

**vmware®**

**IT ACADEMY**

---

CLOUD & VIRTUALIZATION  
CONCEPTS

**KNOWLEDGE**

## Cloud and Virtualization concepts

To be efficient means to get the optimum (maximum) benefit from the resources being consumed. For example, you may be familiar with the term "fuel efficient" being used to describe cars. Although technology has brought us very far, it is not always very efficient. If a large, expensive computer system is using only a fraction of its capabilities to complete small tasks, or at a time or sometimes sitting idle, it is not being used efficiently.

A key benefit of virtualization is the ability to create multiple copies from an original device. If humans had the capability to be virtualized it would mean that you could create copies of yourself in a virtual environment and those copies would be able to function very much like yourself.

## Hardware

component: Processor

definition: Also called a CPU (computer Processing unit), the processor is the part of the computer that executes software programs by performing mathematical, logical and input/output operations. This is the problem-solving part of the hardware.

## Random-Access Memory

Volatile data storage called RAM. RAM contains the programs for execution and the data currently used by the processor. A computer has two types of memory, non-volatile and volatile. Basically, non-volatile memory just stores the programs while volatile memory runs the programs because it is a faster type of memory.

## Read-only Memory

Also called ROM, this is non-volatile type of memory that stores software called the BIOS.

This type of software is responsible for turning on (booting) the hardware.

### Motherboard

A PCB (Printed circuit Board) that holds the processor, RAM, ROM, network, and I/O ports, and components that are beyond the level of this course.

### chipset

A collection of microchips on a motherboard that manages specific functions, such as transporting data to the processor, the RAM, and to the plugs for attaching devices.

### Storage

A persistent storage device such as HDD or SSD.

Each of these hardware devices uses something we do not touch to function, which is called software. Software is the "brains" of our hardware, providing instruction on how the hardware should operate.

## Software

- The first type of software is the system software, and it is like the part of the brain that controls your basic functions such as breathing and blinking.
- The first type of system software is the operating system. The second type of software is called application software.

## Role of hardware and software in Virtualization

- The roles hardware and software play in a computer system, the concept of virtualization will be easier to grasp. Virtualization is the layer of technology that goes between the physical hardware of a device and the operating system and creates one or many copies of the device.

⇒ What is the Virtual Machine?

- A virtual machine is a software computer that, like a physical computer, runs an operating system and applications. It can run the same

programs and behave exactly like the original machine that you can touch with your fingertips except that you can't actually touch the new machine because it only exists in the program.

Virtualization programming solves this inefficiency by gathering the resources of the physical components using code and cloning them in the virtualization layer, creating virtual hardware.

- The virtualization layer includes a piece of technology called the hypervisor. The host is the foundation of the virtualization layer, and everything virtualized exists in this layer. The virtual machine is created and only exists inside of the host. The virtual machine can communicate to others outside of the host using, for example, the internet and messaging, but it cannot exist outside of a host.

### Physical Machine:

- Difficult to move or copy
- Bound to a specific set of hardware components
- Often have a short life cycle

- Requires personal contact to upgrade hardware.

### Virtual Machine:

- Easy to move and copy because they are encapsulated into files and independent of physical hardware.
- Easy to manage because they are isolated from other virtual machines running on the same physical hardware.
- Insulated from physical hardware changes.

### Before Virtualization and After Virtualization:

- The definition of partitioning is the ability to run multiple operating systems on a single physical system and share the underlying hardware resources.
- Before virtualization, running more than one operating system was possible through a process called a dual boot. This is when a user partitions the hard drive and installs a different OS on each partition so when the computer is turned on, the user can pick which OS to boot up. For example, one OS uses only this part of the hard drive, and

the other uses another part of the hardware. This is the logic behind the term partitioning.

With a hypervisor, one computer can run multiple OS simultaneously, and partitioning is more flexible, meaning than one OS can be given more or fewer partitions just by adjusting the settings with the management layer software while the OS is running!

- Another development in the efficiency of technology due to virtualization is the ability to isolate VMs, called isolation. Isolation also means that virtual machines are highly portable, and can be moved or copied to any industry standard hardware platform, regardless of the make or model. This virtualization makes IT resource management more adaptive, and provides greater responsiveness to changing business conditions.

### The Hypervisor

- The virtual machines operate inside of the host, as depicted in the office building analogy from the previous section, which is called a hypervisor.

## Type 1 Hypervisor

The type 1 hypervisor sits directly between the hardware and the virtual machine, which has its very own operating system.

- With a Type 1 hypervisor, a computer can now run an OS and also one or more instances of another operating system such as Linux Ubuntu, or an older version of Windows, for example.
- Because the Type 1 hypervisor is installed directly on the hardware, it is referred to as a bare metal hypervisor. The hypervisor software is literally installed onto the metal hardware.

## Type 2 Hypervisor

- Type 2 hypervisor called a hosted hypervisor needs to be installed on top of the operating system that already exists, the host OS, not on top of the hardware like a bare metal hypervisor.
- The host OS could be the Windows 10 on your laptop.

- The hosted (Type 2) hypervisor depends on the host OS to provide direct access to the computer's hardware resources and manage those resources to create virtual machines.
- The best part about the Type 2 hypervisor is that it is very simple to download and give you the ability to start playing around with virtualization by creating your own virtual machines.

There are two different hosted hypervisors available to download through VMware; VMware workstation

### Two Virtualization Scenario

- Scenario 1
  - Virtualization as a technique to turn one piece of hardware into many usable virtual machines.
  - The bare metal hypervisor becomes incredibly useful.
  - In the basement at the company headquarters are several large computers called servers.
  - A thin client is a small computer device that is less expensive to acquire than a traditional P.C.
  - The thin client functions by relying on the servers for processing rather than using its own hardware.

## • Scenario 2

### • VMware Workstation

The type 1 Bare-metal Oracle VM Server and Microsoft Hyper-V and the Type 2 Hosted Virtual Box and QEMU are few examples.

The number of companies deploying hypervisors technology indicates that the use of hypervisors technology indicates that the use of hypervisors to host VM is popular, especially in big business, also known as enterprise. VMware ESXi caters to this market by delivering efficient bare metal hypervisor technology.

Workstation for windows and workstation for Linux supports numerous operating systems including the following:

- Windows 10
- Windows 8
- Windows 7
- Ubuntu
- Redhat
- SUSE

More than 200 operating systems are supported on VMware's hosted hypervisors. The following are just some of the operating systems supported on VMware Fusion for Mac.

- Windows 10
- Windows 8 and 8.1
- Windows 7
- Ubuntu
- Redhat

→ creating a Virtual Machine

→ Virtual Machine Files

One benefit of a virtual compute system rather than a physical one is that it is more easily modifiable and mobile. Once a virtual machine is created in the host, its settings can be adjusted, saved, and even exported to other hosts.

When a virtual machine is created, it will appear on the host computer as a set of files. It is usually stored in a directory, created by the hypervisor for the specific virtual machine.

A virtual machine end user may never need to know the file names or locations for the virtual machine files because virtual machine file management is performed by the host.

### Snapshots

- The virtual machine host has a very useful capability to save the state of a virtual machine at any given time. When you are working on an essay or document, and you want to take a break, you normally save it and come back to it at a later time. The snapshot feature allows a user to do the same to a VM.
  - The snapshot captures the entire state of the virtual machine at the time you take the snapshot. This includes:
    - The state of all the virtual machine's disks.
    - The contents of the virtual machine's memory.
    - The virtual machine settings.

From the personal desktop to Enterprise Virtualization  
A data center involves a significant amount of hardware. The data center performs three main functions:

It processes, stores, and transmits data. This requires three main types of hardware:

1. Compute
2. Storage
3. Network

## The Data Center

- o Every bit of information that can access on a device is the result of a transfer of data b/w where the information is processed and stored, and the device to which the data is distributed.

The flexibility of having multiple hardware and software resources, called scalability, is important for growing companies and also allows for fast response to events that can cause outages and other issues.

To reduce the possibility of issues, a data center must be managed effectively.

Data center servers fall under three types; tower, rack-mounted and blade.

The rack-mounted system is a thin, large rectangular compute system that slides onto the racks of a frame.

The blade server, like the rack-mounted has

rectangular hardware inserted into a larger frame.

## Networks

- A network connects computers, servers, and other devices to each other so they can communicate and transfer data. The data center now is a critical component of the data center.

List of networking hardware:

Router

Switch

NIC [Network Interface Controller]

Ethernet cable

Port

- A network can have different layouts and range.
- The type of network that normally uses Ethernet cables is called a LAN (Local Area Network).

The protocol most commonly used for a data center network is called TCP/IP. Transmission Control Protocol / Internet Protocol (TCP/IP) is a program that computers use to send messages to each other.

## Storage

Servers are built to process and compute data, but the memory of a server, the hard disk drive and RAM can only accommodate a certain amount of data.

## RAID

To ensure availability in the data center, a type of data storage technology called RAID (Redundant Array of Independent Disks) is used. RAID is a multiple storage device drives, hard drives for example, that are linked together to create one single large volume of storage.

## File level and Block level storage

In block level storage, a storage device such as a hard disk drive (HDD) is identified as something called a storage volume.

File level storage is a type of storage that has a file system installed directly onto it where the storage volumes appear as a hierarchy of files to the server, rather than blocks.

## Direct Attached Storage

Direct Attached Storage (DAS) means that a physical storage device is directly attached to a server or personal computer.

Types of storage that can be used as DAS:

1. Hard Disk Drive (HDD)
2. Solid State Drive (SSD)
3. Optical Disk Drive (ODD)

## Network Attached Storage

NAS short for Network Attached Storage, involves attaching a storage device to a network that, in turn, allows storage to be accessed and distributed on the network to servers attached to the same network.

To communicate to servers on the LAN, the storage uses a TCP/IP, which is basic internet protocol, or language data is transmitted in through the internet.

File system protocols used on NAS devices are NFS (Network File System) and CIFS (Common Internet

- File System). NFS is commonly used with Linux and Unix based operating systems while CIFS is used for file sharing on Microsoft based machines.

## Storage Area Network

- A SAN (Storage Area Network) is one or many block level storage devices clustered together that are attached to a high-speed network and that applications running on the servers can connect to in order to access the data.
- A SAN requires that servers trying to connect to it also have certain protocols. Because a SAN requires a high speed connection, faster protocols such as iSCSI, Fiber Channel (FC), and more recently Fiber Channel over Ethernet (FCoE) are used to transmit data at higher speeds on the TCP/IP network (internet).

## Storage protocols

- SCSI (Small Computer System Interface)
- SATA (Serial Advanced Technology Attachment)
- eSATA (external SATA)
- SAS (Serial Attached SCSI)

- FC (fiber channel)  
(multi-mode) (MMF)
- FC (fiber channel)  
(single-mode) (SMF)
- Provisioning is the process of strategically assigning storage space to servers based on the capacity of the storage device(s), availability and performance requirements. Storage provisioning can be performed in two ways, traditional and virtual (thin provisioning)

### The virtual Data Center

- A data center has powerful, robust technology made to handle volumes of data that paved the way for modern digital world, but there are still areas where improvements can be made.
- The following are several key issues faced by a data center:
- Using servers more efficiently.

- Availability of applications
- Efficiency of manpower.

## Vsphere

vsphere without first introducing the four main components that, essentially, make up vsphere:

- ESXi - VMwares Type I (bare metal) hypervisor.
- vcenter - Vsphere's management layer.
- vsphere Client - A program that configures the vcenter, host and operates its virtual machines.
- vsphere Host Client - A program that only configures the host and operates its virtual machine.

## Server virtualization

server virtualization is the process of dividing a physical server into multiple unique and isolated virtual servers by means of a software application.

## Storage virtualization

storage virtualization is the pooling of physical storage from multiple storage devices into what appears to a single storage device - or pool of available storage.

capacity - that is managed from a central console.

## Network virtualization

Network virtualization (NV) refers to abstracting network resources that were traditionally delivered in hardware to software.

### Types of virtual Networks

Bridged Network

NAT network

Host-only network

## Application and Desktop Virtualization

A virtualized data center can solve this problem by virtualizing the applications themselves and allowing them to be accessed remotely by a user.

VMware uses a technology called ThinApp to deliver virtualized applications themselves compatible with any machine.

The another virtualization technology that can be used along with application virtualization, called

desktop virtualization, to deliver computer function in software form to an end user.

VMware's desktop virtualization technology is called Horizon.

## The cloud:

### Types of cloud computing

The use of cloud computing is expanding at an incredible pace. This is great for businesses and organizations as they now have more and more options about how to achieve their IT goals. To help them to decide how to achieve those goals best, cloud computing is categorized into different types or "service models". The three major types are Software as a service (SaaS), platform as a service (PaaS) and Infrastructure as a service (IaaS).

### Cloud Deployment Models:

"Cloud deployment" includes the activities about installation, configuration, testing, making changes and then running but has more of an emphasis on where the hardware or software is running and

who is controlling it - is it whether it's SaaS, PaaS, IaaS.

- Private and community clouds
- Public clouds
- Hybrid clouds.

## Container Technology

### Introduction to Container

A container is a package for deploying applications.

Containers use virtualization technology similar to virtual machines, but require fewer resources.

Containers use fewer resources because they do not actually run an operating system like a VM.

This is because the container uses the kernel of the guest operating system.

## Kubernetes

Kubernetes (k8s) works with containers, the team of developers has created three containerized application.

Kubernetes places each containerized app inside a pod

The nodes are grouped together in a cluster, with up to 5000 nodes per cluster being possible in Kubernetes. Each cluster contains a special node called a master node which monitors and manages the other nodes. The master node is made up of several components etcd, kube-scheduler, controller manager, cloud controller manager, kube-api-server.

### Container Security

The endpoint on premises and in the cloud. Endpoints are devices that are connected to a network such as a laptop or mobile phone. This is called endpoint security. Endpoint security is the practice of using security system to secure endpoints as in user device like desktops and mobile device in the cloud or on a network.

Protecting endpoints is one part of the whole picture when it comes to cybersecurity for virtualized envts. Another aspect of container security includes protecting the applications installed on them, their workloads. Workload security involves tracking and monitoring workloads for vulnerabilities.

## VMware Virtualization Solutions

The foundation of vSphere consists of the hypervisor (ESXi), the management server (vCenter) and the user interfaces vSphere Client and vSphere Host Client. These three are the foundation of vSphere but vSphere also includes other products as part of the vSphere 'suite'. VMware offers these other products as solutions to solve more specific computing and data center efficiency issues.

### VMotion

There are three underlying technologies that allow VMotion to do live migration. First, the entire state of the VM is encapsulated which means to condense and enclose, as a set of files on shared storage such as Storage Area Network (SAN) or Network Attached Storage (NAS). The servers, which are able to access shared storage through networks, can access those encapsulated files in the NAS or SAN Virtual Machine File System (VMFs), giving them access to the VM being migrated.

Second, the state of the VM is rapidly transferred over a high-speed network, allowing the virtual machine to instantaneously switch from running on the source ESXi server to the destination ESXi server.

Third, the networks being used by the virtual machine are also virtualized by the underlying ESXi server, ensuring that even after the migration, the virtual machine network identity and network connections are preserved.

### Storage VMotion

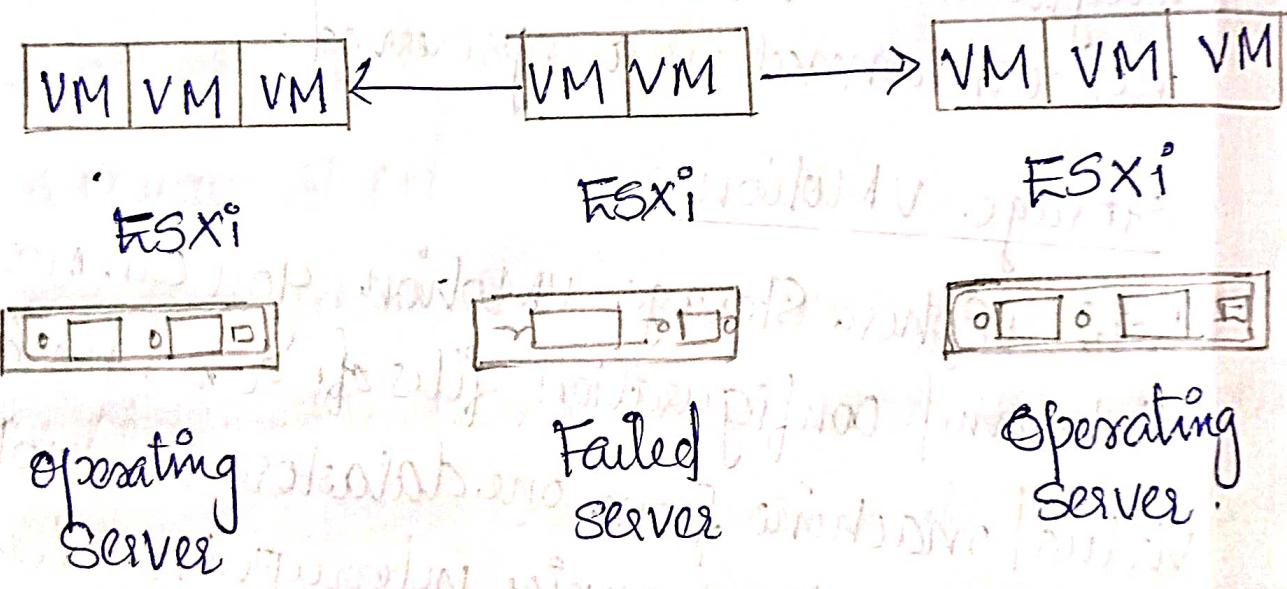
With vSphere Storage VMotion, you can move the disks and configuration files of a running virtual machine from one datastore to another datastore without service interruption. Storage VMotion has several uses in administering virtual infrastructure, including the following examples:

- storage maintenance and reconfiguration: You can use Storage VMotion to move virtual machines off of a storage device to allow maintenance or reconfiguration of the storage device without virtual machine downtime.

## VSphere High Availability (HA)

VSphere HA increases the availability of VMs by pooling servers (hosts) and the VMs that reside on them in a cluster and monitoring them. In the event of a failure, the virtual machine on a failed host are restarted on alternate hosts.

Three ESXi hosts with HA enabled:



## VSphere Storage Distributed Resource Scheduler (Storage DRS)

With VSphere Storage DRS, you can manage multiple datastores as a single resource called a datastore cluster. Clustering datastores is more efficient because historically, provisioning virtual machine

storage has posed operational challenges. During the provisioning process for virtual machines, virtual disk datastores are often randomly selected, leading to over- or underutilized datastores. This makes monitoring datastores capacity very difficult, and as a result, it is often neglected. To help resolve these issues, Storage DRS was added as a feature of VMware vSphere that provides smart virtual machine placement and storage load-balancing mechanisms based on space capacity.

### Vsphere Fault Tolerance (FT)

When vSphere Fault Tolerance is enabled on a virtual machine, a secondary copy of that virtual machine and its files is created on another ESXi host and datastore. The difference between FT and HA is that with HA when the server fails, the end-user will see the virtual machine fail and reboot, while with FT, the transfer to a different server is seamless and will not be noticeable to the end user.

## Vsphere Replication

VMware Vsphere replication is a hypervisor-level replication engine that makes the recovery of virtual machines faster and easier.

- One of the features of Vsphere Replication is that it is integrated with Vsphere web client, which eases administration and monitoring. This means that creating a target site for the replication VMs is easily done through a wizard.

## VMware VSAN

VMware designed an extension of Vsphere called VSAN, to virtualize storage in data center servers.

VSAN interacts with Vsphere to create one layer of virtualization software, which is managed by the Vcenter management layer. The virtualized storage is then available to be distributed to virtual machines.

VSAN stands for Virtual storage Area Network. A VSAN is virtualized SAN (storage area network) created by using virtual routing and switching to

network the clustered storage.

## Hyper Converged Infrastructure

A hyper-converged infrastructure is a converged infrastructure that has been virtualized.

### • VMware NSX

NSX expands standard network virtualization beyond just virtual switches.

### • NSX-T

For NSX to function properly in a virtualized environment, you need vcenter service. This is because without vcenter service, NSX will not be able to integrate with vsphere and the hypervisor.

## VMware Cloud Foundation

VMware cloud foundation can be used to virtualize on-premises or to migrate off-premises.

## Vcloud Automation Center

VMware vcloud automation center can do these things for you - and more. It's a cloud management product full of features and benefits for users and

IT administrators. Through a single self-service catalog, you're able to quickly deliver and easily manage the personalized infrastructure, application and services at your business needs, while improving overall IT efficiency.

### VMware cloud

VMware cloud is an application platform designed to give administrators the flexibility to deploy and manage applications wherever they're needed - in the cloud or in a container in Kubernetes. VMware cloud works with both enterprise-sized cloud providers such as AWS, Azure, and Google, and on many other, smaller-scale cloud providers.

### Tanzu

Tanzu encompasses the full life-cycle of modern applications, managing, automating the delivery of containerized applications managing them centrally, and bringing a stronger focus on the Cloud and all the advantages the cloud can bring.

The purpose of Tanzu Mission control is to operate and secure k8s and modern apps in the cloud.

It provides a single point from which to:

- manage a k8s cluster life cycle
- manage policies
- perform health-checks
- monitor the entire environment from one place
- and more.

### Cloud Health

Cloud Health makes it very easy for you to see how well you're using your infrastructure. It gives you extremely detailed information on what applications you're running, down to the hour - even down to the minute. You can customize the time period you want to look at and monitor either groups of resources or specific resources such as CPU, memory and disk.

## Carbon Black

Carbon Black is able to provide a level of cloud native endpoint protection that "virtualizes" the stage of an attack, such as blocking malware. For example, imagine a scenario where a cyber-attacker is trying to insert malware on an organization's critical production system. Malware is software that has been designed to inflict damage to a networked device such as a server. If the malware were inserted, it could possibly do devastating damage to a networked device such as a server.