with a yellow arrow), a 'Resource group' dropdown set to 'Hybrid-Cloud-SV4PC-ARHO-RG' (highlighted with a yellow arrow), and a 'Create new' button. The 'Instance details' section includes a checkbox 'This zone is a child of an existing zone already hosted in Azure DNS' (unchecked), a 'Name' input field containing 'arhoclustersv4pc.net' (highlighted with a yellow arrow), and a 'Resource group location' dropdown set to 'Germany West Central'.

Figure 30 Creating DNS zones: Basics page

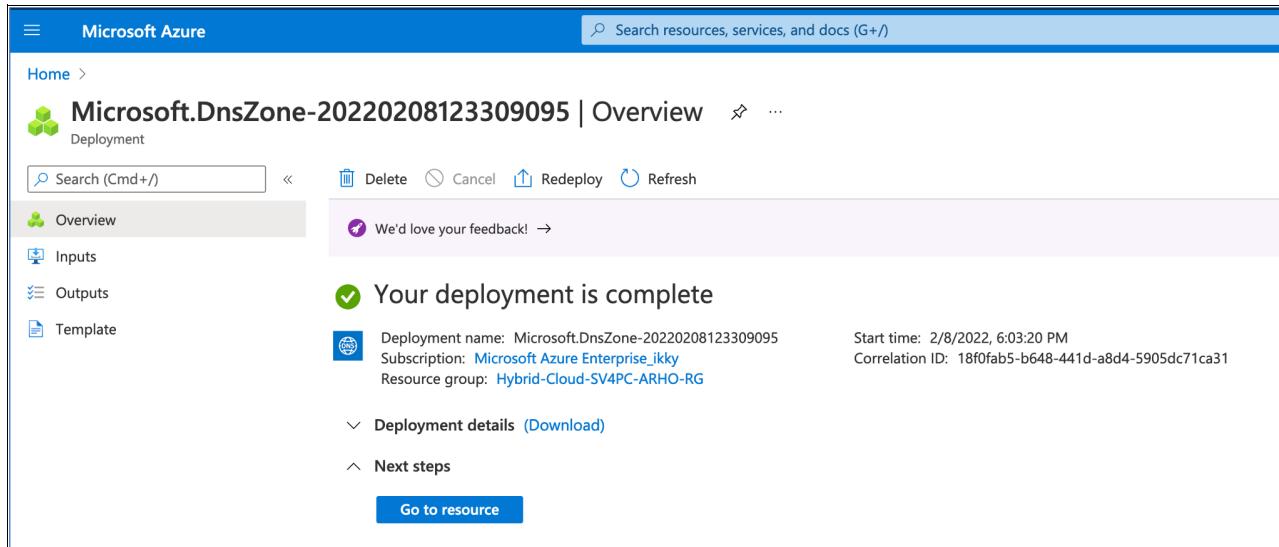


Figure 31 Checking the deployment

**arhoclustersv4pc.net** DNS zone

Resource group (move) : hybrid-cloud-sv4pc-arho-rg  
Subscription (move) : Microsoft Azure Enterprise\_ikky  
Subscription ID : 994c6fdf-6182-4da4-b701-dad9da3c23a0

Name server 1 : ns1-09.azure-dns.com.  
Name server 2 : ns2-09.azure-dns.net.  
Name server 3 : ns3-09.azure-dns.org.  
Name server 4 : ns4-09.azure-dns.info.

Name	Type	TTL	Value
@	NS	172800	ns1-09.azure-dns.com. ns2-09.azure-dns.net. ns3-09.azure-dns.org. ns4-09.azure-dns.info.
@	SOA	3600	Email: azuredns-hostmaster.microsoft.com Host: ns1-09.azure-dns.com. Refresh: 3600 Retry: 300 Expire: 2419200 Minimum TTL: 300 Serial number: 1

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 ocp4.8]# ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
SHA256:GXYWBVQrxmcQD2UwpvVeTwz0pynpTLdh+ONJqdHtnBQ root@hybrid-Cloud-Linux-bastion-vm
The key's randomart image is:
+---[RSA 2048]----+
|      .%B= oo|
|      = 0 . o+|
|      + * * ..+|
|      . * = + o.|
|      S   * *E |
|      + * = .|
|      + B..|
|      =.=.|
|      . o.o|
+---[SHA256]----+
[root@hybrid-Cloud-Linux-bastion-vm ocp4.8]#
```

*Figure 33 Creating SSH key with ssh-keygen*

```
[root@hybrid-Cloud-Linux-bastion-vm bin]# ./openshift-install create install-config --dir /root/ocp4.8/config/
? SSH Public Key /root/.ssh/id_rsa.pub
? Platform azure
? azure subscription id 993a0
? azure tenant id fcf9e9
? azure service principal client id f3a0faa9
? azure service principal client secret [? for help] ****
? Region germanywestcentral
? Base Domain arhoclustersv4pc.net
? Cluster Name arhocluster1sv4pc
? Pull Secret [? for help] ****
*****
***** Saving user credentials to "/root/.azure/osServicePrincipal.json"
INFO Saving user credentials to "/root/.azure/osServicePrincipal.json"
INFO Credentials loaded from file "/root/.azure/osServicePrincipal.json"
```

*Figure 34 Creating install-config file*

```
[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]#
[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
KERNEL-VERSION          CONTAINER-RUNTIME
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
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 (Octpa)  4.18.0-305.34.2.e18_4.x86_64 cri-o://1.21.4-9.rhaos4.8.gitaebb17b.e18
[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	◀
	<a href="#">Create new</a>	

### 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 *	<b>2x Standard D16s v3</b> 16 vcpus, 64 GB memory <a href="#">Change size</a>
Fixed Size Quorum Node *	<b>1x Standard B1ms</b> 1 vcpu, 2 GB memory <a href="#">Change size</a>

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 Management Credentials

Set password for the Security Administrator user profile (superuser) for management GUI.

[Learn more](#)

Password \* ⓘ  ██████████ ✓ 

Confirm password \* ⓘ  ██████████ ✓ 

### Customer Entitlement

Provide IBM Passport Advantage Customer Number of BYOL offering. The IBM customer number is associated with the purchase of the software license. The installation template verifies entitlement to the software with this customer number

[Learn more](#)

IBM Customer Number \* ⓘ  ██████████ ✓ 

### Notification

The email address receives notifications on the status of the installation

[Learn more](#)

Notification Email \* ⓘ  hekantak@in.ibm.com ✓ 

### VM Credential

Provide SSH public key to configure Spectrum Virtualize VM nodes for secured access.

[Learn how to generate SSH keys](#)

SSH public key source  

SSH public key \* ⓘ  s/eWvVIUckLeWmPtbtTehOdUuIA3G6j  
/daJa1wgzVSobbTlfUAuis+PrWXRr6TfBiaJ7nQNIKz78kQGGaUHGPJ5BZG  
5JWctaoytGBjZD9YYptE= generated-by-azure ✓ 

 [Learn more](#)

Review + create < Previous Next : Networking >

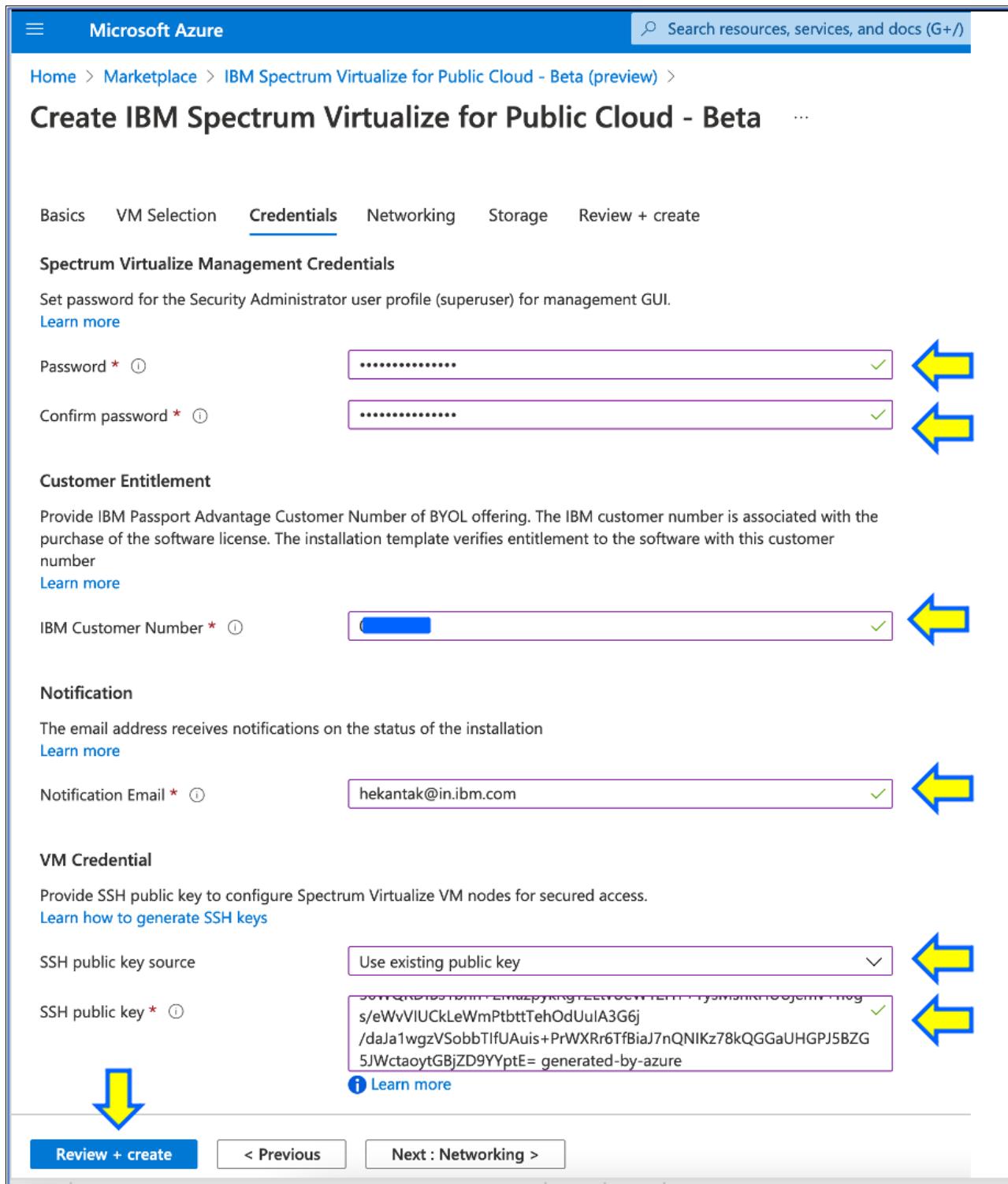


Figure 41 Providing credentials to create SV4PC on Azure

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

The screenshot shows the Microsoft Azure Marketplace interface for creating an IBM Spectrum Virtualize for Public Cloud - Beta (preview) instance. The top navigation bar includes the Microsoft Azure logo, a search bar, and a 'Marketplace' link. Below the navigation, the breadcrumb path is 'Home > Marketplace > IBM Spectrum Virtualize for Public Cloud - Beta (preview) > Create IBM Spectrum Virtualize for Public Cloud - Beta'. A green banner at the top indicates 'Validation Passed'. The main content area has tabs for 'Basics', 'VM Selection', 'Credentials', 'Networking', 'Storage', and 'Review + create', with 'Review + create' being the active tab. Under 'PRODUCT DETAILS', it shows the product name 'IBM Spectrum Virtualize for Public Cloud - Beta' by 'IBM-Alliance-Global-Microsoft Partner-USA-NY-Armonk-HQ-IBMStorage-6201192'. There are links for 'Terms of use' and 'Privacy policy'. The 'TERMS' section contains a detailed legal agreement. The 'Basics' section lists configuration details: Subscription (Microsoft Azure Enterprise\_ikky), Resource group (Hybrid-Cloud-SV4PC-RG), Region (Germany West Central), and Tag (hybridsvpc).

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 AAAAB3NzaC1yc2EAAAQABAAQgQCmNQkZZHHWfzUfMoUm2...

**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

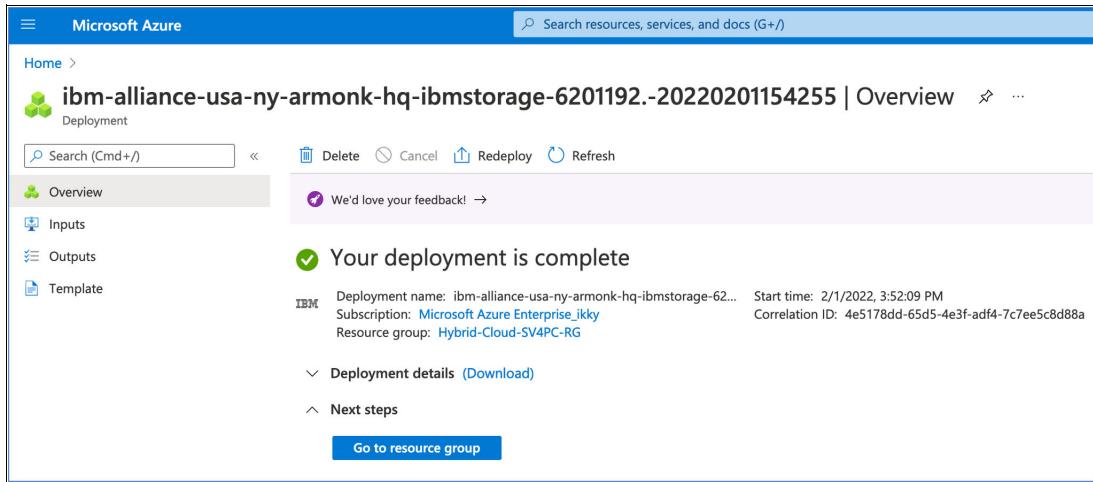


Figure 46 Checking the deployment

**[EXTERNAL] IBM SVPC Cluster Deployment: Cluster Hybrid-Cloud-SV4PC-RG is created successfully**

**root** To: hekantak@in.ibm.com Tuesday, February 01, 2022 04:06PM Show Details

---

Your SVPC cluster **Hybrid-Cloud-SV4PC-RG** is created successfully.  
IP addresses created in resource group:

Item	IP
Cluster IP	40.10.1.4
Node1 Service IP	40.10.1.20
Node1 Node IP 1	40.10.1.18
Node1 Node IP 2	40.10.1.12
Node1 Port IP 1	40.10.1.19
Node1 Port IP 2	40.10.1.13
Node2 Service IP	40.10.1.25
Node2 Node IP 1	40.10.1.23
Node2 Node IP 2	40.10.1.7
Node2 Port IP 1	40.10.1.24
Node2 Port IP 2	40.10.1.8

To access IBM Spectrum Virtualize for Public Cloud management GUI, please follow this link:  
<https://www.ibm.com/docs/en/spectrumvirtualizecl/8.4.x?topic=azure-completing-post-installation-tasks>

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).

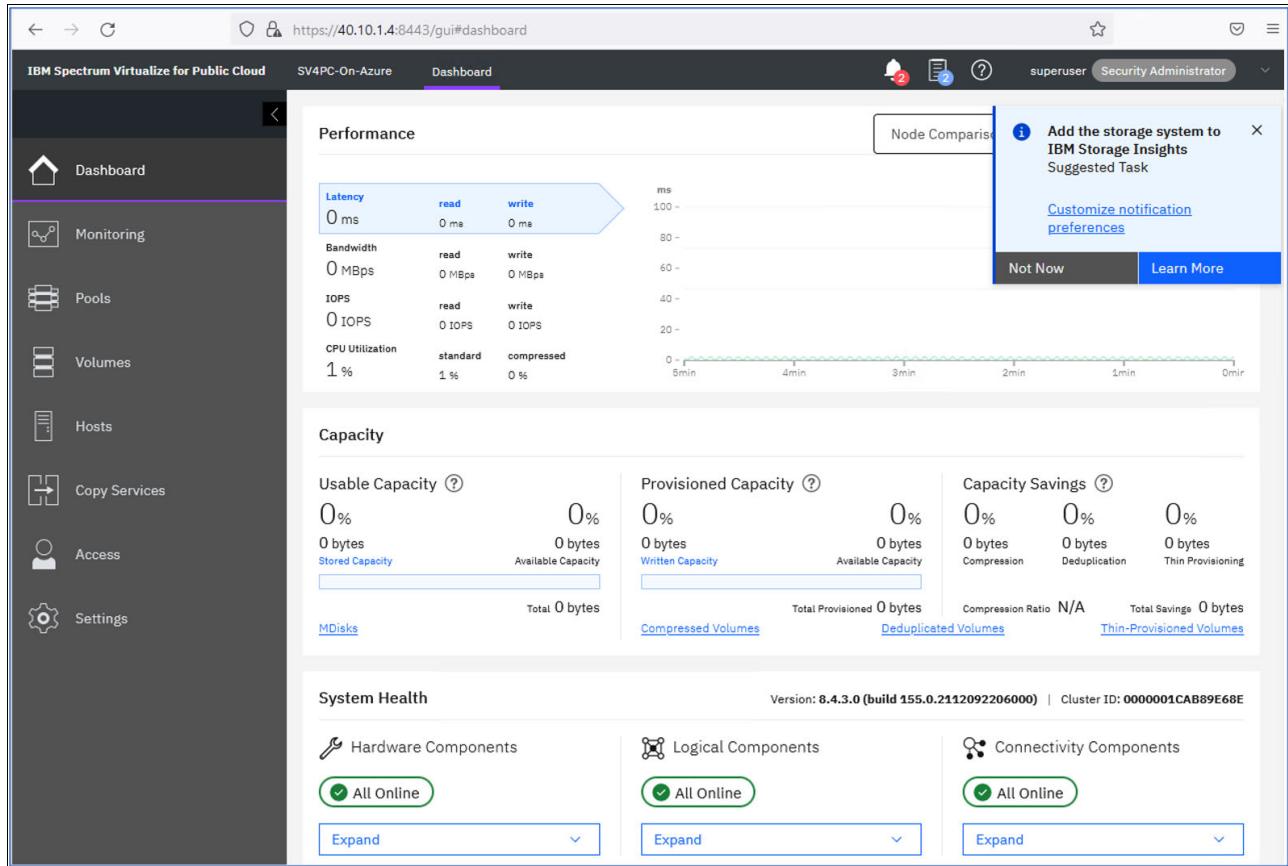


Figure 48 Checking the status of storage

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

- 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 get the initiator name from the RHOCP worker nodes.
- c. Create the host mapping for the worker nodes, as shown in Figure 49 on page 40 - Figure 52 on page 41.
- d. 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 yaml]# oc get nodes
NAME                               STATUS   ROLES     AGE      VERSION
arhoclusterlsv4pc-9w2gw-master-0  Ready    master    6h22m   v1.21.6+bb8d50a
arhoclusterlsv4pc-9w2gw-master-1  Ready    master    6h21m   v1.21.6+bb8d50a
arhoclusterlsv4pc-9w2gw-master-2  Ready    master    6h22m   v1.21.6+bb8d50a
arhoclusterlsv4pc-9w2gw-worker-germanywestcentral1-24417 Ready    worker   6h13m   v1.21.6+bb8d50a
arhoclusterlsv4pc-9w2gw-worker-germanywestcentral2-rzjm7  Ready    worker   6h13m   v1.21.6+bb8d50a
arhoclusterlsv4pc-9w2gw-worker-germanywestcentral3-kk4rv   Ready    worker   6h13m   v1.21.6+bb8d50a
[root@hybrid-Cloud-Linux-bastion-vm yaml]# ssh core@arhoclusterlsv4pc-9w2gw-worker-germanywestcentral1-24417 cat /etc/iscsi/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:402e6796fb6e
[root@hybrid-Cloud-Linux-bastion-vm yaml]# ssh core@arhoclusterlsv4pc-9w2gw-worker-germanywestcentral2-rzjm7 cat /etc/iscsi/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:25dd27569eb1
[root@hybrid-Cloud-Linux-bastion-vm yaml]# ssh core@arhoclusterlsv4pc-9w2gw-worker-germanywestcentral3-kk4rv cat /etc/iscsi/initiatorname.iscsi
InitiatorName=iqn.1994-05.com.redhat:113148c0f72e
[root@hybrid-Cloud-Linux-bastion-vm yaml]#
```

Figure 49 Getting iSCSI initiator name

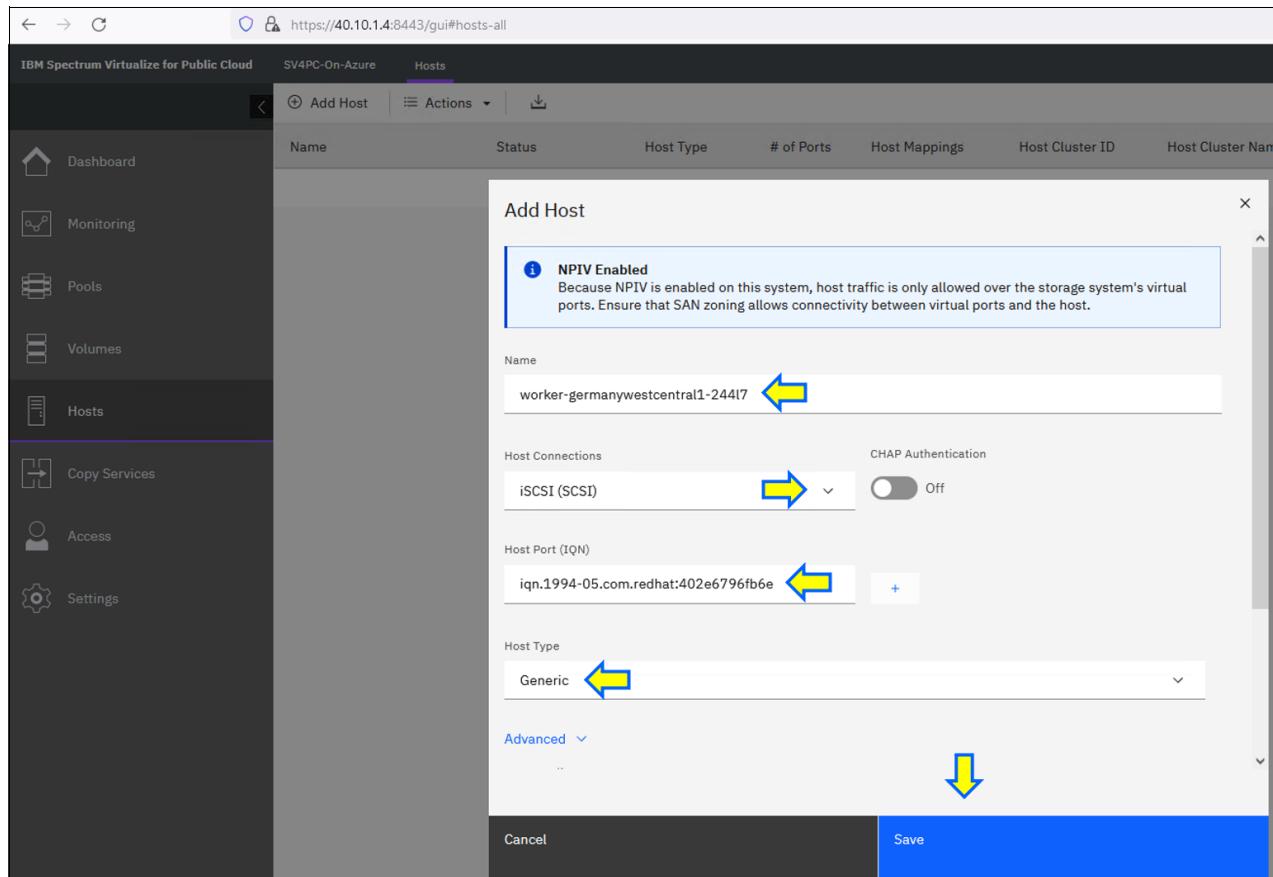


Figure 50 Defining host mapping

```
[root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiamd -m discoverydb -t st -p 40.10.1.13:3260 --discover
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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiamd -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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiamd -m node -p 40.10.1.13 --login
Logging in 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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]# iscsiamd -m node -p 40.10.1.8 --login
Logging in 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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral1-24417 ~]#
[root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiamd -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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiamd -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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiamd -m node -p 40.10.1.13 --login
Logging in 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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# [root@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]# iscsiamd -m node -p 40.10.1.8 --login
Logging in 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@arhocluster1sv4pc-9w2gw-worker-germanywestcentral2-rzjm7 ~]#
```

Figure 51 Running `iscsiamd` 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 RHOPC 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.
- c. 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: SWJtU3Y0cGNvbkF6dXJlCg==
[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 RHOCOP 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 RHOCOP bastion hosts or the host from where the RHOCOP cluster can be accessed by using `oc cli` 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: c3VwZXJ1c2Vy
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
persistentvolume/pvc-96a829c2-db25-48bc-8ad8-6d334e19323c  20Gi      RWO          Delete        Bound    mysql/mysql-pvc  ibm-block-storage-class
5s
NAME          STATUS    VOLUME
persistentvolumeclaim/mysql-pvc  Bound    pvc-96a829c2-db25-48bc-8ad8-6d334e19323c  CAPACITY   ACCESS MODES  STORAGECLASS     AGE
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.

3-Site	Name	State	Pool	UID	Host Mappings	Capacity
	hybrid_pvc-96a829c2-db25-48bc-8ad8-6d334e19323c	✓ Online	SVPC Pool	60050768108104A2F00000000000BB9B	No	20.00 GiB

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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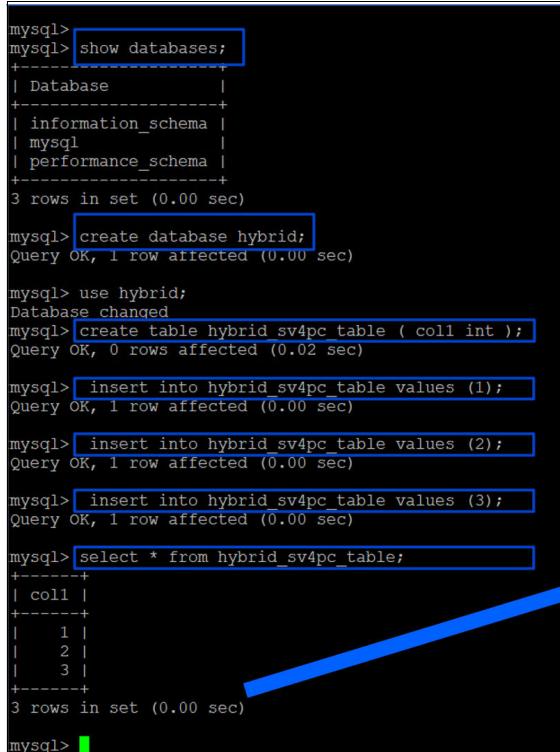
Oracle is a registered trademark of Oracle Corporation and/or its
affiliates. Other names may be trademarks of their respective
owners.

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).



The screenshot shows a terminal window with MySQL command-line interface. The user creates a database named 'hybrid' and a table named 'hybrid\_sv4pc\_table' with one column 'coll'. Three rows are inserted into the table, each containing the value 1, 2, and 3 respectively. Finally, a select query is run to retrieve all data from the table.

```

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)

```

### 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.

The screenshot shows a terminal window with a MySQL session. The user runs 'show databases;' to list existing databases (information\_schema, mysql, performance\_schema). Then, they create a new database 'hybrid' with 'create database hybrid;'. Next, they switch to the 'hybrid' database with 'use hybrid;'. They create a table 'sv4pc\_table' with 'create table hybrid\_sv4pc\_table ( col1 int );'. Finally, they insert three rows of data into the table with 'insert into hybrid\_sv4pc\_table values (1), (2), (3);'. A blue arrow points from the 'select \* from hybrid\_sv4pc\_table;' command in the MySQL session to the results section on the right.

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 ( col1 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;

+-----+  
| col1 |  
+-----+  
| 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;
+-----+
| col1 |
+-----+
| 1 |
| 2 |
| 3 |
+-----+
3 rows in set (0.00 sec)
```

Figure 62 Creating 20gi volume on sv4pc on Azure

The screenshot shows the 'Volumes' tab in the IBM Spectrum Virtualize for Public Cloud interface. A table lists volumes, with one row selected for 'replicated-mysql-pv-20GB'. The 'Volume Overview' panel displays detailed properties for this volume, including Name, Volume ID, State, Capacity, IOPS limit, Bandwidth limit, Encrypted status, FlashCopy mappings, and Mirror sync rate. The 'Name' field in both the table and the panel is highlighted with a blue border. A yellow arrow points from the table's 'Name' field to the panel's 'Name' field. Another yellow arrow points from the 'Close' button at the bottom right of the panel to the bottom right of the screenshot.

Name	State	Pool	UID
replicated-mysql-pv-20GB	Online (formatting)	CloudPool0	6005076072AE279A3800000000000005

**Properties for Volume**

**Volume Overview**

Name:	replicated-mysql-pv-20GB	Cache mode:	Enabled
Volume ID:	4	Cache state:	Not empty
State:	✓ Online (formatting)	UDID (OpenVMS):	N/A
Capacity:	20.00 GiB	Volume UID:	6005076072AE279A3800000000000005
IOPS limit:	Disabled	I/O group:	Caching: io_grp0 Accessible: io_grp0
Bandwidth limit:	Disabled	Preferred node:	node2
Encrypted:	No	Last Access Time:	
FlashCopy mappings:	0		
Mirror sync rate:	2 MiB/s		

**Close**

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.

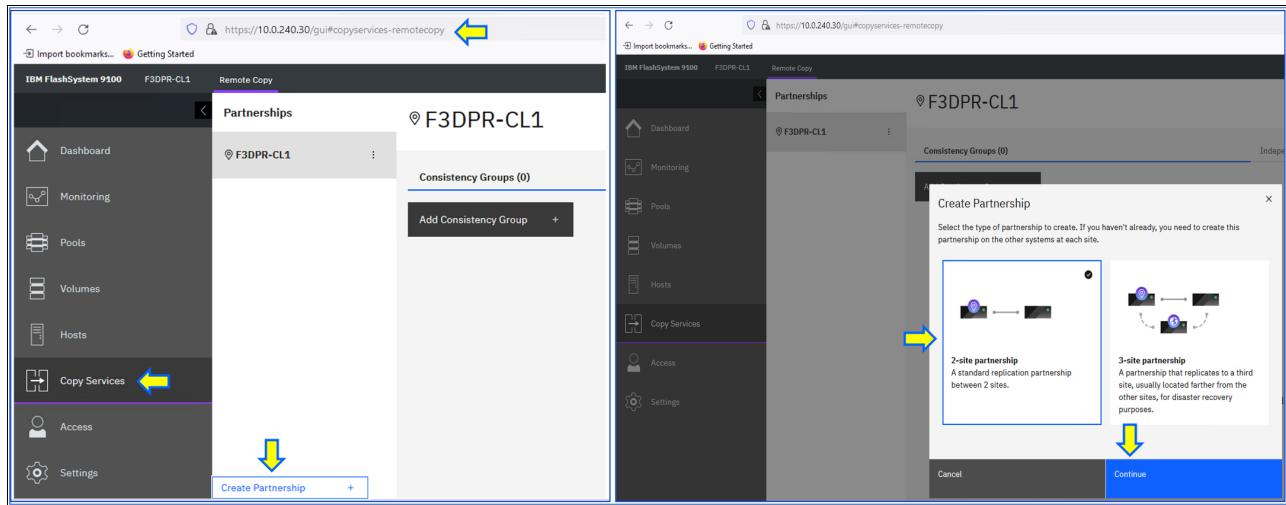


Figure 64 Creating partnership: On-premises storage, Part 1

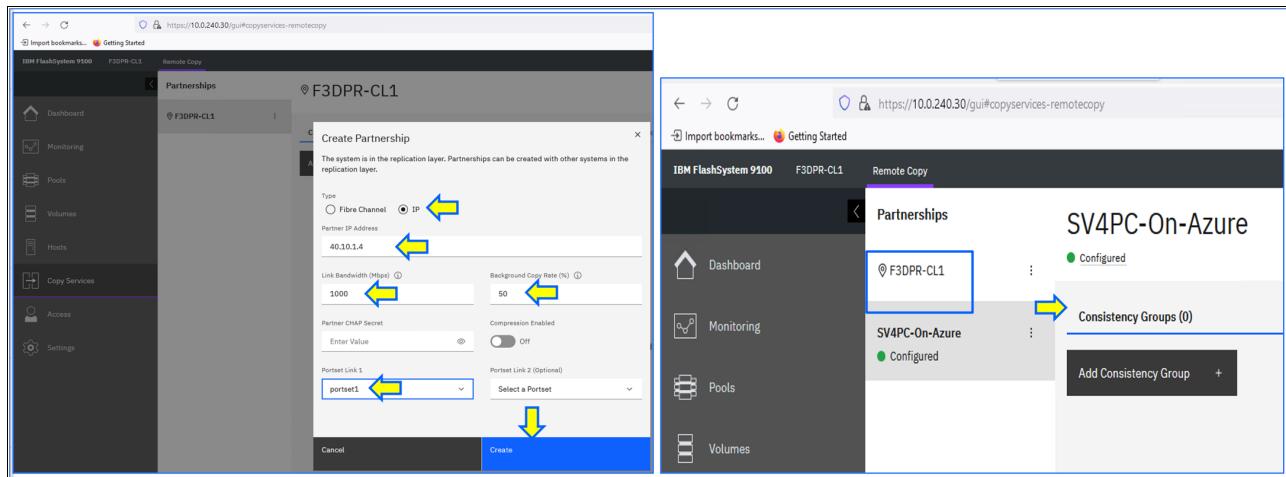


Figure 65 Creating partnership: On-premise storage, Part 2

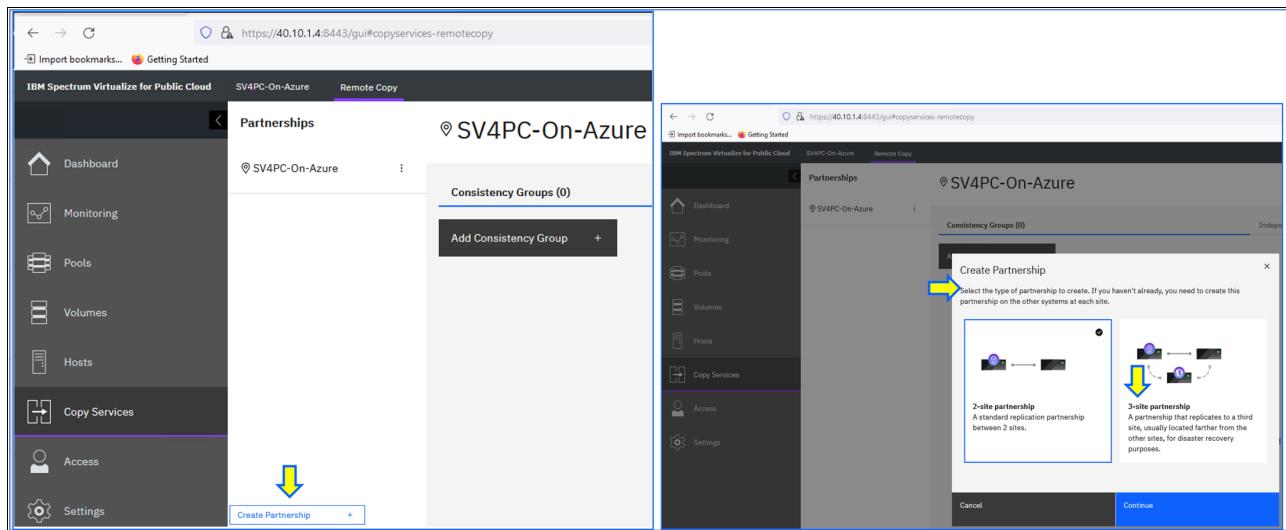


Figure 66 Creating partnership: sv4pc on Azure, Part 1

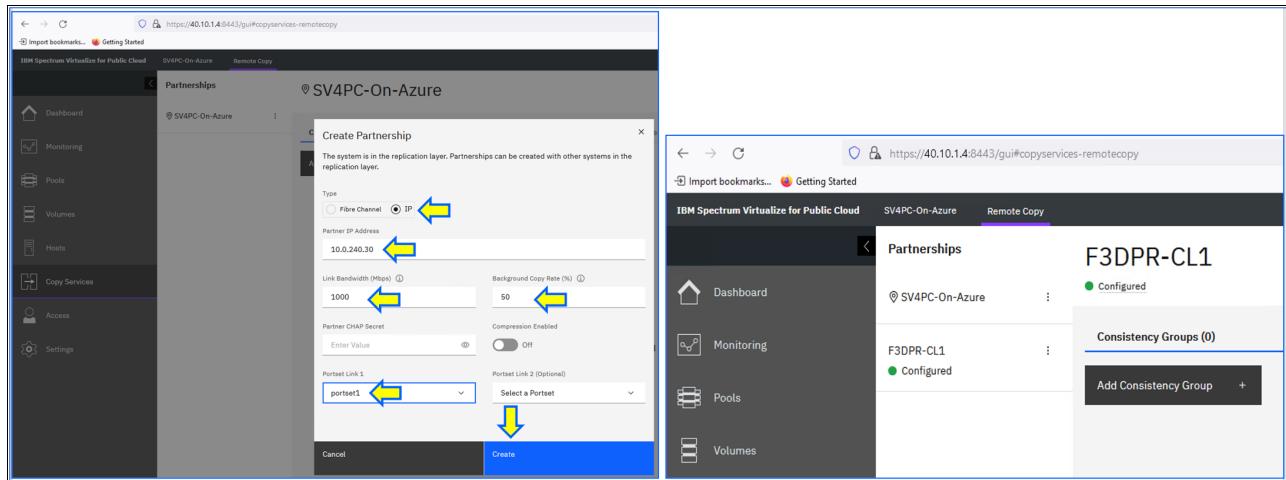


Figure 67 Creating partnership: sv4pc on Azure, Part 2

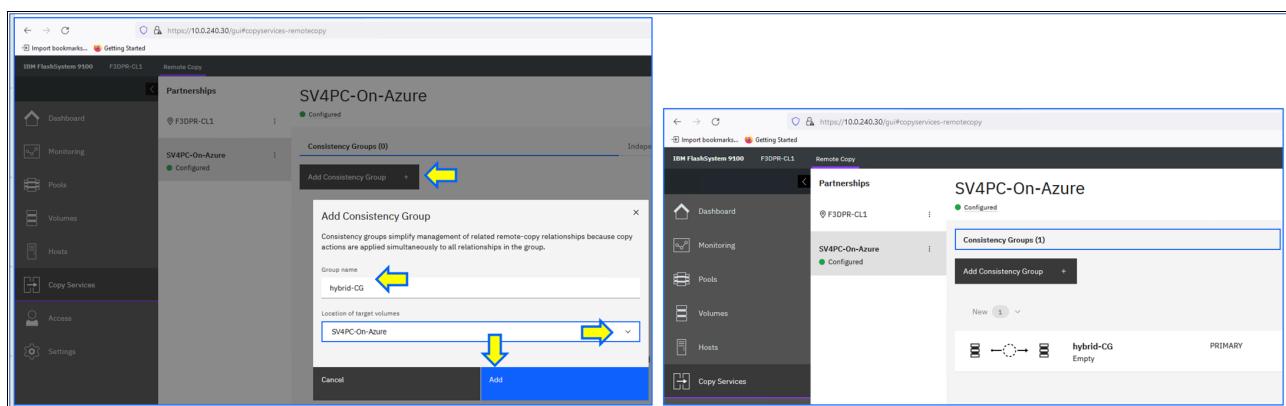


Figure 68 Adding consistency group: On-premises storage

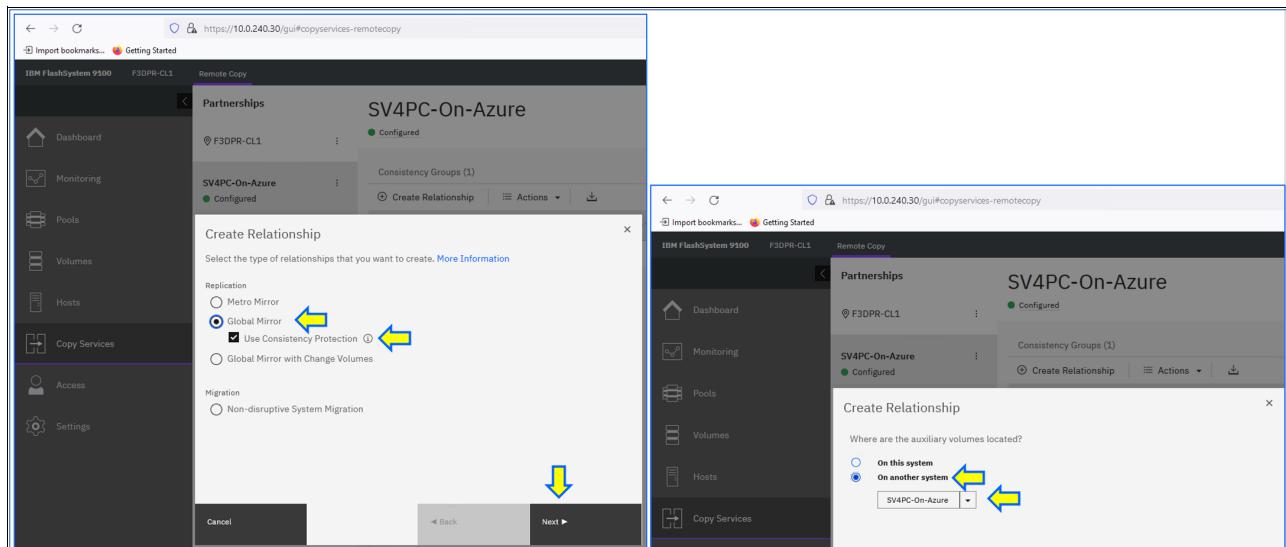


Figure 69 Creating relationship: On-premises storage Part 1

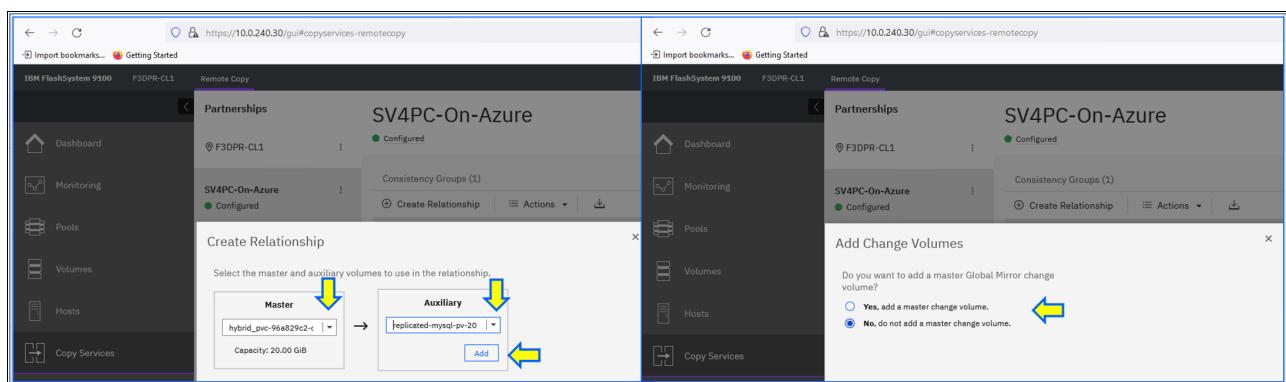


Figure 70 Creating relationship: On-premises storage Part 2

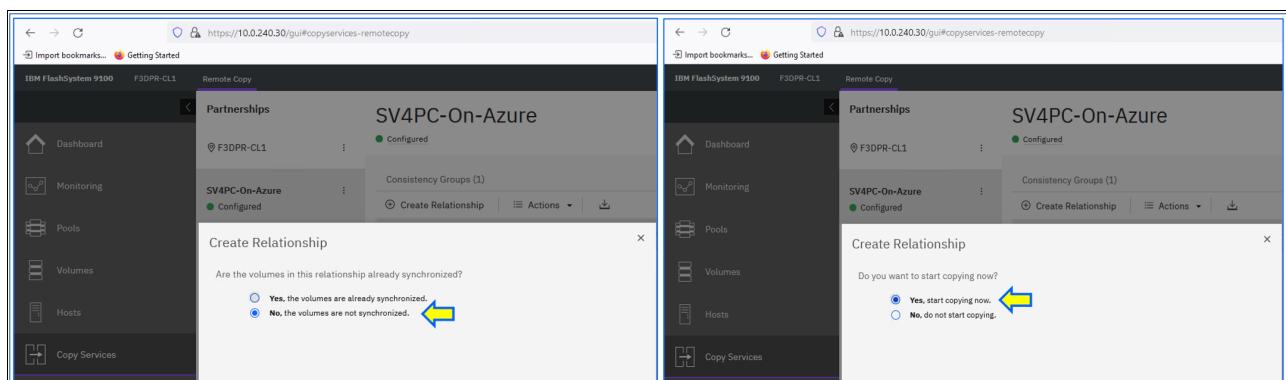


Figure 71 Creating relationship: On-premises storage Part 3

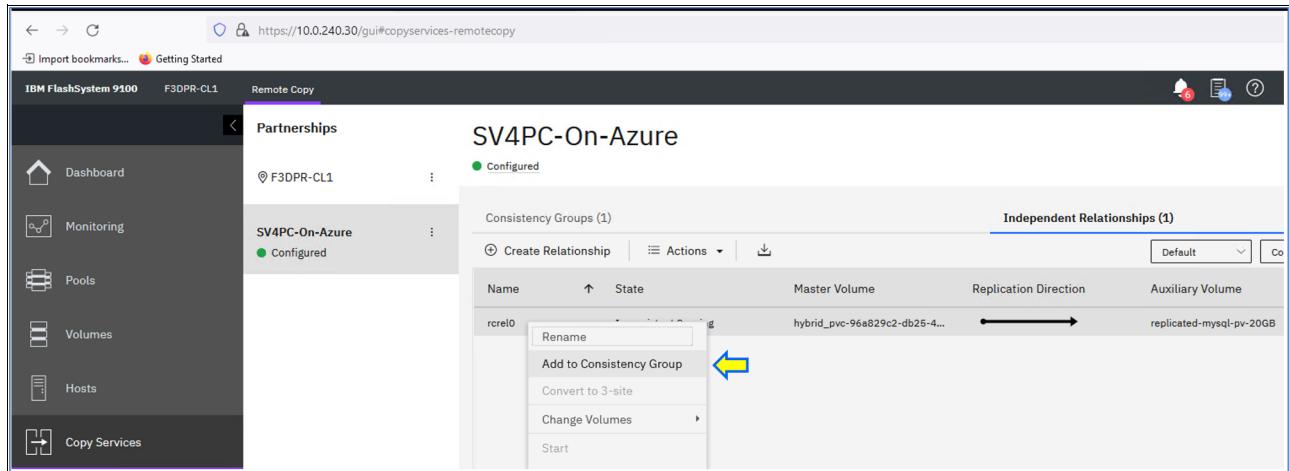


Figure 72 Adding consistency group: On-premises storage

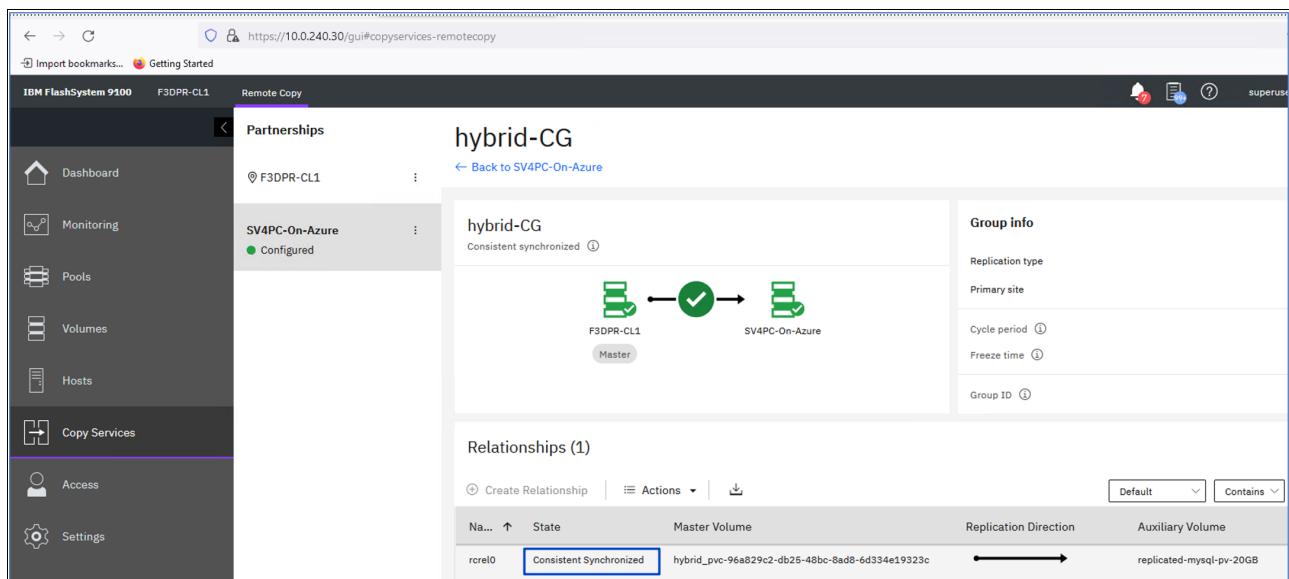


Figure 73 Checking status: Consistent synchronized

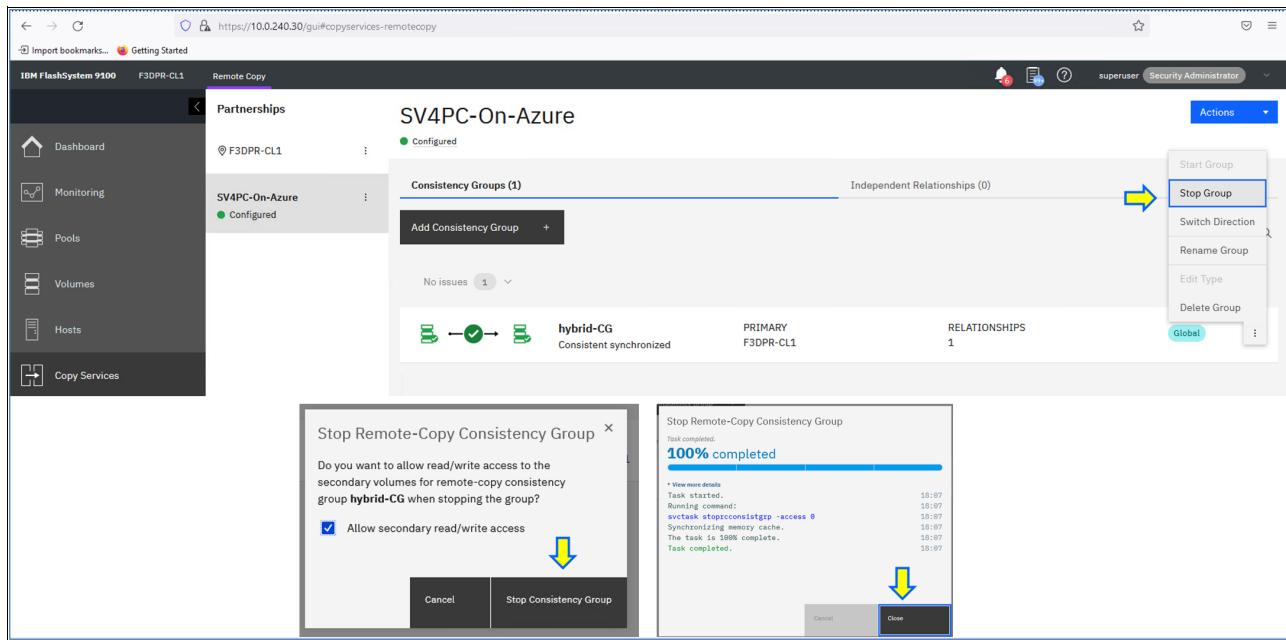


Figure 74 Stopping remote-copy consistency group

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 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: SVC4;6005076072AE279A380000000000000005
  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]# oc get pv,pvc
NAME                                     CAPACITY   ACCESS MODES   RECLAIM
                                         STORAGECLASS   REASON     AGE
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]# 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
EASON        AGE
persistentvolume/pvc-016db124-d744-4e5c-a74e-4919ee05ff28  5Gi        RWO          Delete
          Bound      ibm-block-storage-ns/test-claim-on-sv4pc
          3d5h
persistentvolume/replicated-mysql-pv-20gb  20Gi       RWO          Delete
          Bound      mysql-cloud/replicated-mysql-pvc-20gb
          112s
NAME                                     STATUS     VOLUME
ACCESS MODES   STORAGECLASS
EASON        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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Oracle is a registered trademark of Oracle Corporation and/or its
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> select * from hybrid_sv4pc_table;
+-----+
| coll |
+-----+
| 1   |
| 2   |
| 3   |
+-----+
3 rows in set (0.00 sec)

mysql>

```

Figure 81 Validating the replicated data

<b>On-premise, MySQL Volume data</b> <pre> mysql&gt; show databases; +-----+   database   +-----+   information_schema     performance_schema     sys     test   +-----+ 3 rows in set (0.00 sec)  mysql&gt; create database hybrid; Query OK, 1 row affected (0.00 sec)  mysql&gt; use hybrid; Database changed mysql&gt; create table hybrid_sv4pc_table ( coll int ); Query OK, 0 rows affected (0.02 sec)  mysql&gt; insert into hybrid_sv4pc_table values (); Query OK, 1 row affected (0.00 sec)  mysql&gt; insert into hybrid_sv4pc_table values (2); Query OK, 1 row affected (0.00 sec)  mysql&gt; insert into hybrid_sv4pc_table values (3); Query OK, 1 row affected (0.00 sec)  mysql&gt; select * from hybrid_sv4pc_table; +-----+   coll   +-----+   1       2       3     +-----+ 3 rows in set (0.00 sec)  mysql&gt; </pre>	<b>SV4PC on Azure, MySQL Volume data</b> <pre> mysql&gt; mysql&gt; 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&gt; select * from hybrid_sv4pc_table; +-----+   coll   +-----+   1       2       3     +-----+ 3 rows in set (0.00 sec)  mysql&gt; </pre>
---	--

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 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]# oc create -f 01-mysqlpvc.yaml
persistentvolumeclaim/mysql-pvc-csi-vreplication created
[root@gw-10 MySQL]# oc get pv,pvc
NAME                                     CAPACITY   ACCESS MODES  RECLAIM POLICY
STATUS CLAIM           STORAGECLASS   AGE
persistentvolume/pvc-b86b0900-575c-4e6b-96b0-a01acf3cbae3  20Gi        RWO          Delete
  Bound   mysql/mysql-pvc-csi-vreplication  ibm-block-storage-class   <invalid>
NAME          STATUS   VOLUME
CAPACITY  ACCESS MODES  STORAGECLASS   AGE
persistentvolumeclaim/mysql-pvc-csi-vreplication  Bound   pvc-b86b0900-575c-4e6b-96b0-a01acf3cbae3
  20Gi      RWO          ibm-block-storage-class   7s
[root@gw-10 MySQL]#
```

Figure 83 Creating mysql pvc yaml file

```
[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]# oc create -f 02-mysql-deployment.yaml
service/mysql created
deployment.apps/mysql created
[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]# oc get pods
NAME          READY   STATUS      RESTARTS   AGE
mysql-d5f4bcd79-bb68r   1/1    Running     0   30s
[root@gw-10 MySQL]#
```

Figure 84 Deploying mysql

The image shows two terminal windows side-by-side. The left window displays the logs of a MySQL pod in an OpenShift cluster. It includes commands like `oc get pods` and `mysql -u root -p` to log in, followed by the MySQL prompt and its license notice. The right window shows the MySQL command-line interface where a database is created, tables are created and populated with sample data, and then queried.

```

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

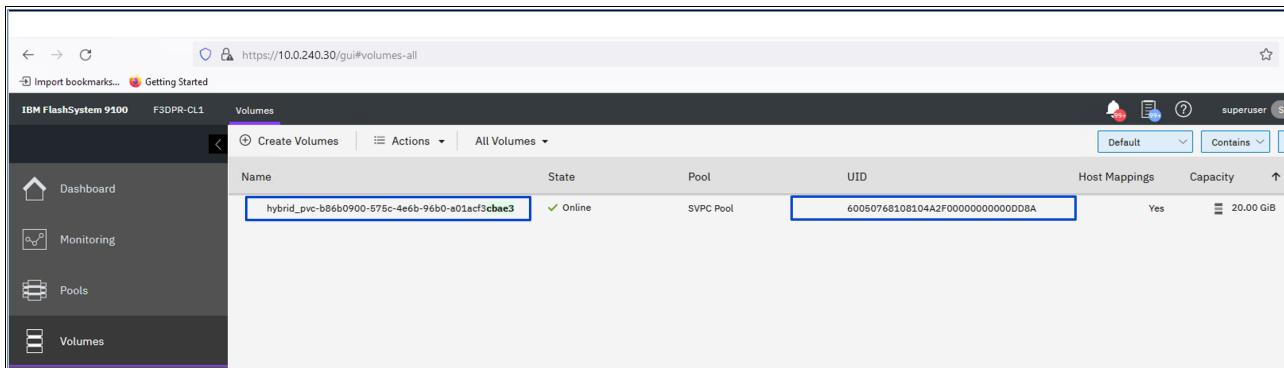


Figure 86 Checking that the volume is created in storage

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

3-Site	Name	State	Pool
	volume-20gi-inbytes	✓ Online	CloudPool0
	csi-volumereplication-20gi-azure	✓ Online	CloudPool0

**Properties for Volume**

**Volume Overview** Copy 0

<b>Name:</b>	csi-volumereplication-20gi-azure	<b>Cache mode:</b>	Enabled
<b>Volume ID:</b>	7	<b>Cache state:</b>	Empty
<b>State:</b>	✓ Online	<b>UDID (OpenVMS):</b>	N/A
<b>Capacity:</b>	20.00 GiB	<b>Volume UID:</b>	6005076072AE279A380000000000000C
<b>IOPS limit:</b>	Disabled	<b>I/O group:</b>	Caching: io_grp0
<b>Bandwidth limit:</b>	Disabled		Accessible: io_grp0
<b>Encrypted:</b>	No	<b>Preferred node:</b>	node1
<b>FlashCopy mappings:</b>	0	<b>Last Access Time:</b>	[empty]
<b>Mirror sync rate:</b>	2 MiB/s		

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   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   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 RHOCP Bastion hosts or the host from where the RHOCP 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.

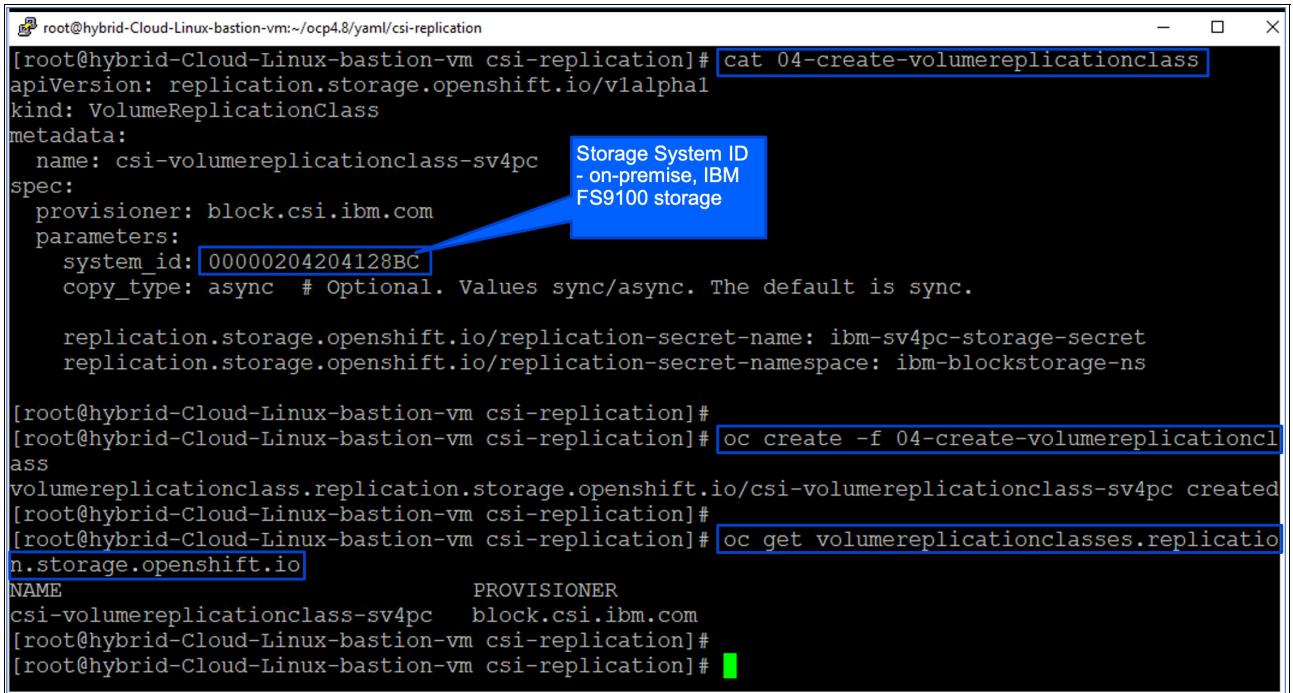
  replication.storage.openshift.io/replication-secret-name: ibm-block-storage-secret
  replication.storage.openshift.io/replication-secret-namespace: ibm-flashsystem-csi
[root@gw-10 CSI-Replication]#
[root@gw-10 CSI-Replication]# oc create -f 01-create-volumereplicationclass
volumereplicationclass.replication.storage.openshift.io/csi-volumereplicationclass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

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.openshi
ft.io volumereplicationclasses.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplicationclasses.replication.storage.opens
ift.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.openshi
ft.io volumereplications.yaml
customresourcedefinition.apiextensions.k8s.io/volumereplications.replication.storage.openshift.i
o 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-volumereplicationcl
ass
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.replicat
ion.storage.openshift.io
NAME                      PROVISIONER
csi-volumereplicationclass-sv4pc  block.csi.ibm.com
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
```

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 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;6005076072AE279A380000000000000000
  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
CSI-VOLUMEREPLICATION-20GI  16m   CSI-VOLUMEREPLICATIONCLASS  MYSQL-PVC-CSI-VREPLICATION  PRIMARY
DEMO-VOLUMEREPLICATION     20D   DEMO-VOLUMEREPLICATIONCLASS  DEMO-PVC-FILE-SYSTEM    PRIMARY
Unknown
[root@gw-10 CSI-Replication]#

```

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.

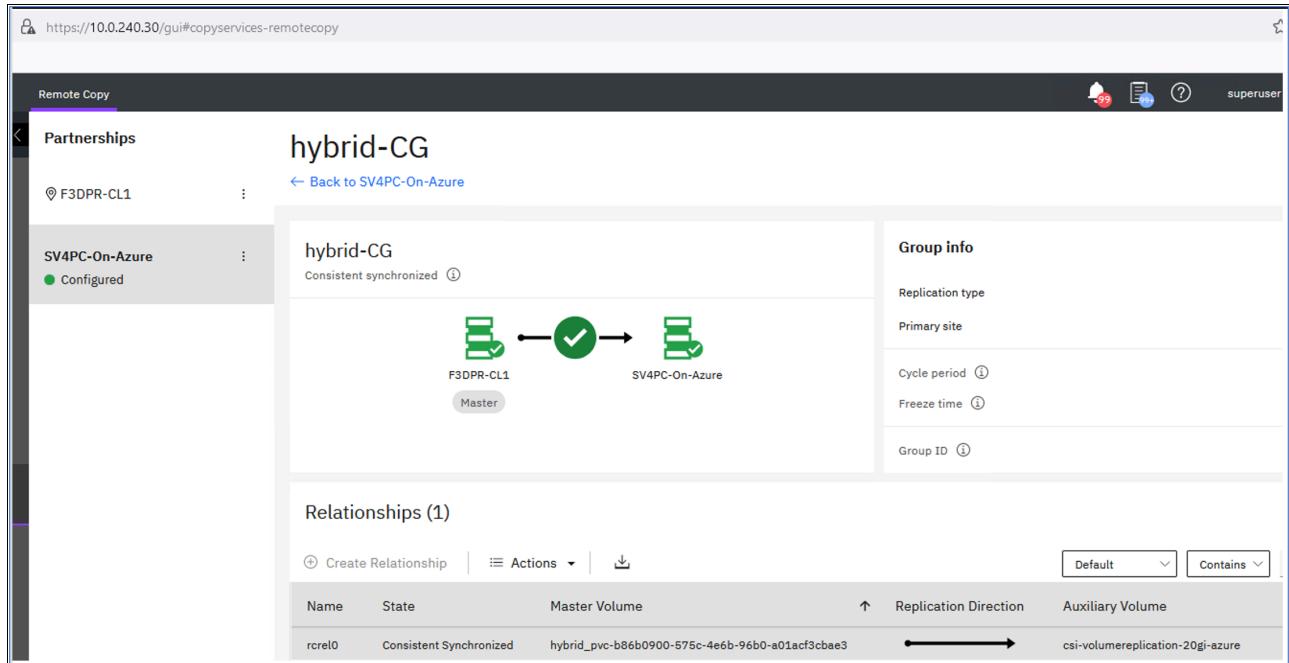


Figure 93 check status consistent synchronized

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

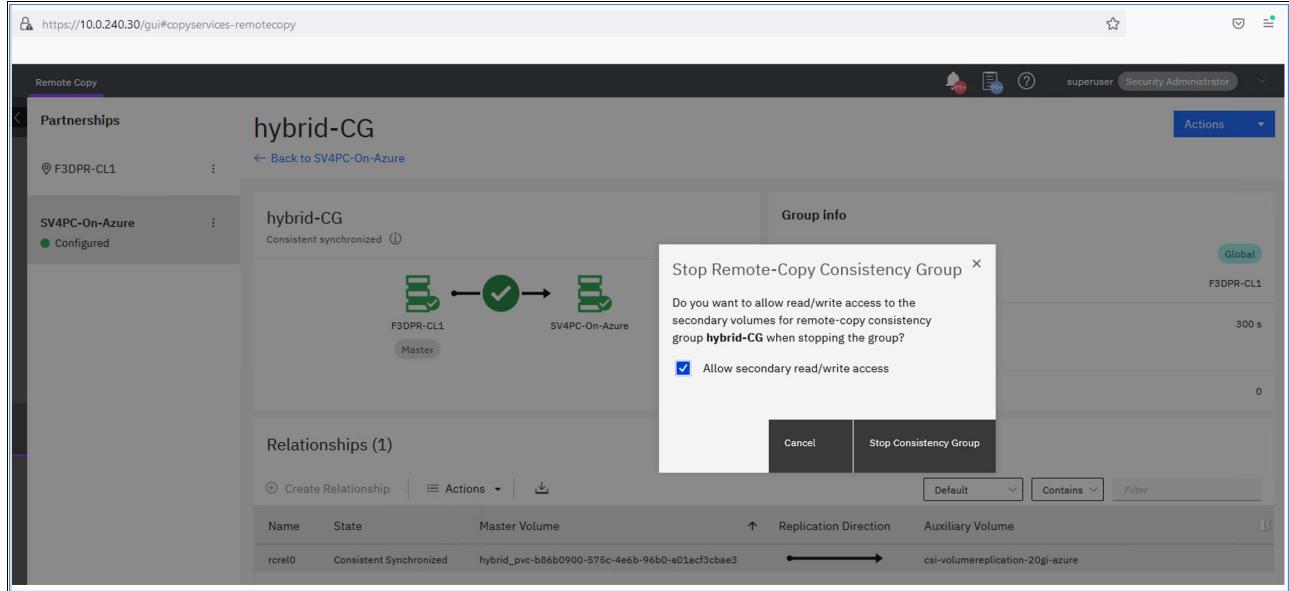


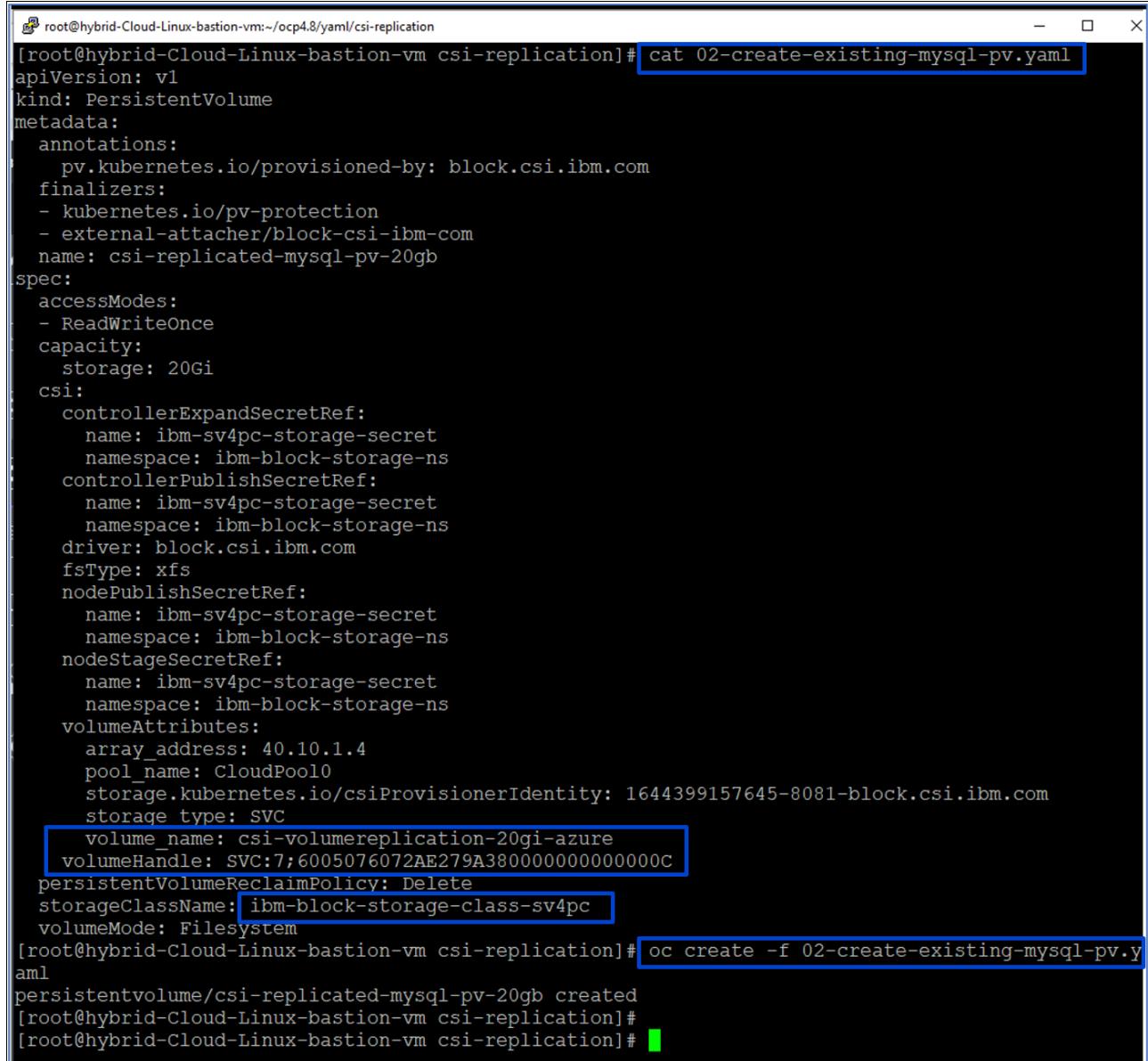
Figure 94 Stopping remote-copy consistency group

10. Log in to the Microsoft Azure portal at <https://portal.azure.com>.
11. 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).

```
root@hybrid-Cloud-Linux-bastion-vm:~/ocp4.8/yaml/csi-replication
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# cat 01-create-existing-mysql-pvc.yaml
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: csi-replicated-mysql-pvc-20gb
spec:
  accessModes:
  - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  storageClassName: ibm-block-storage-class-sv4pc
  volumeName: csi-replicated-mysql-pv-20gb
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc create -f 01-create-existing-mysql-pvc.yaml
persistentvolumeclaim/csi-replicated-mysql-pvc-20gb created
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]#
```

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 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.yaml
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]# oc get persistentvolume/csi-replicated-mysql-pv-20gb
NAME          CAPACITY   ACCESS MODES   RECLAIM POLICY   STATUS   CLAIM
STORAGECLASS
csi-replicated-mysql-pv-20gb  20Gi        RWO           Delete       Bound    mysql-cloud/csi-replicated-mysql-pvc-20gb
si-replicated-mysql-pvc-20gb  ibm-block-storage-class-sv4pc
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get persistentvolumeclaim/csi-replicated-mysql-pvc-20gb
NAME          STATUS     VOLUME
STORAGECLASS
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]# 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]# 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-nqlj7   1/1     Running   0          51s
[root@hybrid-Cloud-Linux-bastion-vm csi-replication]# oc get all
NAME           READY   STATUS    RESTARTS   AGE
pod/mysql-546f486f56-nqlj7   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]# oc get pods
NAME           READY   STATUS    RESTARTS   AGE
mysql-546f486f56-nqlj7   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-nqlj7
$ 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

This blueprint guide was produced by a team of specialists from around the world working at IBM Redbooks, Poughkeepsie Center.

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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](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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