VIRTUALIZATION

Cloud and Virtualization

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Cloud computing
Engineer

A seasoned Cloud and DevOps Engineer with expertise in architecting and implementing cutting-edge solutions. Renowned for proficiency in optimizing development workflows.

My career is defined by a relentless pursuit of excellence, delivering impactful results and fostering a culture of innovation.

As your instructor, I am dedicated to sharing my knowledge and practical insights to empower you in mastering Cloud and DevOps.

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If a large, expensive computer system is using only a fraction of its capabilities to complete small tasks, one at a time or sometimes sitting idle, it is not being used efficiently.

HARDWARE

Represents the tangible, physical components that make up the computer system.

o CPU (Computer Processing Unit)
o ROM (Read-Only Memory)
o Chipset

o RAM (Random-Access Memory)
o Motherboard (A PCB to hold components)
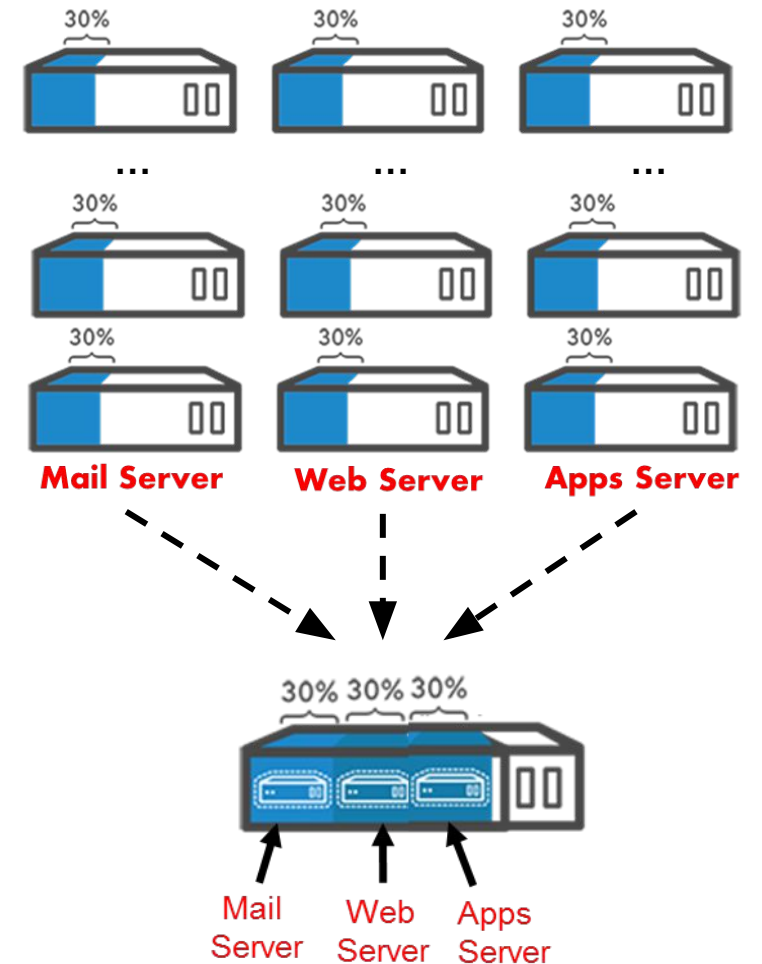o Storage (HDD / SSD)

SOFTWARE

The "brains" of our hardware, providing instructions on how it should operate.

System software necessary for the hardware to function.
    o **BIOS:** The lowest level of system software a computer needs to have to turn on
    o **OS:** controls the hardware and is directly connected to it. It runs in the background and pulls up a user interface so you can access files and install programs.

Application software runs on top of the OS and carries out a task.

VIRTUALIZATION

The layer of tecahnology that goes between the physical hardware of a device and the operating system and creates one or many copies of the device.

Full

VMware's ESXi server

The hypervisor completely simulates the underlying hardware.
Guest OS is intact and completely unaware that it's being virtualized.
Uses a combination of direct execution and binary translation.

Para

open-source Xen project

The hypervisor doesn't simulate underlying hardware.
Instead, it provides hypercalls.
Guest OS is modified and aware that it's being virtualized.
Provides better performance but not as portable as full virtualization.

Native

Intel-VT & AMD-V Processors

Also known as Hardware-assisted virtualization.
Underlying hardware provides special CPU instructions to aid virtualization.
Highly portable as the hypervisor can run an unmodified guest OS.
Hypervisor implementation is less complex and more maintainable.

" Virtualization is to have an instance of Something in a reality on top of our Reality.
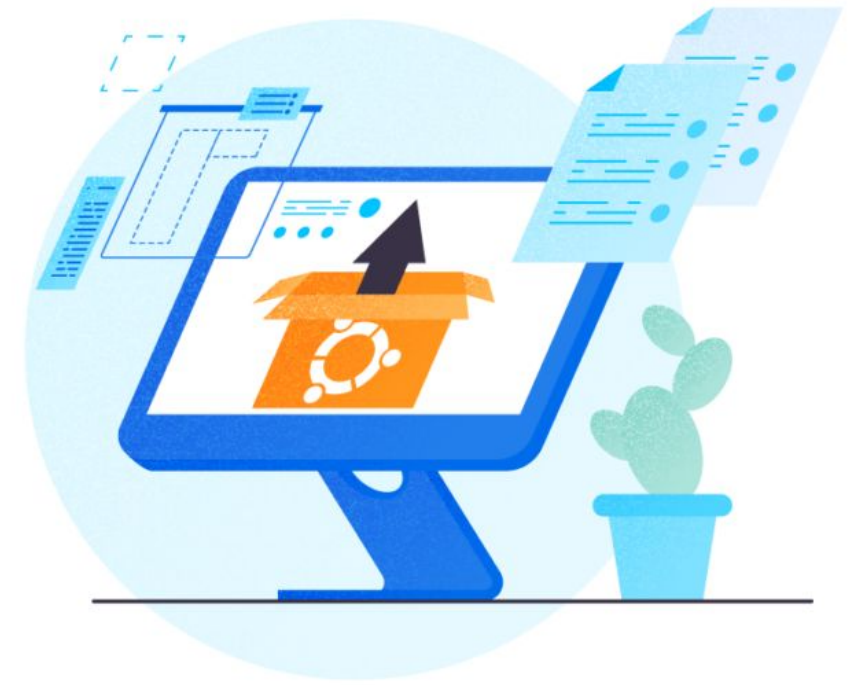
" A virtual machine is a software computer that, like a physical computer, runs an operating system and applications. It can run the same programs and behave exactly like the original machine.

VIRTUALIZATION IS A LAYER OF PROGRAMMING INSTALLED ONTO THE HARDWARE. IT GATHERS THE RESOURCES OF THE PHYSICAL COMPONENTS USING CODE AND CLONING THEM IN THE VIRTUALIZATION LAYER, CREATING VIRTUAL HARDWARE. EVEN THOUGH IT IS NOW AN INSTANCE IN THE VIRTUAL LAYER, VIRTUAL HARDWARE FUNCTIONS THE SAME AND PRODUCES THE SAME RESULTS.

Once virtual hardware is created, the MV is ready to be built. Like a physical computer, the VM requires an OS in order for the virtual hardware to actually work. The virtualization layer allows you to install an OS of your choice to the VM.

THE VIRTUALIZATION LAYER INCLUDES A PIECE OF TECHNOLOGY CALLED THE HYPERVISOR. It's the foundation of the virtualization layer, and everything virtualized exists in this layer.

Many virtual machines can be created on a hypervisor. A new VM can be hosted as long as the physical machine can support the VM's hardware needs.

The virtualization program packages all of the virtual components of a VM together as a set of files. The files are executed in the virtual layer, creating the virtual machine. It can now have applications installed onto it which will run just like they do on a physical machine.

Aside from being a solution for hardware inefficiency, what are the most obvious benefits of a virtual machine to a user?

☑ **Partitioning**

☑ **Isolation**

☑ **Insulated from physical hardware changes**

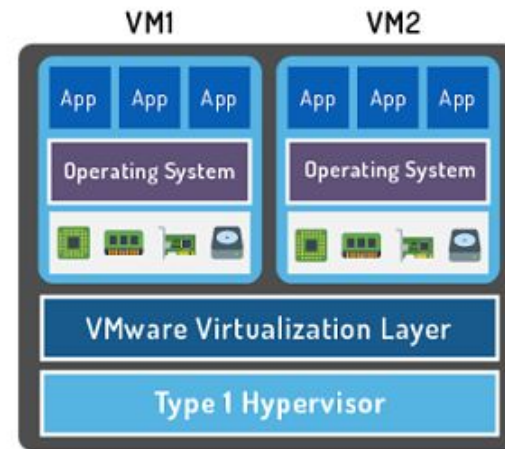☑ **Green IT**

Bare Metal Hypervisor

The Bare Metal Hypervisor sits directly between the hardware and the virtual machine. Meaning that the host hardware does not need to be limited to one operating system because it allows the computer to host more than one operating system at a time.

One of the highlights of using a bare metal hypervisor is that any problems present in one VM do not affect other VMs. This allows the user to run multiple programs all at once and multitask without worrying about one of those programs crashing and stopping all the other programs from working.

In some settings, a bare metal hypervisor is also referred to as an embedded hypervisor.
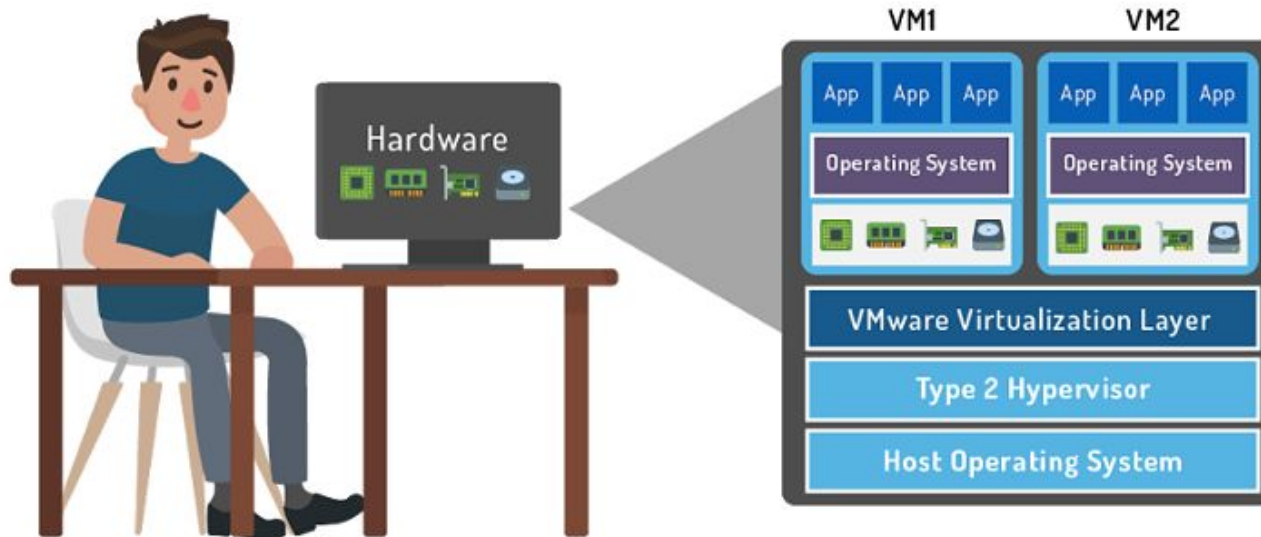This is because the hypervisor software is embedded into the hardware device.

HOW IS A USER SUPPOSED TO USE THE COMPUTER WITHOUT FIRST GOING THROUGH THE COMPUTER'S OS ?

To make it possible for a user to interact with the bare-metal hypervisor, the hypervisor includes a management layer that creates a user interface.
Without this management software, you would just get a black screen when you turn on the computer because there is no OS.

VMware's Type 1 hypervisor is called **ESXi**
Management layer software is called **vCenter**

Hosted Hypervisor

The Hosted Hypervisor is installed on top of the operating system that already exists, the host OS, not on top of the hardware like a bare metal hypervisor.

It depends on the host OS to provide direct access to the computer's hardware resources and manage those resources to create virtual machines.

Why ? Why Not ?

Bare Metal Hypervisor

✅ Performance improvement: self-hosted with embedded OS that are optimized for virtualization.

❌ One role: The bare metal machine becomes dedicated for the unique purpose of being a hypervisor.

❌ Device driver inflexibility: Unlike OS, they do not have the ability to dynamically load device drivers.

Hosted Hypervisor

✅ Fewer hardware/driver issues as the host OS is responsible for interfacing with the hardware.

❌ Weak in reliability and security because they inherit the vulnerabilities of the user-controlled host operating system.

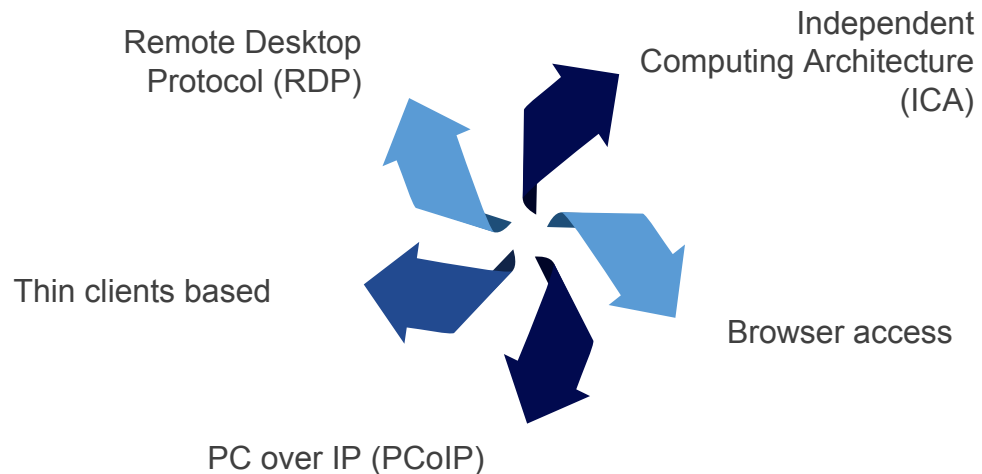❌ VMs are affected by the update process of the Host OS

Desktop Virtualization

Desktop virtualization is software technology that separates the desktop environment and associated application software from the physical client device that is used to access it.

Several VMs equipped with an OS run on a server, itself operating with a particular OS
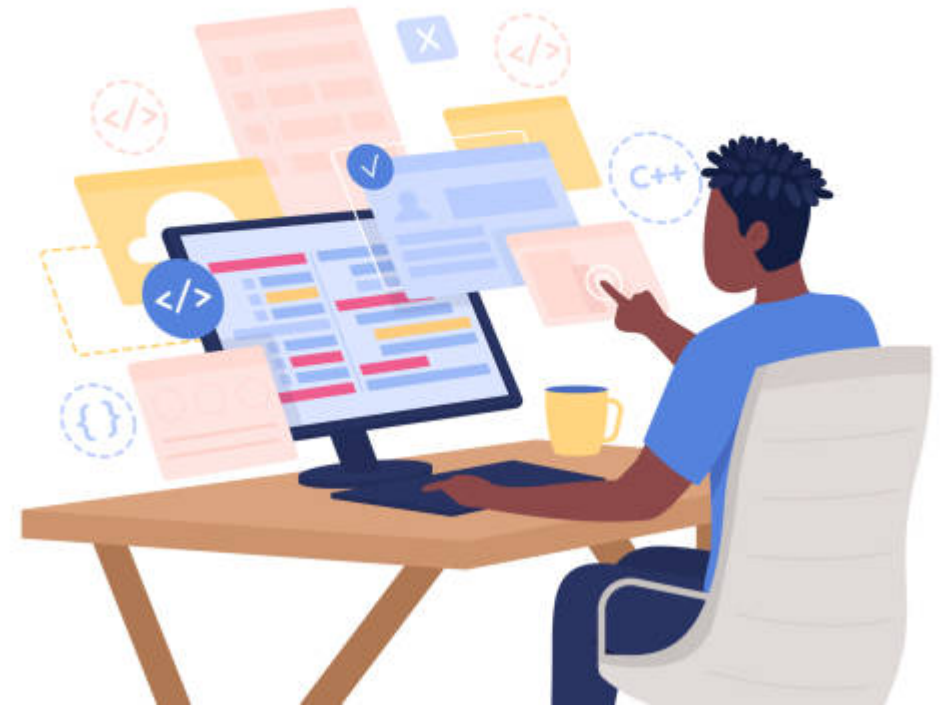o When a user turns on his physical station, he logs on to one of these machines.
o The display and sound of this virtual machine are transferred to the physical station via the network.

Users view and interact with their desktops over a network by using a remote display protocol.

Remote Desktop Protocol (RDP)

Independent Computing Architecture (ICA)

Thin clients based

Browser access

PC over IP (PCoIP)

Why Desktop Virtualization ?

o PC management is time consuming & inefficient

o Desktop operating costs are high

o Low end user SLA levels

o Security and compliance risks

Server Virtualization

Server virtualization refers to a number of "virtual machines" that are created on one server, saving on processing power, cost and space.
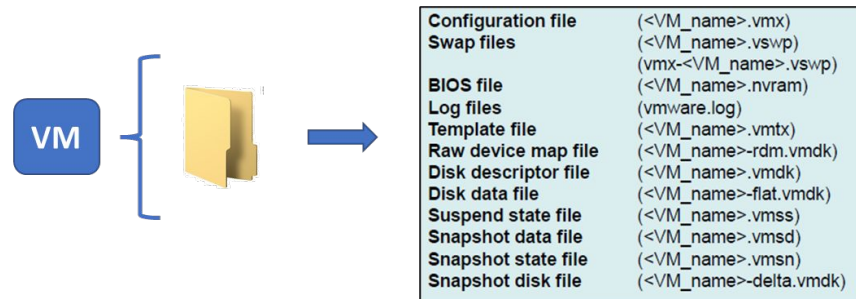
Server virtualization inserts a layer of abstraction between the physical server hardware and the software that runs on the server allowing us to run multiple guest computers on a single host computer with those guest computers believing they are running on their own hardware.

Why Server Virtualization ?

- Server consolidation
- Encapsulation and mobility
- Enhanced disaster recovery
- Hardware independence
- Isolation
- Reduced cost
- Rapid deployment

From user's perspective

- A logical compute system that runs an OS and applications like a physical machine
- A logical compute system that contains virtual components such as CPU, RAM, disk, and NIC
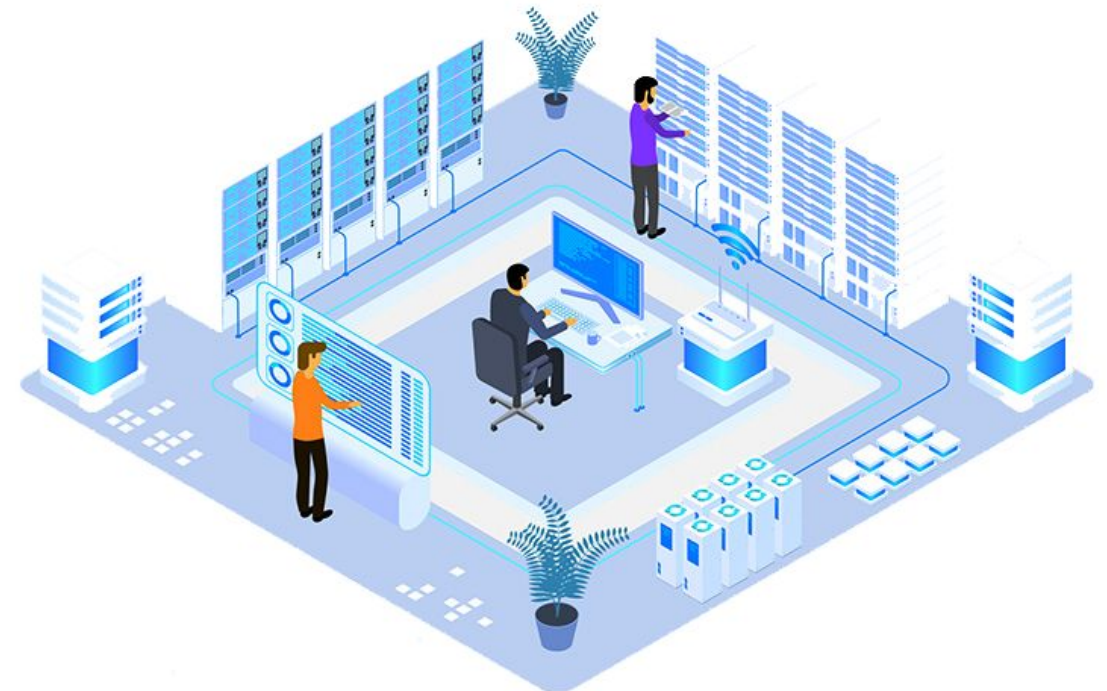
From hypervisor's perspective

A Virtual machine is a discrete set of files such as configuration file, virtual disk files, virtual BIOS file, VM swap file, and log file

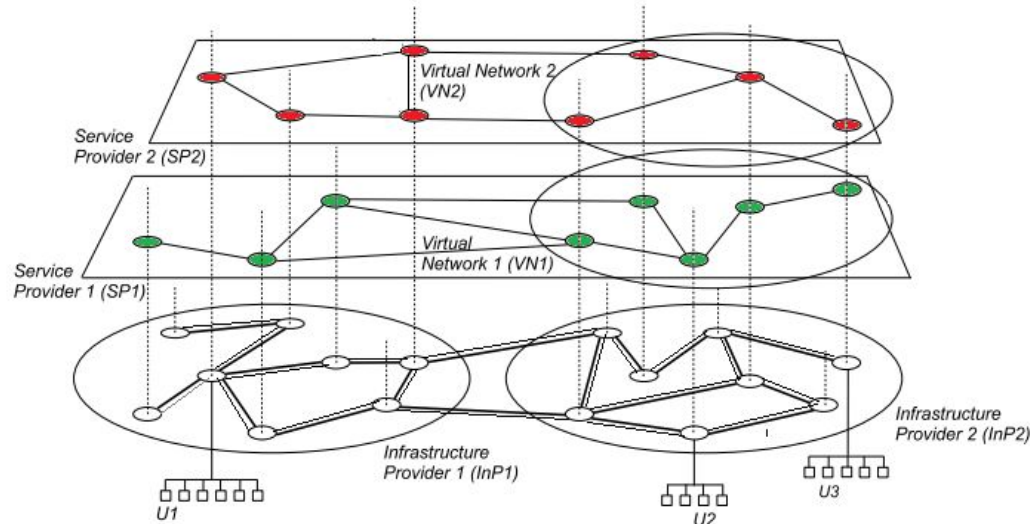| Configuration file	(<VM_name>.vmx)
Swap files	(<VM_name>.vswp)
	(vmx-<VM_name>.vswp)
BIOS file	(<VM_name>.nvram)
Log files	(vmware.log)
Template file	(<VM_name>.vmtx)
Raw device map file	(<VM_name>-rdm.vmdk)
Disk descriptor file	(<VM_name>.vmdk)
Disk data file	(<VM_name>-flat.vmdk)
Suspend state file	(<VM_name>.vmss)
Snapshot data file	(<VM_name>.vmsd)
Snapshot state file	(<VM_name>.vmsn)
Snapshot disk file	(<VM_name>-delta.vmdk)

Network virtualization

The Network Virtualization creates multiple logical virtual networks having separate control and data plane.

It simulates network functionality as a "virtual instance" that can be loaded on standard platforms. Physical devices are responsible for packet transmission, while network intelligence is provided by software.

the decoupling of the roles of the traditional Internet Service Providers

- **Infrastructure providers:** manage the physical infrastructure,
- **Service providers:** create virtual networks by aggregating resources from multiple infrastructure providers and offer end-to-end services.

Why Network Virtualization ?

- Flexibility
- Manageability
- Scalability
- Stability and convergence
- Isolation
- Programmability
- Heterogeneity
- Legacy support

Storage virtualization

Storage Virtualization is the process of masking the underlying complexity of physical storage resources and presenting the logical view of these resources to compute systems.

Why Storage Virtualization ?

o No downtime

o Increases storage utilization

o Non-disruptive data migration

o Supports heterogeneous storage platforms

o Simplifies storage management

Host-based approach

o used as a software running on host systems.
o Storage provisioning for VMs

Network-based approach

o Used on network devices.
o Block-level virtualization
o File-level virtualization

Storage-based approach

o used on storage target subsystem.
o Virtual Provisioning
o Automated Storage Tiering

How does Storage Virtualization work ?

o Logical to physical storage mapping is performed by virtualization layer

o Virtualization layer abstracts the identity of physical storage devices

o Creates a storage pool from multiple, heterogeneous storage arrays

o Virtual volumes are created from the storage pools and are assigned to the compute system

o Compute system remains unaware of the mapping operation and access the virtual volumes,

as if accessing physical storage attached to them.

Video Links

Virtualization Explained

Full vs. Paravirtualization

What is a Hypervisor?

Bare Metal vs. Dedicated Host

What is a Virtual Server?

What is Desktop Virtualization?

Virtual Networking Explained

SDN and NFV

SAN, NAS, DAS

RAID

QUIZ TIME!