

VMware vSphere 7.0: Install, Configure, Manage

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Course Outline

1. Introduction to vSphere and the Software-Defined Data Center
2. Virtual Machines
3. vCenter Server
4. Configuring and Managing Virtual Networks
5. Configuring and Managing Virtual Storage
6. Virtual Machine Management
7. Resource Management and Monitoring
8. vSphere Clusters

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Module 1: Introduction to vSphere and the Software-Defined Data Center

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About Virtual Machines

A virtual machine (VM) is a software representation of a physical computer and its components. The virtualization software converts the physical machine and its components into files.

Virtual Machine



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Virtual Machine Components

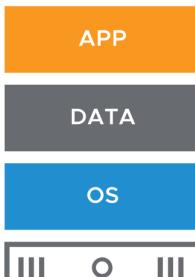
- Guest operating system
- VMware Tools
- Virtual resources, such as:
 - CPU and memory
 - Network adapters
 - Disks and controllers
 - Parallel and serial ports

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Benefits of Using Virtual Machines

Physical Machines	Virtual Machines
<ul style="list-style-type: none"> • Difficult to move or copy • Bound to a specific set of hardware components • Often have a short lifecycle • Require personal contact to upgrade hardware 	<ul style="list-style-type: none"> • Easy to move or copy: <ul style="list-style-type: none"> -Encapsulated into files -Independent of physical hardware • Easy to manage: <ul style="list-style-type: none"> -Isolated from other virtual machines running on same physical hardware -Insulated from physical hardware changes 

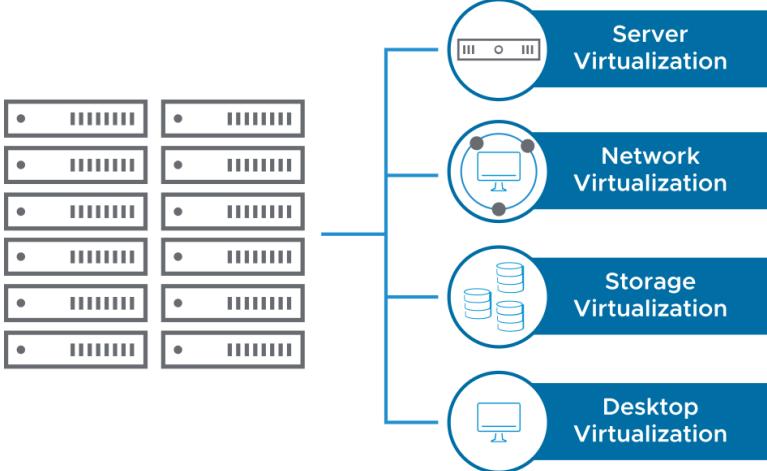
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Types of Virtualization

Virtualization is the process of creating a software-based representation of something physical, such as a server, desktop, network, or storage device.

Virtualization is the single most effective way to reduce IT expenses while boosting efficiency and agility for all business sizes.



Server Virtualization

Network Virtualization

Storage Virtualization

Desktop Virtualization

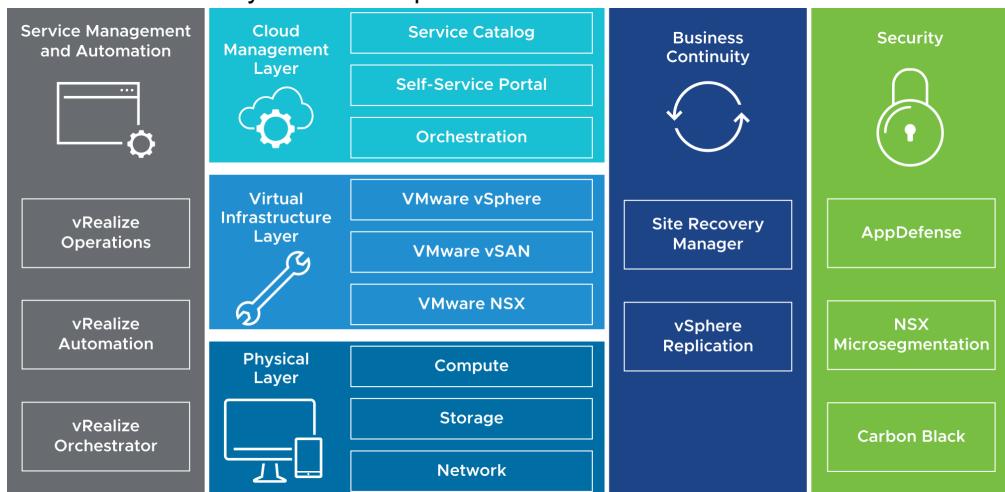
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About the Software-Defined Data Center

In a software-defined data center (SDDC), all infrastructure is virtualized, and the control of the data center is automated by software. vSphere is the foundation of the SDDC.



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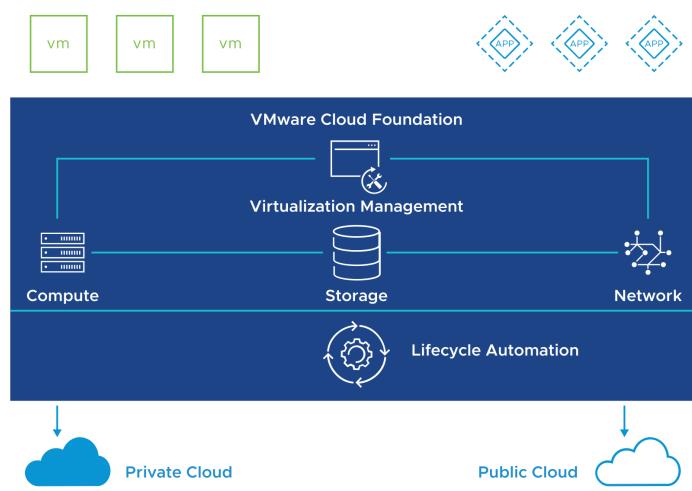
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vSphere and Cloud Computing

Cloud computing exploits the efficient pooling of an on-demand, self-managed, and virtual infrastructure.



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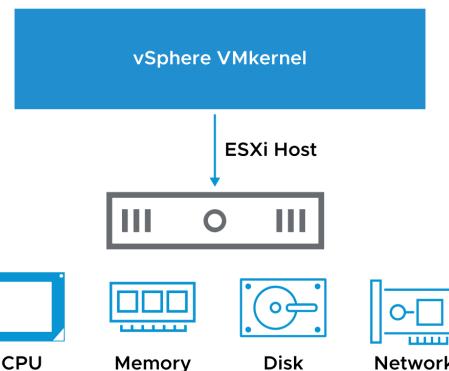
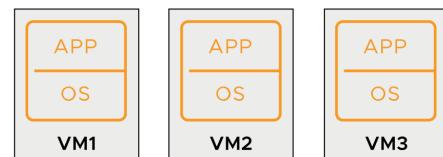
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Virtual Machine: Guest and Consumer of ESXi Host

Any application in any supported OS can run in a VM (guest) and consume CPU, memory, disk, and network from host-based resources.



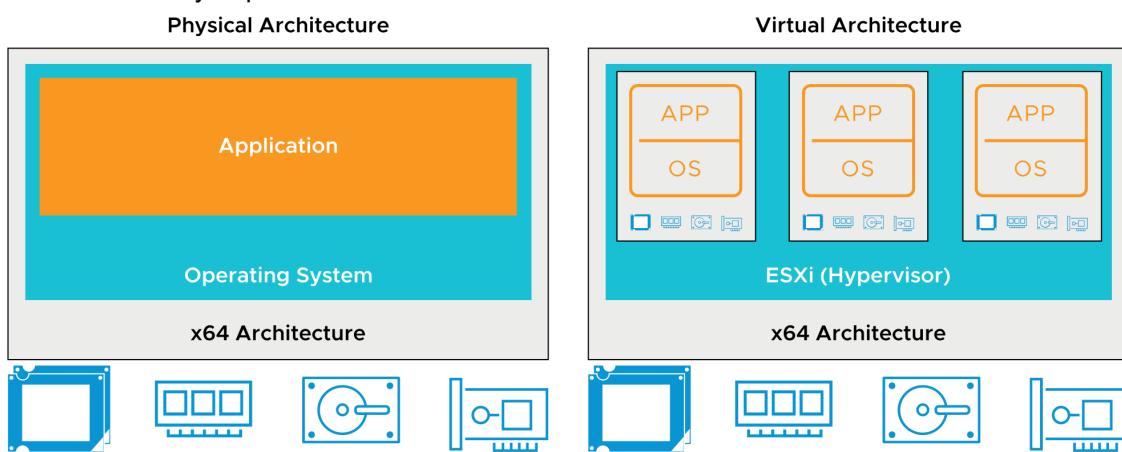
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Physical and Virtual Architecture

Virtualization technology abstracts physical components into software components and provides solutions for many IT problems.



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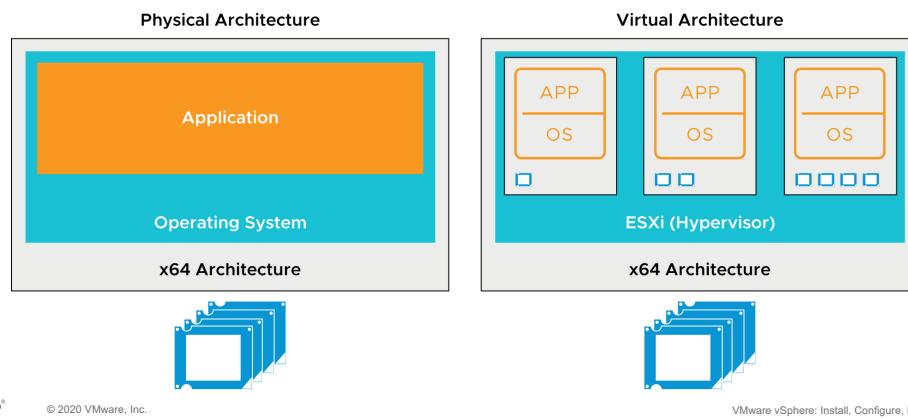
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CPU Virtualization

In a physical environment, the operating system assumes the ownership of all the physical CPUs in the system.

CPU virtualization emphasizes performance and runs directly on the available CPUs.

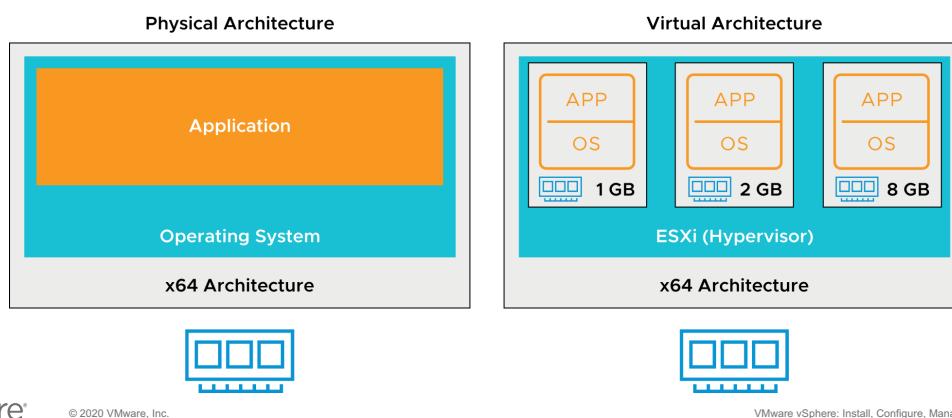


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Physical and Virtualized Host Memory Usage

In a physical environment, the operating system assumes the ownership of all physical memory in the system.

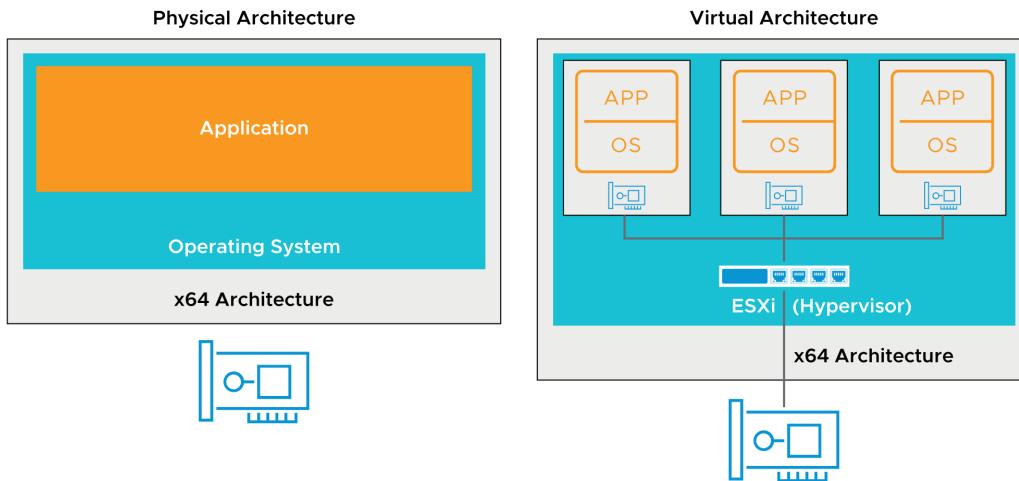
Memory virtualization emphasizes performance and runs directly on the available RAM.



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Physical and Virtual Networking

Virtual Ethernet adapters and virtual switches are key virtual networking components.



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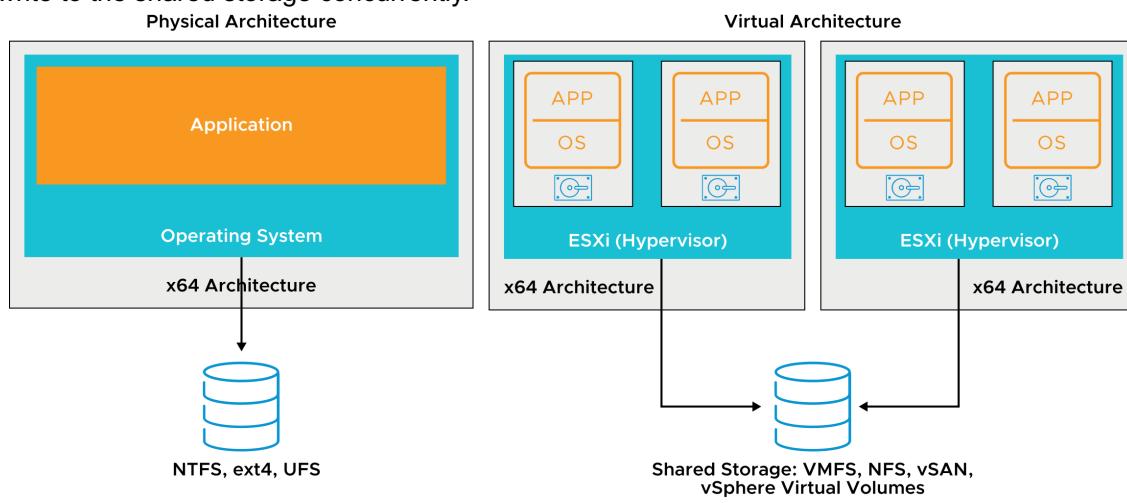
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Physical File Systems and Datastores

vSphere VMFS provides a distributed storage architecture, where multiple ESXi hosts can read or write to the shared storage concurrently.



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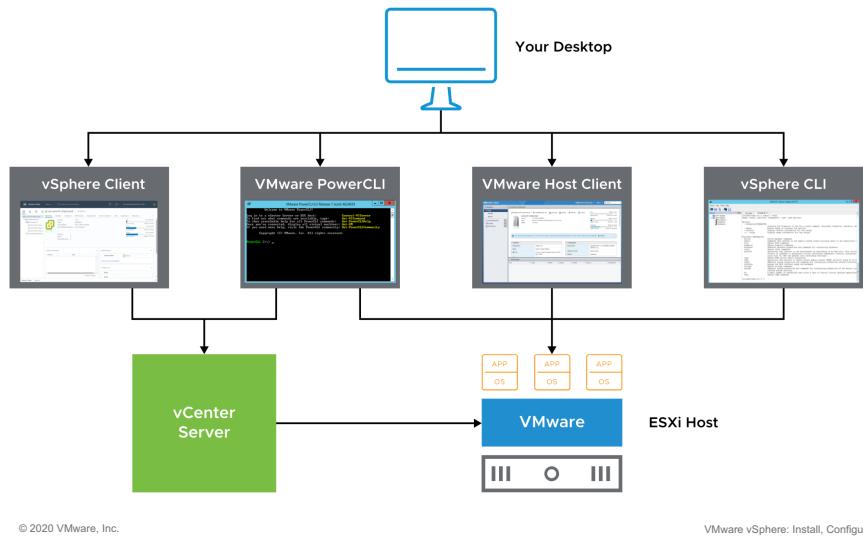
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vSphere User Interfaces

You can use the vSphere Client, PowerCLI, VMware Host Client, and vSphere CLI to interact with the vSphere environment.



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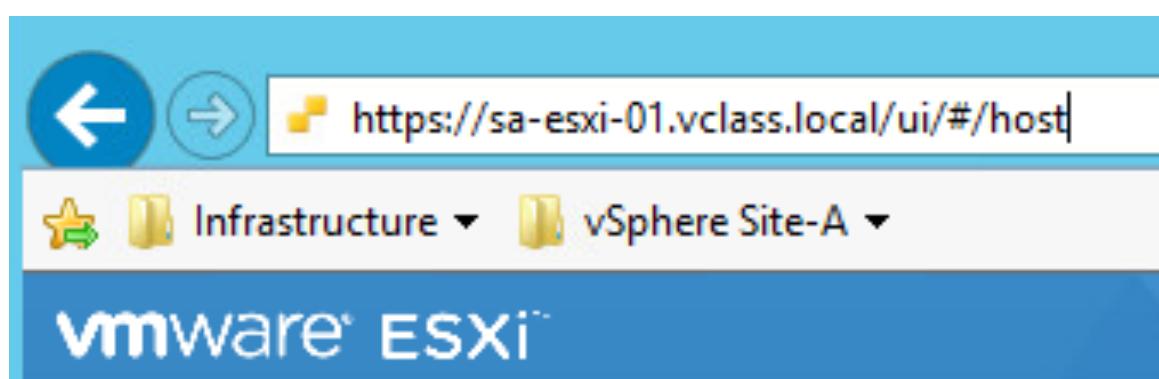
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About VMware Host Client

VMware Host Client is an HTML5-based user interface that you can use to manage individual ESXi hosts directly when vCenter Server is unavailable.

VMware Host Client is served from ESXi, and you access it from a supported browser at https://ESXi_FQDN_or_IP_Address/ui.

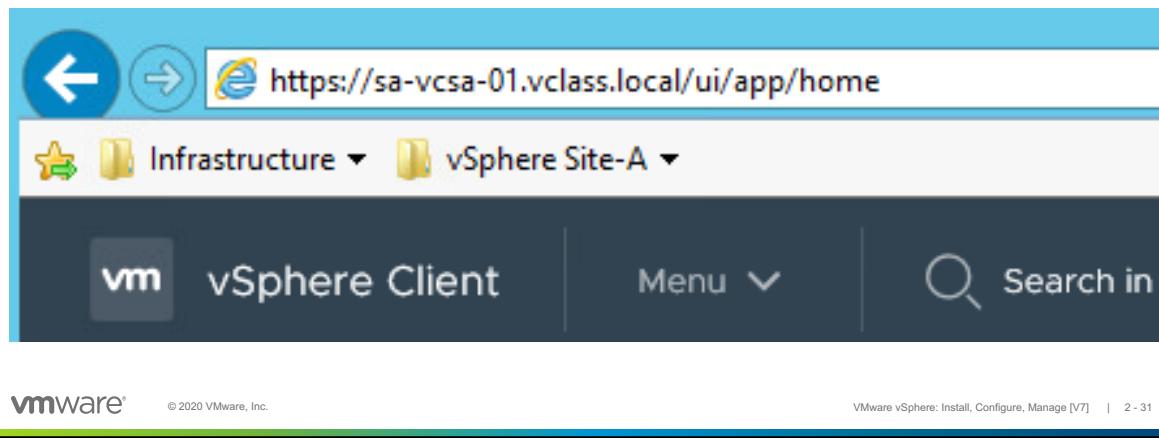


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About vSphere Client

The vSphere Client is an HTML5-based client. You manage the vSphere environment with the vSphere Client by connecting to vCenter Server Appliance.

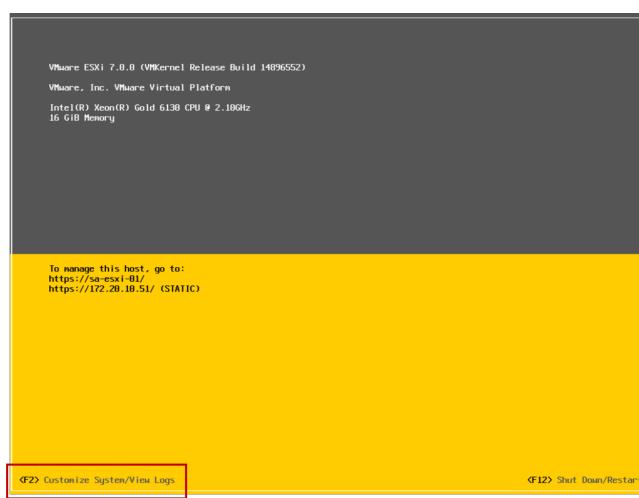
You access the vSphere Client from a supported browser at <https://vCenter Server Appliance FQDN or IP Address/ui>.



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Configuring an ESXi Host

The DCUI is a text-based user interface with keyboard-only interaction.



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Configuring an ESXi Host: Root Access

Administrators use the DCUI to configure root access settings:

- Set a root password (complex passwords only).
- Enable or disable lockdown mode:
 - Limits management of the host to vCenter Server
 - Can be configured only for hosts managed by a vCenter Server instance

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Configuring an ESXi Host: Management Network

Using the DCUI, you can modify network settings:

- Host name
- IP configuration (IP address, subnet mask, default gateway)
- DNS servers

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Configuring an ESXi Host: Other Settings

Using the DCUI, you can configure the keyboard layout, enable troubleshooting services, view support information, and view system logs.



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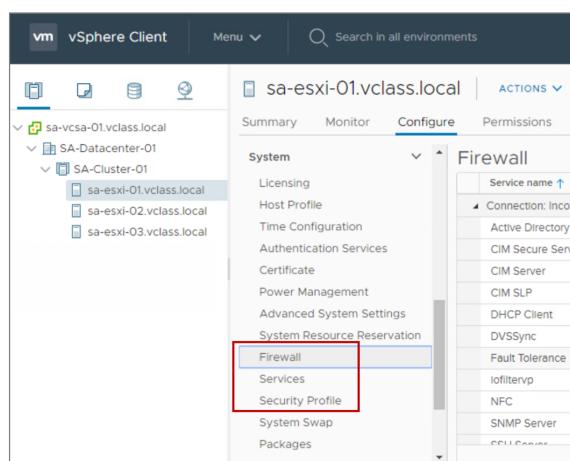
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Controlling Remote Access to an ESXi Host

You can use the vSphere Client to customize essential security settings that control remote access to an ESXi host:

- The ESXi firewall is enabled by default:
 - The firewall blocks incoming and outgoing traffic, except for the traffic that is enabled in the host's firewall settings.
- Services, such as the NTP client and the SSH client, can be managed by the administrator.
- Lockdown mode prevents remote users from logging in to the host directly. The host is accessible only through the DCUI or vCenter Server.



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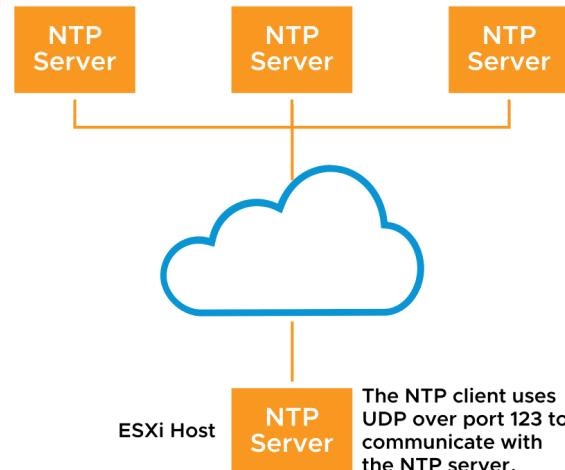
ESXi Host as an NTP Client

Network Time Protocol (NTP) is a client-server protocol used to synchronize a computer's clock to a time reference.

NTP is important:

- For accurate performance graphs
- For accurate time stamps in log messages
- So that virtual machines have a source to synchronize with

An ESXi host can be configured as an NTP client. It can synchronize time with an NTP server on the Internet or your corporate NTP server.



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Module 2: Virtual Machines



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Creating Virtual Machines

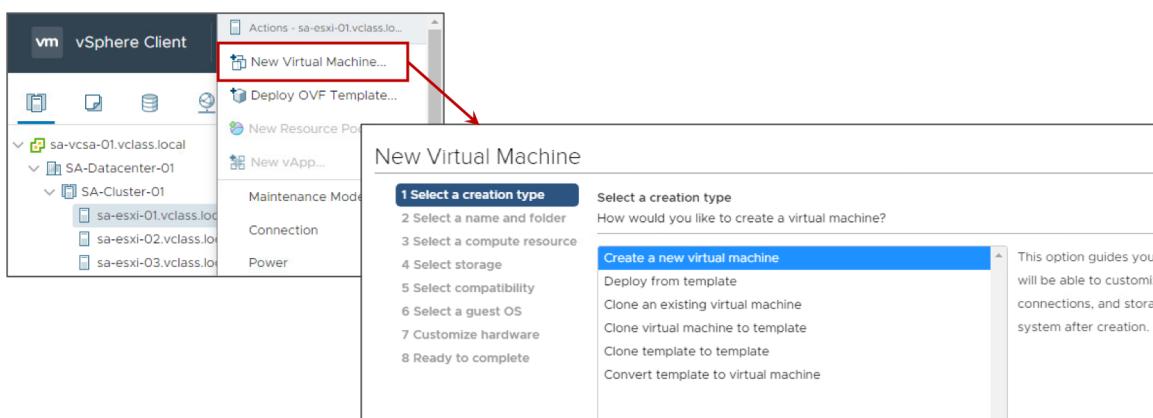
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Creating VMs with the New Virtual Machine Wizard (1)

You can use the New Virtual Machine wizard in the vSphere Client to create a VM.



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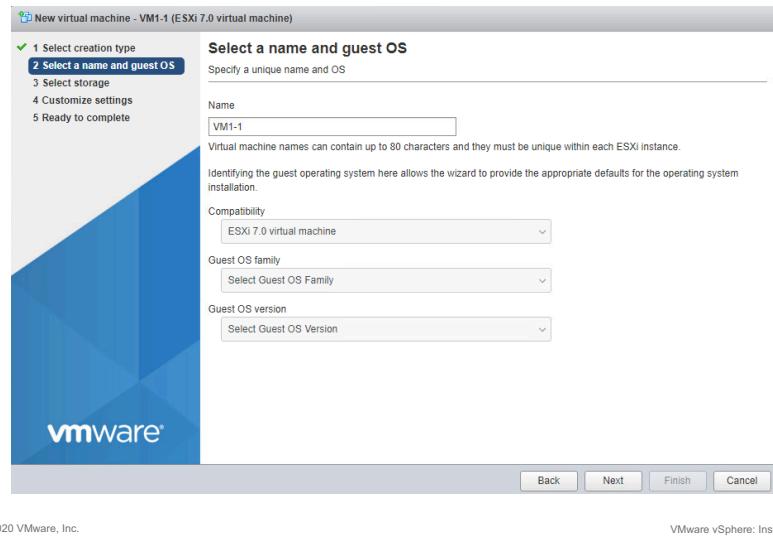
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Creating VMs with the New Virtual Machine Wizard (2)

You can use the New Virtual Machine wizard in VMware Host Client to create a VM.



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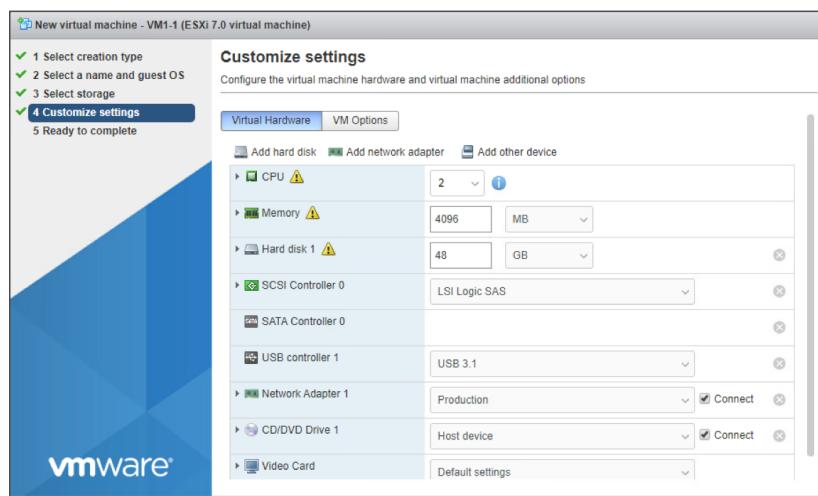
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New Virtual Machine Wizard Settings

VM configuration settings are based on the prior choices made about the operating system.



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Installing the Guest Operating System

Installing a guest operating system in your VM is like installing it on a physical computer.



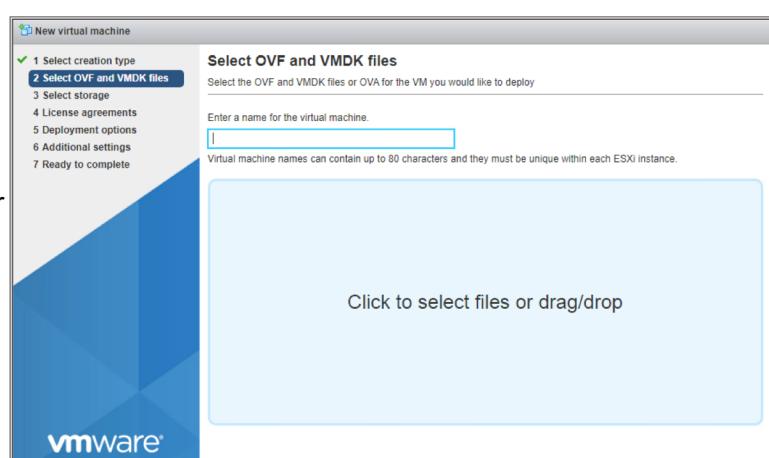
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Deploying OVF Templates

You can deploy any VM or virtual appliance stored in OVF format.

Virtual appliances are preconfigured VMs:

- They are usually designed for a single purpose.
- They are also available from VMware Solution Exchange.



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About VMware Tools

VMware Tools is a set of features that enhance the performance of a VM's guest operating system.

Benefits and features include:

- Device drivers
 - SVGA display
 - VMXNET/VMXNET3
 - Balloon driver for memory management
 - Sync driver for quiescing I/O
- Increased graphics performance
- Improved mouse performance
- Guest OS heartbeat service
- Time synchronization
- Ability to shut down the VM



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Virtual Machine Hardware



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Virtual Machine Encapsulation

vSphere encapsulates each VM into a set of VM files.

VM files are stored in directories on a VMFS, NFS, vSAN, or vSphere Virtual Volumes datastore.

VM1

VM2

VM3

APP
OS

APP
OS

APP
OS

VM1

VM2

VM3

Datastore:
VMFS, NFS,
vSAN, or
vSphere Virtual
Volumes

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About Virtual Machine Files

A VM includes a set of related files.

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VM Folder

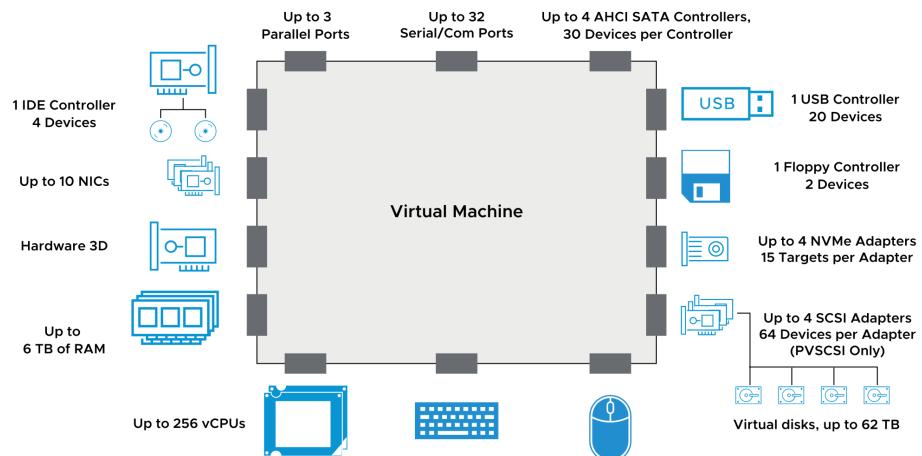
Configuration file	VM_name.vmx
Swap files	VM_name.vswp vmx-VM_name.vswp
BIOS file	VM_name.nvram
Log files	vmware.log
Template configuration file	VM_name.vmtx
Disk descriptor file	VM_name.vmdk
Disk data file	VM_name-flat.vmdk
Suspend state file	VM_name-.vmss

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About VM Virtual Hardware

A VM uses virtual hardware.



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Virtual Hardware Versions

The virtual hardware version, or VM compatibility level, determines the operating system functions that a VM supports.

Do not use a later version that is not supported by the VMware product.

Compatibility	Virtual Hardware Version
ESXi 7.0	17
ESXi 6.7 U2 and later	15
ESXi 6.7 and later	14
ESXi 6.5 and later	13
ESXi 6.0 and later	11

* Virtual hardware versions 12 and 16 are specific to Workstation and Fusion Pro.



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About CPU and Memory

You can add, change, or configure CPU and memory resources to improve VM performance. The maximum number of virtual CPUs (vCPUs) that you can assign to a VM depends on the following factors:

- The number of logical CPUs on the host
- The type of installed guest operating system

A VM running on an ESXi 7.x host can have up to 256 vCPUs.

The maximum memory size of a VM depends on the VM's compatibility setting.

The maximum memory size of a VM with ESXi 7.0 compatibility running on ESXi 7.0 is 6 TB.



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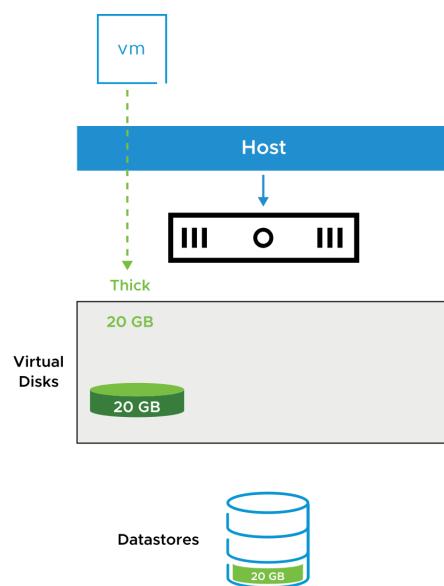
About Thick-Provisioned Virtual Disks

Thick provisioning uses all the defined disk space at the creation of the virtual disk.

VM disks consume all the capacity, as defined at creation, regardless of the amount of data in the guest operating system file system.

Thick-provisioned disk types are eager zeroed or lazy zeroed:

- In an eager-zeroed thick-provisioned disk, every block is prefilled with a zero.
- In a lazy-zeroed thick-provisioned disk, every block is filled with a zero when data is written to the block.



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About Thin-Provisioned Virtual Disks

With thin provisioning, VMs use storage space as needed:

- Virtual disks consume only the capacity needed to hold the current files.
- A VM sees the full allocated disk size at all times.

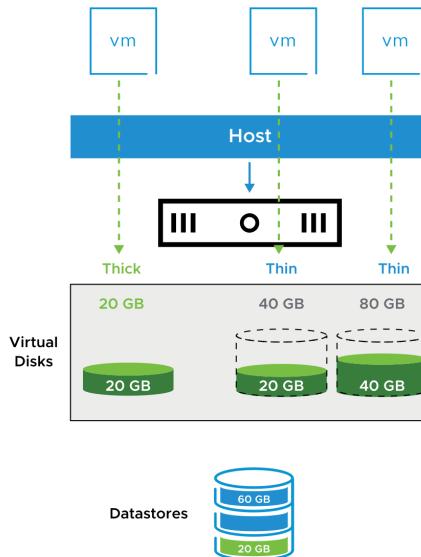
Run the `unmap` command to reclaim unused space from the array.

Reporting and alerts help manage allocations and capacity.

You can mix thick and thin formats.

More efficient use of storage, for example:

- Provisioned space for virtual disks: 140 GB
- Available datastore capacity: 100 GB
- Used datastore capacity: 80 GB



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Thick-Provisioned and Thin-Provisioned Disks

Virtual disk options differ in terms of creation time, block allocation, layout, and zeroing out of allocated file blocks.

	Thick Provisioned Lazy-Zeroed	Thick Provisioned Eager-Zeroed	Thin Provisioned
Creation time	Fast.	Slow and proportional to disk size.	Fastest.
Block allocation	Fully preallocated.	Fully preallocated.	Allocated and zeroed out on demand at first write to block.
Virtual disk layout	Higher chance of contiguous file blocks.	Highest chance of contiguous file blocks.	Layout varies according to the dynamic state of the volume at time of block allocation.
Zeroing out of allocated file blocks	File blocks are zeroed out when each block is first written to.	File blocks are allocated and zeroed out when disk is created.	File blocks are zeroed out when blocks are allocated.

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About Virtual Network Adapters

When you configure a VM, you can add network adapters (NICs) and specify the adapter type. Whenever possible, select VMXNET3.

Network Adapter Type	Description
E1000-E1000E	Emulated version of an Intel Gigabit Ethernet NIC, with drivers available in most newer guest operating systems.
VMXNET3	Available only with VMware Tools.
Flexible	Can function as either a Vlance or VMXNET adapter.
SR-IOV pass-through	Allows VM and physical adapter to exchange data without using the VMkernel as an intermediary.
vSphere DirectPath I/O	Allows VM access to physical PCI network functions on platforms with an I/O memory management unit.
PVRDMA	Paravirtualized device that provides improved virtual device performance. It provides an RDMA-like interface for vSphere guests.



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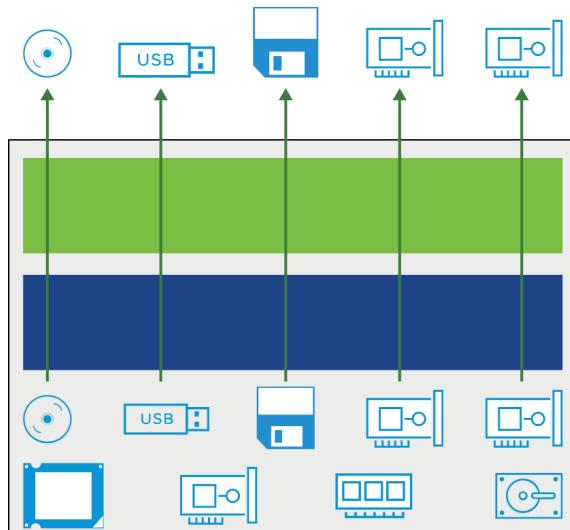
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Other Virtual Devices

A VM must have a vCPU and virtual memory. The addition of other virtual devices makes the VM more useful:

- CD/DVD drive: For connecting to a CD, DVD, or ISO image.
- USB 3.0: Supported with host-connected and client-connected devices on Linux or Windows 8/Server 2012.
- Floppy drive: For connecting a VM to a floppy drive or a floppy image.
- Generic SCSI devices: A VM can be connected to additional SCSI adapters.
- vGPUs: A VM can use GPUs on the physical host for high-computation activities.



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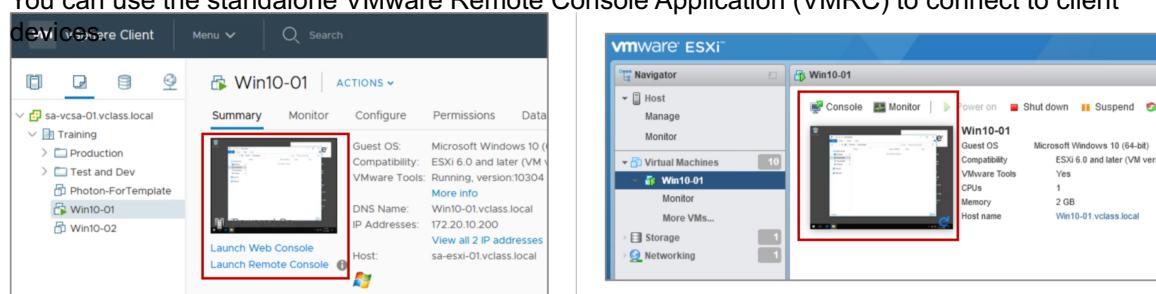
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About the Virtual Machine Console

The VM console provides the mouse, keyboard, and screen features to control the VM.

You can use the standalone VMware Remote Console Application (VMRC) to connect to client devices.



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Introduction to Containers

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Traditional Application Development

In data centers, traditional applications are enhanced with modern application capabilities and models. But traditional application development is different from modern application development.

Traditional Application Development	
Waterfall development	Development cycles are relatively long (several months). Requirements can change over time.
Handover to the operations team	The operations team is responsible for the code in production. Training is not provided.
Monolithic applications	All functionality is handled by a single large application. Typically, monolithic applications can only be scaled vertically, not horizontally.
Separate development, staging, and production environments	Inconsistencies between environments occur. Issues in production do not occur during staging.



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Modern Application Development

Modern application development is transforming modern business.

Modern Application Development	
Typically use microservices style architectures.	Monolithic applications are broken into many smaller standalone modular functions or services that make it easier for developers to be innovative when producing and changing code.
Minimize time to market.	Streamline the process of deploying new code into a staging environment for testing. Identify and address bugs almost immediately. Quickly deploy small, incremental changes in the production environment and easily withdraw if problems arise.
Deliver updates and features quickly.	Minimize the time it takes to build, test, and release new features.
Increase product quality and avoid risk.	Automate tests, get user feedback, and improve software iteratively.
Fewer resource requirements and more productivity.	Apply continuous development and continuous integration in small iterations to reduce labor.



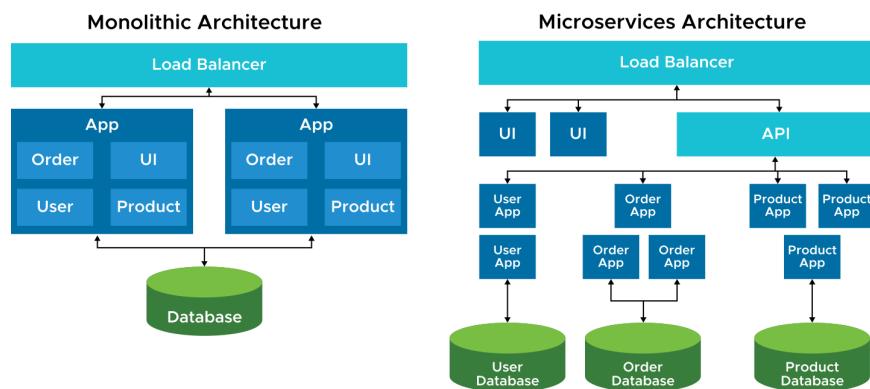
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Benefits of Microservices and Containerization

Containers are an ideal technology for supporting microservices because the goals of containers (lightweight, easily packaged, can run anywhere) align well with the goals of a microservices architecture.



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Container Terminology

Several terms and concepts apply to containers.

Term	Definition
Container	An application packaged with dependencies
Container host	A virtual machine or physical machine on which containers run
Container engine	A runtime engine that manages the containers on the container host
Docker	The most recognized runtime engine for container support, which is often used as a synonym for many aspects of container technologies
Kubernetes	Google-developed orchestration for containers

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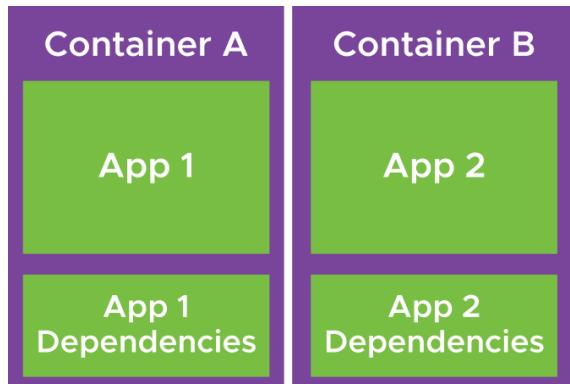
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About Containers

A container is an encapsulation of an application and dependent binaries and libraries. The application is decoupled from the operating system and becomes a serverless function.

Among the reasons that containers were popularized by software developers are:

- They make coding easier, locally and anywhere.
- You can deploy and test applications quickly in a staging environment. No operating system or load is required.



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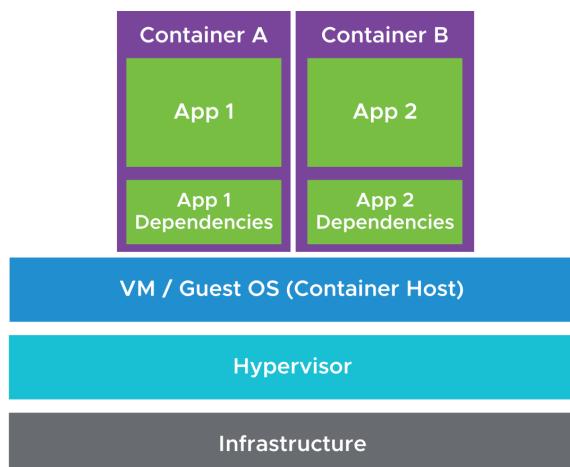
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About Container Hosts

The container host runs the operating system on which the containers run.

Container hosts can be of the following types:

- Standard OS with a container engine installed:
 - Ubuntu with Docker
- OS developed specifically with containers in mind:
 - Photon
 - CoreOS
- Virtual machine or physical machine:
 - Among the many benefits of using VMs are easy management and scalability.



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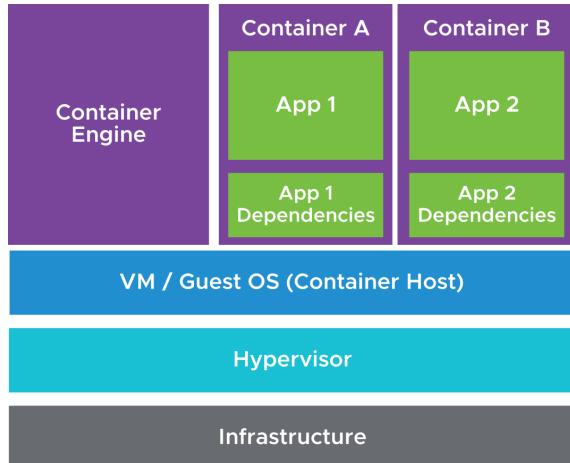
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Container Engines

A container engine is a control plane that is installed on each container host. The control plane manages the containers on that host.

Container engines perform several functions:

- Build container images from source code (for example, Dockerfile). Alternatively, load container images from a repository.
- Create running containers based on a container image.
- Commit a running container to an image.
- Save an image and push it to a repository.
- Stop and remove containers.
- Suspend and restart containers.
- Report container status.



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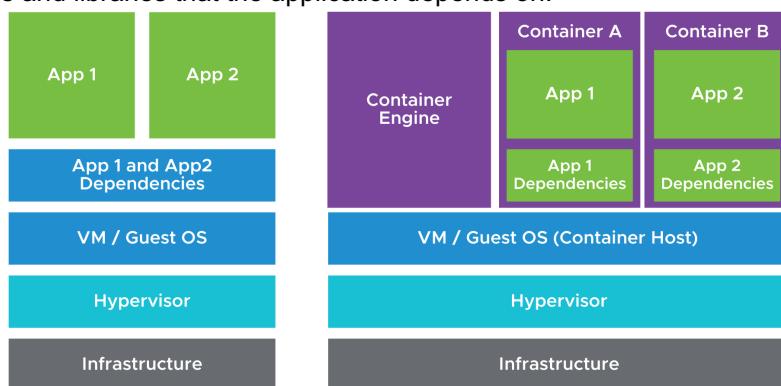
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Virtual Machines and Containers (1)

VMs provide virtual hardware that the guest OS uses to run applications. Multiple applications run on a single VM but they are logically separated and isolated.

With containers, developers take a streamlined base OS file system and layer on only the required binaries and libraries that the application depends on.



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Virtual Machines and Containers (2)

VMs and containers work in different ways.

Virtual Machines	Containers
Encapsulation of an entire operating system	Encapsulation of an application and dependent binaries or libraries
Scheduled by the hypervisor	Scheduled by the container host OS
Run on the hypervisor	Run on the container host OS
Starting a VM means starting an operating system (seconds to minutes)	Starting a container means starting the application process (milliseconds to seconds)



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About Kubernetes

Containers are managed on a single container host. Managing multiple containers across multiple container hosts creates many problems:

- Managing large numbers of containers
- Restarting failed containers
- Scaling containers to meet capacity
- Networking and load balancing

Kubernetes provides an orchestration layer to solve these problems.

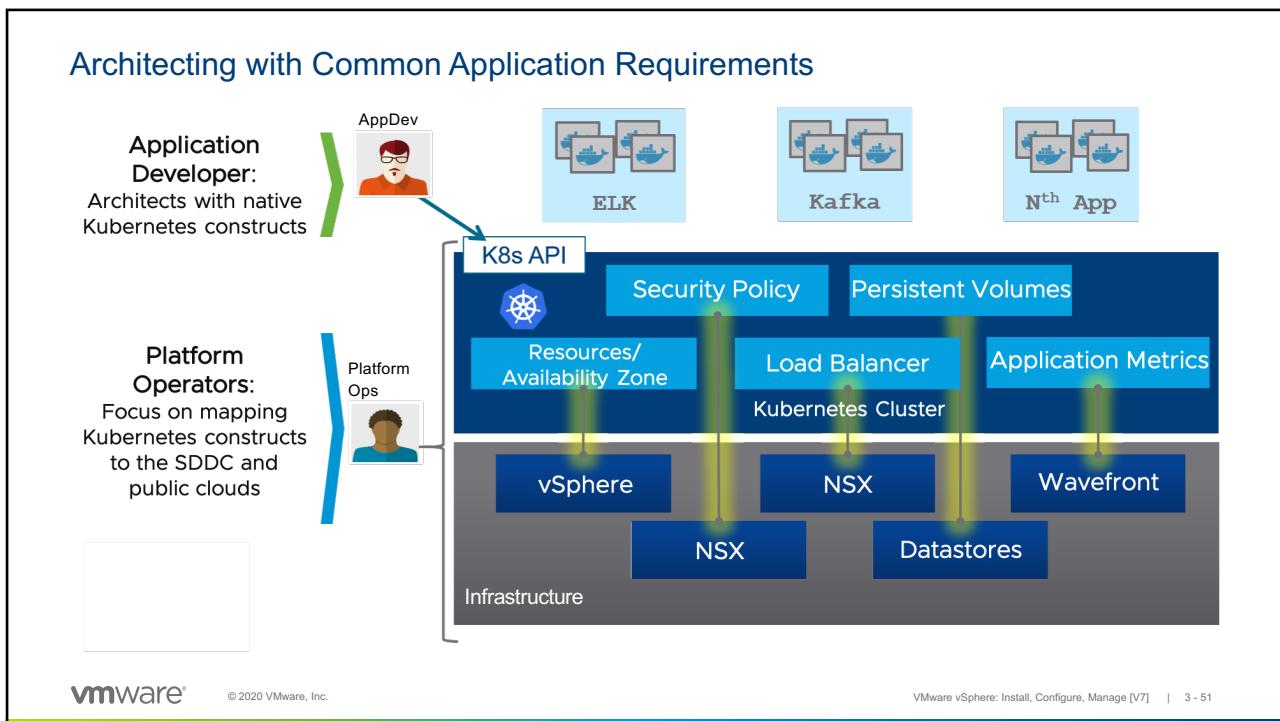
Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications.



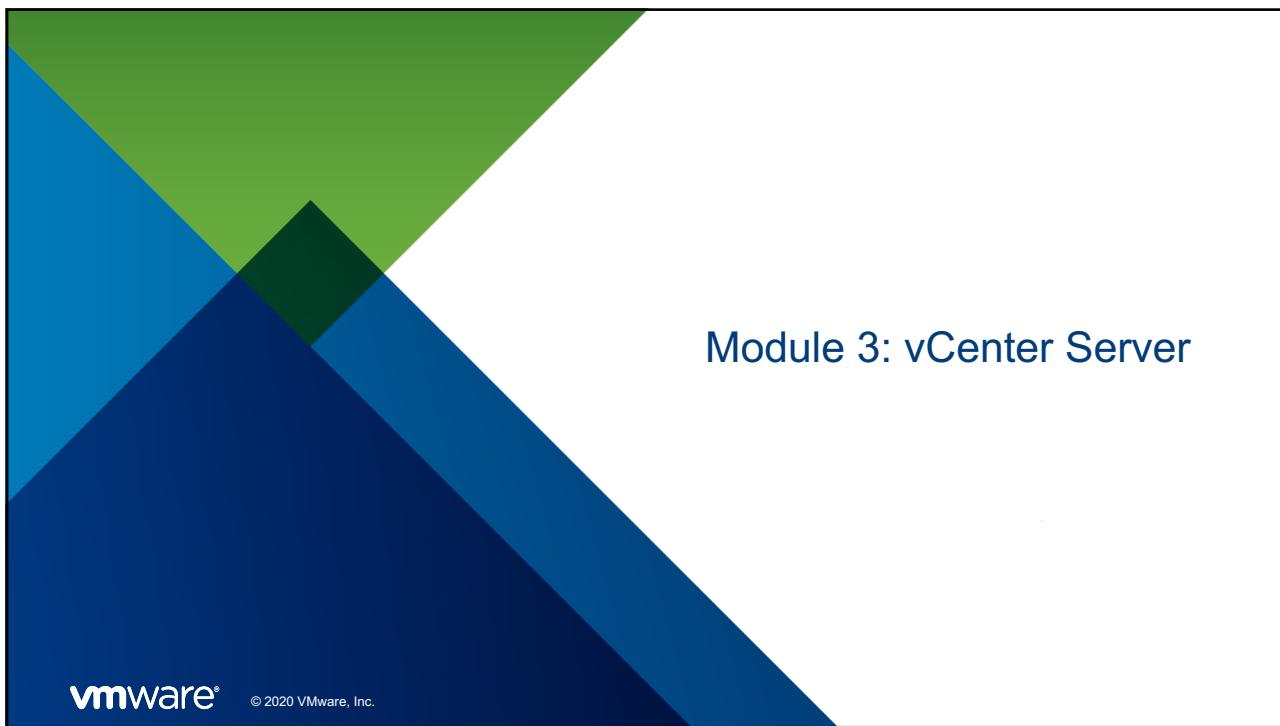
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Centralized Management with vCenter Server

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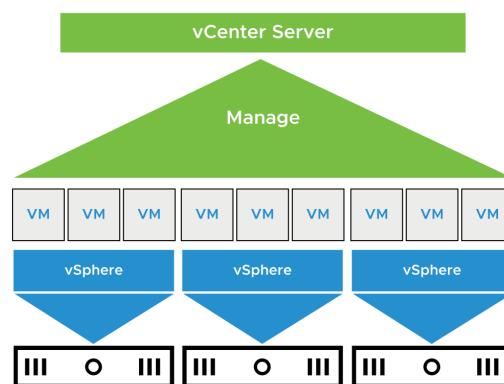
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About the vCenter Server Management Platform

vCenter Server acts as a central administration point for ESXi hosts and virtual machines that are connected in a network:

- Directs the actions of VMs and hosts
- Runs on a Linux-based appliance



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About vCenter Server Appliance

vCenter Server Appliance is a prepackaged Linux-based VM that is optimized for running vCenter Server and associated services.

The vCenter Server Appliance package contains the following software:

- Photon
- PostgreSQL database
- vCenter Server services

During deployment, you can select the vCenter Server Appliance size for your vSphere environment and the storage size for your database requirements.



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vCenter Server Services

vCenter Server services include:

- vCenter Server
- vSphere Client
- vCenter Single Sign-On
- License service
- vCenter Lookup Service
- VMware Certificate Authority
- Content Library
- vSphere ESXi Dump Collector

When you deploy vCenter Server Appliance, all these features are included.

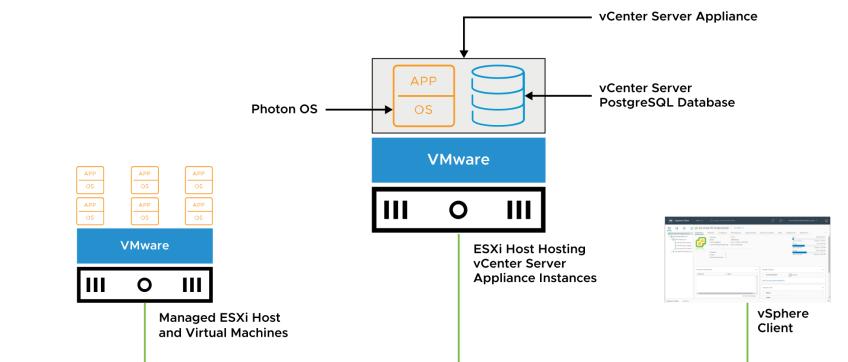
vSphere Appliance Management		Fri 09-30 2020 08:40 PM UTC		Actions	
		RESTART	START	STOP	
	Name	Health	Start Type	State	
Monitor	Appliance Management Service	Automatic	Healthy	Started	
Access	Auto Deploy	Automatic	Healthy	Started	
Networking	Content Library Service	Automatic	Healthy	Started	
Firewall	Etnovy Sidecar Proxy	Automatic	Healthy	Started	
Time	Hybrid vCenter Service	Automatic	Healthy	Started	
Services	ImageBuilder Service	Manual		Stopped	
	License Service	Automatic	Healthy	Started	
Update	Service Control Agent	Automatic	Healthy	Started	
Administration	vAPI Endpoint	Automatic	Healthy	Started	
Syslog	VMware Analytics Service	Automatic	Healthy	Started	
Backup	VMware Appliance Monitoring Service	Automatic	Healthy	Started	
	VMware Certificate Authority Service	Automatic	Healthy	Started	
	VMware Certificate Management Service	Automatic	Healthy	Started	
	VMware ESX Agent Manager	Automatic	Healthy	Started	
	VMware HTTP Reverse Proxy	Automatic	Healthy	Started	
	VMware Infraprofile Service	Automatic	Healthy	Started	
	VMware Lookup Service	Automatic	Healthy	Started	
	VMware Observability Vapi Service	Automatic	Healthy	Started	
	VMware Performance Charts Service	Automatic	Healthy	Started	
	VMware Postgres	Automatic	Healthy	Started	
	VMware Postgres Archiver	Automatic	Healthy	Started	
	VMware PSC Health	Automatic	Healthy	Started	
	VMware Secure Token Service	Automatic	Healthy	Started	
	VMware Service Lifecycle Manager API	Automatic	Healthy	Started	
	VMware Topology Service	Automatic	Healthy	Started	
	VMware Trust Management Service	Automatic	Healthy	Started	
	VMware vCenter High Availability	Disabled		Stopped	
	VMware vCenter Life Cycle Management	Automatic	Healthy	Started	
	VMware vCenter Server	Automatic	Healthy	Started	
	VMware vCenter Services	Automatic	Healthy	Started	

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vCenter Server Architecture

vCenter Server is supported by the vSphere Client, the vCenter Server database, and managed hosts.



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About Enhanced Linked Mode

With Enhanced Linked Mode, you can log in to a single instance of vCenter Server and manage the inventories of all the vCenter Server systems in the group:

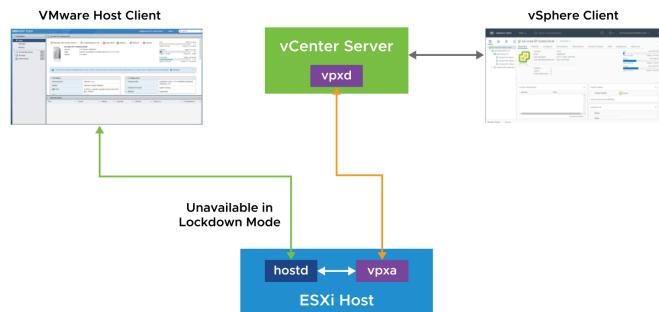
- Up to 15 vCenter Server instances can be linked in one vCenter Single Sign-On domain.
- An Enhanced Linked Mode group can be created only during the deployment of vCenter Server Appliance.

The screenshot shows the vSphere Client interface. On the left, a navigation tree displays two entries under "sa-vcsa-01.vclass.local": "SA-Datacenter-01" and "sa-vcsa-02.vclass.local", both highlighted with a red box. The main pane shows the "Summary" tab for "sa-vcsa-01.vclass.local". It includes details like Version: 7.0.0, Build: 14896559, Last Updated: Oct 11, 2019, 4:09 PM, and a list of resources: Clusters: 1, Hosts: 4, Virtual Machines: 4. On the right, there are performance graphs for CPU, Memory, and Storage usage.

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ESXi and vCenter Server Communication

The vSphere Client communicates directly with vCenter Server. To communicate directly with an ESXi host, you use VMware Host Client.



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vCenter Server Appliance Scalability

Metric	vCenter Server Appliance 7.0
Hosts per vCenter Server instance	2,500
Powered-on VMs per vCenter Server instance	30,000
Registered VMs per vCenter Server instance	35,000
Hosts per cluster	64
VMs per cluster	8,000



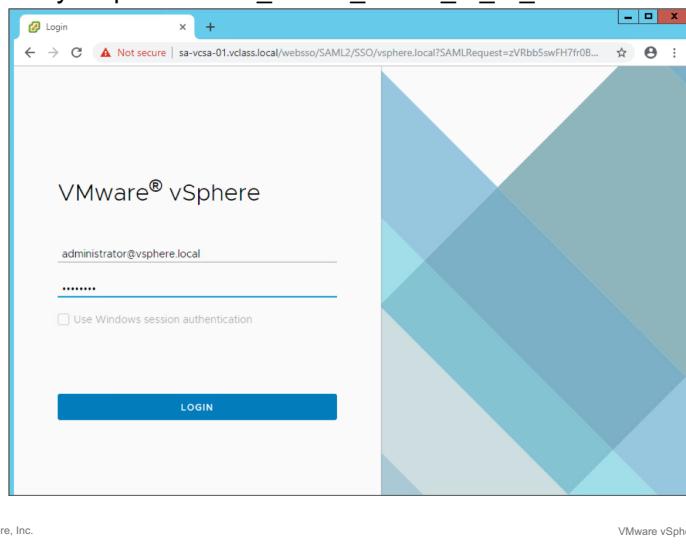
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Getting Started with vCenter Server

After you deploy vCenter Server Appliance, use the vSphere Client to log in and manage your vCenter Server inventory: https://vCenter_Server_FQDN_or_IP_address/ui.

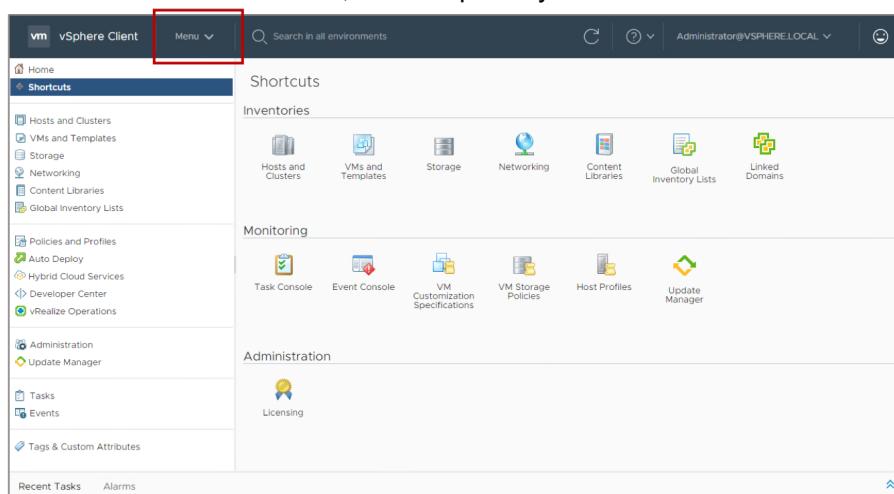


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vSphere Client Shortcuts Page

From the vSphere Client Shortcuts page, you can manage your vCenter Server system inventory, monitor your infrastructure environment, and complete system administration tasks.



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Using the Navigation Pane

You can use the navigation pane to browse and select objects in the vCenter Server inventory.

The screenshot shows the vSphere Client interface. The navigation pane on the left contains a tree view with a red box around it, showing nodes like 'sa-vcsa-01.vclass.local' and 'SA-Datacenter-01'. The main pane displays the summary for the selected host 'sa-vcsa-01.vclass.local'. It includes sections for Summary, Monitor, Configure, Permissions, Datacenters, Hosts & Clusters, VMs, Datastores, Networks, and more. The Summary section shows details such as Version: 7.0.0, Build: 14996559, Last Updated: Oct 11, 2019, 4:09 PM, and Last File-Based Backup: Not scheduled. Resource usage charts show CPU, Memory, and Storage usage. Other sections include Custom Attributes, Health Status (Overall Health: Good), and APPLIANCE MANAGEMENT (vCenter HA: Mode: --, State: --).

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vCenter Server Views for Hosts, Clusters, VMs, and Templates

Host and cluster objects are shown in one view, and VM and template objects are displayed in another view.

Host and Clusters Inventory View

The screenshot shows the vSphere Client interface with the title 'Host and Clusters Inventory View'. The navigation pane on the left contains a tree view with a red box around it, showing nodes like 'sa-esxi-01.vclass.local', 'SA-Datacenter', 'SA-Compute-01', and 'Win10-01' through 'Win10-04'. The main pane displays the summary for the selected host 'sa-esxi-01.vclass.local'. It includes sections for Summary, Monitor, Configure, Permissions, VMs, Datastores, and Networks. The Summary section shows details such as Hypervisor: VMware ESXi 6.7.0_7839586, Model: VMware Virtual Platform, Processor Type: Intel(R) Xeon(R) CPU E5-2680 v2 @ 2.80GHz, and Logical Processors: 4. Resource usage charts show CPU, Memory, and Storage usage. Other sections include Hardware (Manufacturer: VMware, Inc.) and VMware (Version: 7.0.0).

VMs and Templates Inventory View

The screenshot shows the vSphere Client interface with the title 'VMs and Templates Inventory View'. The navigation pane on the left contains a tree view with a red box around it, showing nodes like 'sa-vcsa-01.vclass.local', 'SA-Datacenter', and 'Win10-02'. The main pane displays the configuration for the selected VM 'Win10-02'. It includes sections for Summary, Monitor, Configure, Permissions, Datastores, and Networks. The Configuration section shows details such as CPU (1 CPU(s)), Memory (2 GB, 0 GB memory active), Hard disk 1 (32 GB), Network adapter 1 (Production (disconnected)), Floppy drive 1 (Disconnected), Video card (4 MB), and VMC device (Device on the virtual machine PCI bus that provides support for the virtual machine).

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vCenter Server Views for Storage and Networks

The Storage inventory view shows all the details for datastores in the data center. The Networking inventory view shows all standard switches and distributed switches.

The image contains two screenshots of the vSphere Client interface. The top screenshot, titled 'Storage Inventory View', shows the 'Class-Datastore' summary for 'sa-vcsa-01.vclass.local'. It displays storage usage details: Type: VMFS 5, URL: 05://vmfs/volumes/Sda06f10, Usage: 17.73 GB, Free: 55.75 GB, and Capacity: 55.75 GB. The bottom screenshot, titled 'Network Inventory View', shows the 'Production' summary for 'sa-vcsa-01.vclass.local'. It lists two hosts: 'sa-esxi-01.vclass.local' and 'sa-esxi-02.vclass.local', both connected and in normal status, associated with 'SA-Cluster-01'.

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Viewing Object Information

Because you can view object information and access related objects, monitoring and managing object properties is easy.

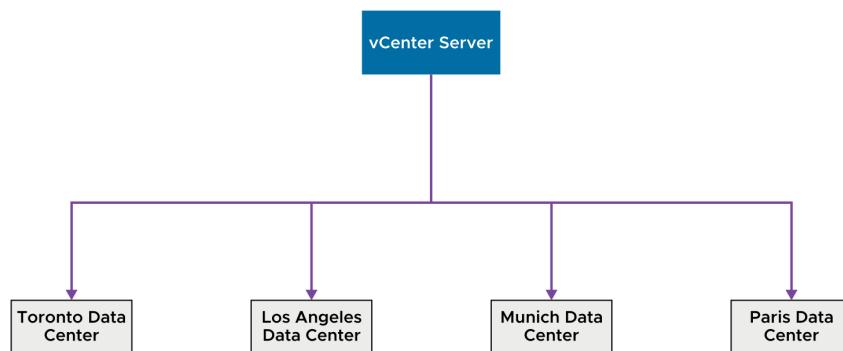
This screenshot shows the 'Summary' tab for the host 'sa-esxi-02.vclass.local'. The host is running VMware ESXi, 7.0.0, 14896552. It has 4 CPUs x 2.1GHz, 1.33 GB / 16 GB memory, and 0 B / 0 B Virtual Flash Resource. In the Configuration section, it shows an Image Profile of '(Updated) ESXi-7.0.0-14896552-standard', vSphere HA State as Running (Master), and Fault Tolerance set to Unsupported (Legacy). The hardware section lists the manufacturer as VMware, Inc., model as VMware Virtual Platform, and logical processors as 4.

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About Data Center Objects

A virtual data center is a logical organization of all the inventory objects required to complete a fully functional environment for operating VMs:

- You can create multiple data centers to organize sets of environments.
- Each data center has its own hosts, VMs, templates, and datastores, and networks.



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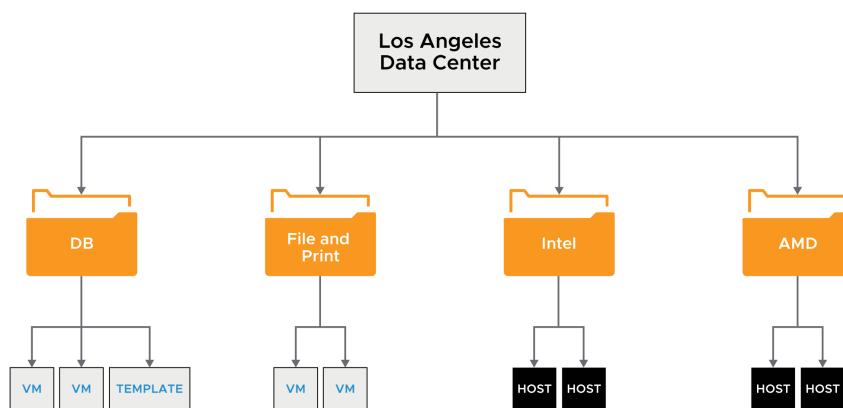
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Organizing Inventory Objects into Folders

Objects in a data center can be placed into folders. You can create folders and subfolders to better organize systems.



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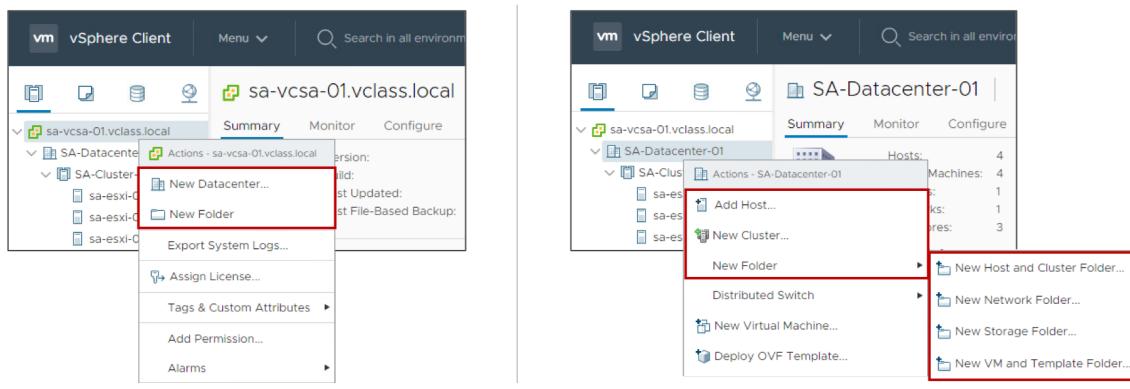
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Adding a Data Center and Organizational Objects to vCenter Server

You can add a data center, a host, a cluster, and folders to vCenter Server.

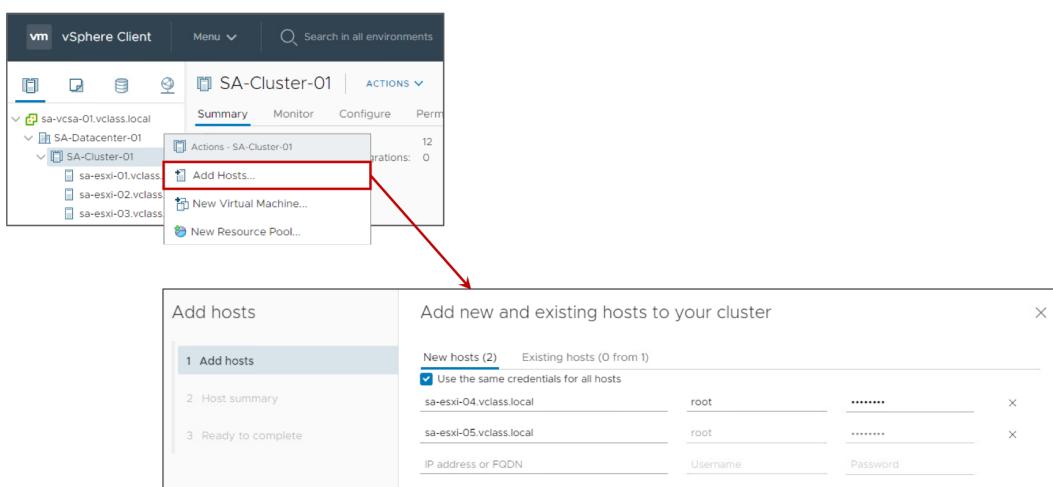
You can use folders to group objects of the same type for easier management.



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Adding ESXi Hosts to vCenter Server

You can add ESXi hosts to vCenter Server using the vSphere Client.



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Backing Up and Restoring vCenter Server Appliance

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About vCenter Server Backup and Restore

vCenter Server backup and restore operations protect data. These operations work in the following ways:

- Use the vCenter Server Appliance Management Interface
- Remove dependency on third-party backup solutions
- Support FTPS, HTTP, HTTPS, SFTP, FTP, NFS, and SMB
- Include the option to encrypt backups
- Restore directly from the vCenter Server Appliance GUI installer
- Restore a vCenter Server instance to a brand-new appliance

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Methods for vCenter Server Appliance Backup and Restore

You can use different methods to back up and restore vCenter Server Appliance:

- File-based backup and restore:
 - Use the vCenter Server Appliance Management Interface to create a file-based backup.
 - Restore the backup through the GUI installer of the appliance.
 - Schedule the file-based backup and restore.
- Image-based backup and restore:
 - Use vSphere Storage APIs - Data Protection with a third-party backup product to perform centralized, efficient, off-host, LAN-free backups.



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File-Based Backup of vCenter Server Appliance

You can perform a file-based backup manually.

Backup Now

Use backup location and user name from backup schedule

Backup location

Backup server credentials

User name	<input type="text" value="root"/>
Password	<input type="password" value="*****"/>
Encryption Password	<input type="password"/>
Confirm Password	<input type="password"/>

Encrypt backup (optional)

DB Health Check Enable

Data

<input checked="" type="checkbox"/> Stats, Events, and Tasks	39 MB
<input checked="" type="checkbox"/> Inventory and configuration	201 MB
Total size (compressed) 240 MB	

CANCEL **START**



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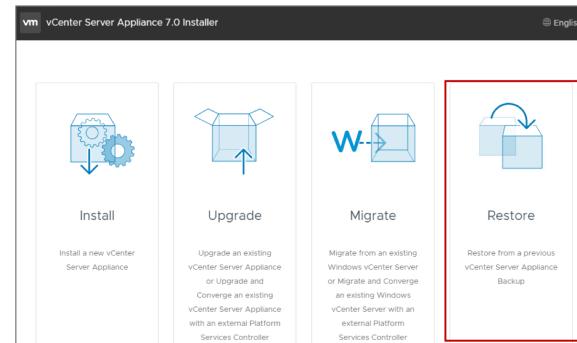
File-Based Restore of vCenter Server Appliance

Use the vCenter Server Appliance GUI installer to restore a vCenter Server Appliance to an ESXi host or a vCenter Server instance.

The restore procedure occurs in stages:

1. A new appliance is deployed.
2. The newly deployed vCenter Server Appliance is populated with the data stored in the file-based backup.

When you use the file-based restore method, reconciliation is automatically performed.



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Scheduling Backups

You can schedule automatic file-based backups.

The backup scheduler supports:

- A retention policy to keep all backups or a defined number of backups
- Daily, weekly, or custom schedule

Failed backups trigger an alarm in the vSphere Client.

The screenshot shows the 'Appliance Management' interface with the 'Backup' tab selected. On the left, there's a sidebar with various management options like Summary, Monitor, Access, Networking, Firewall, Time, Services, Update, Administration, Syslog, and Backup. The 'Backup' option is highlighted. In the main area, a message box states: 'Before taking a backup, a backup server must be set up and configured such that the appliance has access to it. The protocols supported for backup are SFTP, HTTPS, SFTP, FTP, NFS, SMB and HTTP.' Below this is a 'Backup Schedule' section with a 'CONFIGURE' button, which is highlighted with a red box and an arrow points to it. The 'Create Backup Schedule' dialog box is open, showing fields for 'Backup location' (ftp://sa-ftp-01.vclass.local/backups/nyc), 'Backup server credentials' (User name: root, Password: [redacted]), 'Schedule' (Daily at 11:59 P.M. Etc/UTC), 'Encrypt backup (optional)', 'DB Health Check' (Enable checked), and 'Number of backups to retain' (Retain all backups selected). At the bottom of the dialog are 'CANCEL' and 'CREATE' buttons.

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Monitoring vCenter Server Appliance

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vCenter Server Events

The vCenter Server events and audit trails allow selectable retention periods in increments of 30 days:

- User-action information includes the user's account and specific event details.
- All actions are reported, including file ID, file path, source of operation, operation name, and date and time of operation.
- Events and alarms are displayed to alert the user to changes in the vCenter Server service health or when a service fails.

The screenshot shows the vSphere Client interface with the 'Issues and Alarms' tab selected. A single event is highlighted with a red border:

Description	Type	Date Time	User
Host is not responding	Error	11/5/2019, 1:31:32 AM	sa-esxi-01

Below the table, a message box displays the event details:

Description:
11/5/2019, 1:31:32 AM Host sa-esxi-01.vclass.local in SA-Datacenter-01 is not responding
Event Type Description:
Connection to the host has been lost

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About Log Levels

You can set log levels to control the quantity and type of information logged.

Examples of when to set log levels:

- When troubleshooting complex issues, set the log level to verbose or trivia. Troubleshoot and set it back to info.
- To control the amount of information being stored in the log files.

Option	Description
None	Turns off logging
Error (errors only)	Displays only error log entries
Warning (errors and warnings)	Displays warning and error log entries
Info (normal logging)	Displays information, error, and warning log entries
Verbose	Displays information, error, warning, and verbose log entries
Trivia (extended verbose)	Displays information, error, warning, verbose, and trivia log entries



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Setting Log Levels

You can configure the amount of detail that vCenter Server collects in log files:

- You can edit the log levels in the vSphere Client.
- More verbose logging requires more space on your vCenter Server system.

The screenshot shows the vSphere Client interface for managing a vCenter Server named 'sa-vcsa-01.vclass.local'. In the left navigation pane, the 'General' settings under 'VCenter Server Settings' are selected. On the right, the 'Edit vCenter general settings' dialog is open, specifically showing the 'Logging settings' section. The 'Log level' dropdown menu is displayed, with 'info' highlighted as the current selection. Other options in the dropdown include 'none', 'error', 'warning', 'verbose', and 'trivia'.

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Forwarding vCenter Server Appliance Log Files to a Remote Host

vCenter Server and ESXi can stream their log information to a remote Syslog server:

- You can enable this feature in the vCenter Server Appliance Management Interface.
- With this feature, you can further analyze vCenter Server Appliance log files with log analysis products, such as vRealize Log Insight.

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Monitoring vCenter Server Appliance

The vCenter Server Appliance Management Interface has a built-in monitoring interface.

CPU & Memory provides a historical view of CPU and memory use.

Summary	CPU & Memory	Disk	Network Database
Monitor			
Access			
Networking			
Firewall			
Time			
Services			
Update			
Administration			
Syslog			
Backup			

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The vCenter Server Appliance disks can be monitored for available space.



86

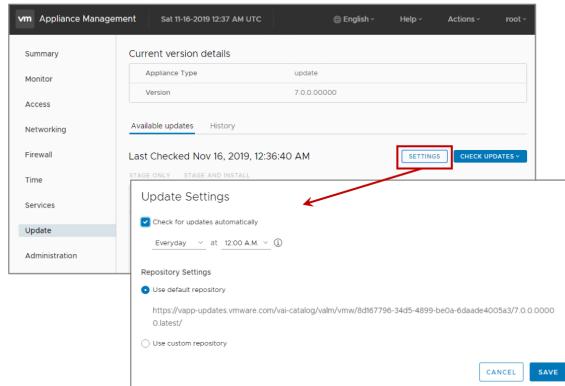
43

Monthly Patch Updates for vCenter Server Appliance

VMware provides monthly security patches for vCenter Server Appliance:

- Critical vulnerability patches are delivered on a monthly release cycle.
- Important or low vulnerabilities are delivered with the next available vCenter Server patch or update.

You can configure the vCenter Server Appliance to perform automatic checks for available patches in the configured repository URL at a regular interval.



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vCenter Server High Availability

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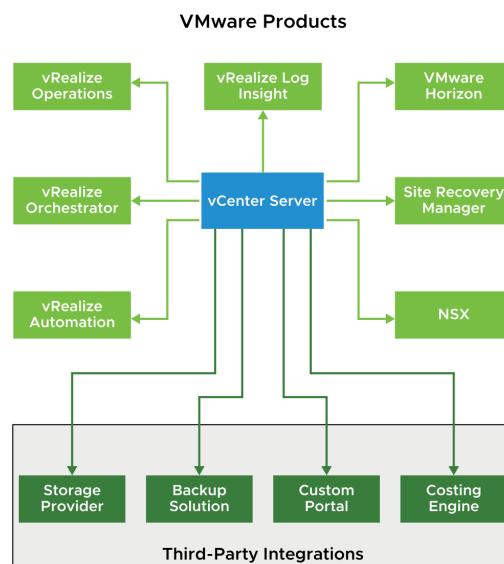
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Importance of Keeping vCenter Server Highly Available

High availability is an important characteristic for many VMware and third-party solutions that depend on vCenter Server as the primary management platform:

- vCenter Server is the foundation for the virtual desktop infrastructure.
- Backup and disaster recovery solutions rely on vCenter Server.



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89

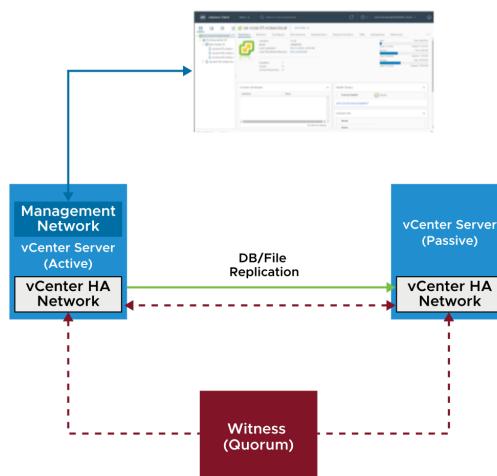
About vCenter Server High Availability

vCenter Server High Availability protects vCenter Server Appliance against both hardware and software failures.

vCenter Server High Availability forms a cluster of nodes:

- Active node: Runs the active vCenter Server Appliance instance
- Passive node: Automatically takes over the role of the Active node if a failure occurs
- Witness node: Provides a quorum to protect against a split-brain situation

vCenter Server High Availability is built in to vCenter Server Appliance and is included with the standard license.



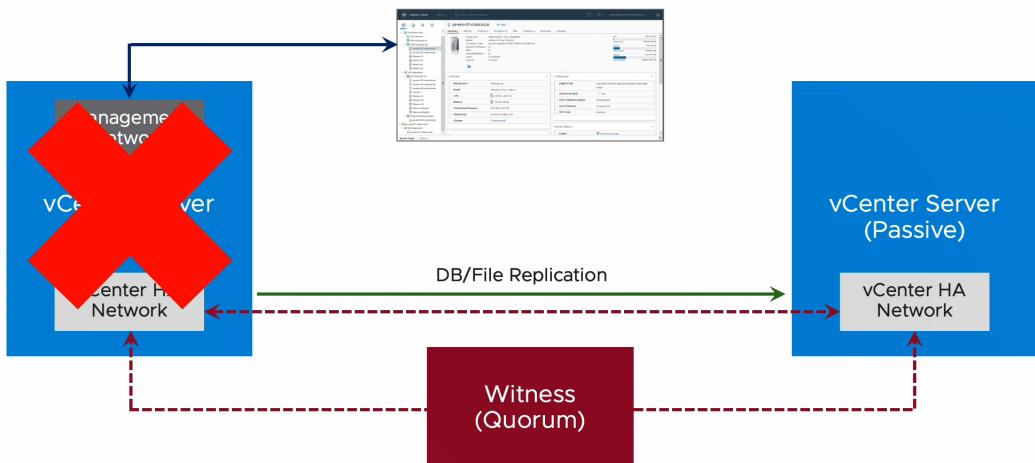
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Scenario: Active Node Failure

If the active node fails, the passive node takes over the role of the active node. The cluster is considered to be running in a degraded state.



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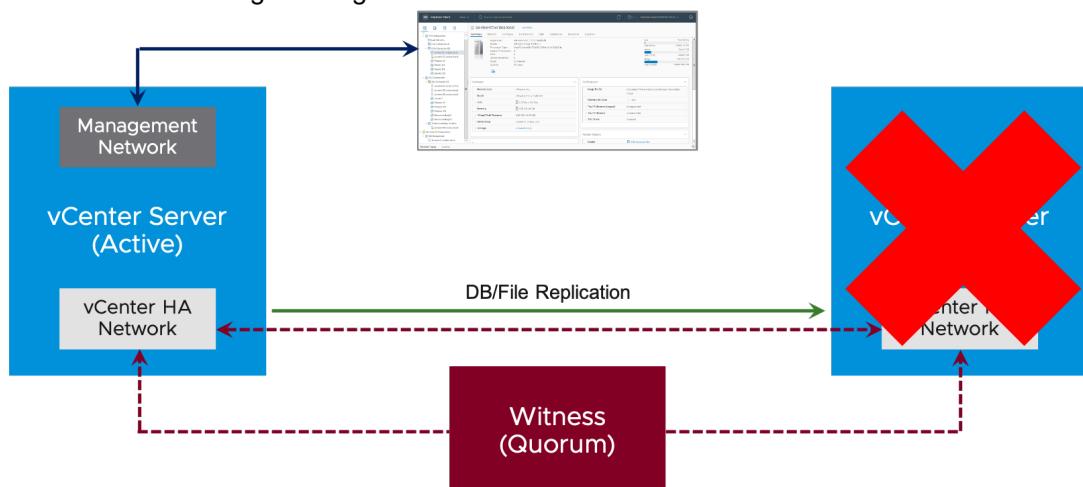
| 4 - 94



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Scenario: Passive Node Failure

If the passive node fails, the active node continues to operate normally. However, the cluster is considered to be running in a degraded state.



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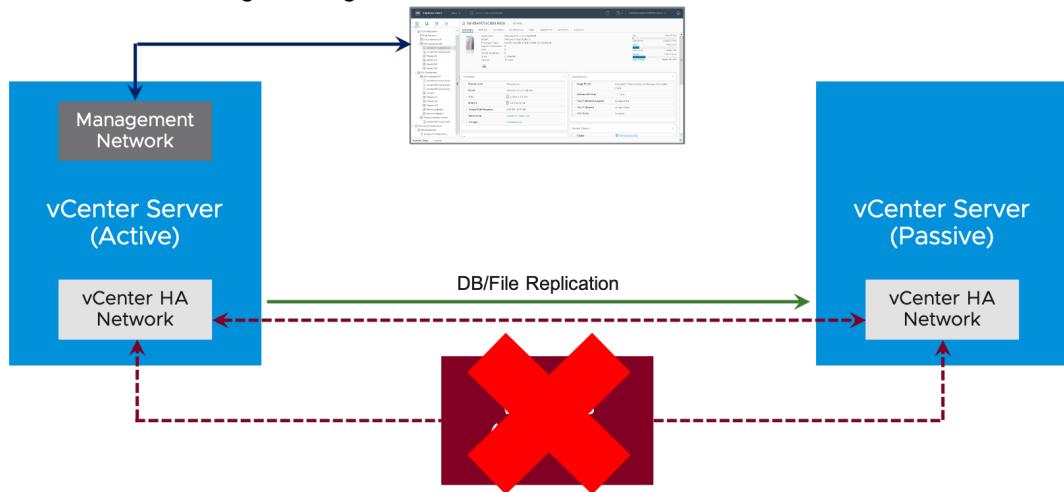
|

4 - 95

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Scenario: Witness Node Failure

If the witness node fails, the active node continues to operate normally. However, the cluster is considered to be running in a degraded state.



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Benefits of vCenter Server High Availability

vCenter Server High Availability provides many benefits:

- vCenter Server Appliance is made more resilient.
- Protection against hardware, host, and application failures is provided.
- Recovery occurs in minutes. End-to-end downtime is minimized.
- Active-passive architecture provides transparent failover:
 - Recovery point objective: No data loss.
 - Recovery time objective: Within minutes.
- One-click automated high availability is set up.
- Nodes can be geographically distant.
- No shared storage is required.
- No third-party technologies are required.

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Module 4: Configuring and Managing Virtual Networks

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Introduction to vSphere Standard Switches

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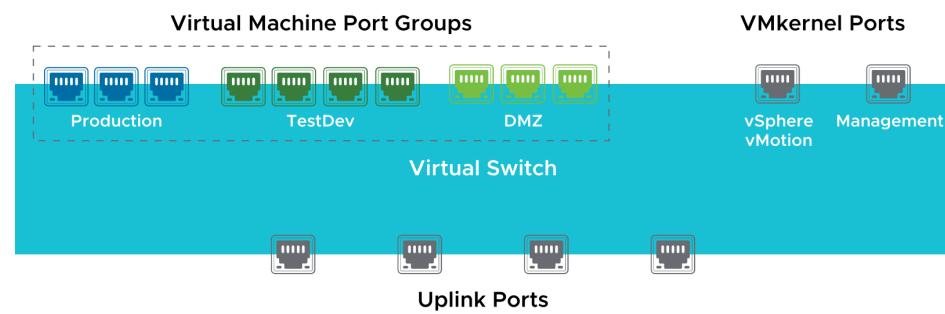
96

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Types of Virtual Switch Connections

A virtual switch has specific connection types:

- VM port groups
- VMkernel port: For IP storage, vSphere vMotion migration, vSphere Fault Tolerance, vSAN, vSphere Replication, and the ESXi management network
- Uplink ports



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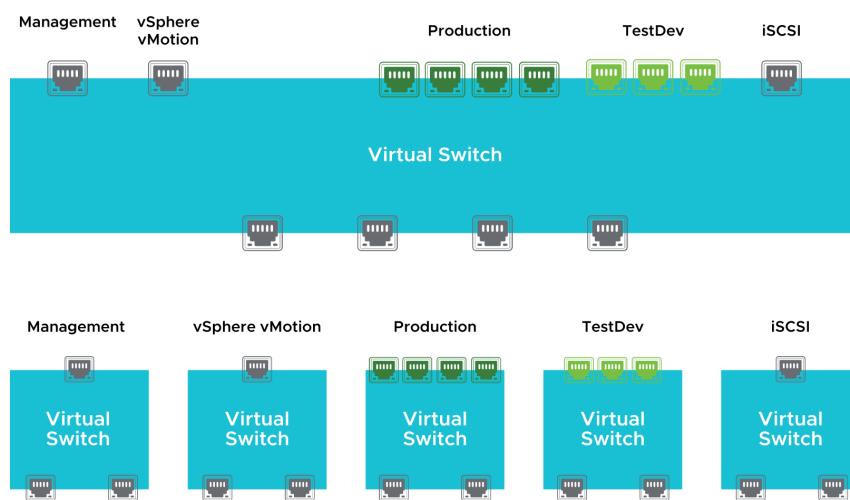
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Virtual Switch Connection Examples

More than one network can coexist on the same virtual switch or on separate virtual switches.



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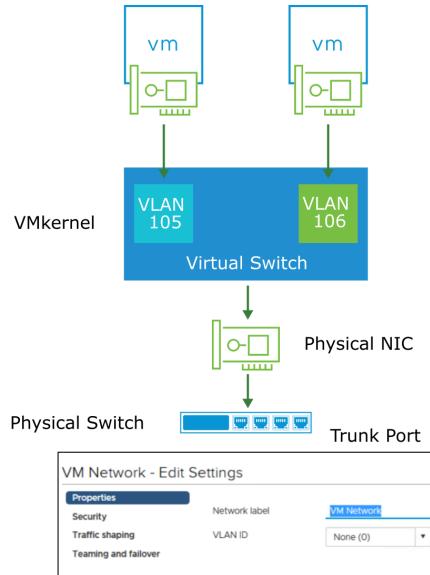
98

About VLANs

ESXi supports 802.1Q VLAN tagging. Virtual switch tagging is one of the supported tagging policies:

- Frames from a VM are tagged as they exit the virtual switch.
- Tagged frames arriving at a virtual switch are untagged before they are sent to the destination VM.
- The effect on performance is minimal.

ESXi provides VLAN support by assigning a VLAN ID to a port group.



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Types of Virtual Switches

A virtual network supports standard and distributed switches. Both switch types are elastic: Ports are created and removed automatically.

- Standard switch:
 - Virtual switch that is configured for a single host.
- Distributed switch:
 - Virtual switch that is configured for an entire data center.
 - Up to 2,000 hosts can be attached to the same distributed switch.
 - The configuration is consistent across all attached hosts.
 - Hosts must either have an Enterprise Plus license or belong to a vSAN cluster.

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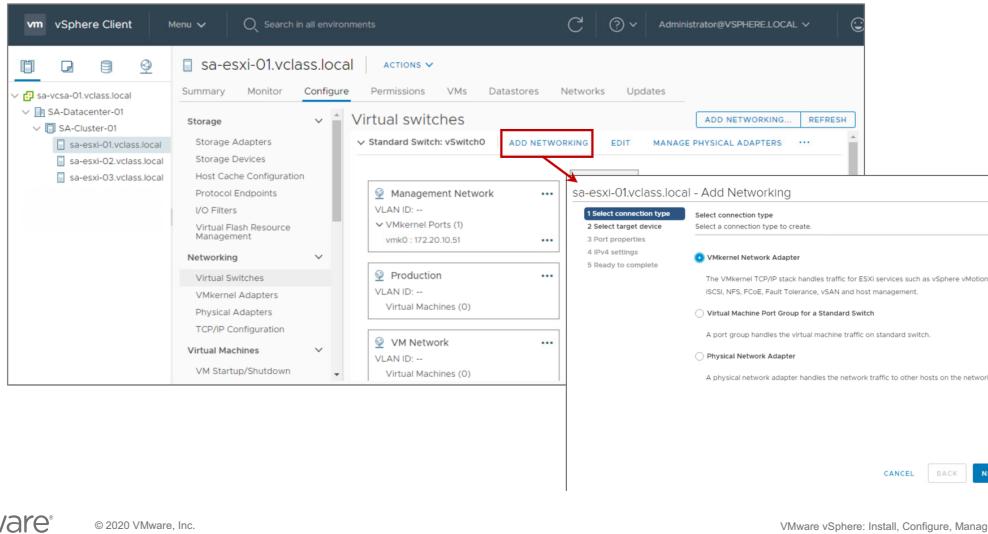
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Adding ESXi Networking

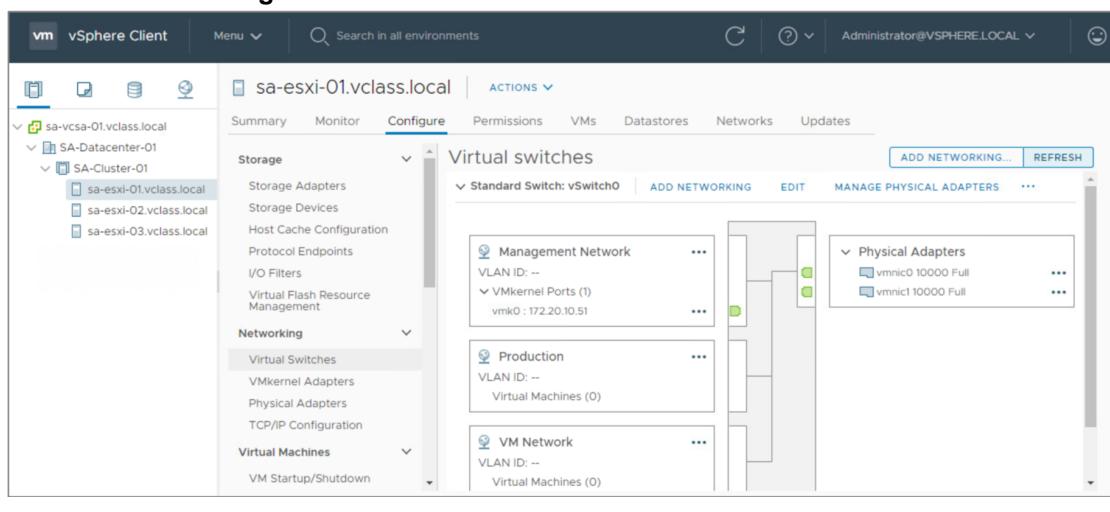
You can add new standard switches to an ESXi host or configure existing ones using the vSphere Client or VMware Host Client.



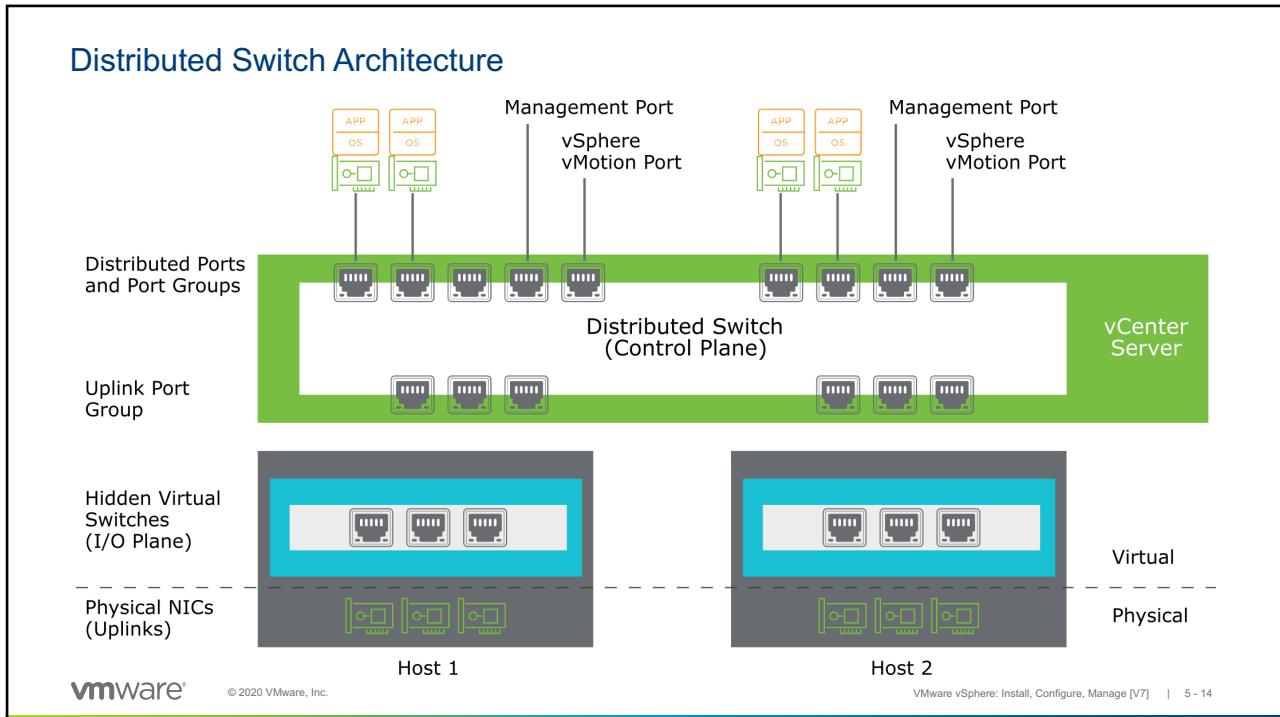
101

Viewing the Configuration of Standard Switches

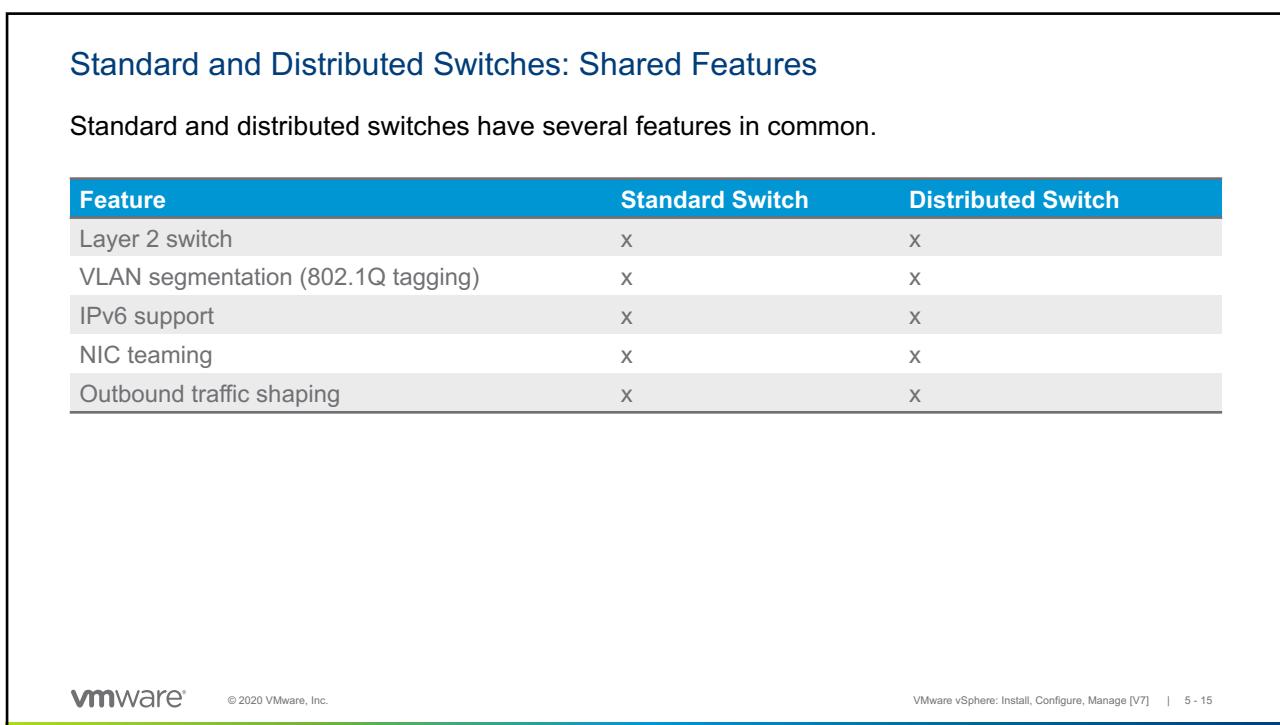
In the vSphere Client, you can view a host's standard switch configuration by selecting **Virtual Switches** on the **Configure** tab.



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Additional Features of Distributed Switches

Distributed switches include several features that are not part of standard switches.

Feature	Standard Switch	Distributed Switch
Inbound traffic shaping	X	
VM network port block	X	
Private VLANs	X	
Load-based teaming	X	
Data center level management	X	
vSphere vMotion migration of virtual networking state	X	
Per-port policy settings	X	
Port state monitoring of network statistics	X	
NetFlow	X	
Port mirroring	X	
Access to NSX-T port groups	X	



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Module 5: Configuring and Managing Virtual Storage



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Storage Concepts

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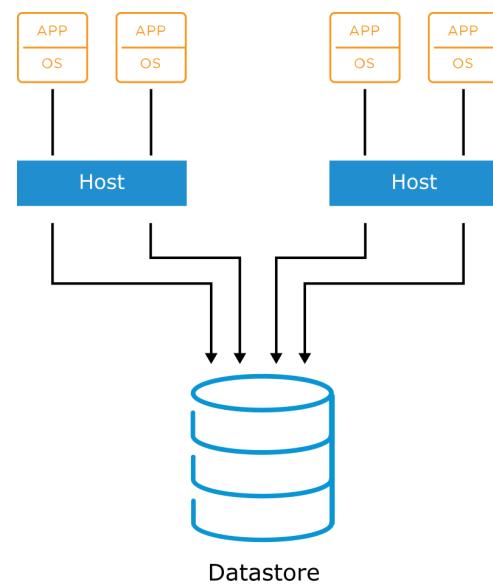
About Datastores

A datastore is a logical storage unit that can use disk space on one physical device or span several physical devices.

Datastores are used to hold VM files, VM templates, and ISO images.

vSphere supports the following types of datastores:

- VMFS
- NFS
- vSAN
- vSphere Virtual Volumes



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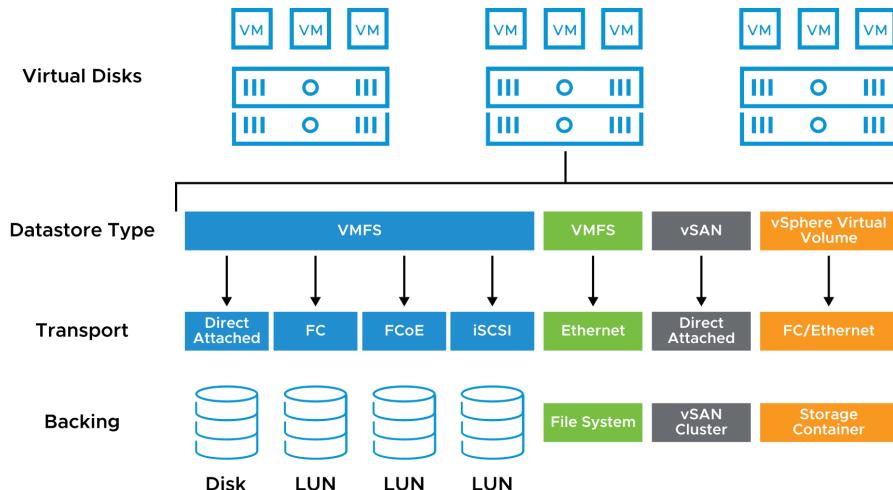
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Storage Overview

ESXi hosts should be configured with shared access to datastores.



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Storage Protocol Overview

Each datastore uses a protocol with varying support features.

Datastore Type	Storage Protocol	Boot from SAN Support	vSphere vMotion Support	vSphere HA Support	vSphere DRS Support
VMFS	Fibre Channel	●	●	●	●
	FCoE	●	●	●	●
	iSCSI	●	●	●	●
NFS	NFS		●	●	●
Local-Attached	DAS		●		
vSphere Virtual Volumes	FC/ Ethernet		●	●	●
vSAN			●	●	●

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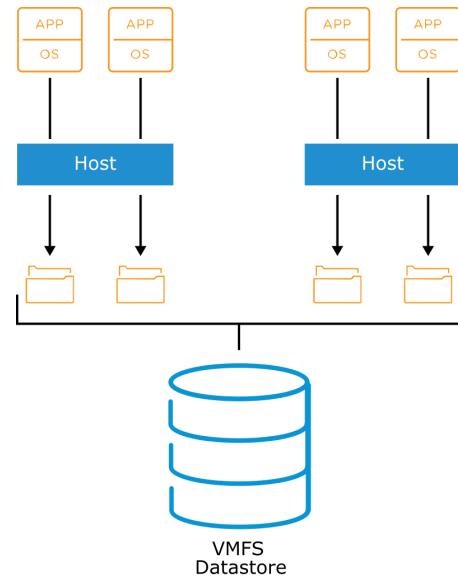
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About VMFS

ESXi hosts support VMFS5 and VMFS6:

- Features supported by both VMFS5 and VMFS6:
 - Concurrent access to shared storage
 - Dynamic expansion
 - On-disk locking
- Features supported by VMFS6:
 - 4K native storage devices
 - Automatic space reclamation



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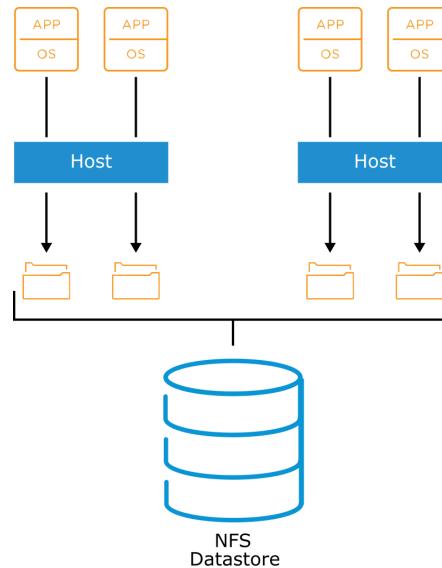
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About NFS

NFS is a file-sharing protocol that ESXi hosts use to communicate with a network-attached storage (NAS) device.

NFS supports NFS version 3 and 4.1 over TCP/IP.



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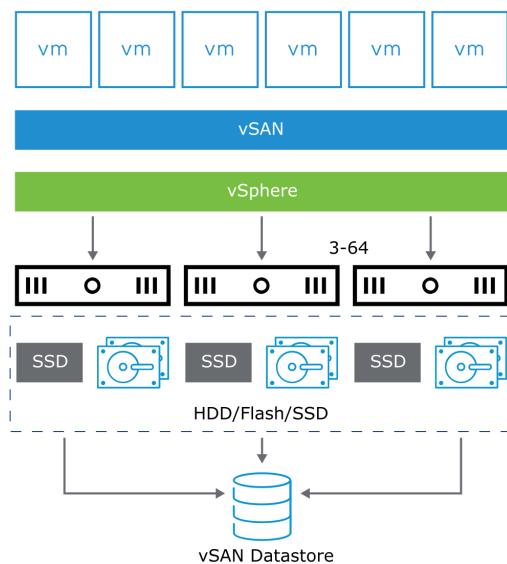
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About vSAN

vSAN is hypervisor-converged, software-defined storage for virtual environments that does not use traditional external storage.

By clustering host-attached hard disk drives (HDDs) or solid-state drives (SSDs), vSAN creates an aggregated datastore shared by VMs.



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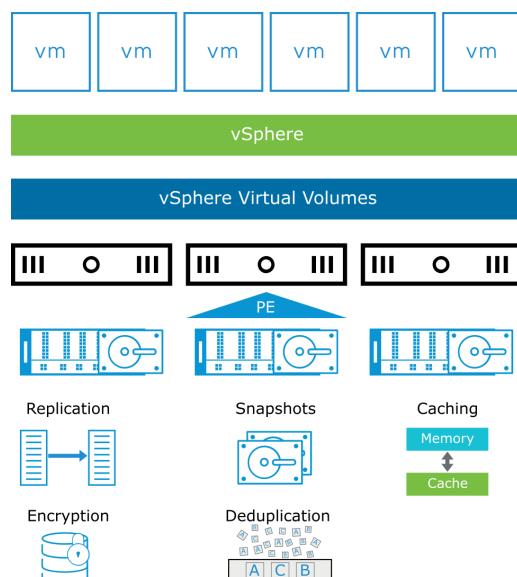
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About vSphere Virtual Volumes

vSphere Virtual Volumes provides several functionalities:

- Native representation of VMDKs on SAN/NAS: No LUNs or volume management
- Works with existing SAN/NAS systems
- A new control path for data operations at the VM and VMDK level
- Snapshots, replications, and other operations at the VM level on external storage
- Automates control of per-VM service levels
- Standard access to storage with the vSphere API for Storage Awareness protocol endpoint
- Storage containers that span an entire array



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Module 6: Virtual Machine Management

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Creating Templates and Clones

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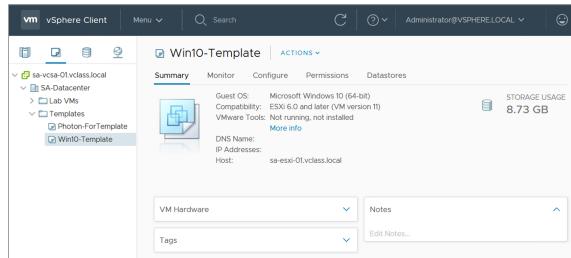
116

About Templates

A template is a master copy of a virtual machine. You use templates to create and provision new VMs.

A template typically includes:

- A guest operating system
- One or more applications
- A specific VM configuration



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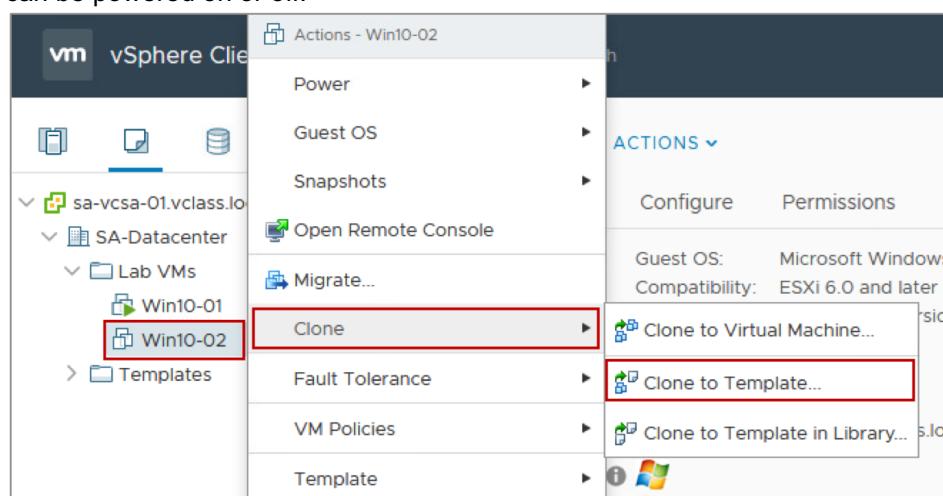
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Creating a Template: Clone VM to Template

You can create templates using different methods. One method is to clone the VM to a template. The VM can be powered on or off.



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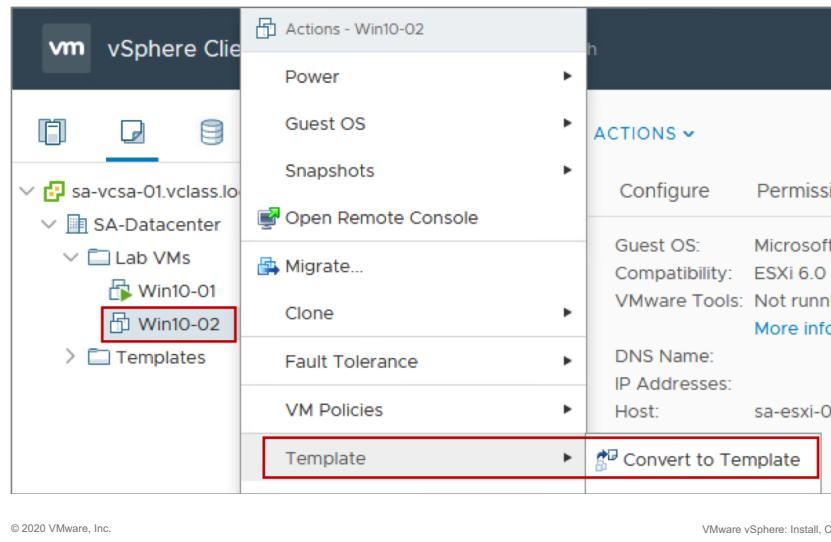
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Creating a Template: Convert VM to Template

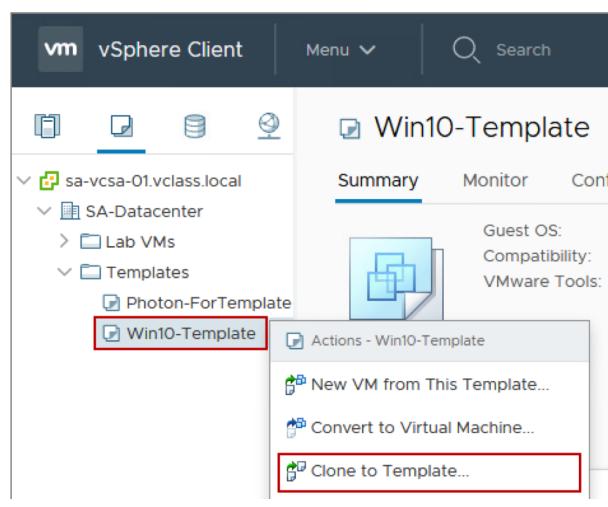
You can create a template by converting a VM to a template. In this case, the VM must be powered off.



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Creating a Template: Clone a Template

You can create a template from an existing template, or clone a template.



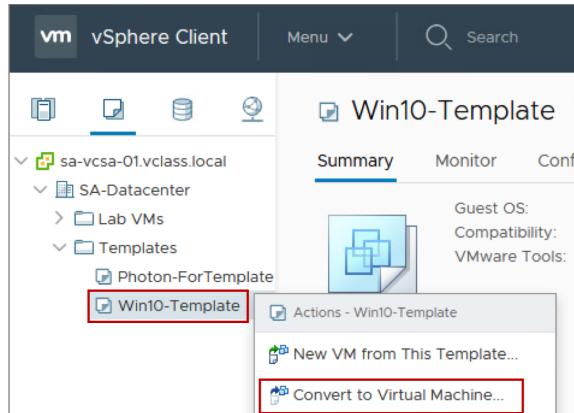
120

Updating Templates

You update a template to include new patches, make system changes, and install new applications.

To update a template:

1. Convert the template to a VM.
2. Place the VM on an isolated network to prevent user access.
3. Make appropriate changes to the VM.
4. Convert the VM to a template.



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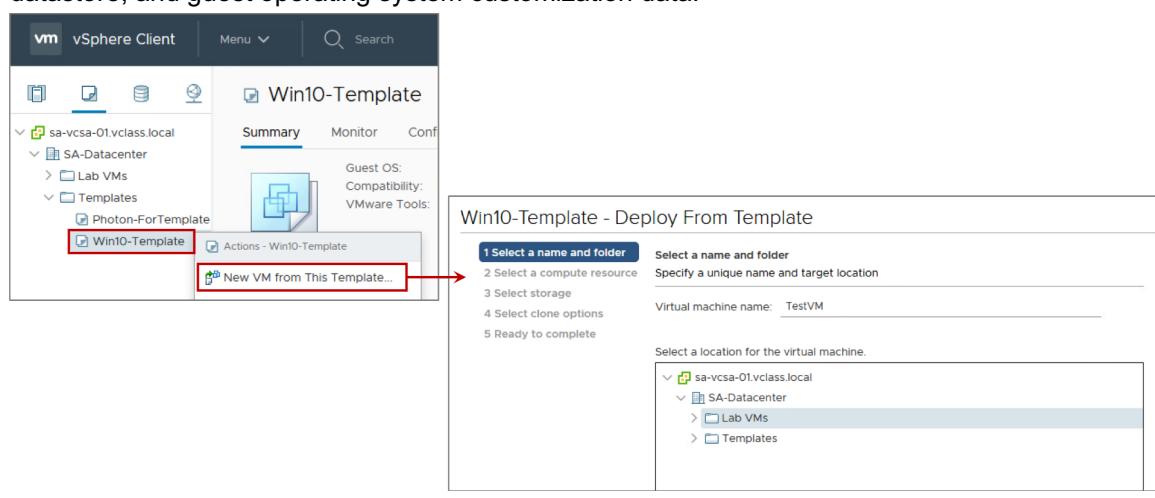
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Deploying VMs from a Template

To deploy a VM, you must provide information such as the VM name, inventory location, host, datastore, and guest operating system customization data.



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Guest Operating System Customization

You customize the guest operating system to make VMs, created from the same template or clone, unique.

By customizing a guest operating system, you can change information, including the following details:

- Computer name
- Network settings
- License settings
- Windows Security Identifier



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About Customization Specifications

You can create a customization specification to prepare the guest operating system:

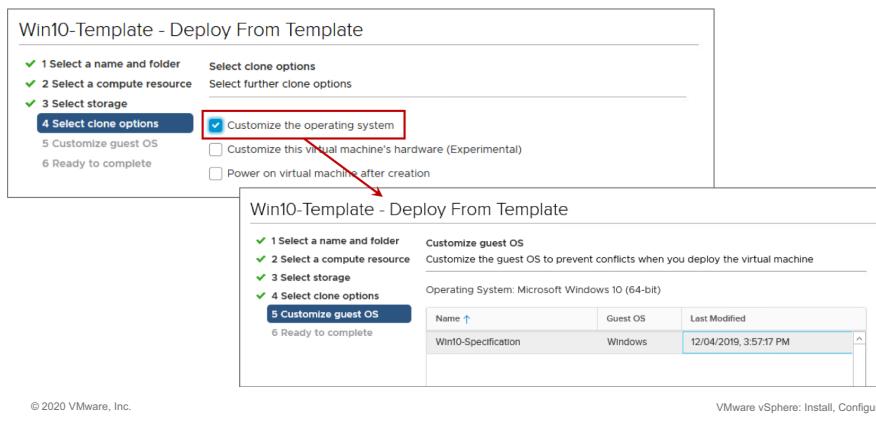
- Specifications are stored in the vCenter Server database.
- Windows and Linux guests are supported.

The screenshot shows the vSphere Client interface. The top navigation bar includes the VMware logo, the title "vSphere Client", a "Menu" dropdown, and a search bar. On the left, there's a sidebar titled "Policies and Profiles" with options for "VM Customization Specifi...", "VM Storage Policies", "Host Profiles", and "Storage Policy Components". The main content area is titled "VM Customization Specifications" and displays a table with one row. The table has columns for "Name" (set to "Linux Specification") and "Guest OS" (set to "Linux"). At the bottom of the table are buttons for "+ New...", "Import...", "Edit...", "Duplicate", and "Export". The bottom of the screen shows the copyright notice "© 2020 VMware, Inc." and the page number "7 - 14".

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Customizing the Guest Operating System

When cloning a VM or deploying a VM from a template, you can use a customization specification to prepare the guest operating system.

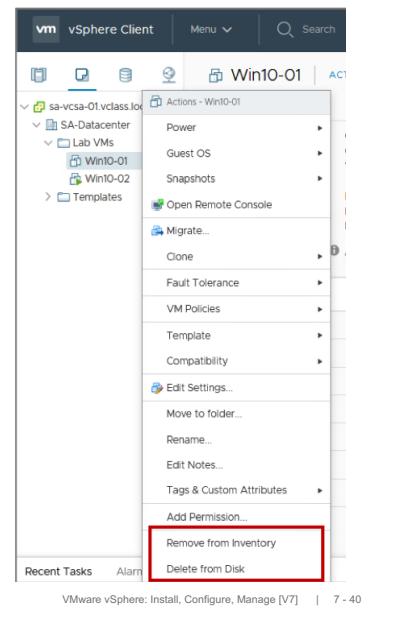


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Removing VMs

You can remove a VM in the following ways:

- Remove from the inventory:
 - The VM is unregistered from the ESXi host and vCenter Server.
 - The VM's files remain on the disk.
 - The VM can later be registered (added) to the inventory.
- Delete from disk:
 - All VM files are permanently deleted from the datastore.
 - The VM is unregistered from the ESXi host and vCenter Server.



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VM Migration Methods

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Migrating VMs

Migration means moving a VM from one host, datastore, or vCenter Server instance to another host, datastore, or vCenter Server instance.

Depending on the power state of the VM that you migrate, migration can be cold or hot:

- A cold migration involves moving a powered-off or suspended VM to a new host.
- A hot migration involves moving a powered-on VM to a new host.

Depending on the VM resource type, you can perform different types of migrations.

Migration Type	Description
Compute resource only	Move VM, but not its storage, to another host. For a hot migration, vSphere vMotion is used to move the VM.
Storage only	Move a VM's storage, but not its host, to a new datastore. For a hot migration, vSphere Storage vMotion is used to move the VM.
Both compute resource and storage	Move a VM to another host and datastore. For a hot migration, vSphere vMotion and vSphere Storage vMotion are used to move the VM.

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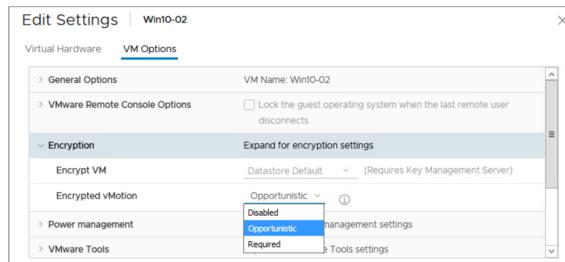
128

Encrypted vSphere vMotion

When migrating encrypted VMs, you always use encrypted vSphere vMotion.

For VMs that are not encrypted, select one of the following encrypted vSphere vMotion menu items:

- **Disabled.**
- **Opportunistic** (default): Encrypted vSphere vMotion is used if the source and destination hosts support it.
- **Required:** If the source or destination host does not support encrypted vSphere vMotion, the migration fails.



Cross vCenter Migrations

With vSphere vMotion, you can migrate VMs between linked vCenter Server systems.

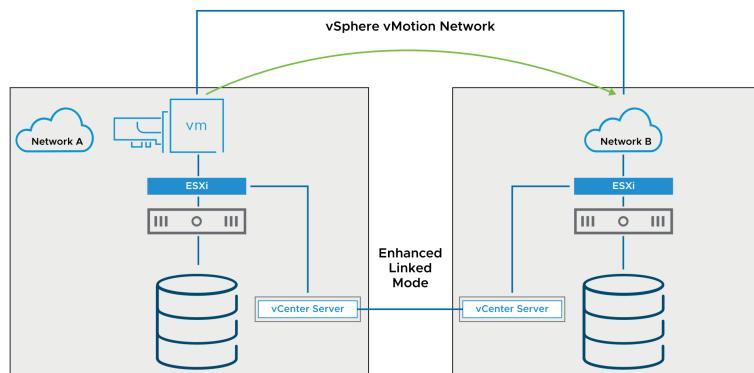
Migration of VMs across vCenter Server instances is helpful in the following cases:

- Balancing workloads across clusters and vCenter Server instances that are in the same site or in another geographical area.
- Moving VMs between environments that have different purposes, for example, from a development environment to production environment.
- Moving VMs to meet different Service Level Agreements (SLAs) for storage space, performance, and so on.

Cross vCenter Migration Requirements

Cross vCenter migrations have the following requirements:

- ESXi hosts and vCenter Server systems must be at vSphere 6.0 or later.
- vCenter Server instances must be in Enhanced Linked Mode.
- Hosts must be time-synchronized.



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Network Checks for Cross vCenter Migrations

vCenter Server performs several network compatibility checks to prevent the following configuration problems:

- MAC address incompatibility on the destination host
- vSphere vMotion migration from a distributed switch to a standard switch
- vSphere vMotion migration between distributed switches of different versions

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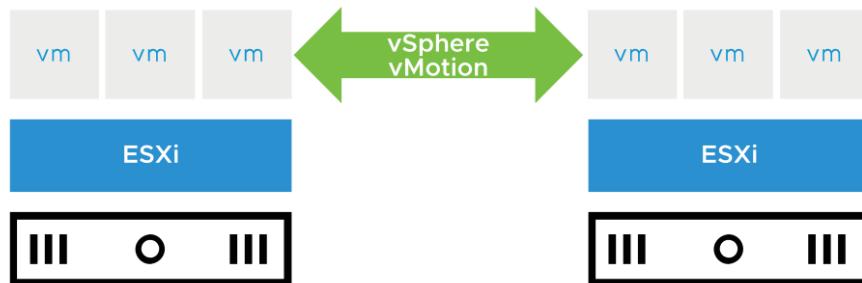
132

About vSphere vMotion

A vSphere vMotion migration moves a powered-on VM from one host to another. vSphere vMotion changes the compute resource only.

vSphere vMotion provides the following capabilities:

- Improvement in overall hardware use
- Continuous VM operation while accommodating scheduled hardware downtime
- vSphere DRS to balance VMs across hosts



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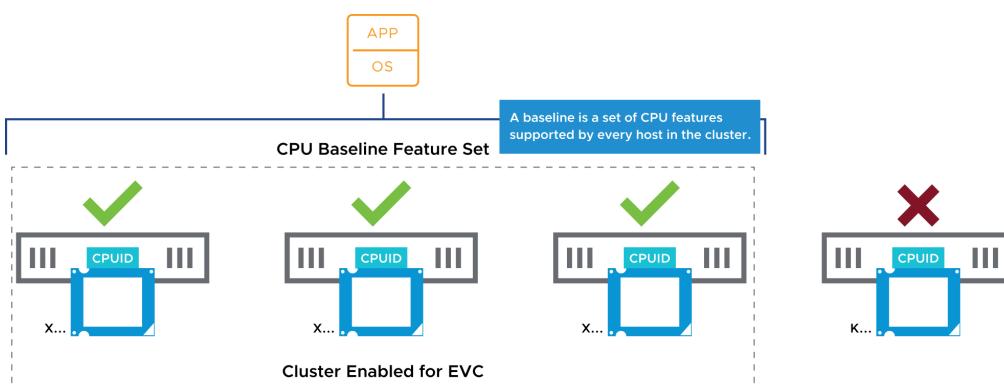
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About Enhanced vMotion Compatibility

Enhanced vMotion Compatibility is a cluster feature that prevents vSphere vMotion migrations from failing because of incompatible CPUs.

This feature works at the cluster level, using CPU baselines to configure all processors in the cluster that are enabled for Enhanced vMotion Compatibility.



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Enhanced vMotion Compatibility Cluster Requirements

All hosts in the cluster must meet the following requirements:

- Use CPUs from a single vendor, either Intel or AMD:
 - Use Intel CPUs with Merom microarchitecture and later.
 - Use AMD first-generation Opteron CPUs and later.
 - Be enabled for hardware virtualization: AMD-V or Intel VT.
 - Be enabled for execution-disable technology: AMD No eXecute (NX) or Intel eXecute Disable (XD).
 - Be configured for vSphere vMotion migration.
- Applications in VMs must be CPU ID compatible.



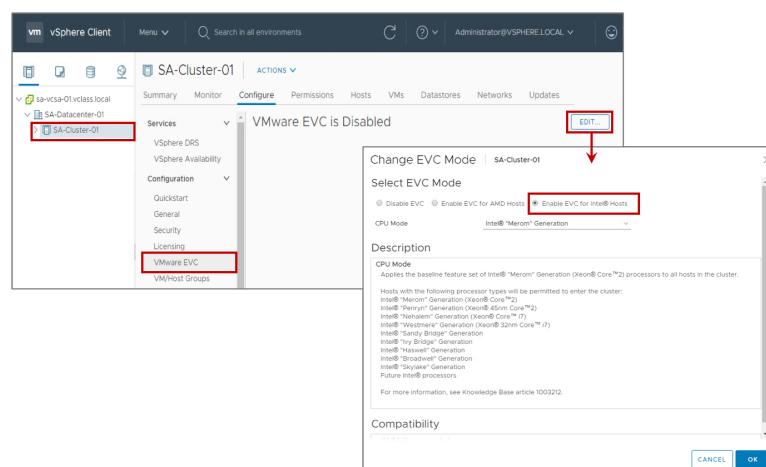
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Enabling EVC Mode on an Existing Cluster

You enable EVC mode on an existing cluster to ensure vSphere vMotion CPU compatibility between the hosts in the cluster.



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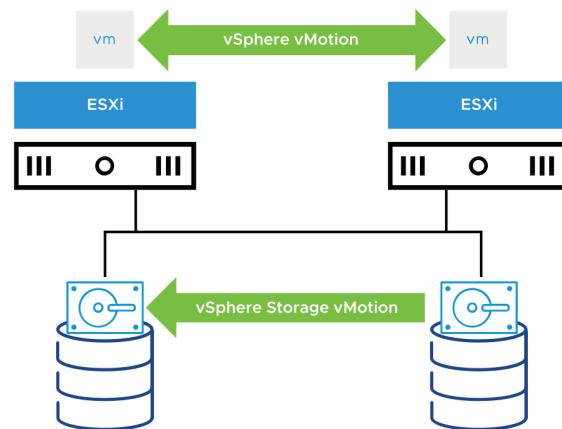
136

About vSphere Storage vMotion

With vSphere Storage vMotion, you can migrate a powered-on VM from one datastore to another.

Using vSphere Storage vMotion, you can perform the following tasks:

- Move VMs off arrays for maintenance or to upgrade.
- Change the disk provisioning type.
- Change VM files on the destination datastore to match the inventory name of the VM.
- Migrate between datastores to balance traffic across storage paths and reduce latencies.
- Redistribute VMs or virtual disks to different storage volumes to balance capacity or improve performance.



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Creating Virtual Machine Snapshots



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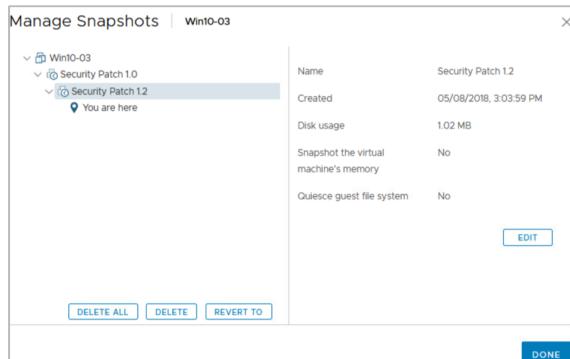
138

VM Snapshots

With snapshots, you can preserve the state of the VM so that you can repeatedly return to the same state.

For example, if problems occur during the patching or upgrading process, you can stop the process and revert to the previous state.

VM snapshots are not recommended as a VM backup strategy.



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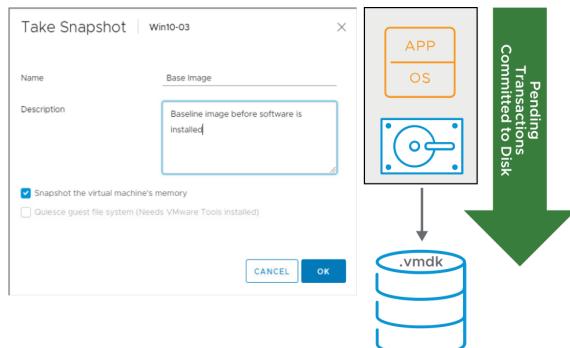
Taking Snapshots

You can take a snapshot while a VM is powered on, powered off, or suspended.

A snapshot captures the following items:

- VM configuration
- VM memory state (optional)
- Virtual disks

A snapshot capture does not include independent virtual disks (persistent and nonpersistent).



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Types of Snapshots

A delta or child disk is created when you create a snapshot:

- On the VMFS datastore, the delta disk is a sparse disk.
- Delta disks use different sparse formats depending on the type of datastore.

Snapshot Type	Datastore Type	Filename	Block Size
VMFSsparse	VMFS5 with virtual disks smaller than 2 TB	#-delta.vmdk	512 bytes
SEsparse	<ul style="list-style-type: none"> VMFS6 VMFS5 with virtual disks larger than 2 TB Space efficient (thin provisioned) Supports disk reclamation (unmap) 	#-sesparse.vmdk	4 KB
vSANsparse	vSAN	Delta object	4 MB



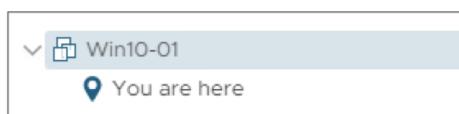
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VM Snapshot Files Example (1)

VM with
no snapshots



Win10-01.vmsd
Win10-01-flat.vmdk
Win10-01.vmdk



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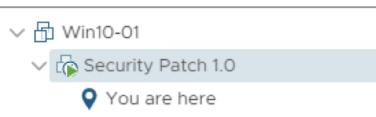
VM Snapshot Files Example (2)

VM with
no snapshots



Win10-01.vmsd
Win10-01-flat.vmdk
Win10-01.vmdk

First snapshot taken
(with memory state)



Win10-01-Snapshot1.vmem
Win10-01-Snapshot1.vmsn
Win10-01-000001-sesparse.vmdk
Win10-01-000001.vmdk



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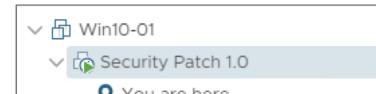
VM Snapshot Files Example (3)

VM with
no snapshots



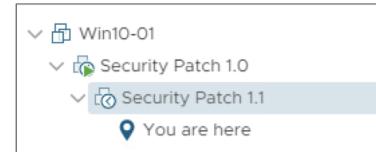
Win10-01.vmsd
Win10-01-flat.vmdk
Win10-01.vmdk

First snapshot taken
(with memory state)



Win10-01-Snapshot1.vmem
Win10-01-Snapshot1.vmsn
Win10-01-000001-sesparse.vmdk
Win10-01-000001.vmdk

Second snapshot taken
(without memory state)



Win10-01-Snapshot2.vmsn
Win10-01-000002-sesparse.vmdk
Win10-01-000002.vmdk



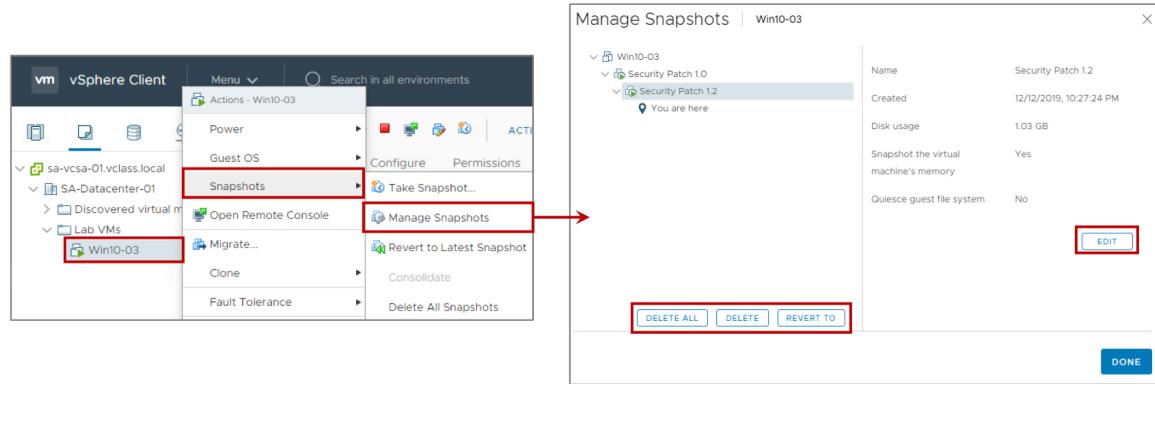
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Managing Snapshots

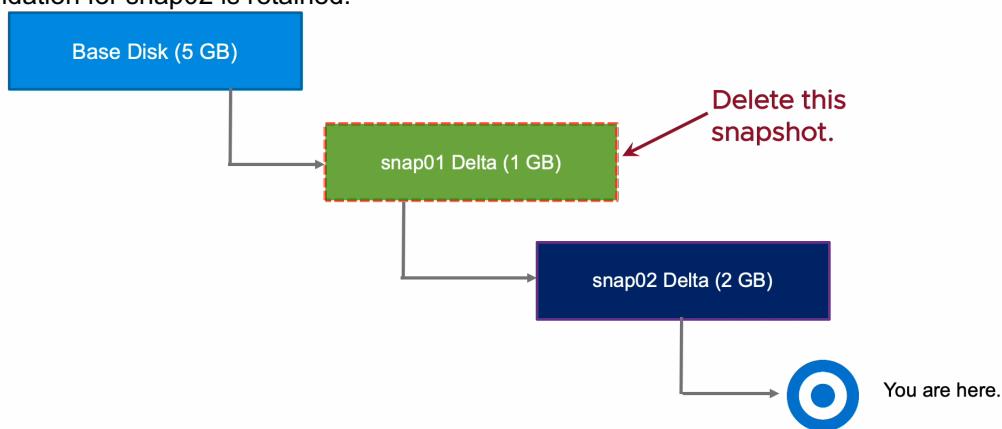
In the vSphere Client, you can view snapshots for the active VM and take edit, delete, and revert to actions.



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Deleting VM Snapshots (1)

If you delete a snapshot one or more levels above the You are here level, the snapshot state is deleted. In this example, the snap01 data is committed into the parent (base disk), and the foundation for snap02 is retained.

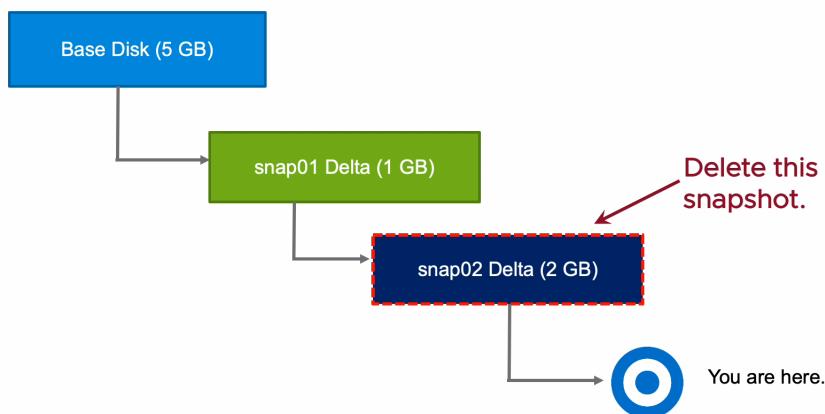


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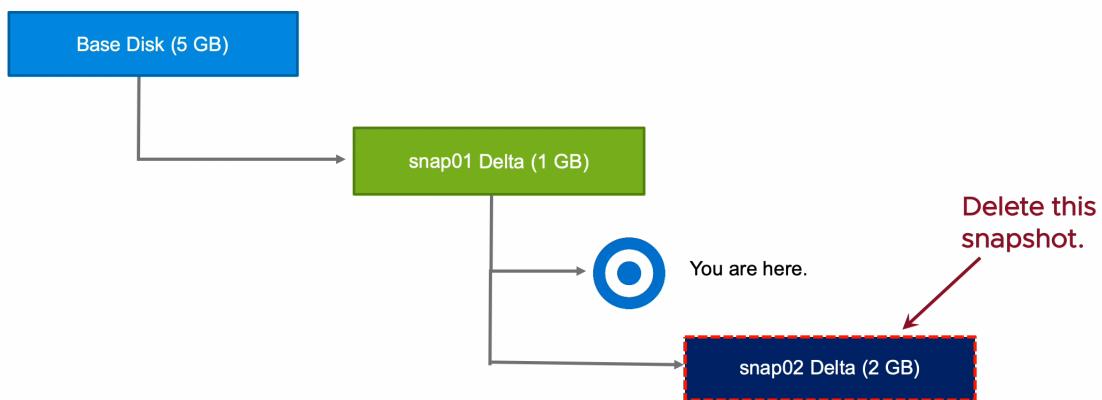
Deleting VM Snapshots (2)

If you delete the latest snapshot, the changes are committed to its parent. The snap02 data is committed into snap01 data, and the `snap02 -delta.vmdk` file is deleted.



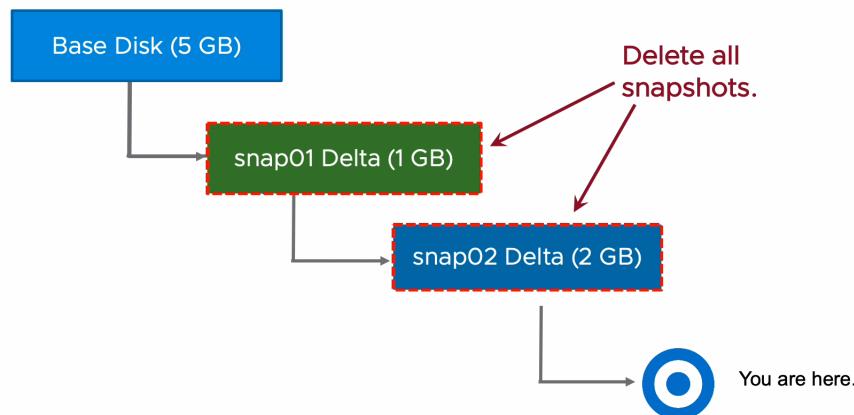
Deleting VM Snapshots (3)

If you delete a snapshot one or more levels below the You are here level, subsequent snapshots are deleted, and you can no longer return to those states. The snap02 data is deleted.



Deleting All VM Snapshots

The delete-all-snapshots mechanism uses storage space efficiently. The size of the base disk does not increase. Snap01 is committed to the base disk before snap02 is committed.



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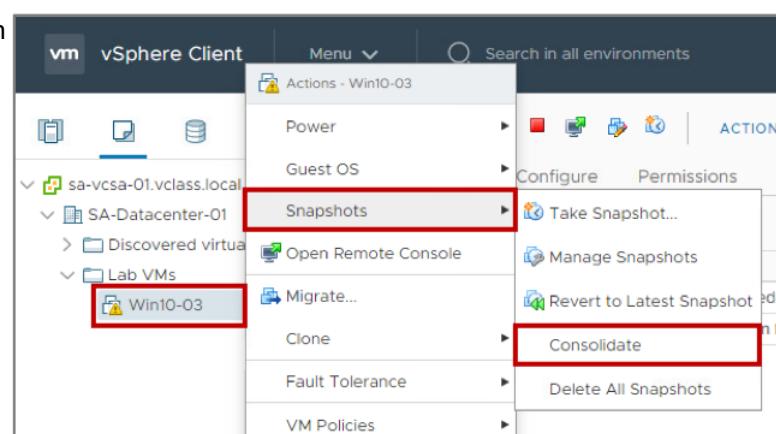


149

Consolidating Snapshots

After the snapshot consolidation warning appears, you can use the vSphere Client to consolidate the snapshots.

All snapshot delta disks are committed to the base disks.



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Module 7: Resource Management and Monitoring

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Virtual CPU and Memory Concepts

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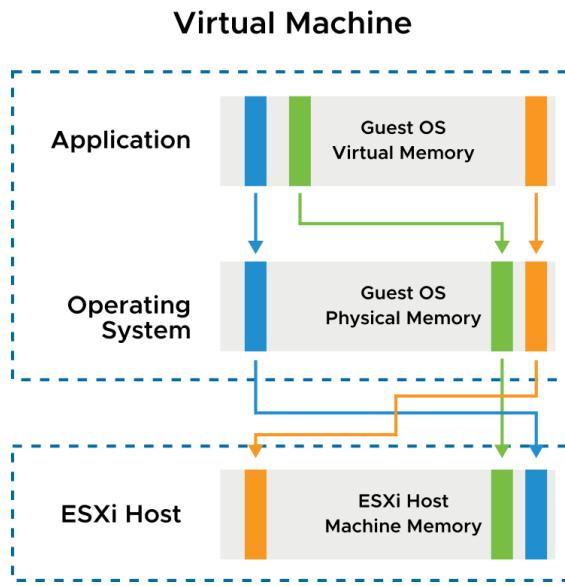
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Memory Virtualization Basics

- vSphere has the following layers of memory:
- Guest OS virtual memory is presented to applications by the operating system.
 - Guest OS physical memory is presented to the virtual machine by the VMkernel.
 - Host machine memory that is managed by the VMkernel provides a contiguous, addressable memory space that is used by the VM.



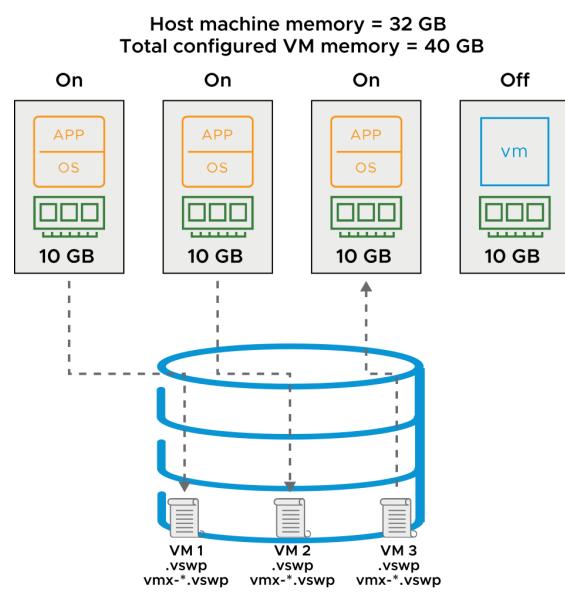
153

VM Memory Overcommitment

Memory is overcommitted when the combined configured memory footprint of all powered-on VMs exceeds that of the host memory sizes.

When memory is overcommitted:

- VMs do not always use their full allocated memory.
- To improve memory usage, an ESXi host transfers memory from idle VMs to VMs that need more memory.
- Overcommitted memory is stored in the .vswp file.
- Memory overhead is stored in the vmx-* .vswp file.



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Memory Overcommit Techniques

An ESXi host uses memory overcommit techniques to allow the overcommitment of memory while possibly avoiding the need to page memory out to disk.

Methods Used by the ESXi Host	Details
Economize use of physical memory pages.	Known as transparent page sharing. In this method, pages with identical contents are stored only once.
Deallocate memory from one VM to another.	The ballooning mechanism becomes active when memory is scarce and then forces VMs to use their own paging areas.
Compress memory.	Memory compression tries to reclaim some memory performance when memory contention is high.
Perform host-level SSD swapping.	Use of a solid-state drive on the ESXi host for a host cache swap file might increase performance.
Page VM memory out to disk.	Using VMkernel swap space is the last resort because of poor performance.



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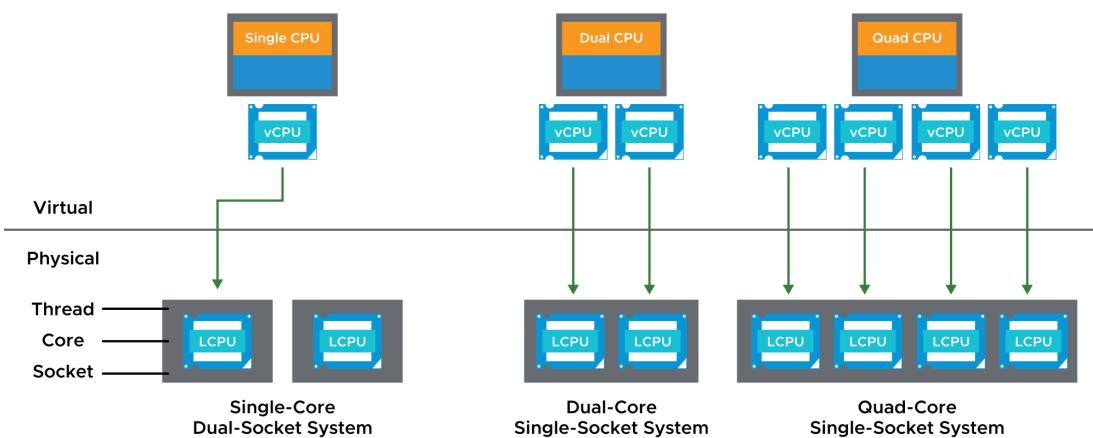
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Configuring Multicore VMs

You can build VMs with multiple virtual CPUs.

The number of vCPUs that you configure for a single VM depends on the physical architecture of the ESXi host.



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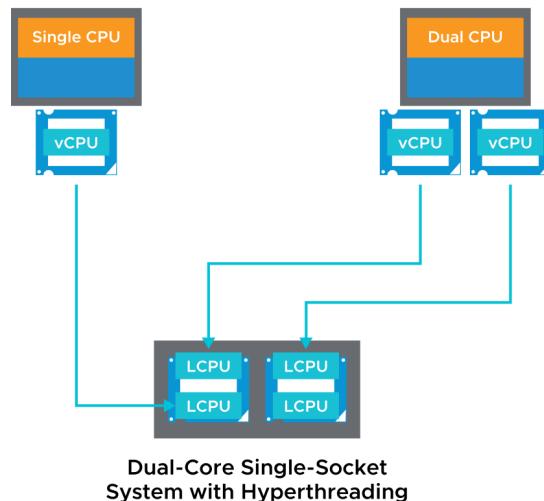
About Hyperthreading

With hyperthreading, a core can execute two threads or sets of instructions at the same time.

- Hyperthreading provides more scheduler throughput.
- Hyperthreading is enabled by default.

To enable hyperthreading:

- Verify that the host system supports hyperthreading.
- Enable hyperthreading in the system BIOS.
- Ensure that hyperthreading for the ESXi host is turned on.



Dual-Core Single-Socket System with Hyperthreading



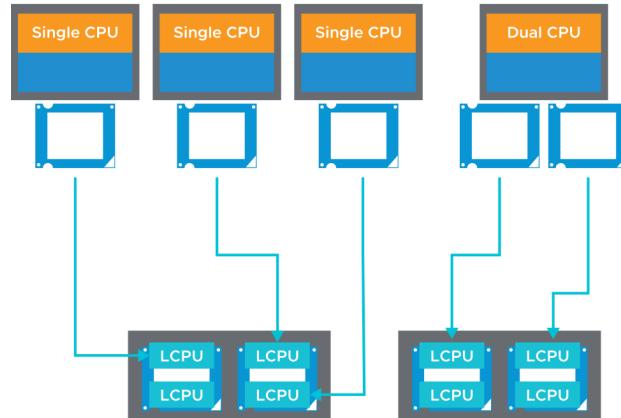
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CPU Load Balancing

The VMkernel balances processor time to guarantee that the load is spread smoothly across processor cores in the system.



Hyperthreaded Dual-Core Dual-Socket System



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Resource Monitoring Tools

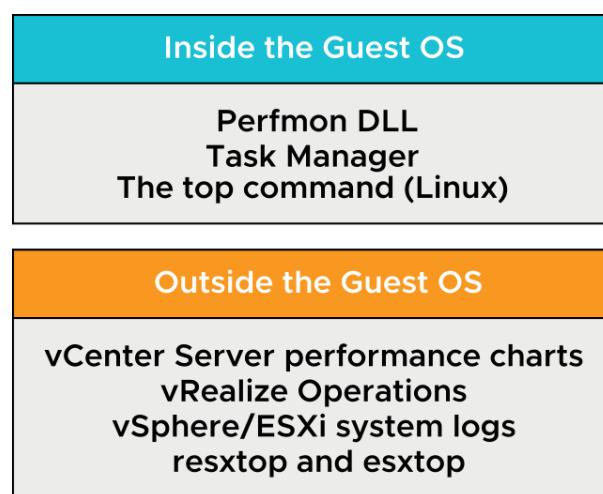
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Resource-Monitoring Tools

Many resource-monitoring and performance-monitoring tools are available for use with vSphere.



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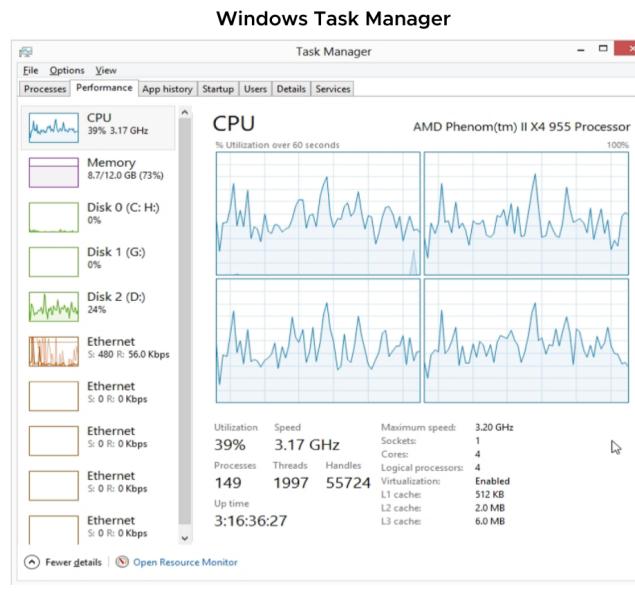
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Guest Operating System Monitoring Tools

To monitor performance in the guest operating system, use tools that you are familiar with, such as Windows Task Manager.



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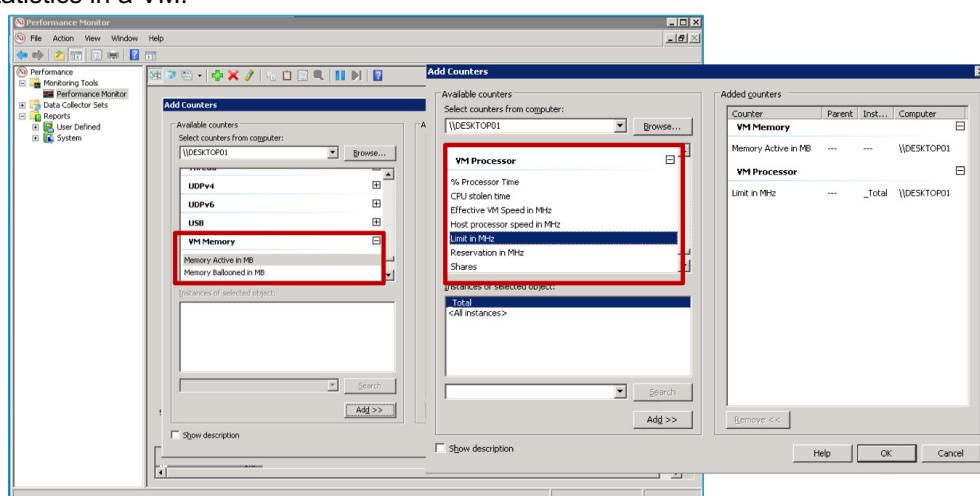
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Using Perfmon to Monitor VM Resources

The Perfmon DLL in VMware Tools provides VM processor and memory objects for accessing host statistics in a VM.



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Using esxtop to Monitor VM Resources

The `esxtop` utility is the primary real-time performance monitoring tool for vSphere:

- Can be run from the host's local vSphere ESXi Shell as `esxtop`
- Can be run remotely from vSphere CLI as `resxtop`
- Works like the `top` performance utility in Linux operating systems

In this example, you enter lowercase `c` and uppercase `V` to view CPU metrics for VMs.

```
2:48:37pm up 7 days 13:36, 493 worlds, 3 vCPUs; CPU load average: 0.03, 0.03, 0.02
PCPU USED(%): 1.8 3.9 AVG: 2.8
PCPU UTIL(%): 2.2 4.2 AVG: 3.2

ID      GID NAME          NWLD %USED %RUN %SYS %WAIT %VMWAIT %RDY %IDLE %OVRLP %CSTP
52127   52127 VM2-1     8    0.15  0.14  0.00  800.00  0.72  0.03  99.67  0.00  0.00
43316   43316 VM1-2     8    0.11  0.10  0.01  800.00  0.74  0.07  99.67  0.00  0.00
55009   55009 VM2-2     8    0.11  0.10  0.01  800.00  0.73  0.12  99.63  0.00  0.00
```

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Monitoring Inventory Objects with Performance Charts

The vSphere statistics subsystem collects data on the resource usage of inventory objects, which include:

- Clusters
- Hosts
- Datastores
- Networks
- Virtual machines



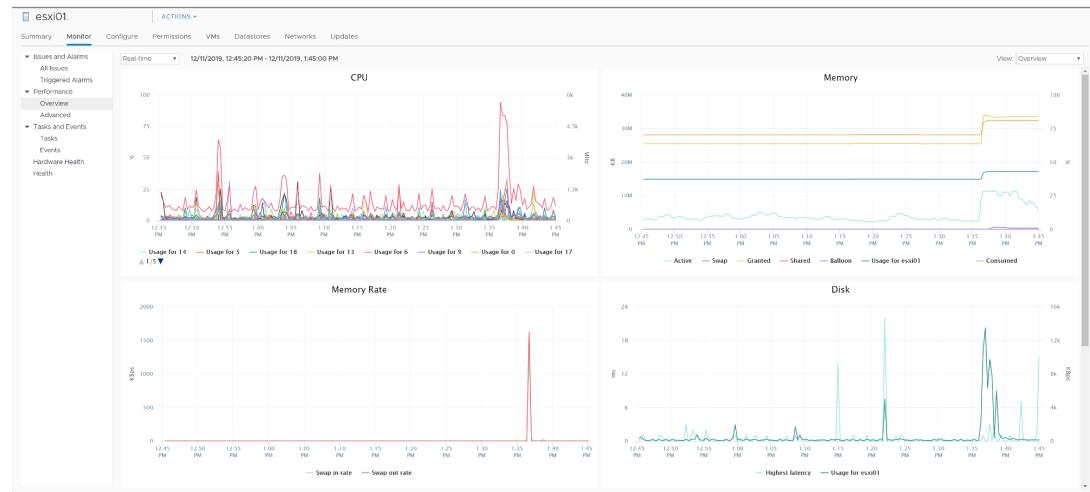
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Working with Overview Performance Charts

The overview performance charts display the most common metrics for an object in the inventory.



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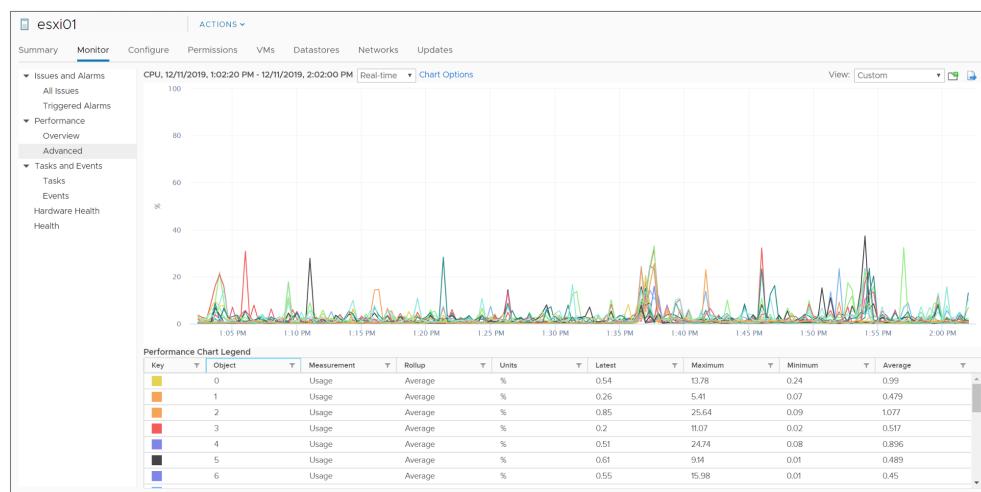
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Chart Types: Line

A line chart displays metrics for a single inventory object, for example, metrics for each CPU on an ESXi host.



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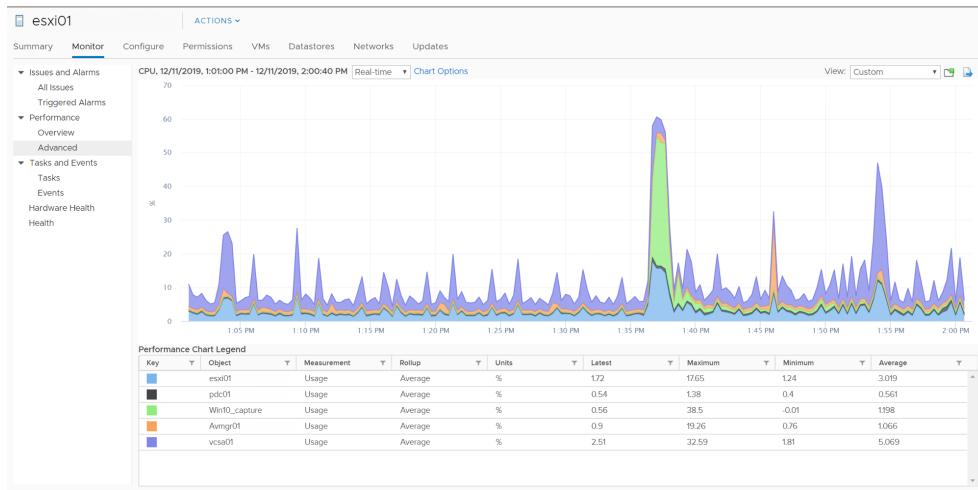
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Chart Types: Stacked Per VM

Per-VM stacked graphs are available only for hosts.



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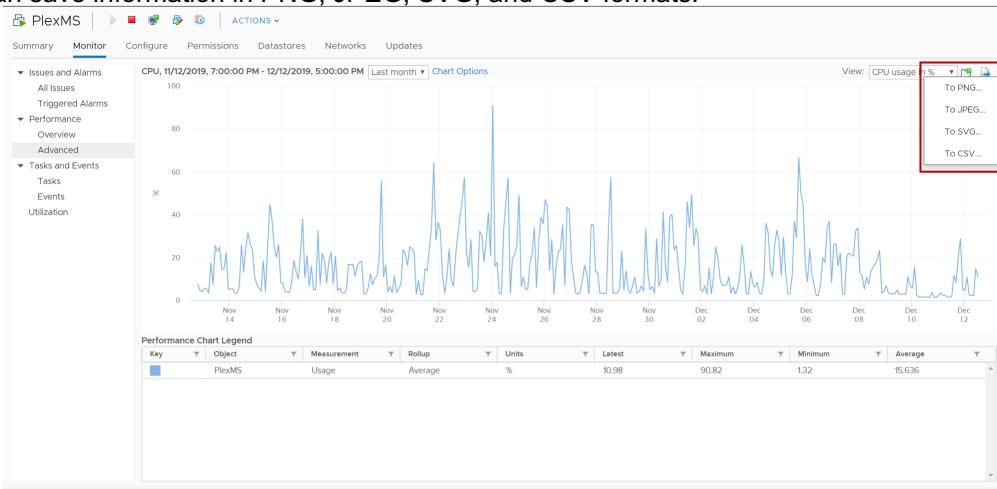
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Saving Charts

You click the **Save Chart** icon above the graph to save performance chart information.

You can save information in PNG, JPEG, SVG, and CSV formats.



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Using Alarms

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About Alarms

An alarm is a notification that is sent in response to an event or condition that occurs with an object in the inventory.

Alarm Name	Object	Object type	Severity	Triggered Time	Acknowledged Time	Act By
Virtual machine CPU usage	Win10-02	VirtualMachine	CRITICAL	12/18/2019, 2:02:03...		

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Predefined Alarms (1)

You can access many predefined alarms for various inventory objects, such as hosts, virtual machines, datastores, networks, and so on.

Alarm Name	Object type	Defined In
> Host battery status	Host	This Object
> Status of other host hardware objects	Host	This Object
> Host storage status	Host	This Object
> Host hardware sensor state	Host	This Object
> Host connection failure	Host	This Object
> Cannot connect to storage	Host	This Object
> Exit standby error	Host	This Object
> License error	Host	This Object
> Network connectivity lost	Host	This Object
> Network uplink redundancy lost	Host	This Object
> Network uplink redundancy degraded	Host	This Object
> VMKernel NIC not configured correctly	Host	This Object



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Predefined Alarms (2)

You can edit predefined alarms, or you can make a copy of an existing alarm and modify the settings as needed.

Alarm Name	Object type	Defined In
> Migration error	Virtual Machine	This Object
> Virtual machine Fault Tolerance st...	Virtual Machine	This Object
> Virtual Machine Fault Tolerance vL...	Virtual Machine	This Object
> vSphere HA virtual machine failov...	Virtual Machine	This Object
> vSphere HA virtual machine monit...	Virtual Machine	This Object
> vSphere HA virtual machine monit...	Virtual Machine	This Object
> Virtual machine Consolidation Nee...	Virtual Machine	This Object
> Virtual machine CPU usage	Virtual Machine	This Object
> VM storage compliance alarm	Virtual Machine	This Object
> vSphere HA VM Component Prote...	Virtual Machine	This Object
> Virtual machine memory usage	Virtual Machine	This Object
> Virtual Machine network adapter r...	Virtual Machine	This Object



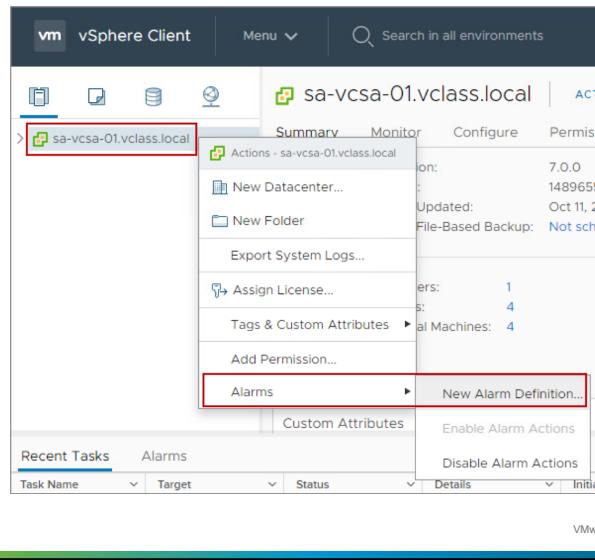
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Creating a Custom Alarm

In addition to using predefined alarms, you can create custom alarms in the vSphere Client.



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Defining the Alarm Target Type

On the Name and Targets page, you name the alarm, give it a description, and select the type of inventory object that this alarm monitors.

New Alarm Definition 1 Name and Targets 2. Alarm Rule 1 3. Reset Rule 1 4. Review	Name and Targets Alarm Name * <input type="text" value="Custom_VM Snapshot Size"/> Description <input type="text" value="Issue a warning if a VM's current snapshot is larger than 2 GB."/> Target type * <input type="text" value="Virtual Machines"/> Targets <input type="text" value="All Virtual Machines on sa-vcsa-01.vclass.local (4)"/> <div style="text-align: right; margin-top: 10px;"> CANCEL NEXT </div>
---	--

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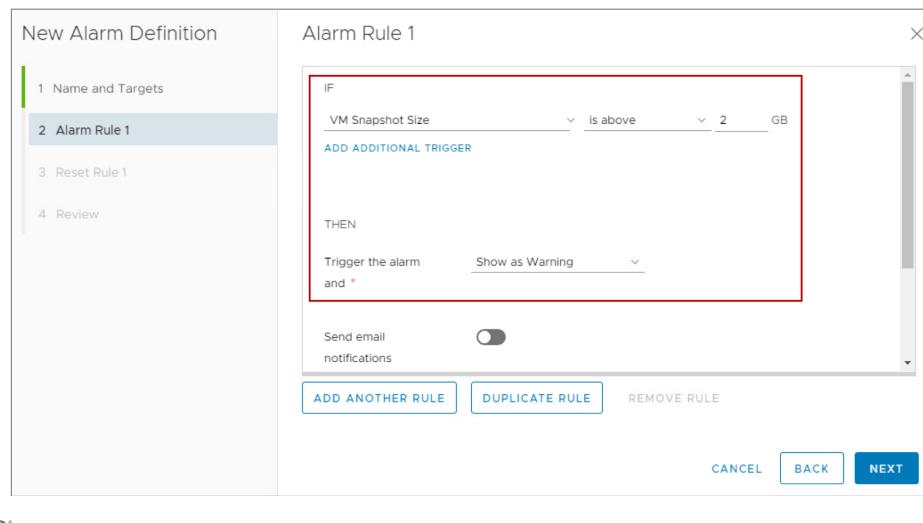
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Defining the Alarm Rule: Trigger (2)

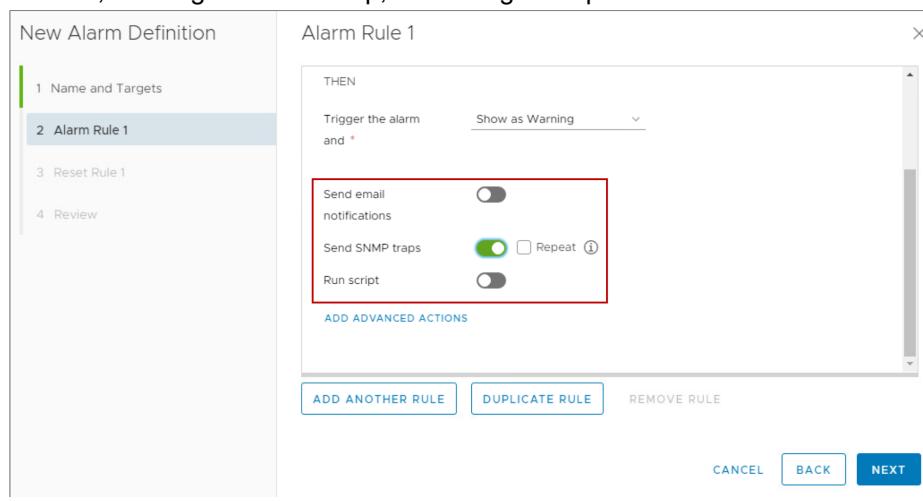
You select and configure the events, states, or conditions that trigger the alarm.



175

Defining the Alarm Rule: Setting the Notification

You configure the notification method to use when the alarm is triggered. The methods are sending an email, sending an SNMP trap, or running a script.

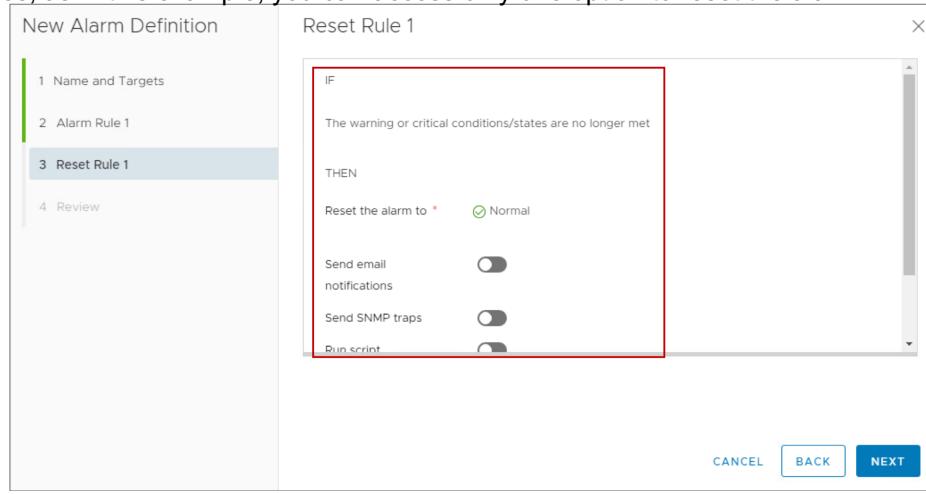


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Defining the Alarm Reset Rules

You can select and configure the events, states, or conditions to reset the alarm to normal.

Sometimes, as in this example, you can access only one option to reset the alarm.



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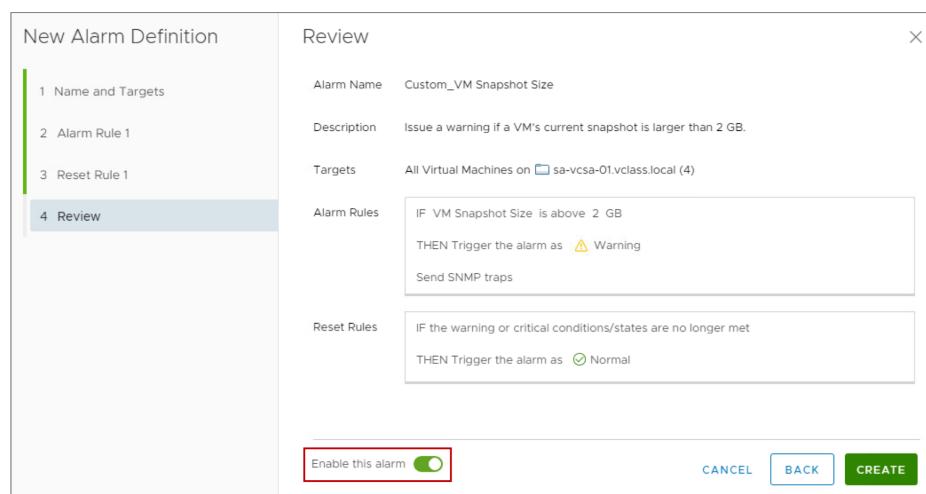
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Enabling the Alarm

On the Review page, the new alarm definition is enabled by default.



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Configuring vCenter Server Notifications

If you use email or SNMP traps as the notification method, you must configure vCenter Server to support these notification methods.

The screenshot shows the vSphere Client interface for managing a vCenter server named 'sa-vcsa-01.vclass.local'. The 'Configure' tab is selected. Under 'Settings', the 'General' tab is active. On the right, the 'vCenter Server Settings' pane is open, showing options like 'Statistics', 'Database', 'Runtime settings', 'User directory', 'Mail', and 'SNMP receivers'. The 'Mail' section contains fields for 'Mail server' and 'Mail sender'. A red box highlights the 'EDIT' button at the top right of the settings pane, and another red box highlights the 'Mail' tab in the list.

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Module 8: vSphere Clusters

vSphere Clusters Overview

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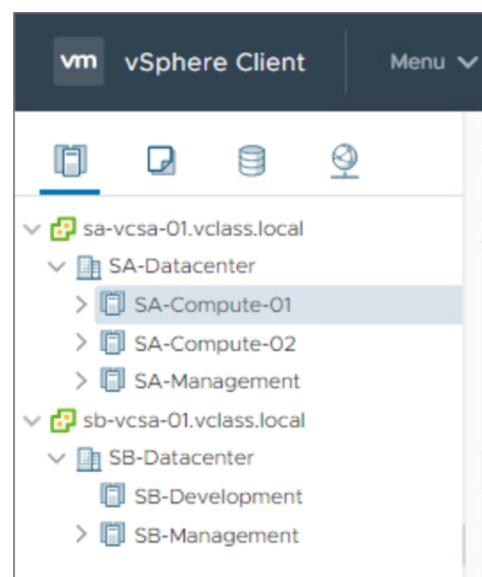
About vSphere Clusters

A cluster is used in vSphere to share physical resources between a group of ESXi hosts. vCenter Server manages cluster resources as a single pool of resources.

You can create one or more clusters based on the purpose each cluster must fulfill, for example:

- Management
- Production
- Compute

A cluster can contain up to 64 ESXi hosts.



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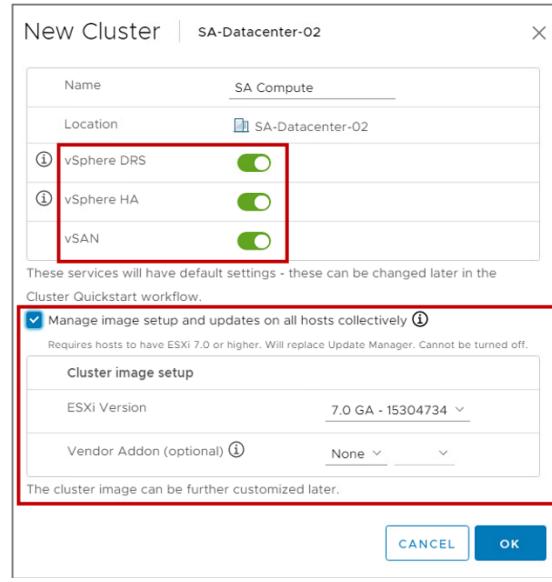
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Creating a vSphere Cluster and Enabling Cluster Features

When you create a cluster, you can enable one or more cluster features:

- vSphere DRS
- vSphere HA
- vSAN

You can also manage image setup and updates on all hosts collectively.



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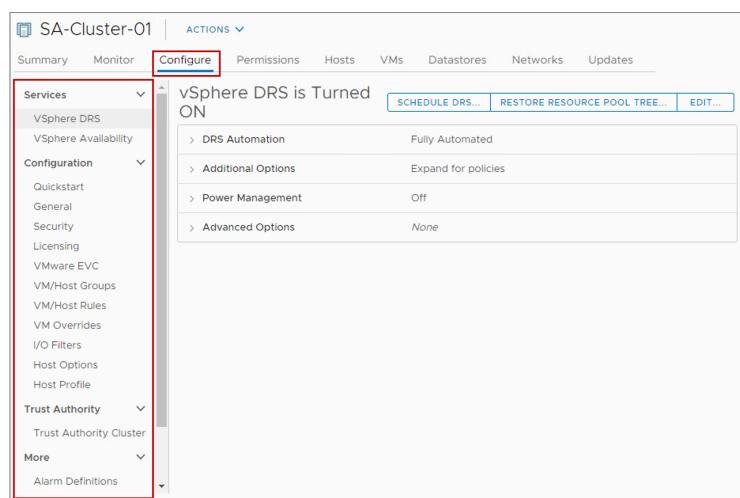
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Configuring the Cluster Manually

Alternatively, you can use the **Configure** tab to manually configure a cluster's settings.



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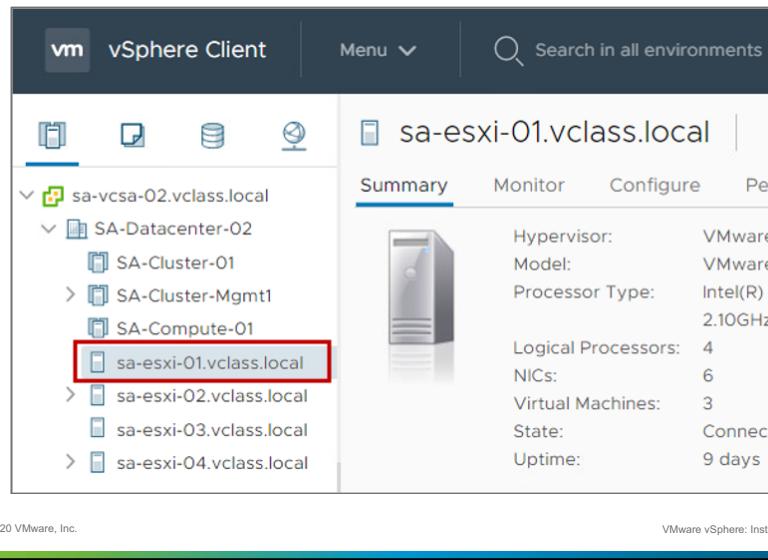
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Adding a Host to a Cluster

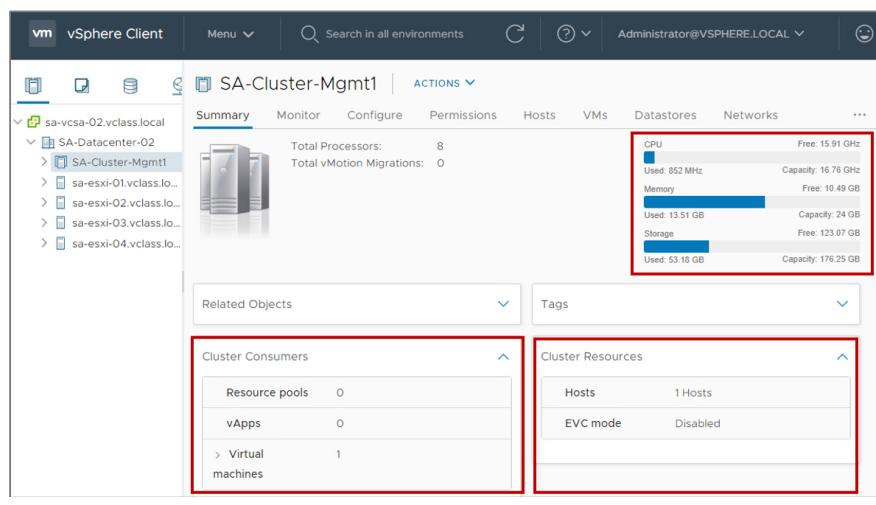
To add a host to a cluster, drag the host onto the cluster object in the inventory.



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Viewing Cluster Summary Information

For a quick view of your cluster configuration, the **Summary** tab provides general information about a cluster's resources and its consumers.



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Monitoring Cluster Resources

You can view a report of total cluster CPU, memory, memory overhead, storage capacity, the capacity reserved by VMs, and how much capacity remains available.

	Value	Unit
Cluster Total Capacity	16 GB	
Total Reservation Capacity	9.79 GB	
Used Reservation	289 MB	
Available Reservation	9.51 GB	

Name	Reservation (MB)	Limit (MB)	Type	Shares	Shares Value	% Shares
Photon-01	0	Unlimited	Fixed	Low	2560	1.89
Photon-02	0	Unlimited	Fixed	Normal	5120	3.77
Photon-03	0	Unlimited	Fixed	Normal	5120	3.77
Win10-01	0	Unlimited	Fixed	Low	20480	15.09
Win10-02	0	Unlimited	Fixed	Normal	20480	15.09
Win10-03	0	Unlimited	Fixed	Normal	40960	30.19
Win10-04	0	Unlimited	Fixed	High	40960	30.19

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vSphere DRS



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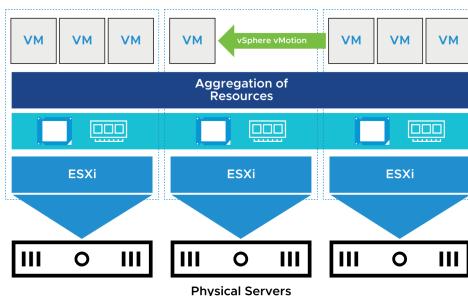
94

About vSphere DRS

vSphere DRS is a cluster feature that helps improve resource allocation across all hosts in a cluster. It aggregates computing capacity across a collection of servers into logical resource pools.

vSphere DRS is used in the following situations:

- Initial placement of a VM when it is powered on
- Load balancing
- Migrating VMs when an ESXi host is placed in maintenance mode



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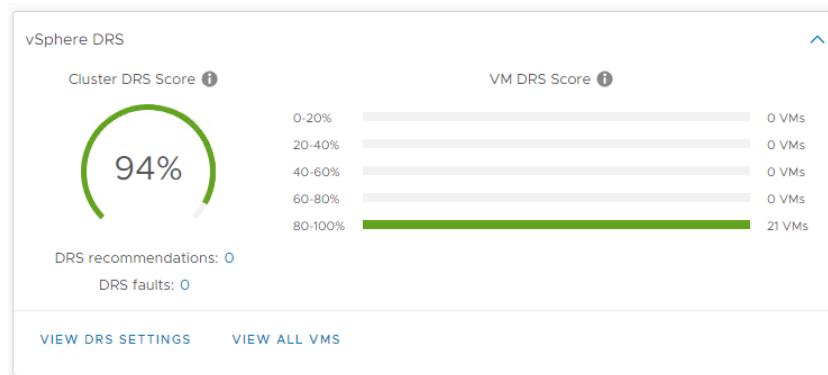
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About the VM DRS Score

The VM DRS score is a metric that tracks a VM's execution efficiency on a given host. Execution efficiency is the frequency that the VM is reported as having its resources requirements met:

- Values closer to 0% indicate severe resource contention.
- Values closer to 100% indicate mild to no resource contention.



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VM DRS Score List

The cluster's **Monitor** tab lists the VM DRS Scores and more detailed metrics for all the VMs in the cluster.

The screenshot shows the 'Monitor' tab of the SA-Cluster interface. On the left, there's a sidebar with various monitoring categories like Issues and Alarms, Performance, Tasks and Events, vSphere DRS, and Resource Allocation. Under 'vSphere DRS', the 'VM DRS Score' option is highlighted with a red box. The main pane displays a table of VMs with their names, DRS Scores (sorted by score), Active CPU, and Used CPU. The table includes rows for VMs named sa-vm-win-110 through sa-vm-win-2230, each with a 94% DRS Score, 20 MHz Active CPU, and 20 MHz Used CPU.

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Viewing VM DRS Scores Using Performance Charts (1)

The advanced performance chart for a cluster object provides the DRS Score counter.

The screenshot shows the 'Chart Options' dialog for the SA-Production cluster. In the 'Chart Metrics' section, 'CPU' is selected. In the 'Select counters for this chart:' table, the 'DRS Score' counter is selected and highlighted with a red box. The table also lists other counters like 'Effective CPU resources' and 'Effective memory resources'. Below the table, the 'Timespan' is set to 'Last day' with a value of '1'. The 'Select object for this chart:' section shows 'Target Objects' with 'SA-Production' selected. At the bottom, the 'Chart Type' is set to 'Line Graph'.

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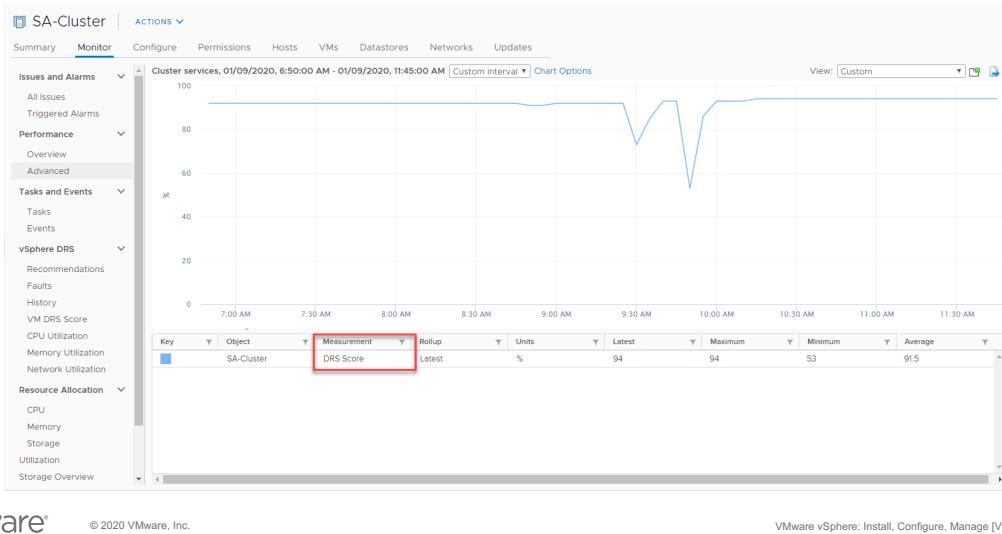
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Viewing VM DRS Scores Using Performance Charts (2)

The DRS Score counter displays the DRS scores for VMs in the cluster over the selected time period.



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vSphere DRS Settings: Predictive DRS

vSphere DRS and vRealize Operations Manager combine data to predict future demand and determine when and where high resource utilization occurs.

To make predictive decisions, the vSphere DRS data collector retrieves the following data:

- Resource usage statistics from ESXi hosts
- Predicted usage statistics from the vRealize Operations Manager server

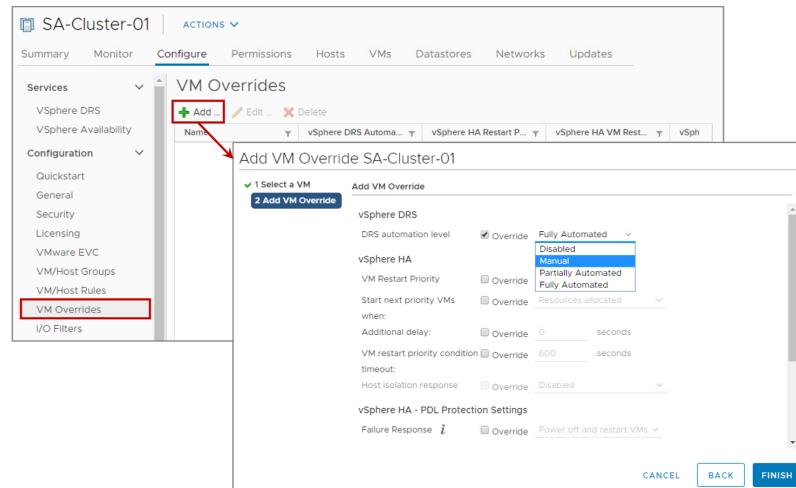
Predicted usage statistics always take precedence over current usage statistics.

Enable

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vSphere DRS Settings: VM-Level Automation

You can customize the automation level for individual VMs in a cluster to override the automation level set on the entire cluster.



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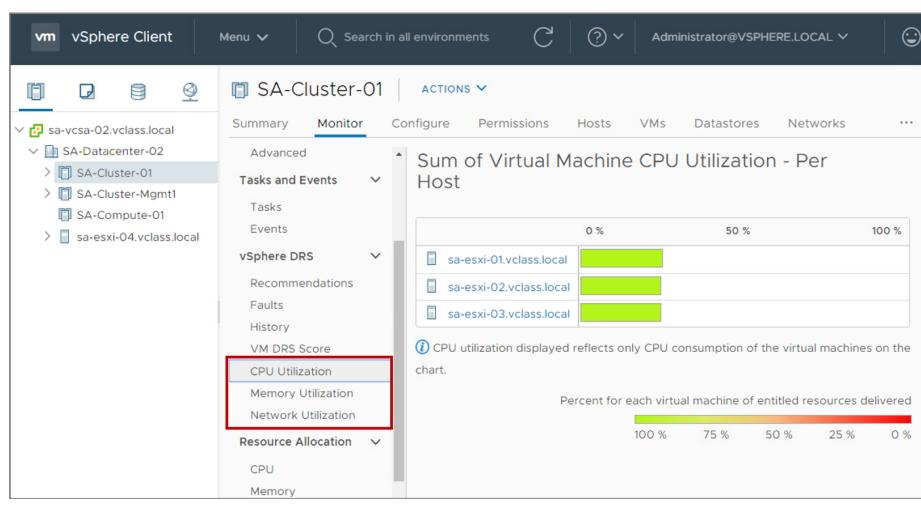
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Viewing vSphere DRS Cluster Resource Utilization

From the cluster's **Monitor** tab, you can view CPU, memory, and network utilization per host.



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Introduction to vSphere HA

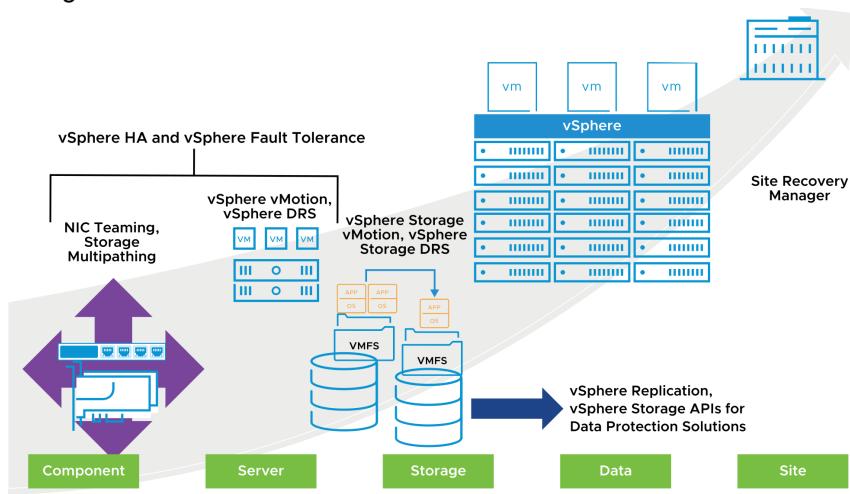
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Protection at Every Level

With vSphere, you can reduce planned downtime, prevent unplanned downtime, and recover rapidly from outages.



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About vSphere HA

vSphere HA provides rapid recovery from outages and cost-effective high availability for applications running in VMs. vSphere HA protects application availability in several ways.

Protects Against	How Does vSphere HA Provide Protection?
ESXi host failure	By restarting the VMs on other hosts within the cluster
VM failure	By restarting the VM when a VMware Tools heartbeat is not received within a set time
Application failure	By restarting the VM when an application heartbeat is not received within a set time
Datastore accessibility failure	By restarting the affected VMs on other hosts that still can access the datastores.
Network isolation	By restarting VMs if their host becomes isolated on the management or vSAN network. This protection is provided even if the network becomes partitioned.



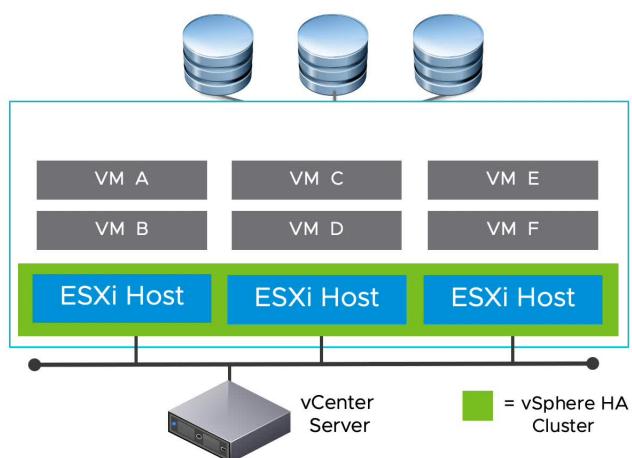
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vSphere HA Scenario: ESXi Host Failure

When a host fails, vSphere HA restarts the impacted VMs on other hosts in the cluster.



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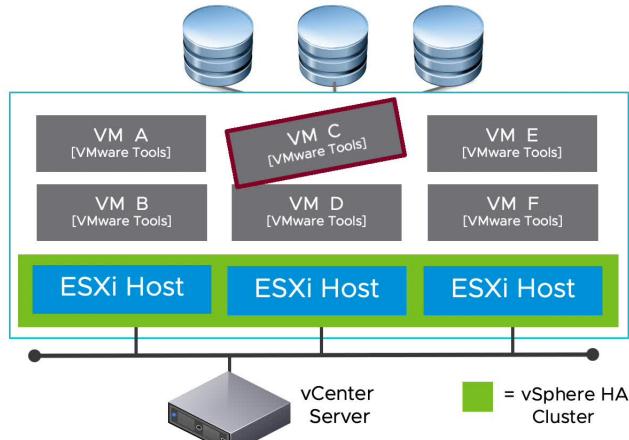


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vSphere HA Scenario: Guest Operating System Failure

When a VM stops sending heartbeats or the VM process (vmx) fails unexpectedly, vSphere HA resets the VM.



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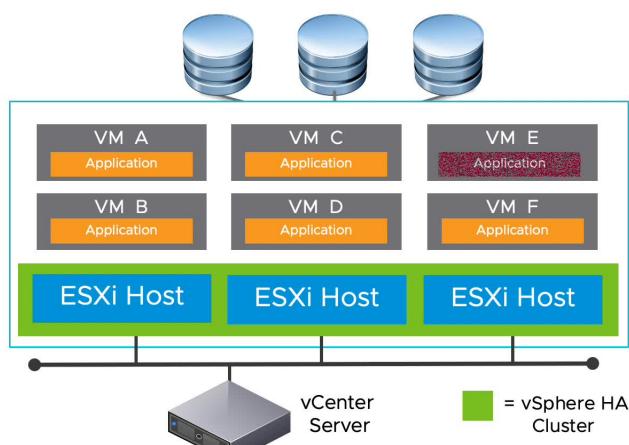
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vSphere HA Scenario: Application Failure

When an application fails, vSphere HA restarts the impacted VM on the same host.



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vSphere HA Scenario: Datastore Accessibility Failures

If VM Component Protection (VMCP) is enabled, vSphere HA can detect datastore accessibility failures and provide automated recovery for affected VMs.

You can determine the response that vSphere HA makes to such a failure, ranging from the creation of event alarms to VM restarts on other hosts:

- Permanent device loss (PDL):
 - Unrecoverable loss of accessibility.
 - Occurs when a storage device reports that the datastore is no longer accessible by the host.
 - Response can be either **Issue events** or **Power off and restart VMs**.
- All paths down (APD):
 - Recoverable.
 - Represents a transient or unknown accessibility loss.
 - Response can be either **Issue events**, **Power off and restart VMs - Conservative restart policy**, or **Power off and restart VMs - Aggressive restart policy**.



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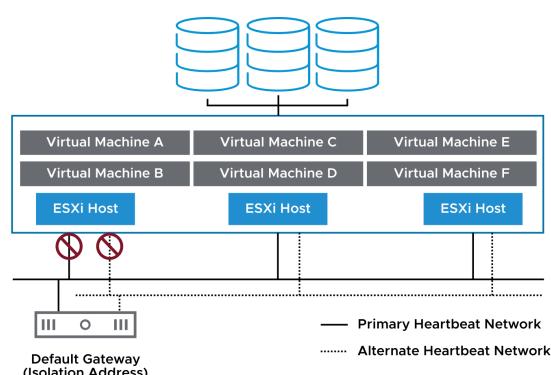
203

vSphere HA Scenario: Protecting VMs Against Network Isolation

vSphere HA restarts VMs if their host becomes isolated on the management or vSAN network.

Host network isolation occurs when a host is still running, but it can no longer observe traffic from vSphere HA agents on the management network:

- vSphere HA tries to ping the isolation addresses. An isolation address is an IP address or FQDN that can be manually specified (the default is the host's default gateway)
- If pinging fails, the host declares that it is isolated from the network.
- This protection is provided even if the network becomes partitioned.



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vSphere HA Architecture

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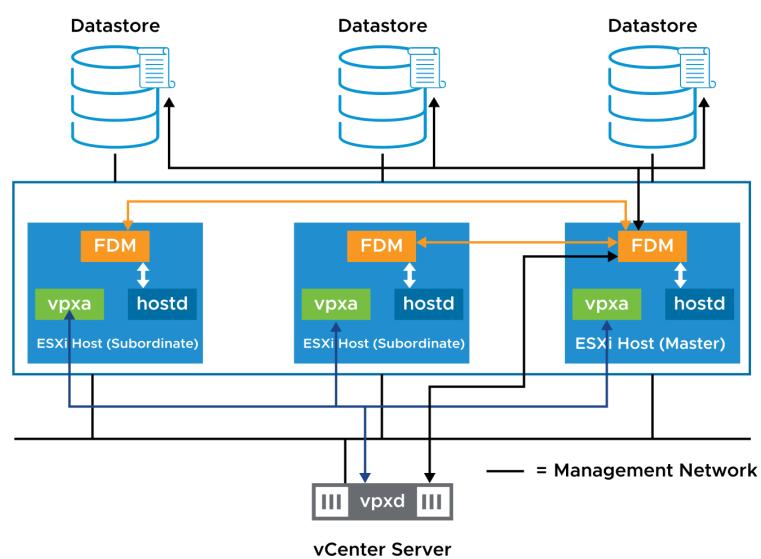
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vSphere HA Architecture: Agent Communication

When vSphere HA is enabled in a cluster, the Fault Domain Manager (FDM) service starts on the hosts in the cluster.

After the FDM services start, the hosts are said to be in a fault domain.



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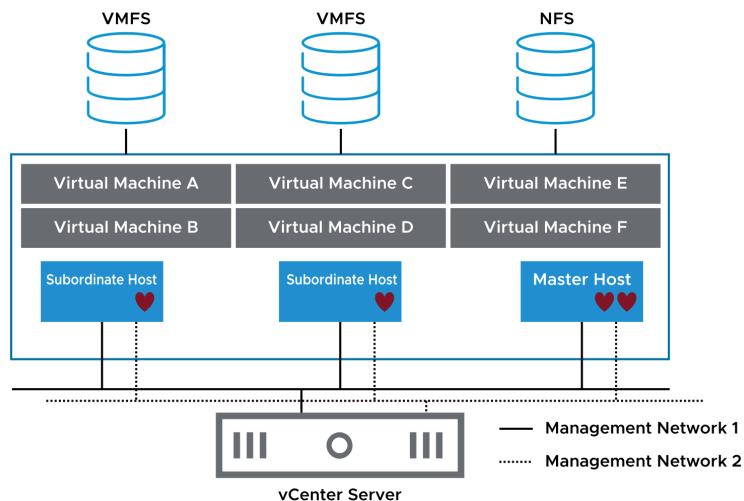
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vSphere HA Architecture: Network Heartbeats

The master host sends periodic heartbeats to the subordinate hosts.

In this way, the subordinate hosts know that the master host is alive and the master host knows that the subordinate hosts are alive.



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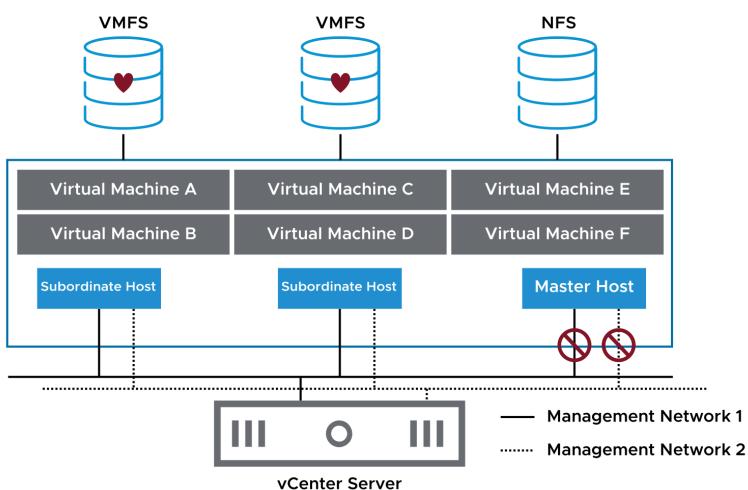
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vSphere HA Architecture: Datastore Heartbeats

When the master host cannot communicate with a subordinate host over the management network, the master host uses datastore heartbeating to determine the cause:

- Subordinate host failure
- Network partition
- Network isolation



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vSphere HA Failure Scenarios

vSphere HA can identify and respond to various types of failures:

- Subordinate host failure
- Master host failure
- Network failure (host isolation)

VMCP enables vSphere HA to detect and respond to datastore access failures:

- APD
- PDL



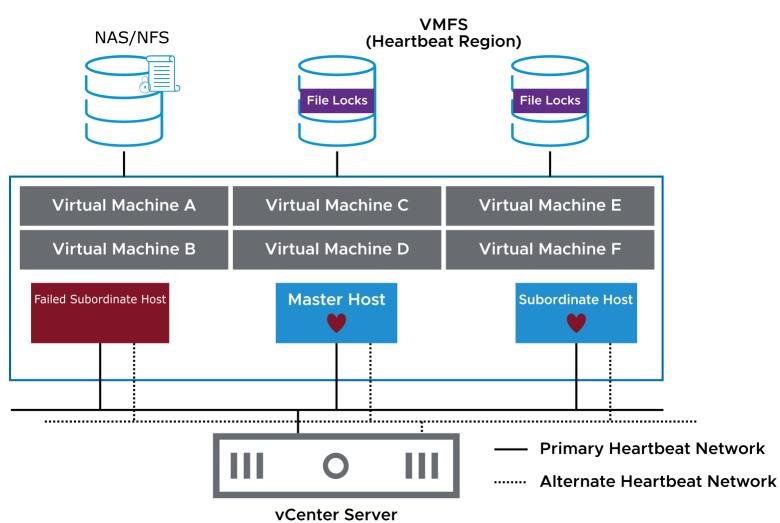
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Failed Subordinate Hosts

When a subordinate host does not respond to the network heartbeat issued by the master host, the master host tries to identify the cause.



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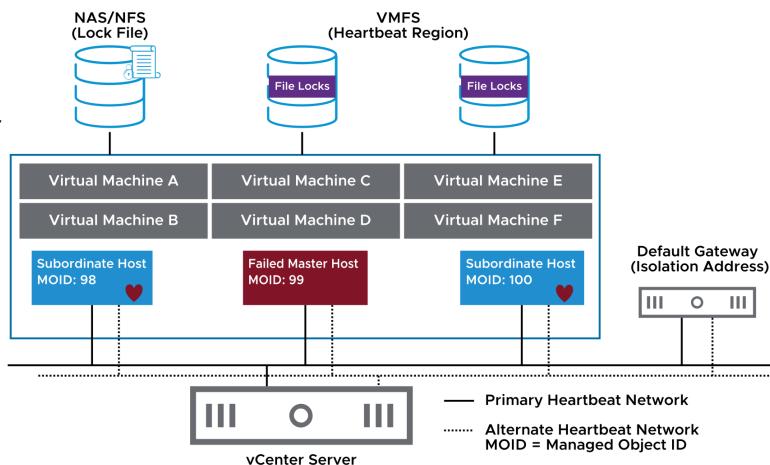
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Failed Master Hosts

When the master host is placed in maintenance mode or fails, the subordinate hosts detect that the master host is no longer issuing heartbeats.



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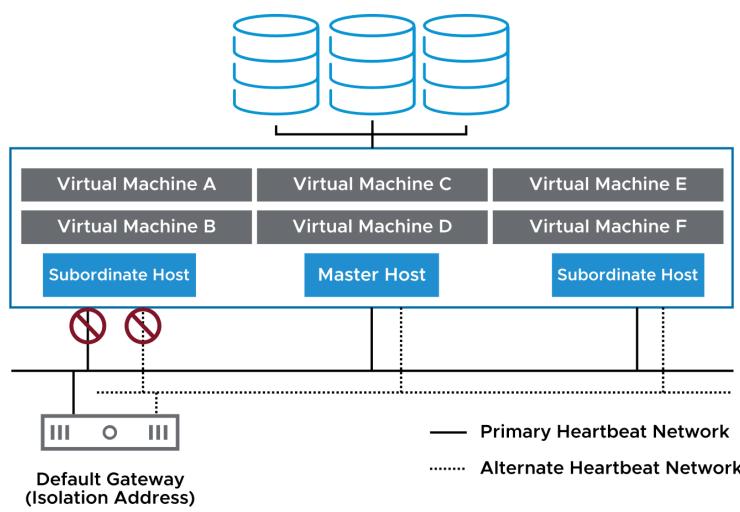
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Isolated Hosts

A host is declared isolated when the following conditions occur:

- The host is not receiving network heartbeats.
- The host cannot ping its isolation addresses.



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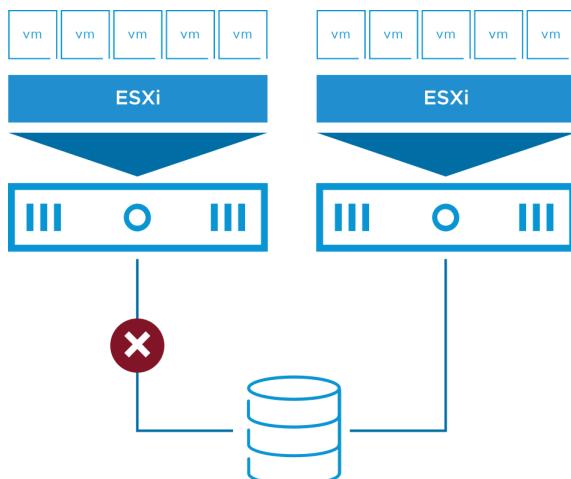
VM Storage Failures

Storage connectivity problems might arise because of:

- Network or switch failure
- Array misconfiguration
- Power outage

Storage connectivity problems affect VM availability:

- VMs on affected hosts are difficult to manage.
- Applications with attached disks fail.



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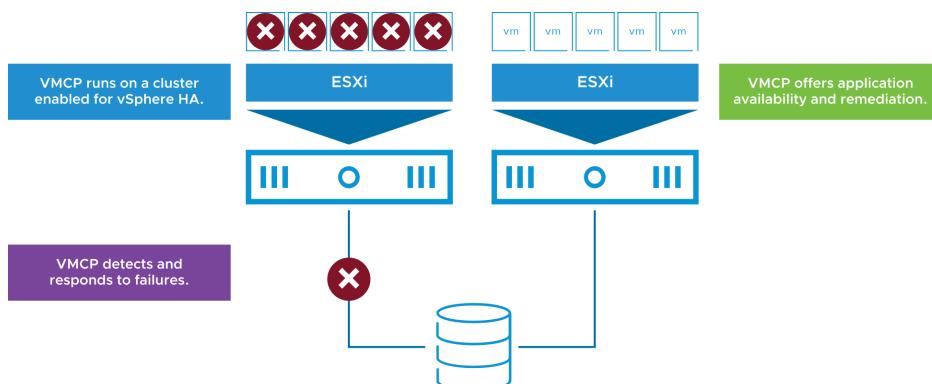
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Protecting Against Storage Failures with VMCP

VM Component Protection protects against storage failures on a VM.

- If VMCP is enabled, vSphere HA can detect datastore accessibility failures and provide automated recovery for affected VMs.
- VMCP is not supported with vSAN.



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Introduction to vSphere Fault Tolerance

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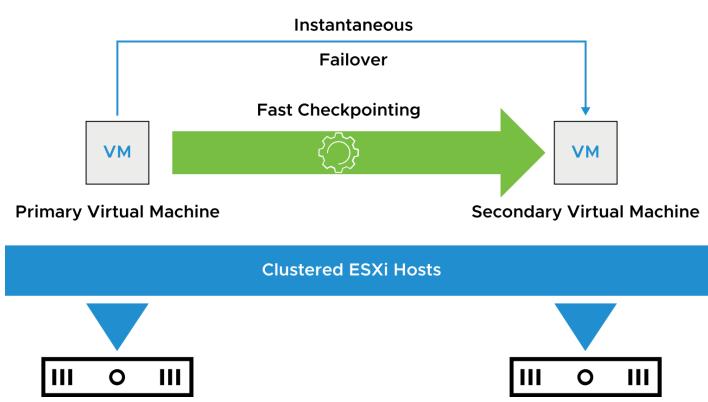
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About vSphere Fault Tolerance

vSphere Fault Tolerance provides instantaneous failover and continuous availability:

- Zero downtime
- Zero data loss
- No loss of VM network connectivity



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vSphere Fault Tolerance Features

vSphere Fault Tolerance protects mission-critical, high-performance applications regardless of the operating system used.

vSphere Fault Tolerance:

- Supports VMs configured with up to eight vCPUs and 128 GB memory
- Supports up to four fault-tolerant VMs per host with no more than eight vCPUs between them
- Supports vSphere vMotion migration for primary and secondary VMs
- Creates a secondary copy of all VM files and disks
- Provides fast checkpoint copying to keep primary and secondary CPUs synchronized
- Supports multiple VM disk formats: thin provision, thick provision lazy-zeroed, and thick provision eager-zeroed
- Can be used with vSphere DRS only when Enhanced vMotion Compatibility is enabled
- Supports interoperability with vSAN



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vSphere Fault Tolerance with vSphere HA and vSphere DRS

vSphere HA and vSphere DRS are vSphere Fault Tolerance aware:

- vSphere HA:
 - Is required for vSphere Fault Tolerance
 - Restarts failed VMs
- vSphere DRS:
 - Selects which hosts run the primary and secondary VM, when a VM is powered on
 - Does not automatically migrate fault-tolerant VMs



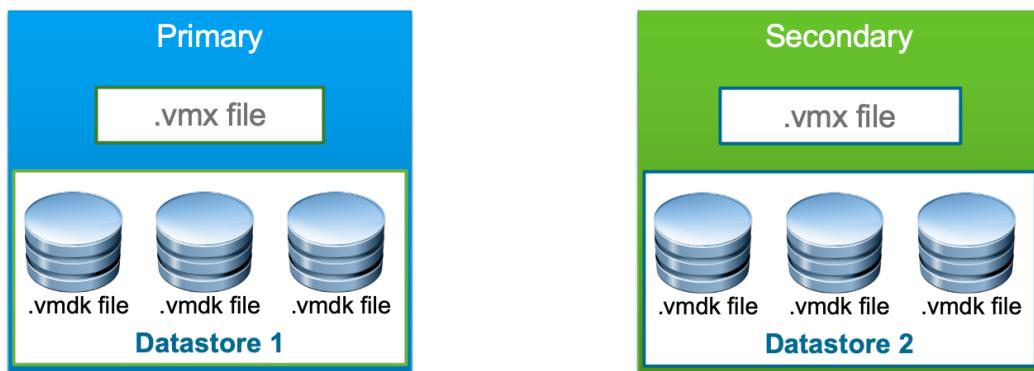
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Redundant VMDK Files

vSphere Fault Tolerance creates two complete VMs.

Each VM has its own .vmx configuration file and .vmdk files. Each VM can be on a different datastore.



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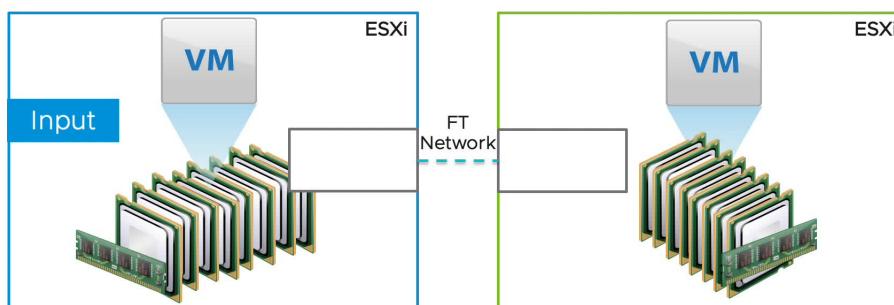
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vSphere Fault Tolerance Checkpoint

Changes on the primary VM are not processed on the secondary VM. The memory is updated on the secondary VM.



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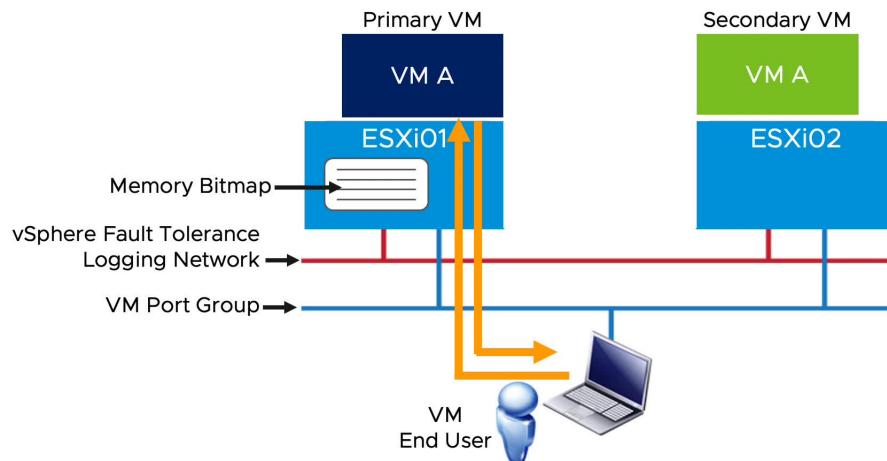


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vSphere Fault Tolerance: Precopy

Using vSphere Fault Tolerance, a second VM is created on the secondary host. The memory of the source VM is then copied to the secondary host.



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vSphere Fault Tolerance Fast Checkpointing

The vSphere Fault Tolerance checkpoint interval is dynamic. It adapts to maximize the workload performance.



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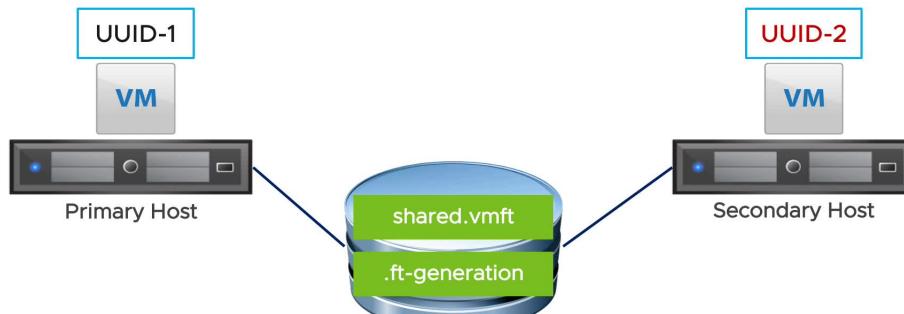


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vSphere Fault Tolerance Shared Files

vSphere Fault Tolerance has shared files:

- **shared.vmft** prevents UUID change.
- **.ft-generation** is for the split-brain condition.



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Enabling vSphere Fault Tolerance on a VM

You can turn on vSphere Fault Tolerance for a VM using the vSphere Client.

The screenshot shows the vSphere Client interface for managing a VM named 'Win10-02'. The 'Actions' menu is open, displaying various options like Power, Guest OS, Snapshots, and Fault Tolerance. The 'Fault Tolerance' option is highlighted with a red box, and its submenu, which includes 'Turn On Fault Tolerance', is also highlighted with a red box.



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