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# Virtual Systems and Services

CS505

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# Introduction to Virtualization

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CS505 - Virtual Systems and Services



# In this lecture

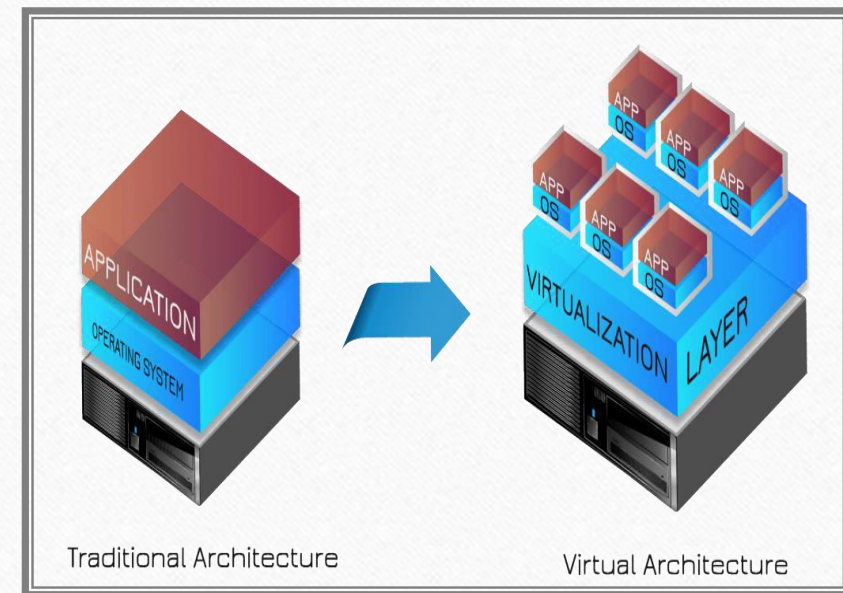
- **Topics to be Covered:**

- What is Virtualization?
- Why Virtualization?
- How Virtualization is done?



## What is Virtualization?

- Pretty old but too critical to understand
- A system pretends to be two or more
- Simulation of hardware devices or features using software
- Used to create virtual version of something (like network)



# Why Virtualization?

- Best use of resources
- Flexibility and scalability
- Increased agility
- Disaster Recovery
- Increased Security
- Cost saving





# How Virtualization



- 
- Achieved through the use of virtualization software called Hypervisor
  - Hypervisor creates virtualized versions of physical resources
  - Hypervisor allocates these resources to virtual machines (VMs)
  - VM operates as if it were a physical machine
  - Run different applications, operating systems, and services using VMs

# Benefits of Virtualization

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# Benefits of Virtualization

- **Topics to be Covered:**

- Resource utilization
- Scalability and flexibility
- Improved disaster recovery and business continuity
- Increased security





# Resource Utilization



- 
- Create virtualized versions of physical resources
  - Use the same hardware more effectively
  - Leading to better utilization of resources

# Scalability and flexibility

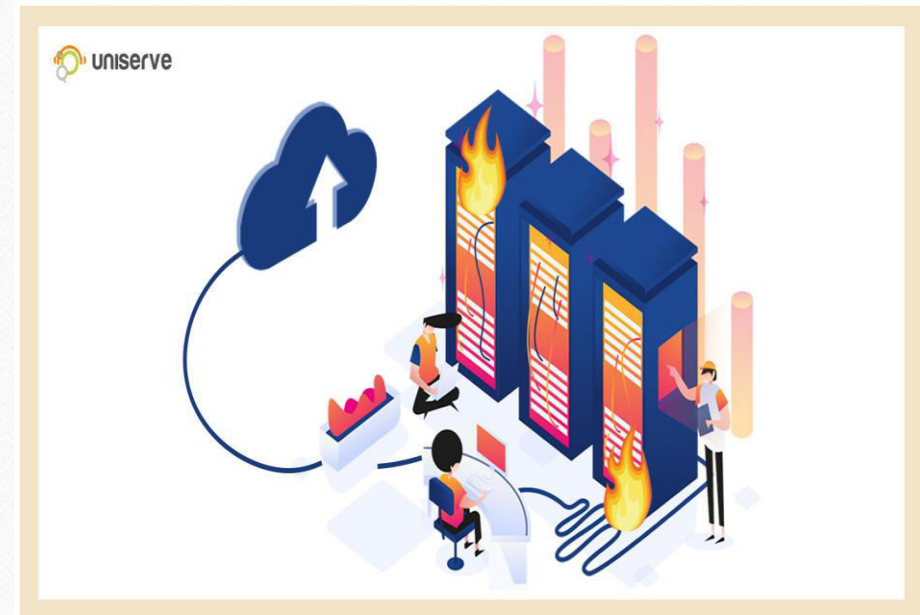
- Easier to scale resources up or down as needed
- No need to make physical changes to the underlying infrastructure



# Improved Disaster Recovery and Business Continuity



- Create replicas of their production environment
- Quickly activated in the event of a disaster
- Does not affect the end user





# Increased Security

- Isolate and secure sensitive applications and data
- It becomes harder for malicious actors to access them
- Minimal to no chances of virus attack or security breach



# Types of Virtualization

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# Types of Virtualization



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- **Topics to be Covered:**

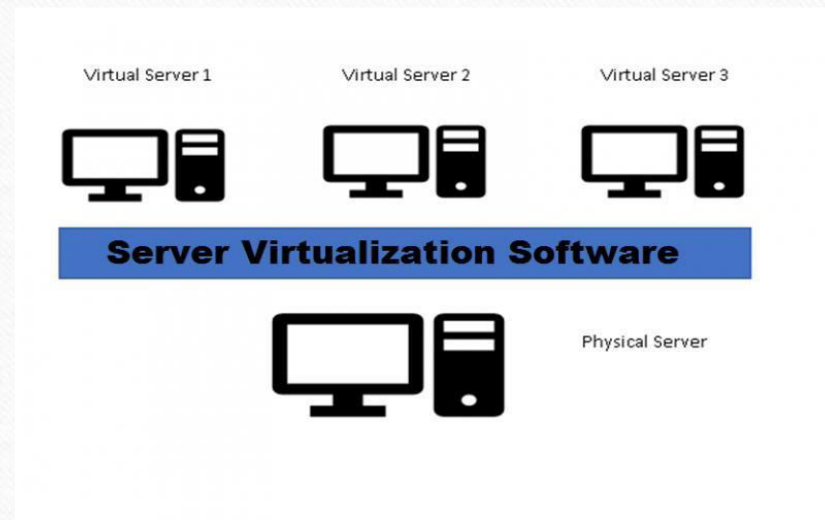
- Server Virtualization
- Desktop Virtualization
- Application Virtualization
- Storage Virtualization
- Network Virtualization
- Hardware Virtualization





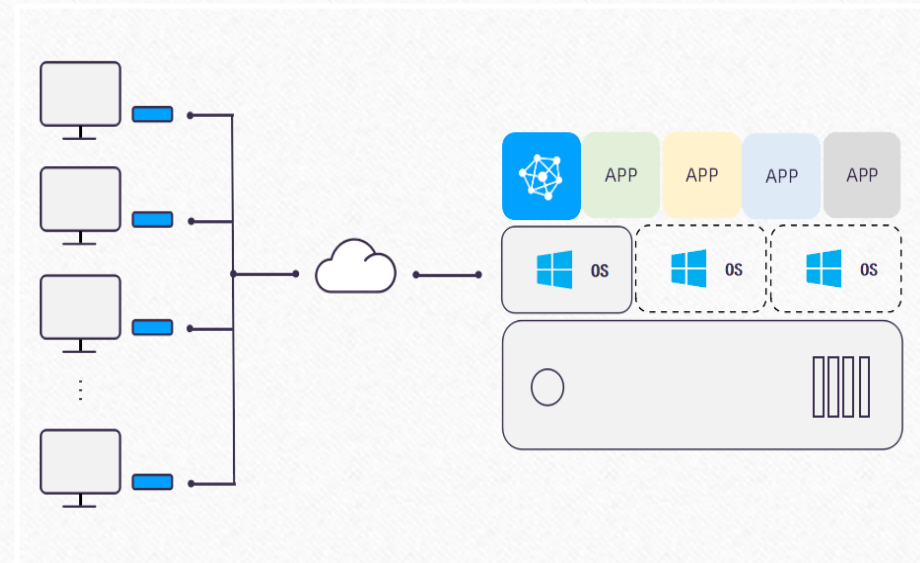
# Server Virtualization

- Allows multiple virtual servers to run on a single physical server
- By sharing the underlying hardware resources



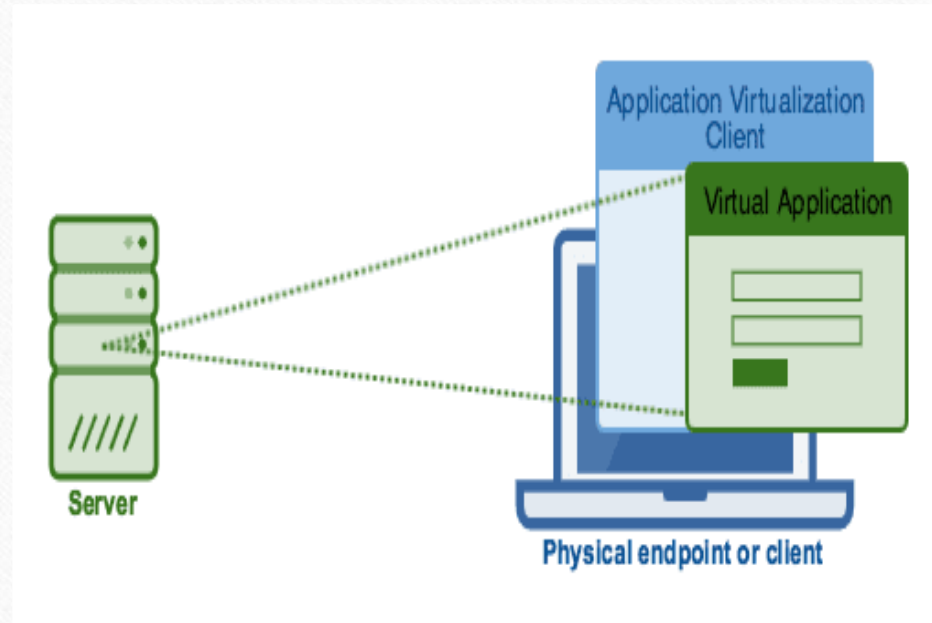
# Desktop Virtualization

- Multiple virtual desktops to run on a single physical machine
- Each user have his separate desktop environment



# Application Virtualization

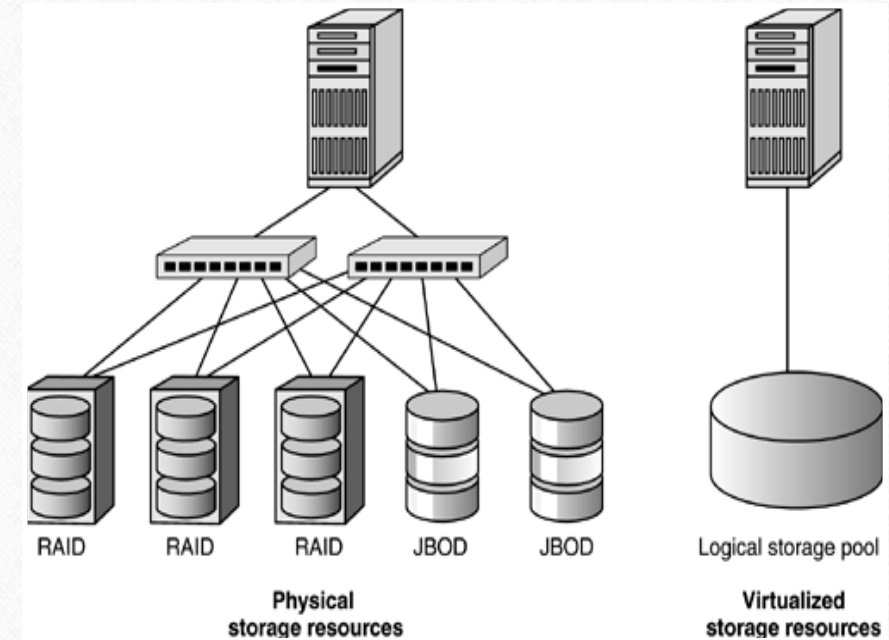
- Allows applications to run on a virtualized operating system
- Separate from the host OS





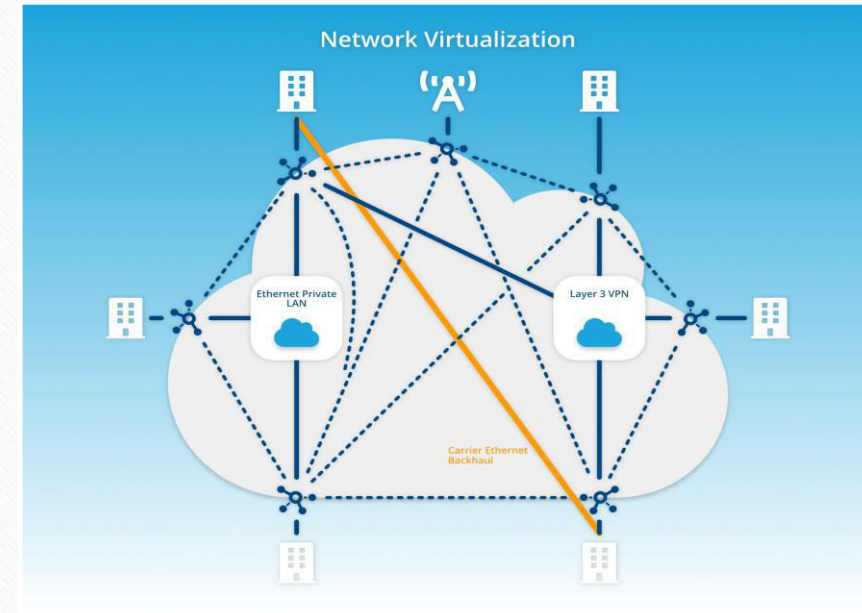
# Storage Virtualization

- Pools storage resources from multiple physical devices into a single virtual storage device
- Making it easier to manage storage and improve utilization



# Network Virtualization

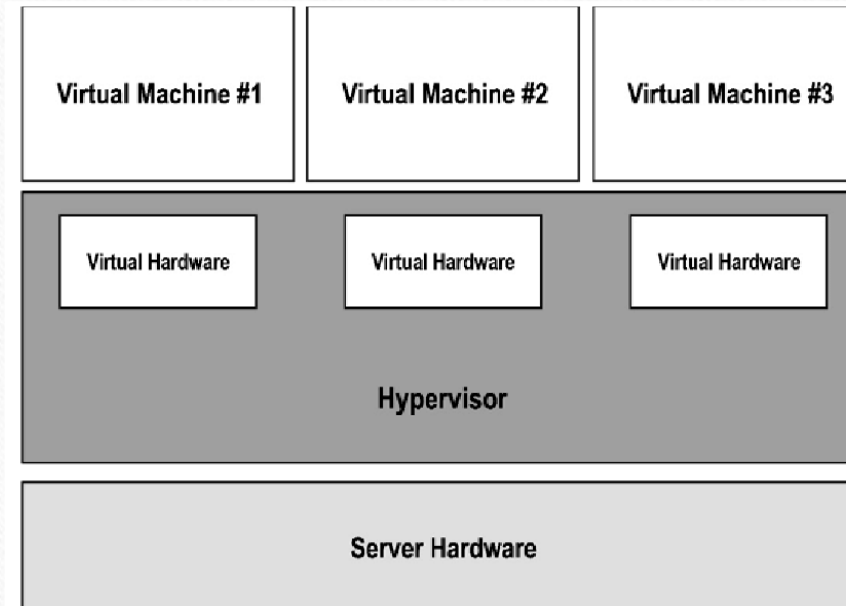
- Creates virtualized versions of physical network devices as such switches and routers
- Multiple virtual networks to run on a single physical network



# Hardware Virtualization



- Creates virtualized versions of physical hardware devices, such as GPUs
- Allows multiple virtual devices to run on a single physical device





# Application level Virtualization

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# Application Virtualization



- 
- **Topics to be Covered:**
    - What is Application Virtualization?
    - Benefits of Application Virtualization
    - Limitations of Application Virtualization



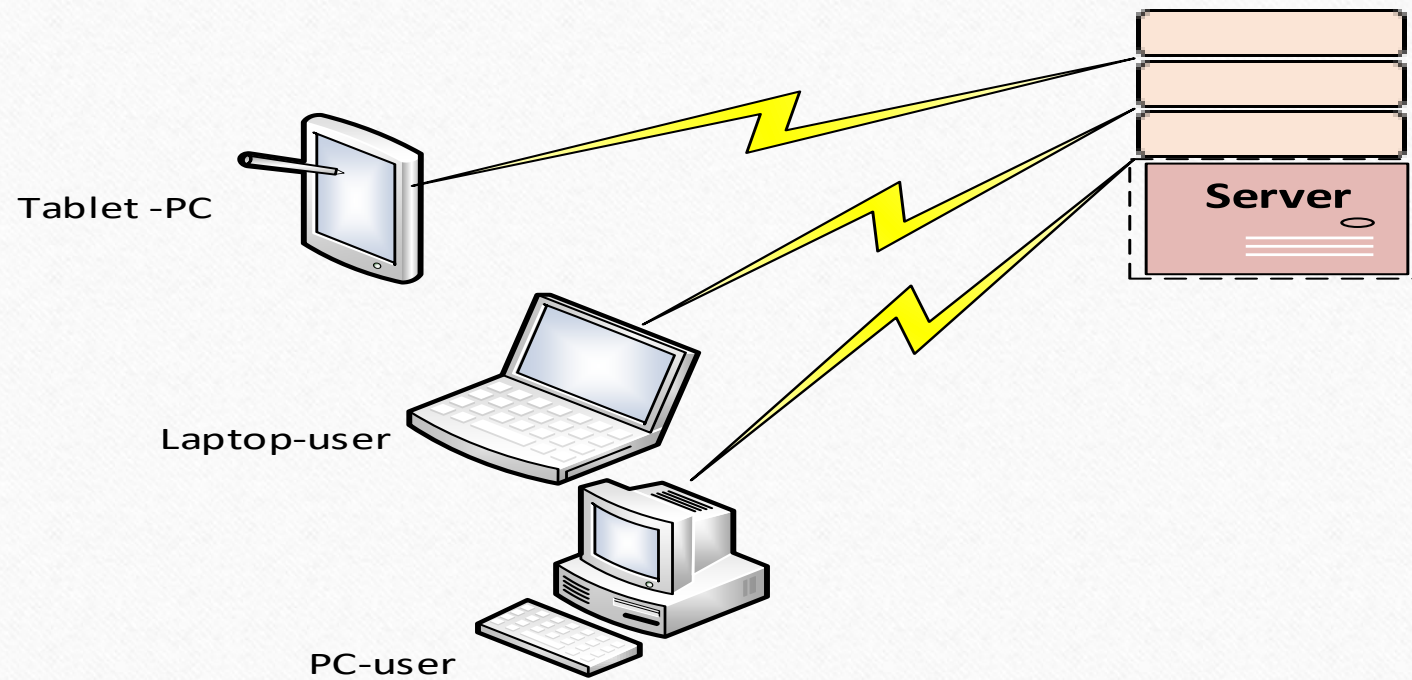
# What is Application Virtualization?



- Application level Virtualization is a technique in which client applications are hosted remotely instead of installing them on clients local devices.
- In this type of technology, the local devices provide physical resources like CPU and RAM that may be required to run the software, but nothing is installed locally on the device itself.
- This technology separates the application from the underlying OS that is execution of application is independent of OS
- In this environment, the application actually runs remotely but virtually runs locally.



# Application level Virtualization



# Benefits of Application Virtualization



- **Reduce cost**
- **Enable Cross Platform Operations:** (Windows applications run on LINUX and vice versa)
- **Simplified Management**
- Application Virtualization allows an IT admin to manage and maintain applications across an organization rather than manually installing applications to every user's machine.
- Security and Stability Improved by isolating the application from the OS.

# Benefits of Application Virtualization

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- Prevent conflicts with other Virtualized Apps
- Permits users to run multiple App Instances:



# Limitations of Application Virtualization



- **Single Point of Failure:** launching all Apps on servers increases the risk of failure.
- **Bandwidth Requirements:** sufficient bandwidth required for Streaming Apps to end-users
- **Problematic Applications:** Some Apps need system drivers and don't work as virtualized applications.
- **High Initial Investment:** Initially migrating data to the Data Center or cloud
- **Challenging Quick Scalability:** to ensure all the requisite software, enough storage, security and resource availability is a tedious job.

# Comparison of Desktop and Application Virtualization

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# Comparison



## Desktop Virtualization

- It is the practice of hosting a Desktop Operating system and applications within a Virtual Machine on a centralized server or cloud
- In this technique, Desktop OS and Applications are decoupled from a hardware system that access it

## Application Virtualization

- Application Virtualization is a practice of hosting Applications only on remote host or server.
- In this technique, Applications are decoupled from a hardware system that access it



# Comparison



## Desktop Virtualization

- Desktop runs as Virtual Machines in a secure Data center
- Each VM is called as Virtual desktop
- Different vendors Virtual desktops can be hosted on virtual server to access.
- The users may be connected from anywhere, anytime to the central server and access Virtual desktop

## Application Virtualization

- Applications actually runs on secure server in Data center
- Each Application is called as Virtual application
- Different vendors applications can be hosted on remote server to run
- The users may be connected from anywhere, anytime to the central server and runs applications

# Comparison

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## Desktop Virtualization

- The user may be a Desktop PC, laptop, thin client or mobile

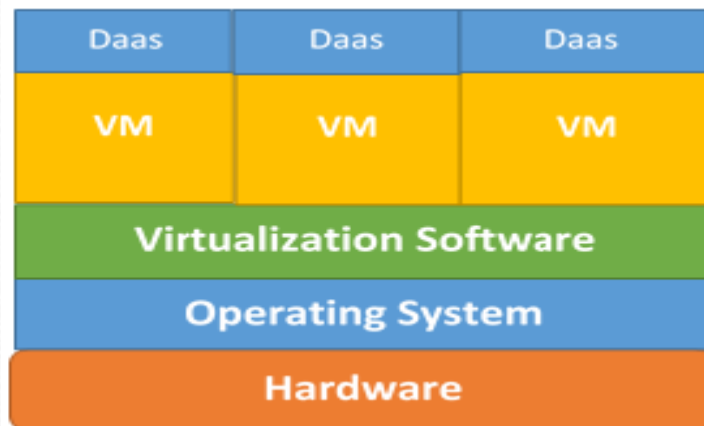
## Application Virtualization

- The user may be a Desktop PC, laptop, thin client or mobile

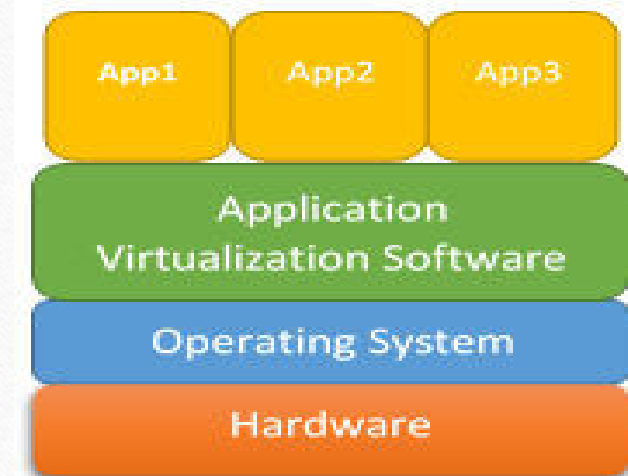
# Comparison



## Desktop Virtualization



## Application Virtualization





# Solutions of Application Virtualization

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# Solutions of Application Virtualization

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- Different vendors provide methods or solutions to achieve Applications Virtualization.
- VMware Thin App
- Microsoft App-V
- Citrix Virtual Apps and Desktops
- Parallel Remote Application Server (RAS)



# Microsoft App-V

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- **On Remote host,**
  - Virtualization App-V server components are required to be installed.
  - App-V server components include
    - App-V Management server,
    - App-V Sequencer
    - App-V Streaming Server
  - Virtual Applications are installed on centrally managed server
  - The App-V Sequencer converts application data into an App-V package for virtualized delivery
  - The package can be streamed down to the clients on demand and cached locally

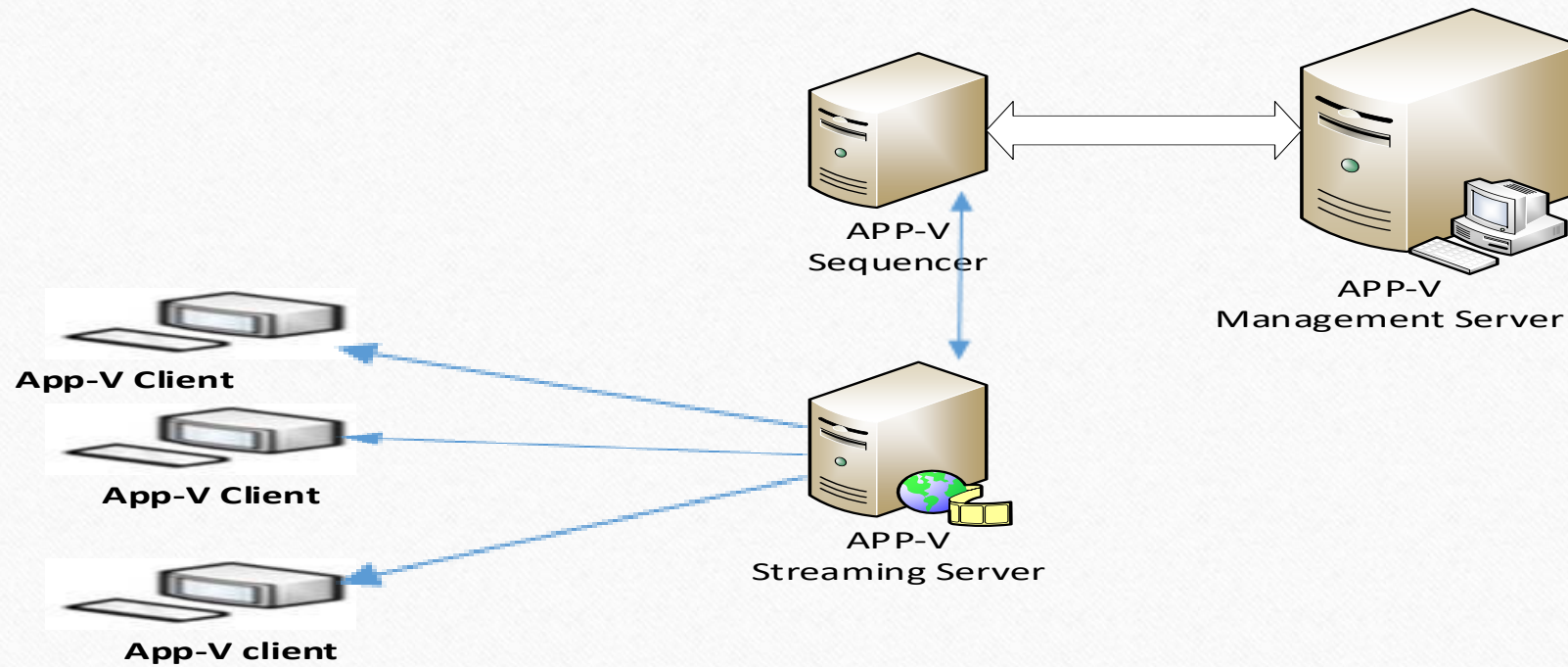


# Microsoft App-V

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- **On Client machine,**
  - App-V client is installed that runs virtualized applications on user devices
  - The App-V client presents a list of applications to the end-users to which that user has access

# App-V Architecture



# Software Define Data center SDDC

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# Software Define Data center SDDC

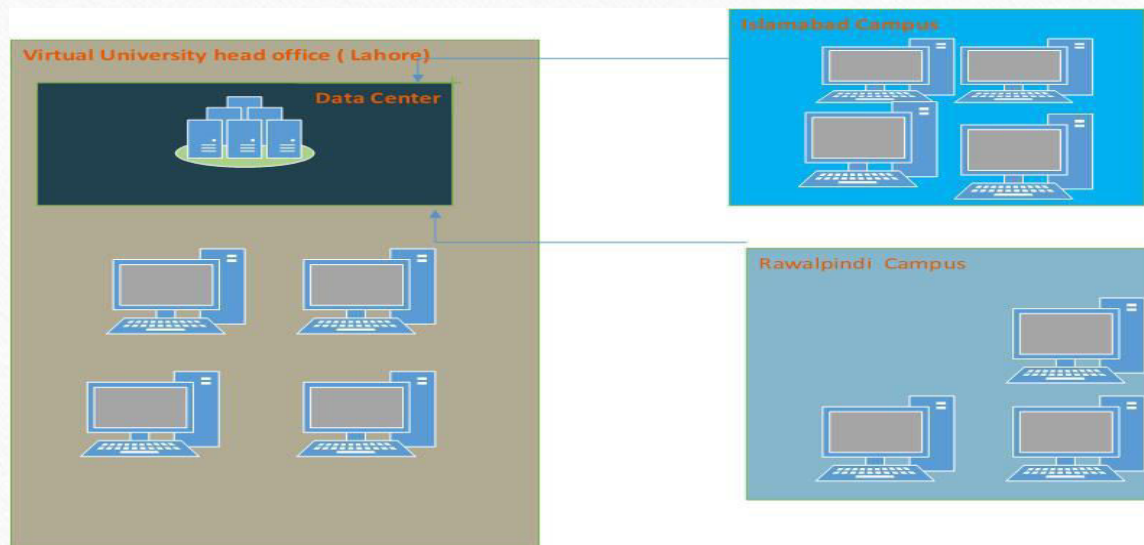


- 
- **Topics to be Covered:**
    - What is Data Center ?
    - What is Software Define Data center SDDC?
    - Component of SDDC?

# What is Data Center?



- A data center is a place that gives people access to apps and data through a complicated network of computer and storage systems





# Software define Data center( SDDC)?

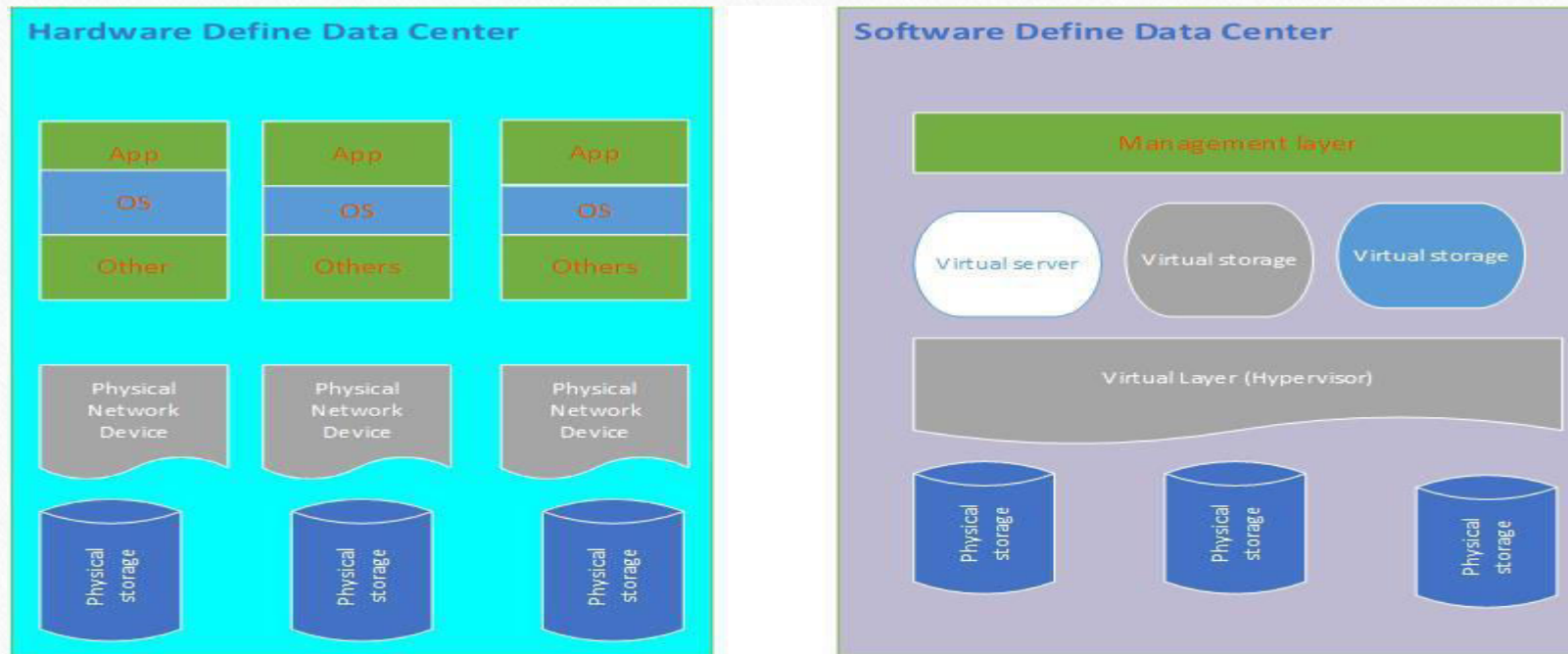


- 
- **Keeping** your data center **up-to-date** with the latest technology means using software-based components.
  - Provide different software to manage and automate the environment
  - Better way of controlling the data Center
  - Reduced it complexity
  - Centralized management

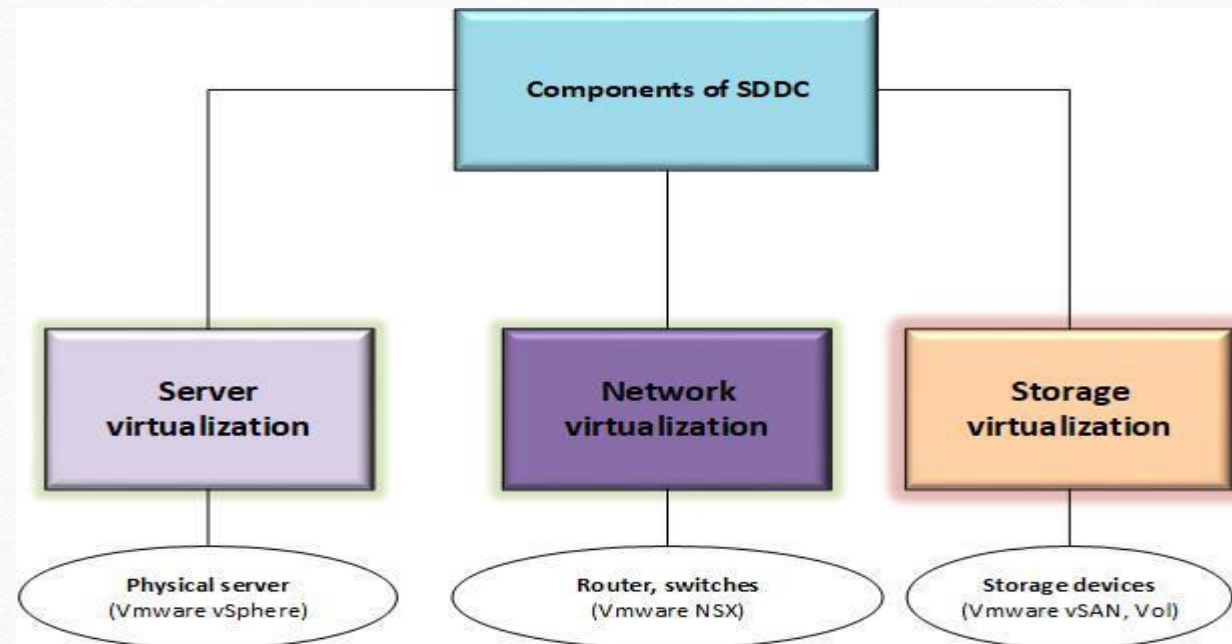


# Software define Data center( SDDC)??

● ?

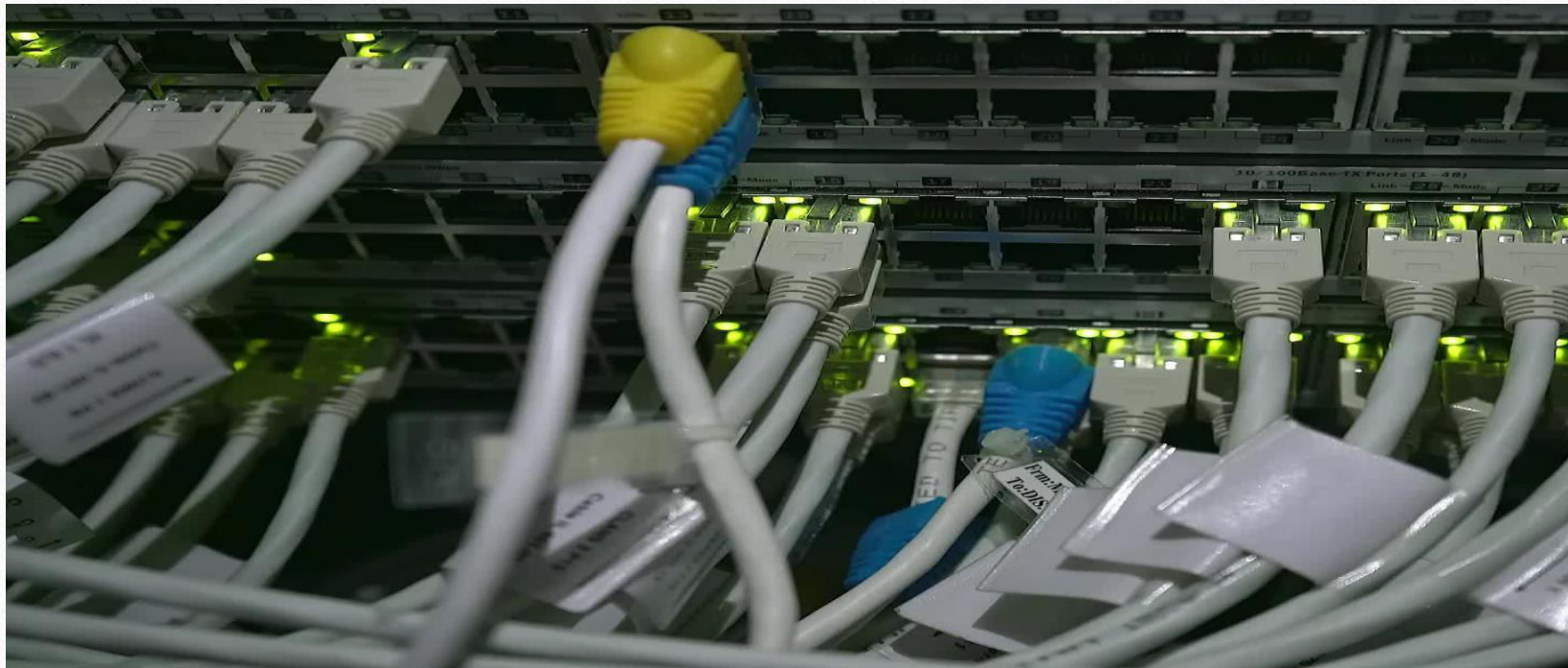


# Component of SDDC?





# Components of a Data Center





# Components of a Data Center



## Computer System

The computer systems in a data center are the servers that are used to process, store, and distribute the data

## Telecommunication System

The telecommunication equipments in a data center is used to connect the computer systems to the outside world. This includes routers, switches, and firewalls.

## Storage System

The storage systems in a data center are used to store the data that is processed by the computer systems. This can include customer records, financial information, and business applications.

# Components of a Data Center



## Power systems

The power systems in a data center are used to provide continuous power to the computer systems and other equipment. These systems are typically designed to be highly reliable and redundant

## Cooling systems:

The cooling systems in a data center are used to keep the temperature down from the computer systems and other equipment. These systems are typically designed to be highly efficient and to prevent the equipment from overheating.

## Security systems

The security systems in a data center are used to protect the data and equipment from unauthorized access. These systems typically include physical security measures, such as access control and video surveillance, as well as logical security measures, such as firewalls and intrusion detection systems.

# Components of a Data Center

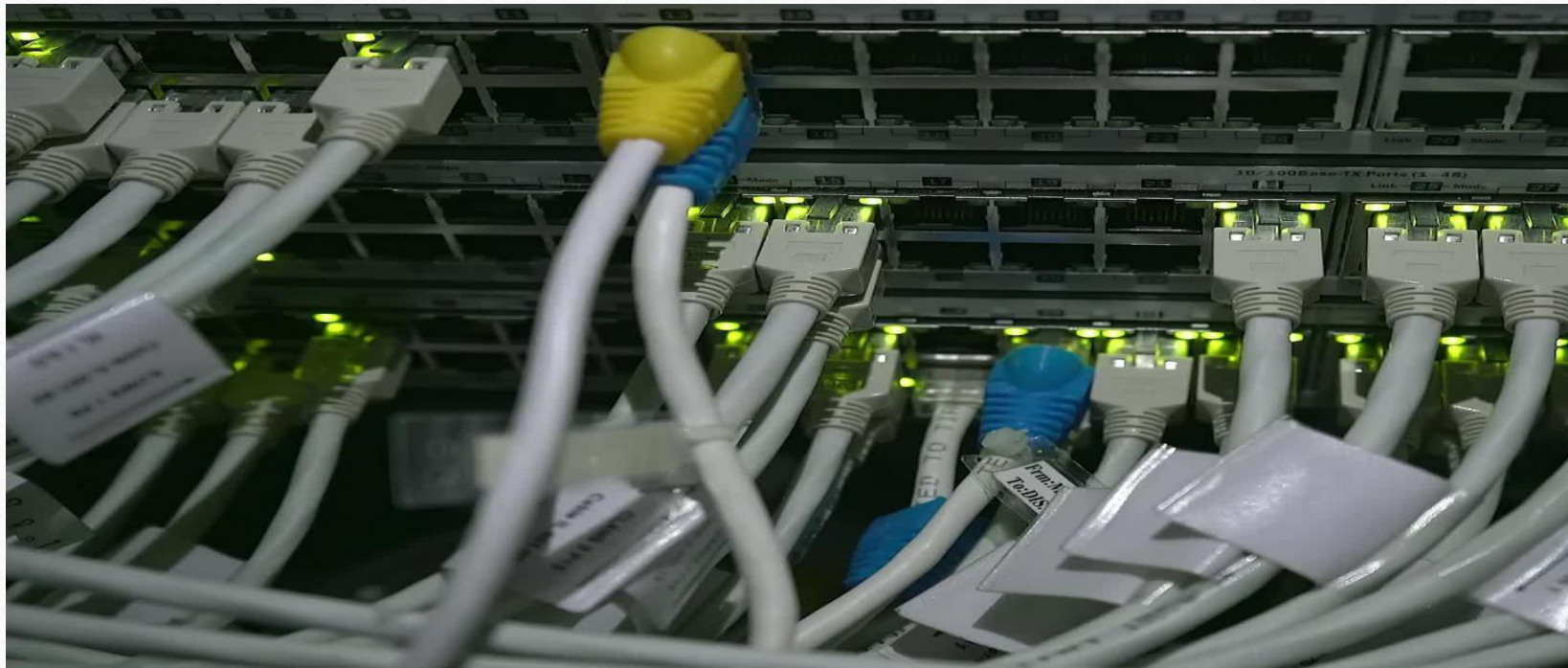


**Remember**

Learning is a continuous process. So keep learning and keep creating and Sharing with others! 💻 ✌️



# Purpose of SDDC?



# Purpose of SDDC?



Abstraction

Abstraction of underlying hardware (Physical CPU, RAM, Network)

Pooling

Pooling of resources

Automation

Automate the delivery of IT services



# Abstraction



- 
- In virtualization, abstraction refers to the process of hiding the underlying physical hardware from the user. This allows the user to view and interact with the resources as if they were dedicated to them, even though they are actually sharing resources with other users or virtual machines.



# Pooling of resources



- In virtualization, pooling refers to the grouping together of physical resources, such as CPU, memory, storage, and network bandwidth, so that they can be shared by multiple virtual machines. This allows organizations to improve the utilization of their IT infrastructure and reduce costs.





# Architecture of Server Virtualization

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# Architecture of Server Virtualization



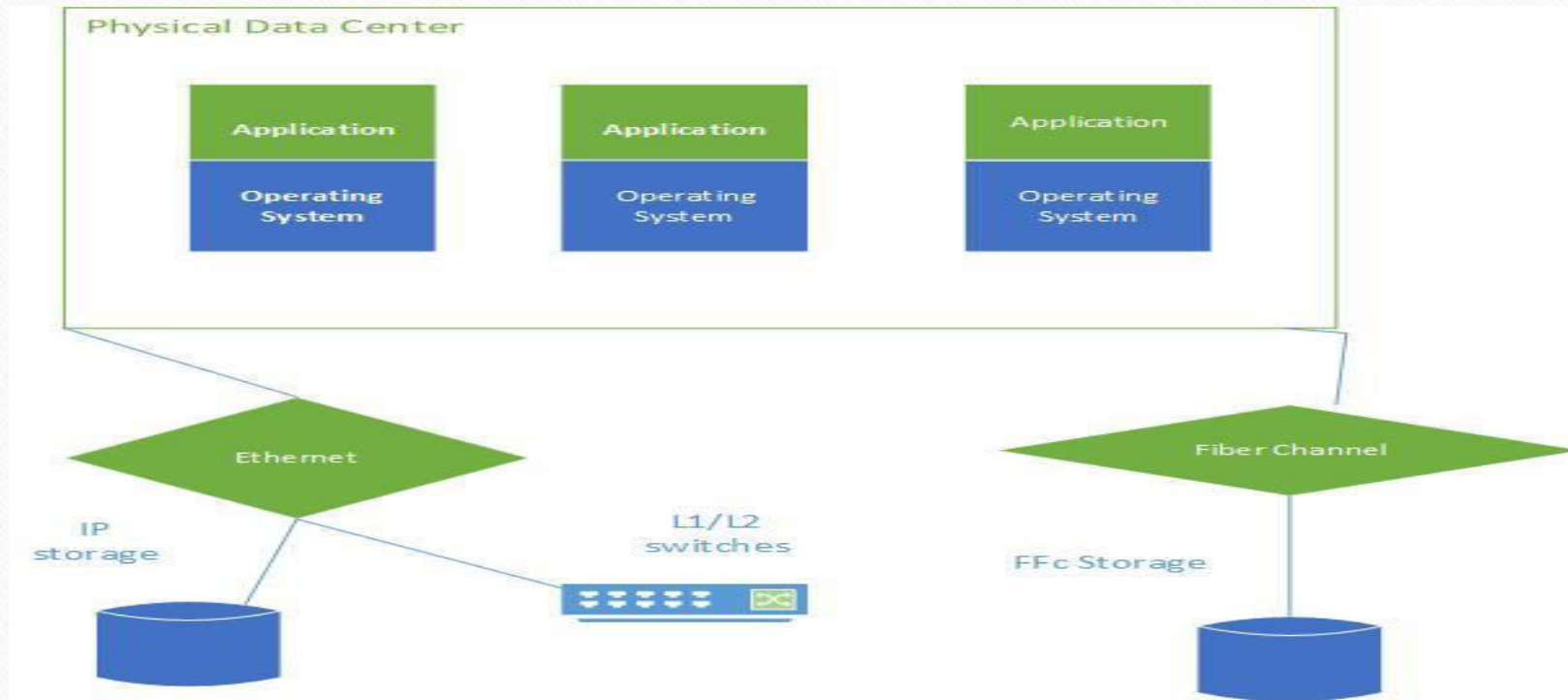
- 
- **Topics to be Covered:**
    - **The design of a physical data center. ?**
    - The design of a virtual data center.?
    - Resource sharing ?

# The design of a physical data cent?



- 
- In a physical data center, there are physical servers running.
  - APP and Operating system are running on physical server
  - **An** Ethernet switch is linked up with l2 and l3 switches, plus IP-based storage.

# The design of a physical data cent?





# Architecture of Server Virtualization

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# Architecture of Server Virtualization



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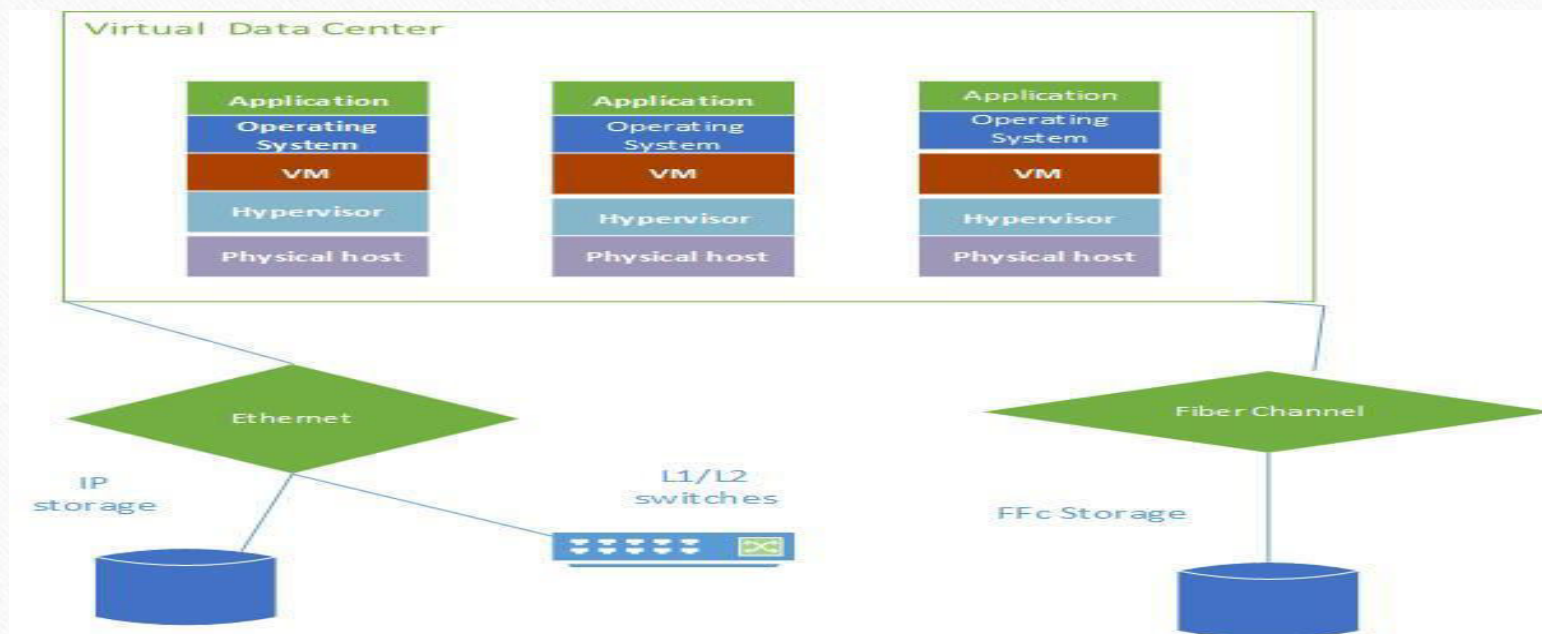
- **Topics to be Covered:**

- The design of a physical data center. ?
- **The design of a virtual data center.?**
- Resource sharing ?



# The design of a Virtual datacenter?

- We can use a Virtual Data Center to get several virtual machines running on minimal hardware..





# Architecture of Server Virtualization

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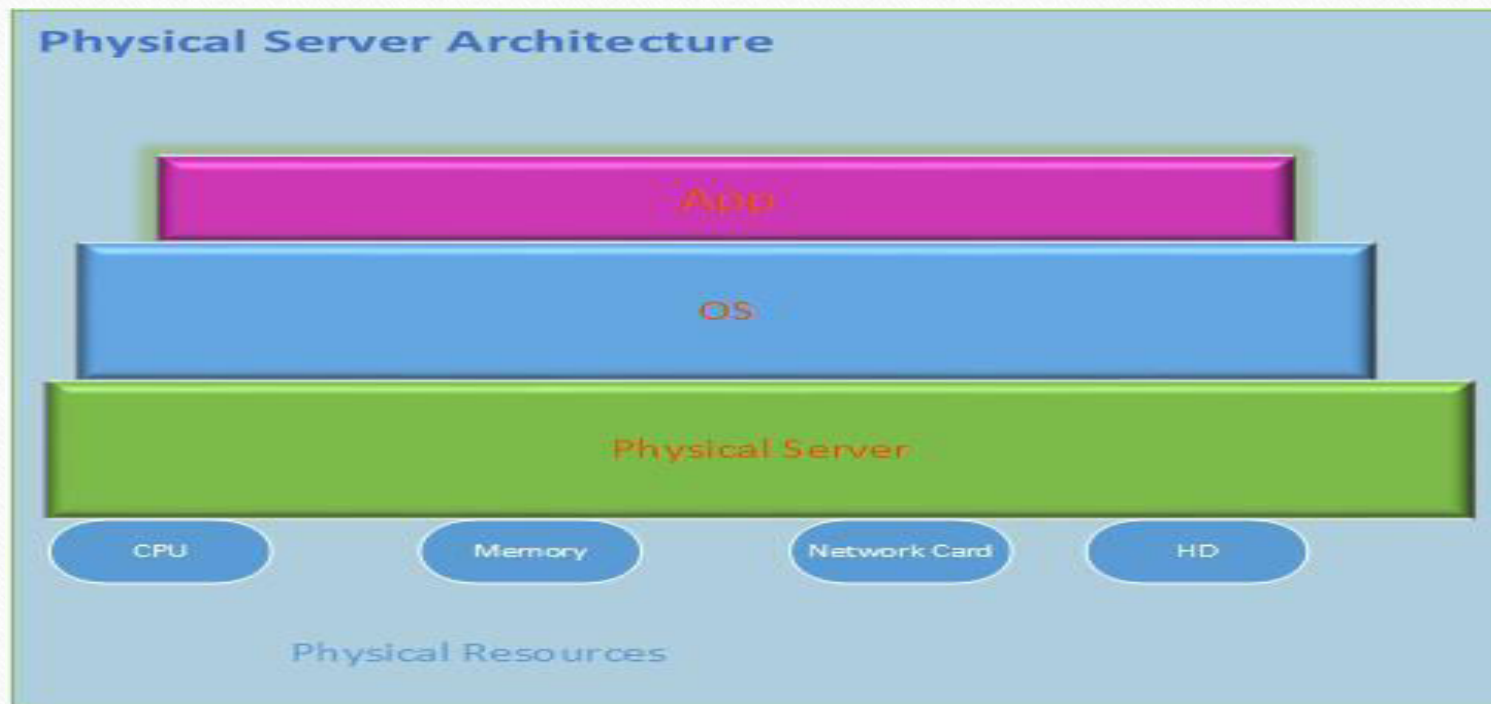
# Architecture of Server Virtualization



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- **Topics to be Covered:**
    - The design of a physical data center. ?
    - The design of a virtual data center.?
    - Resource sharing

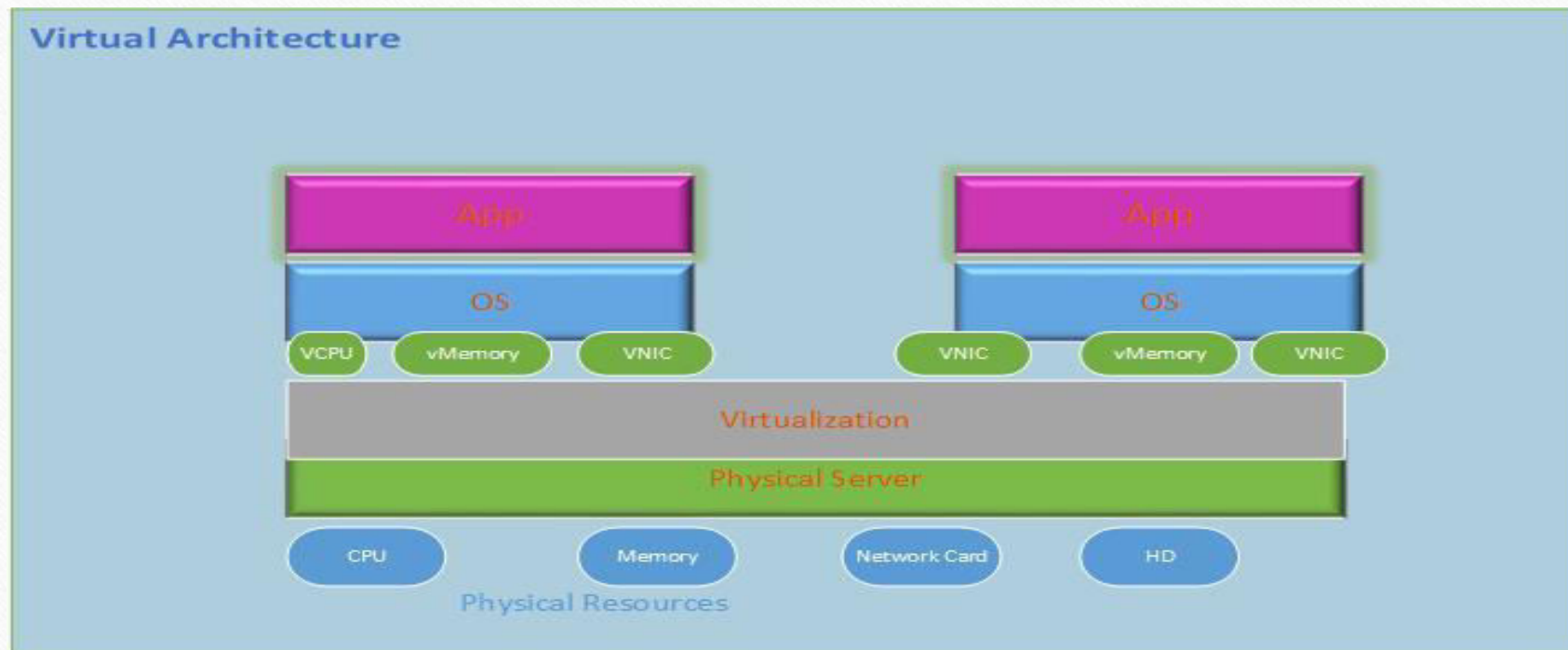


# Resource Sharing Physical Server?





# Resource Sharing Virtual data center?



# Resource Sharing Virtual data center?



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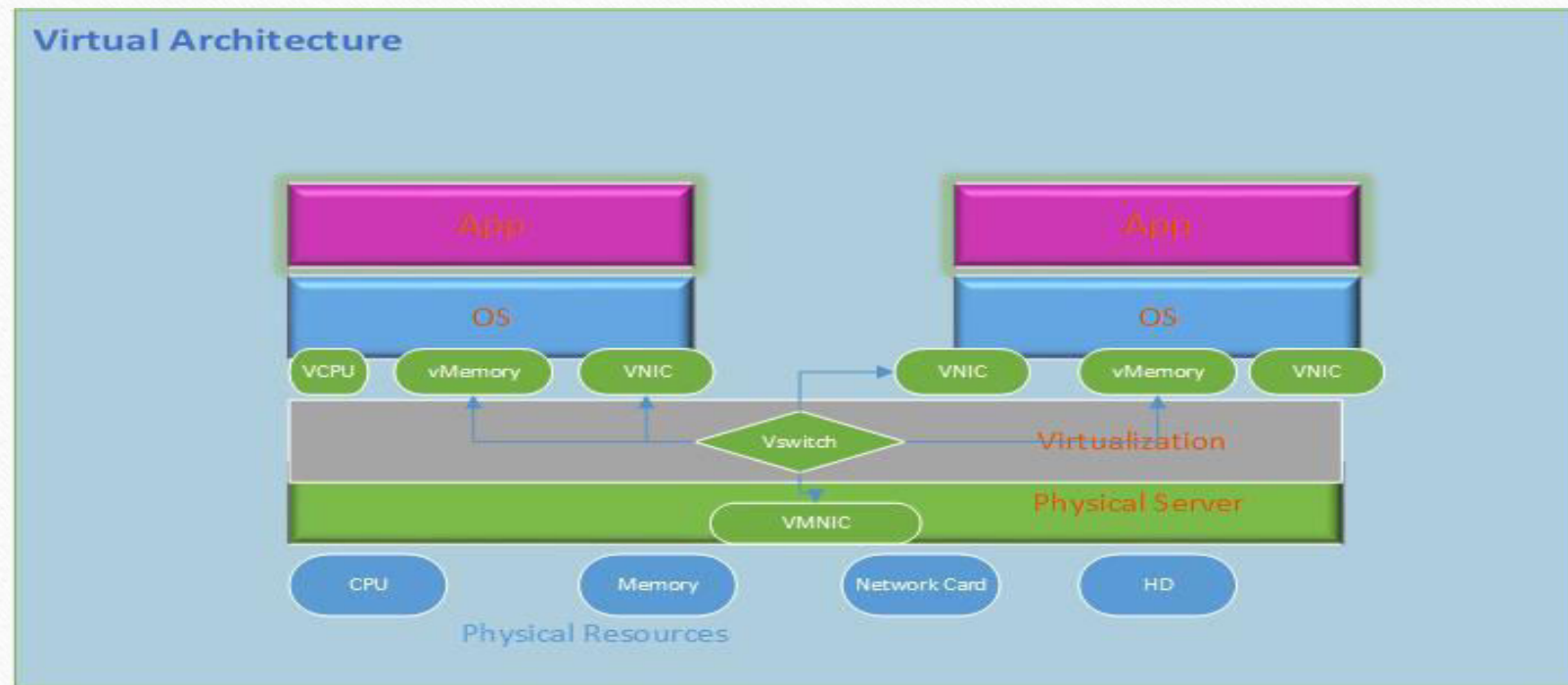
- **CPU**

- Maximum number of vCPU on VM depends on
  - number of logical CPU on the physical host
  - Type of OS on VM,
  - VMware supports up to 128 vCPU on one VM

- **Memory**

- Maximum number of virtual memory on VM depends on
  - Maximum memory available on Physical host
  - Type of OS on VM
- VMware supports up to 6TB Virtual memory on one VM

# Resource Sharing Virtual data center?



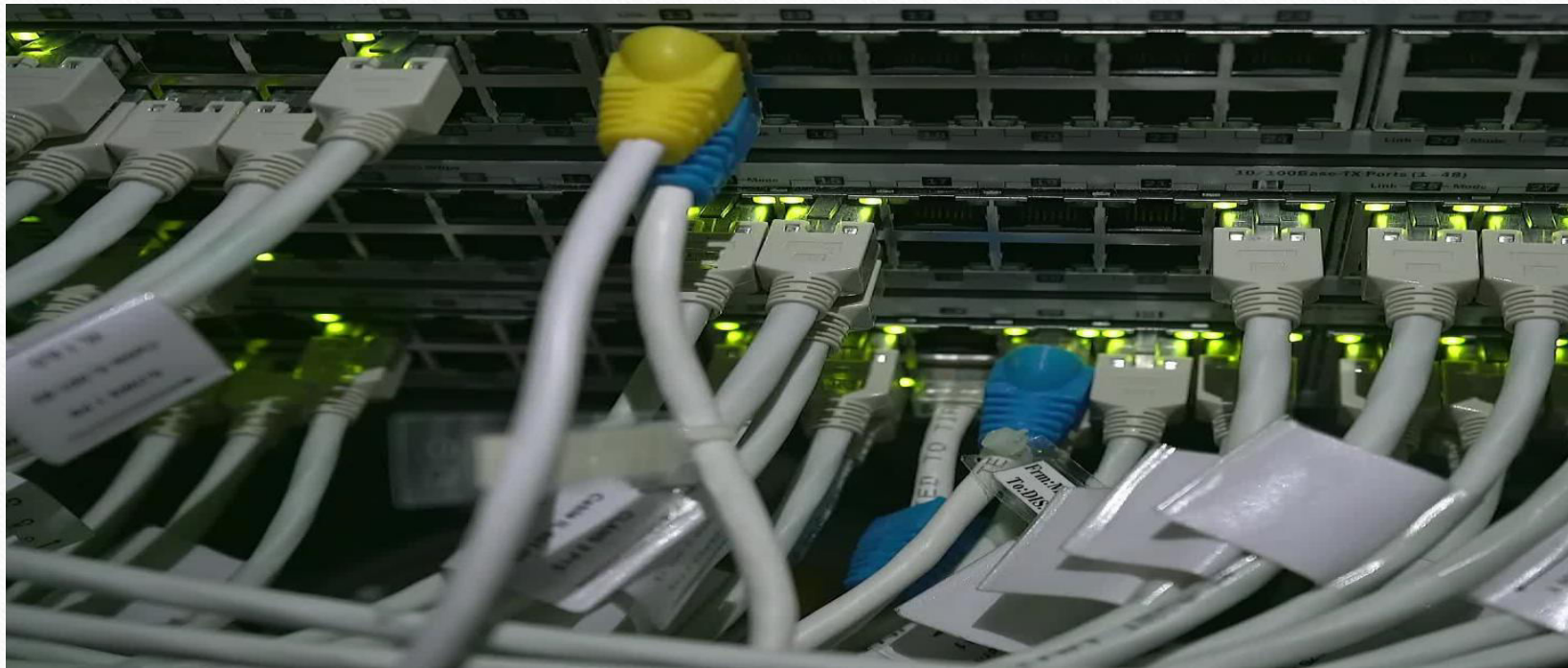


# Resource Sharing Virtual data center?



- 
- VM support up to 10 VNIC

## Examples of server virtualization software:





# Examples of server virtualization software



## VMware vSphere

vSphere is a server virtualization software application from VMware. It is a complete virtualization platform that includes a hypervisor, vCenter Server for centralized management, and a suite of tools for managing virtual machines (VMs), storage, networking, and security.

## Microsoft Hyper-V

Hyper-V is a Microsoft virtualization product or 'hypervisor', allowing you to create and run multiple VMs on a physical host. It is a type-1 hypervisor, which means that it runs directly on the physical hardware and provides a direct interface to the physical resources.

## Citrix Hypervisor

Citrix Hypervisor is a type-1 hypervisor that is optimized for virtual app and desktop workloads. It is developed by Citrix Systems and is built over the Xen virtual machine hypervisor.



# Examples of server virtualization software



## Nutanix AHV

It is a Type 1 hypervisor, which means that it runs directly on the physical hardware without the need for a separate operating system. Nutanix is one of the most well-known vendors that provides cloud computing services and software-defined storage

## •Red Hat Virtualization

The cooling systems in a data center are used to remove heat from the computer systems and other equipment. These systems are typically designed to be highly efficient and to prevent the equipment from overheating.

## Security systems

The security systems in a data center are used to protect the data and equipment from unauthorized access. These systems typically include physical security measures, such as access control and video surveillance, as well as logical security measures, such as firewalls and intrusion detection systems.

# Components of a data center



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# Virtualization Technologies

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# vCenter

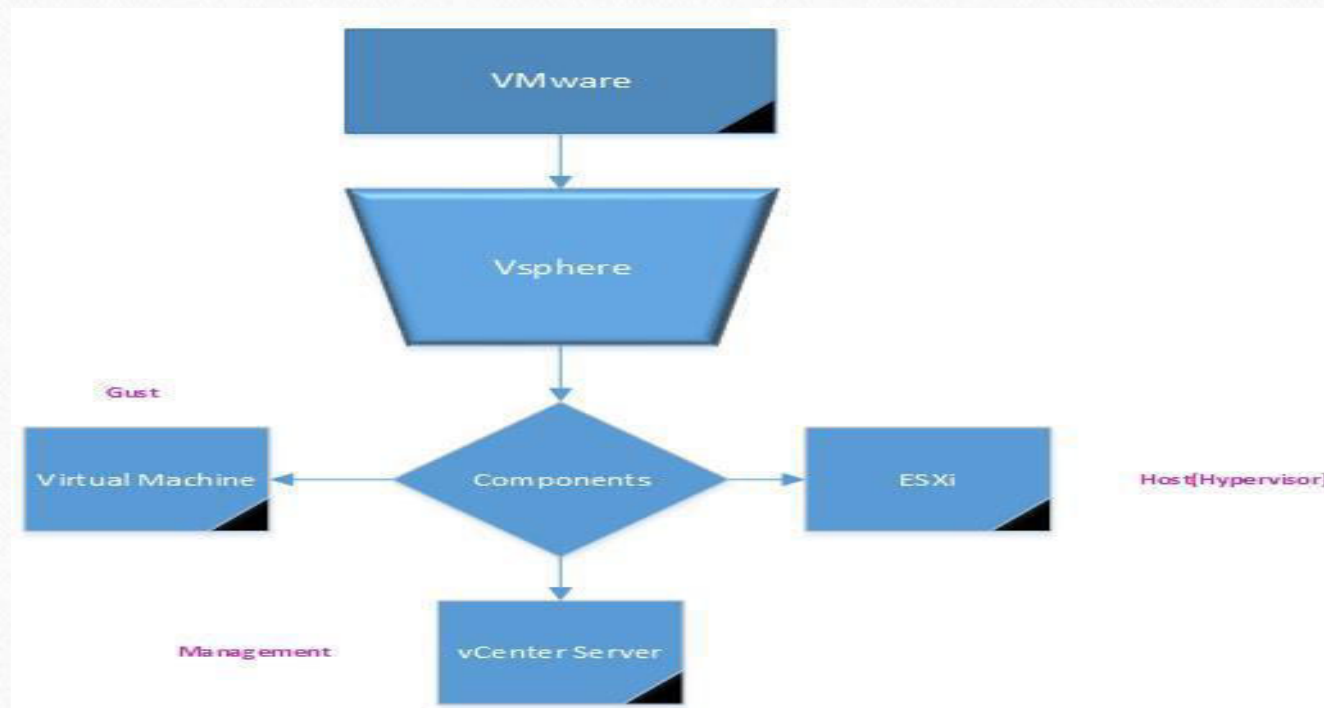


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- **Topics to be Covered:**

- **VMware vSphere ?**
- **ESXI**
- **Virtual Machine**
- **VCenter Server**

# vCenter



# What is vCenter Server ?



- 
- Manage entire Virtualization Data Center
  - Before Virtualization (Manually visit Data Center )
  - Management consoles
  - It also perform day to day task for example take snap shot etc



# vCenter Server



# Virtualization Technologies

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# Architecture of Server Virtualization



- 
- **Topics to be Covered:**
    - **VMware vSphere ?**
    - **ESXI**

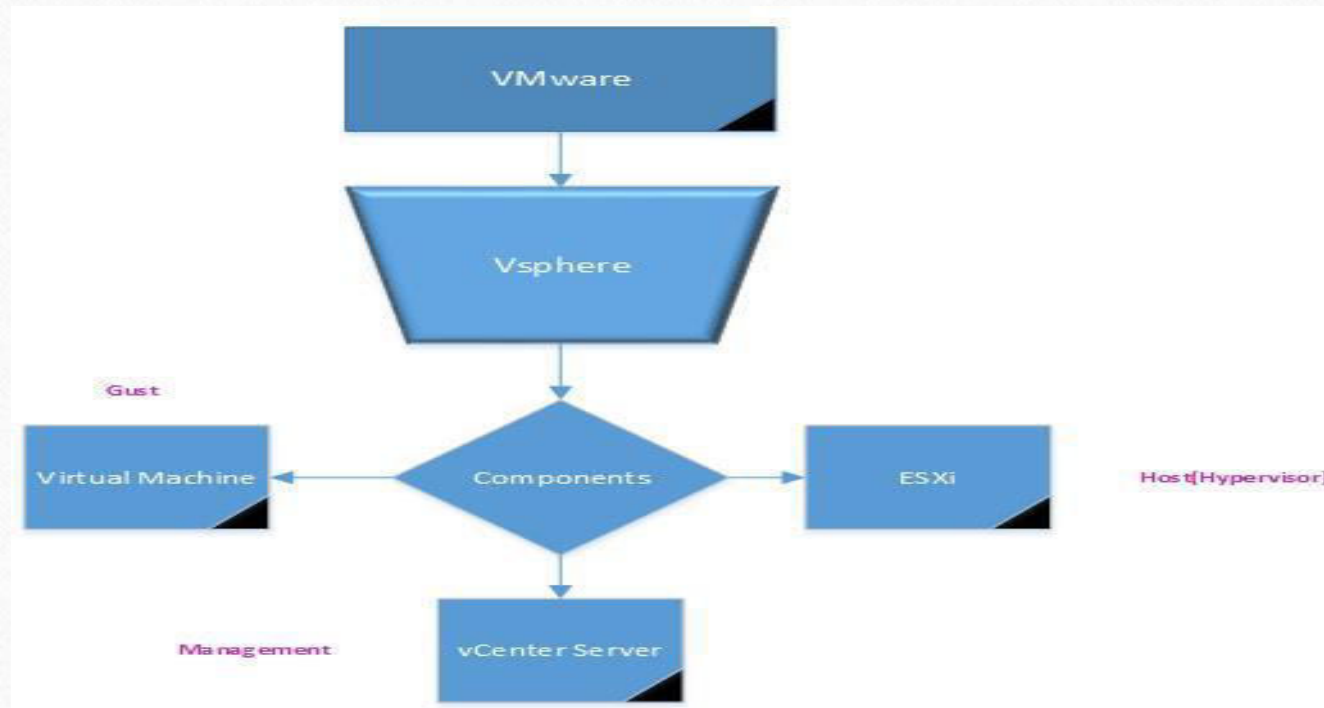


# VMware vSphere?



- 
- VMware is vendor who provide software's for server virtualization
  - Version 6.7 vSphere (Current)

# Component of Vsphere



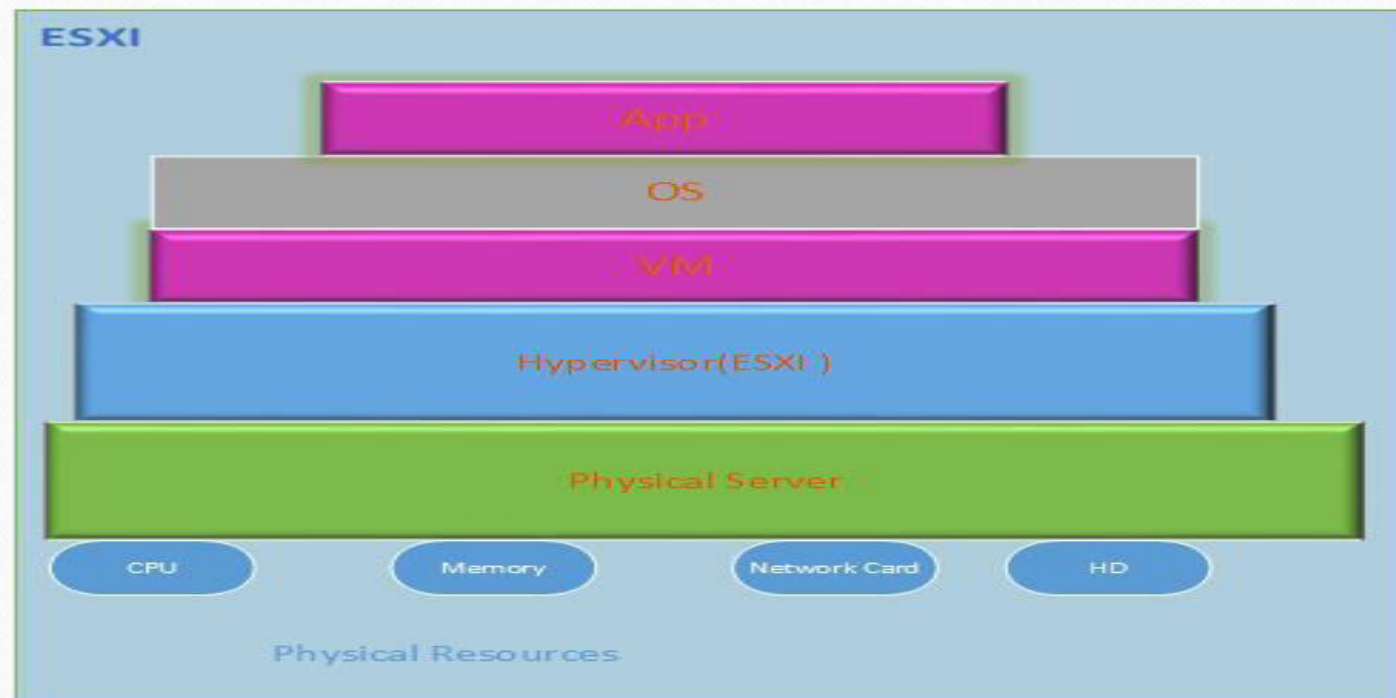
# ESXI



- 
- ESXI is Hypervisor
  - A hypervisor allows one host computer to support multiple guest VMs by virtually sharing its resources, such as memory and processing.
  - Direct install on physical server as OS
  - Assigned resources from physical server to VM



# ESXI



# Hypervisor

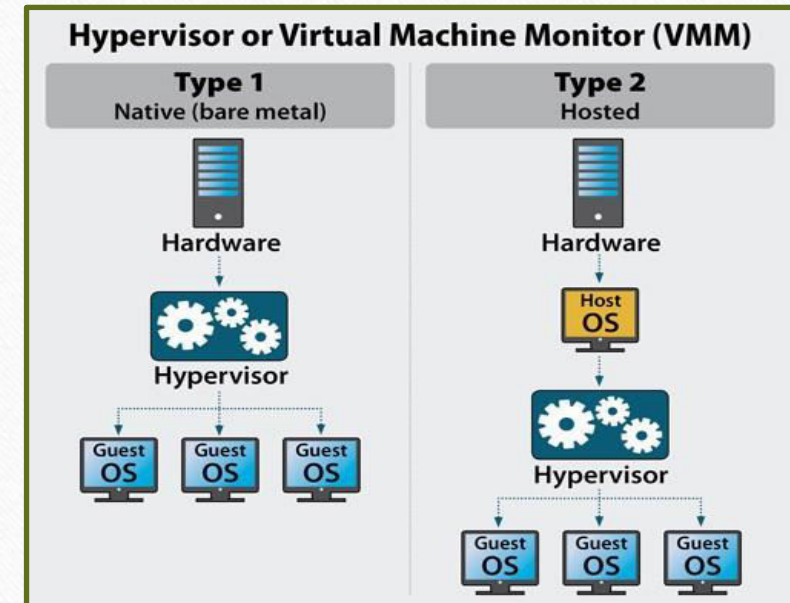
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# Hypervisor

- **Topics to be Covered:**

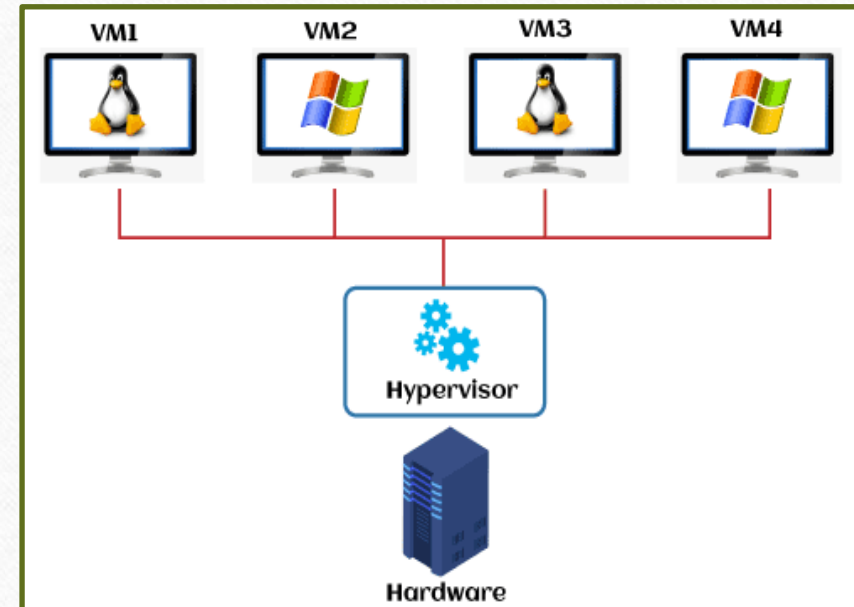
- A software layer
- Creates and manages virtual machines (VMs)
- Acts as a virtualization layer b/w the physical hardware and (VMs)
- Allows multiple VMs to share the underlying hardware resources of Host





# Hypervisor

- Allows multiple operating systems to run on a single physical server
- Improving the utilization and flexibility of the underlying hardware resources



# Components of Hypervisor



- 
- **Virtual Machine Monitor (VMM):**  
Core component, manages Virtual Machines
  - **Virtual Devices:**  
NICs, virtual hard drives, and virtual switches used to provide virtual versions of physical devices
  - **Virtual Machine Executables (VMEs):**  
Virtual versions of operating systems that run on virtual machines
  - **Drivers:**  
Provide access to the physical hardware resources of a host device

# Components of Hypervisor



- **Management Interface:**

Interface that allows administrators to create, manage, and monitor virtual machines (VMs)

- **Virtual Machine File System (VMFS):**

Stores virtual machines and their configuration files

It was a general overview of the Hypervisor structure it may vary from type to type



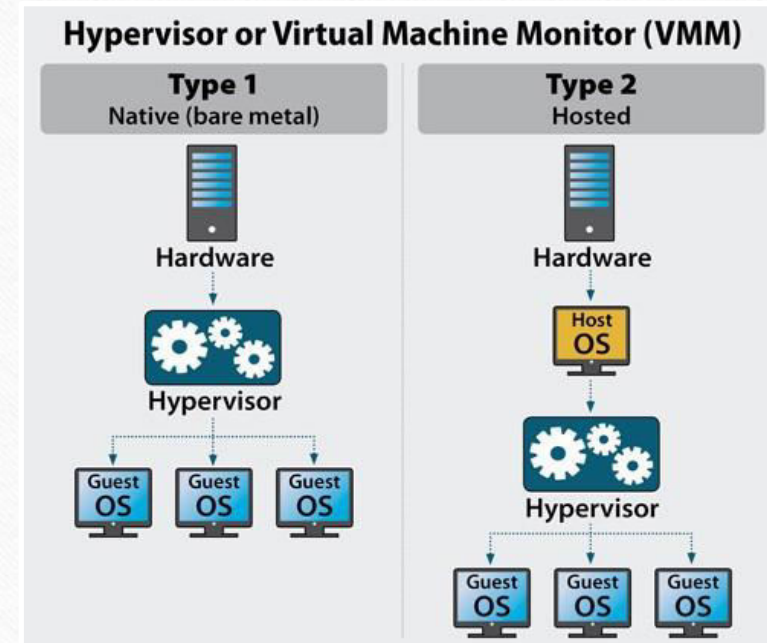
# Types of Hypervisors

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# Types of Hypervisors

There are two main types of hypervisors:

- Type 1:
  - also known as bare-metal hypervisors
  - run directly on the host's physical hardware
- Type 2:
  - also known as Hosted Hypervisor
  - run as an application on a host operating system

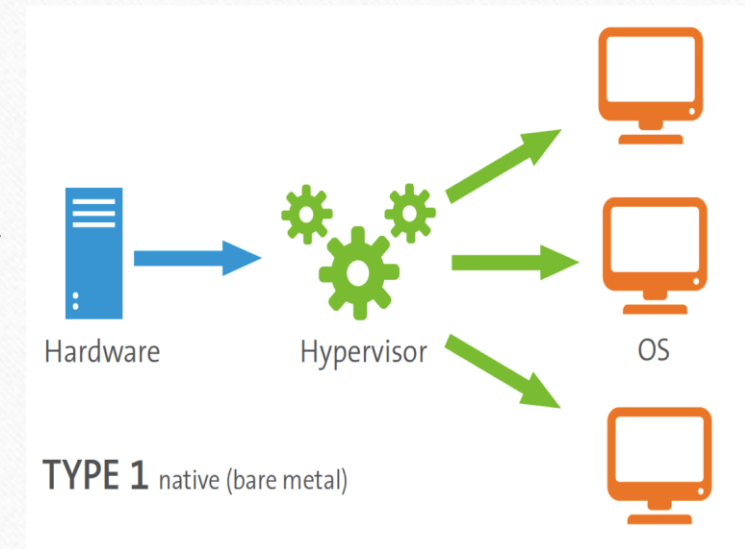




# Type 1 Hypervisor



- Type 1 or bare-metal hypervisors, are virtualization software
- Runs on host's physical hardware.
- Not dependent on any host operating system
- Controls the underlying hardware resources of host
- Provides virtualized environments for guest operating systems





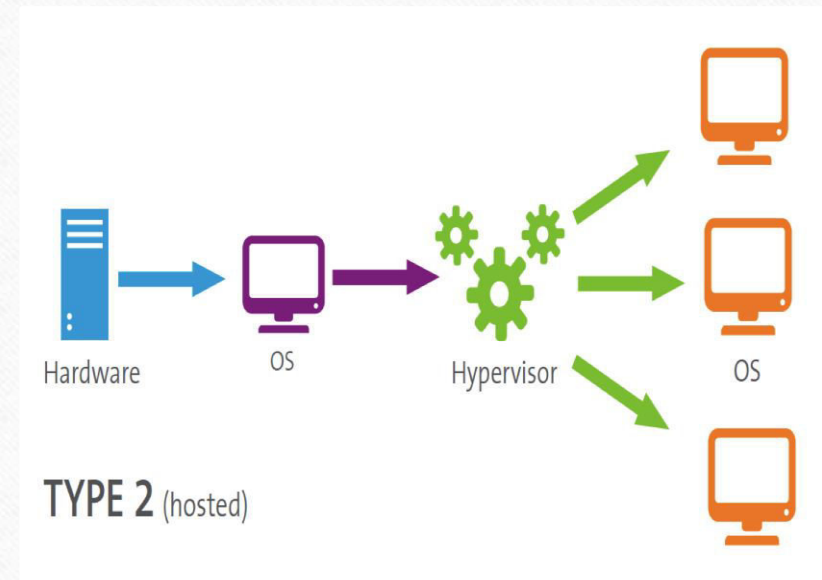
# Examples of Type 1 Hypervisor



- 
- **VMware vSphere**
    - complete virtualization solution for data centers
    - used in large enterprise environments and cloud infrastructures
  - **Microsoft Hyper-V**
    - provides virtualization support for Windows Server operating systems
    - widely used in enterprise environments with a strong Microsoft technology presence.
  - **Citrix XenServer**
    - has a strong presence in the financial services and healthcare industries

# Type 2 Hypervisor

- Commonly used for software development, testing, and personal desktop virtualization
- Used where a higher level of performance is not as critical
- Less secure than Type 1 hypervisors
- Vulnerable to attacks on the host operating system



# Examples of Type 2 Hypervisor



- 
- Oracle VirtualBox
    - supports a wide range of host and guest operating systems
    - used for personal virtualization, software testing, and development
  - VMware Workstation
    - commercial hypervisor
    - supports multiple operating systems, snapshots and cloning of virtual machines
    - support for virtualized hardware such as virtualized GPUs and virtualized USB devices.



# Type 2 hypervisor Vmware workstation

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# Lab:

## Creating Virtual Machine on Vmware Workstation

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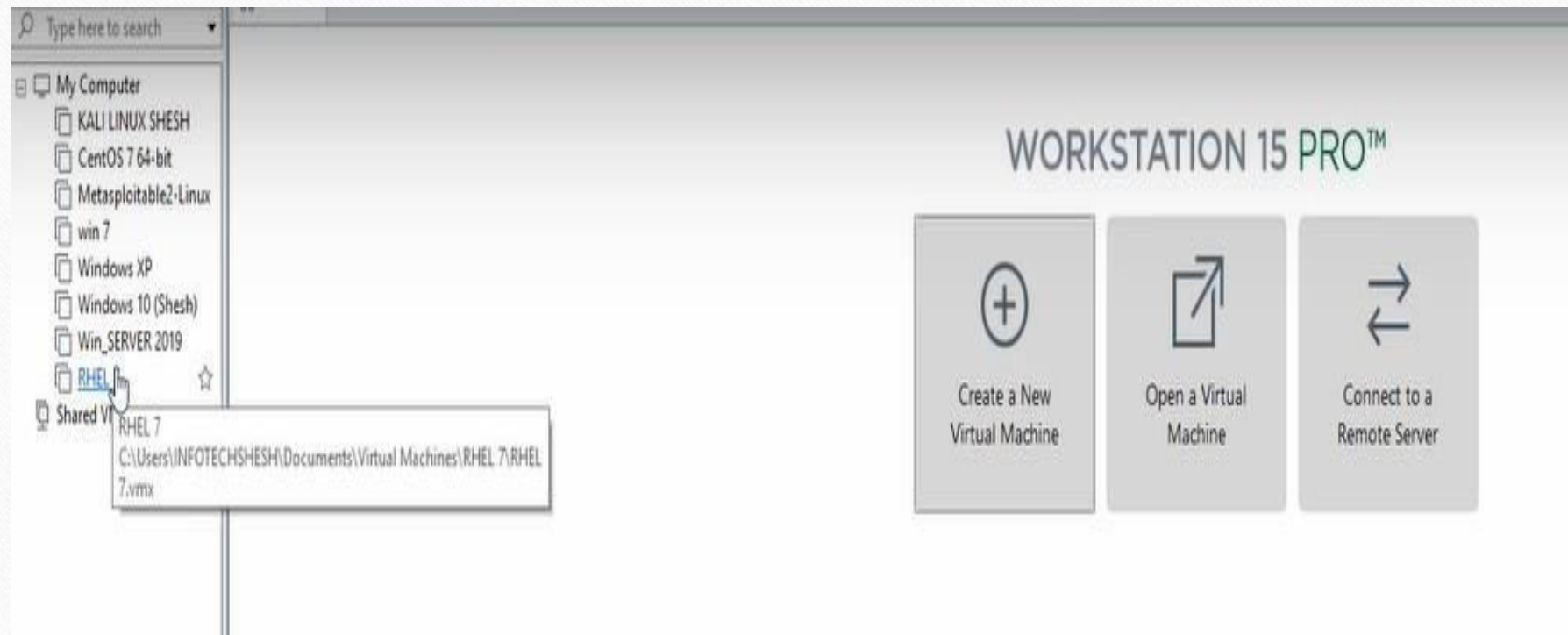
- **Topics to be Covered:**

Interface

Create VM

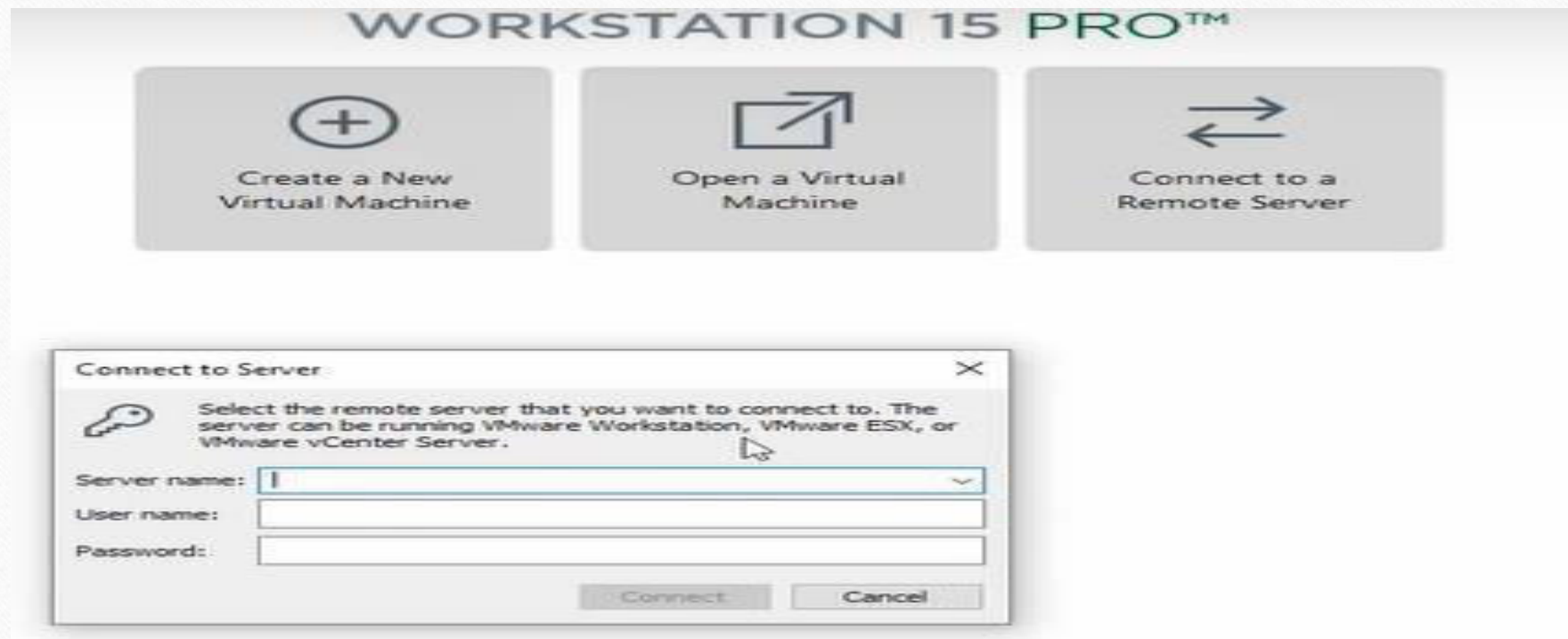


# Interface





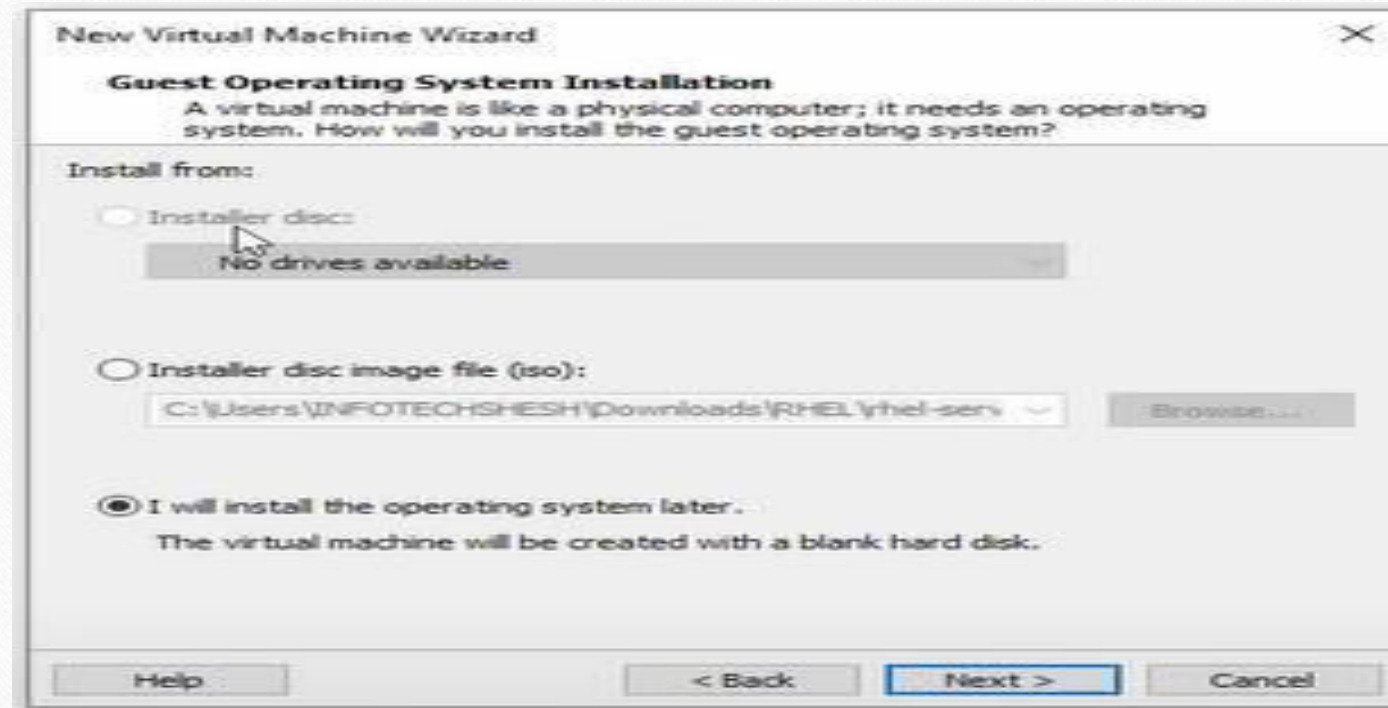
# Interface



# Create VM

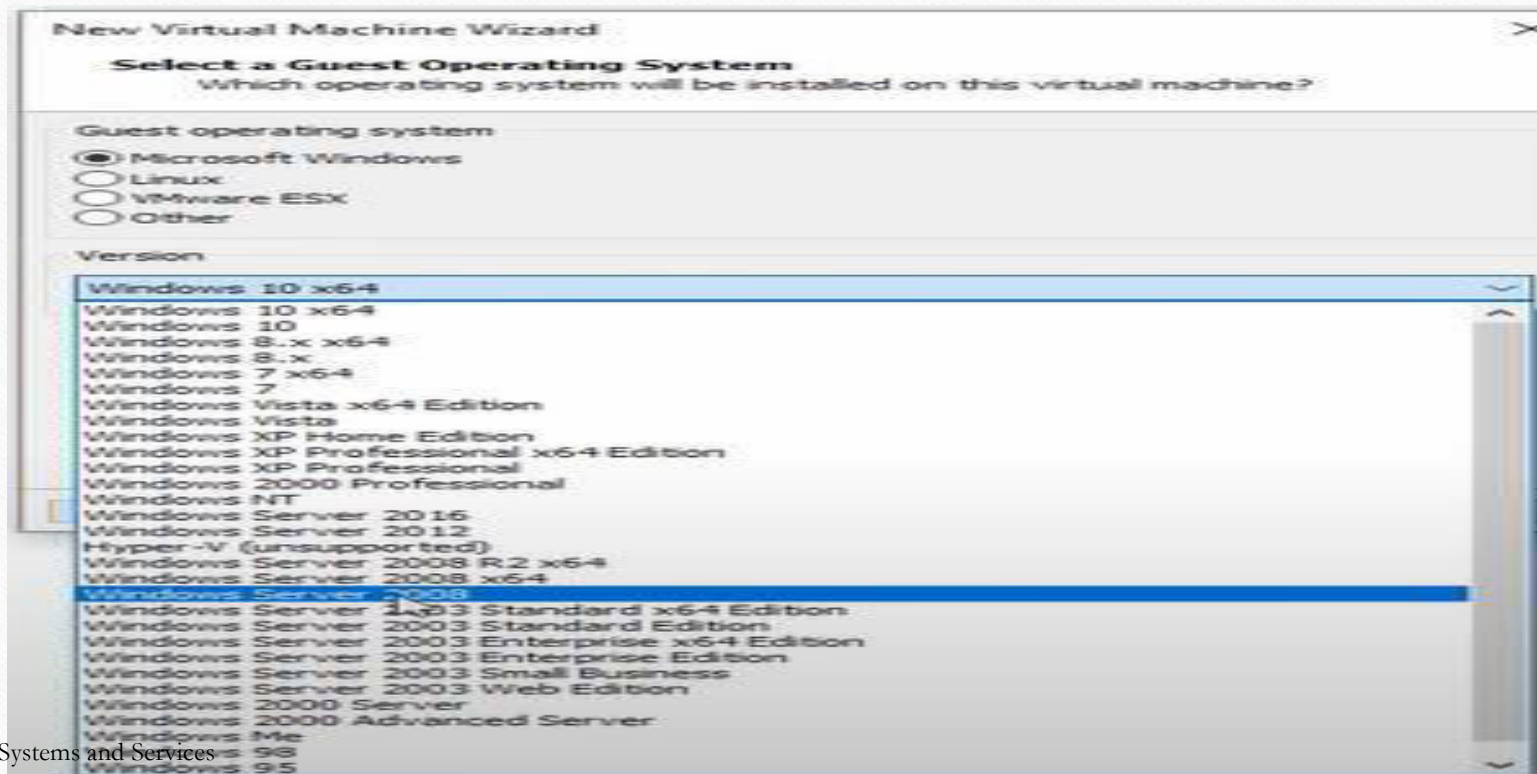


# Create VM

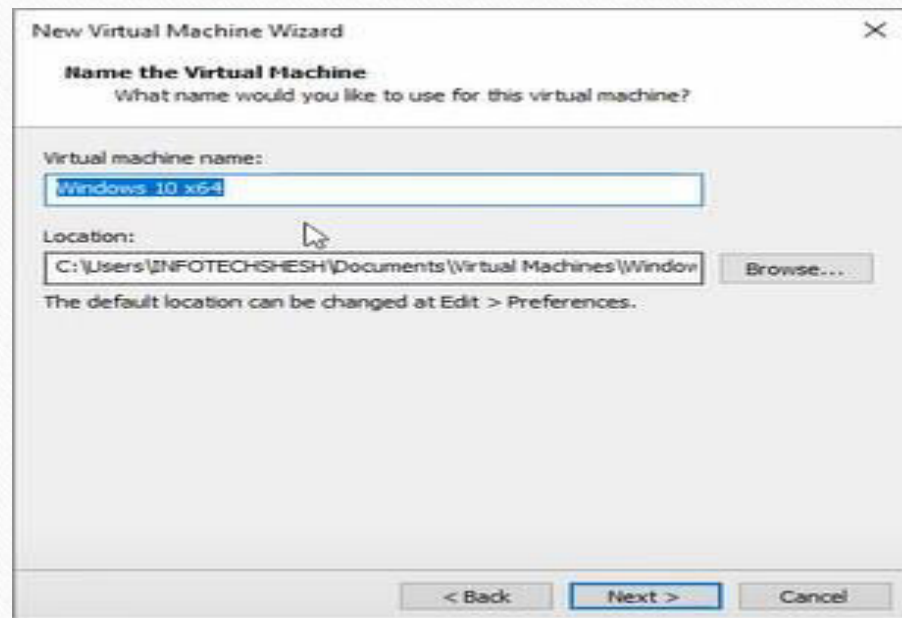




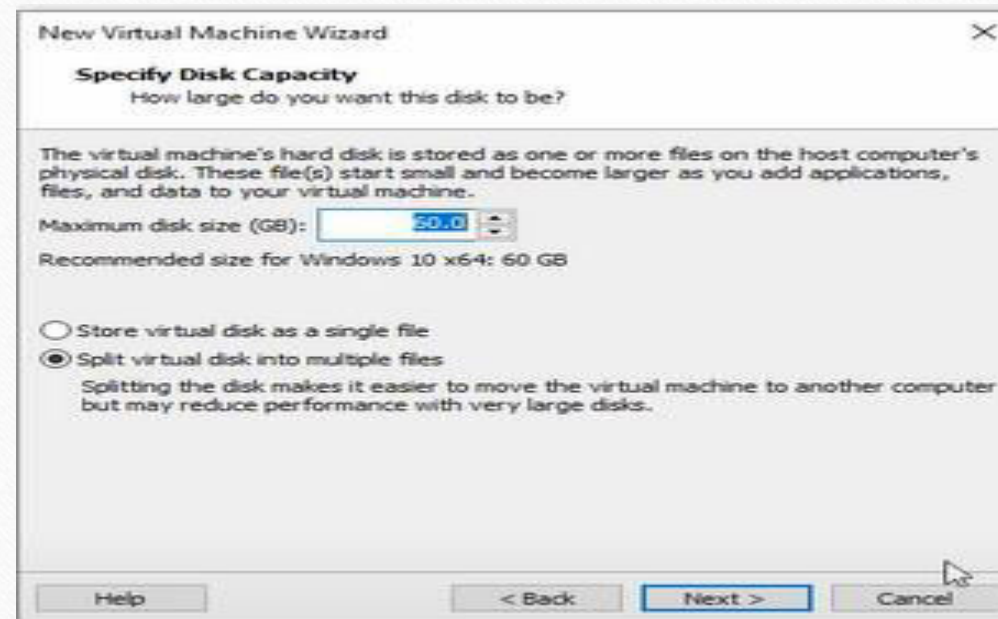
# Create VM



# Create VM



# Create VM





# Type 2 hypervisor Vmware workstation

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# Type 2 hypervisor Creating Virtual Machine

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- **Topics to be Covered:**

What is Type 2 Hypervisor

Type of Type 2 Hypervisor



# Type 2 Hypervisor



- 
- It run at top of OS
  - First you install OS and top of OS you install Wmware workstation / Wmw are fusion as application
  - Using that application you create multiple VM



# Type 2 Hypervisor



- 
- **VMware Fusion**
  - **Workstation**
  - **VirtualBox**

# VMware Fusion:



- 
- This is the company's MacOS-focused offering, which lets Mac users run a large range of guest operating systems.
  - Run window application in Mac OS

# Workstation:



- 
- VMware's Linux- and Windows-focused platform comes in two flavors
    - **Pro:** which is a paid version, The Pro version allows users to run multiple operating systems on a single PC
    - **Player**, which is free for personal use, Player only supports a single guest OS



# VirtualBox



- 
- A Type 2 hypervisor running on Linux, Mac OS, and Windows operating systems.

# ESXi (Hypervisor)

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# ESXi (Hypervisor)



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- **Topics to be Covered:**

What is ESXI

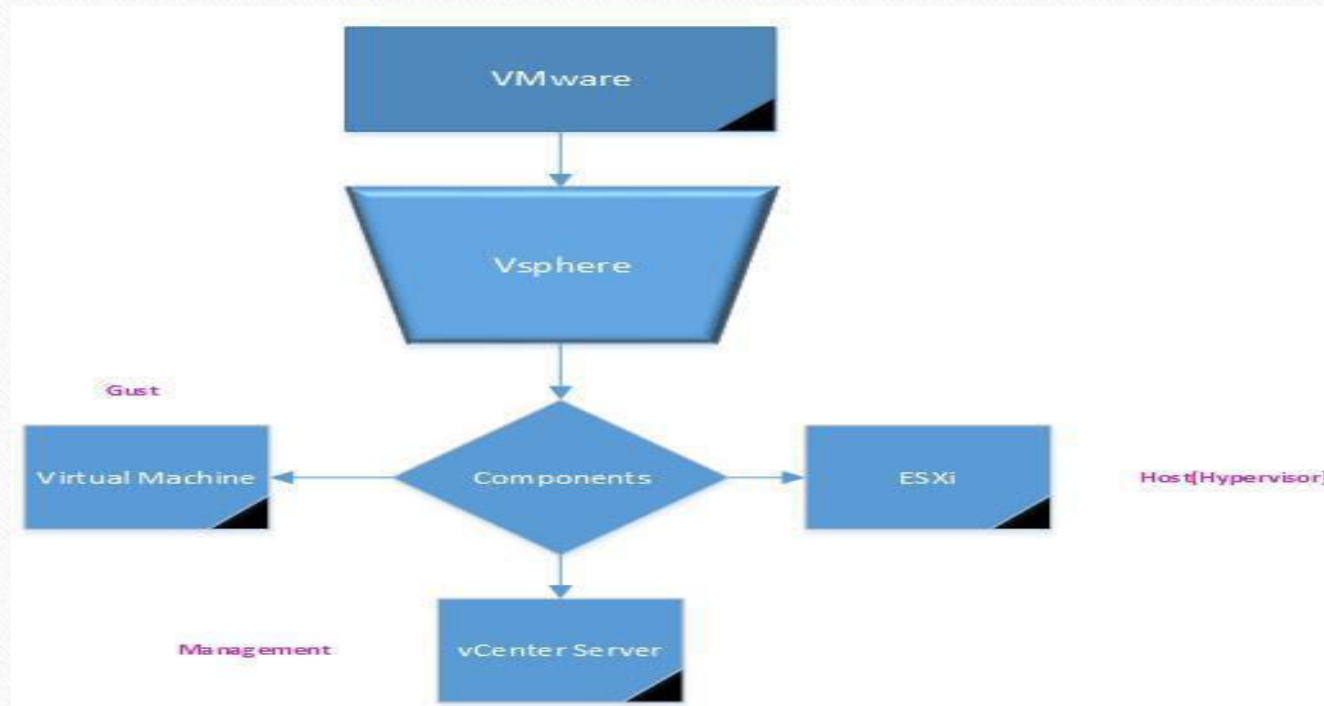


# What is ESXI



- 
- It is Type 1 Hypervisor
  - Version 6.7 vSphere (Current)

# Component of Vsphere



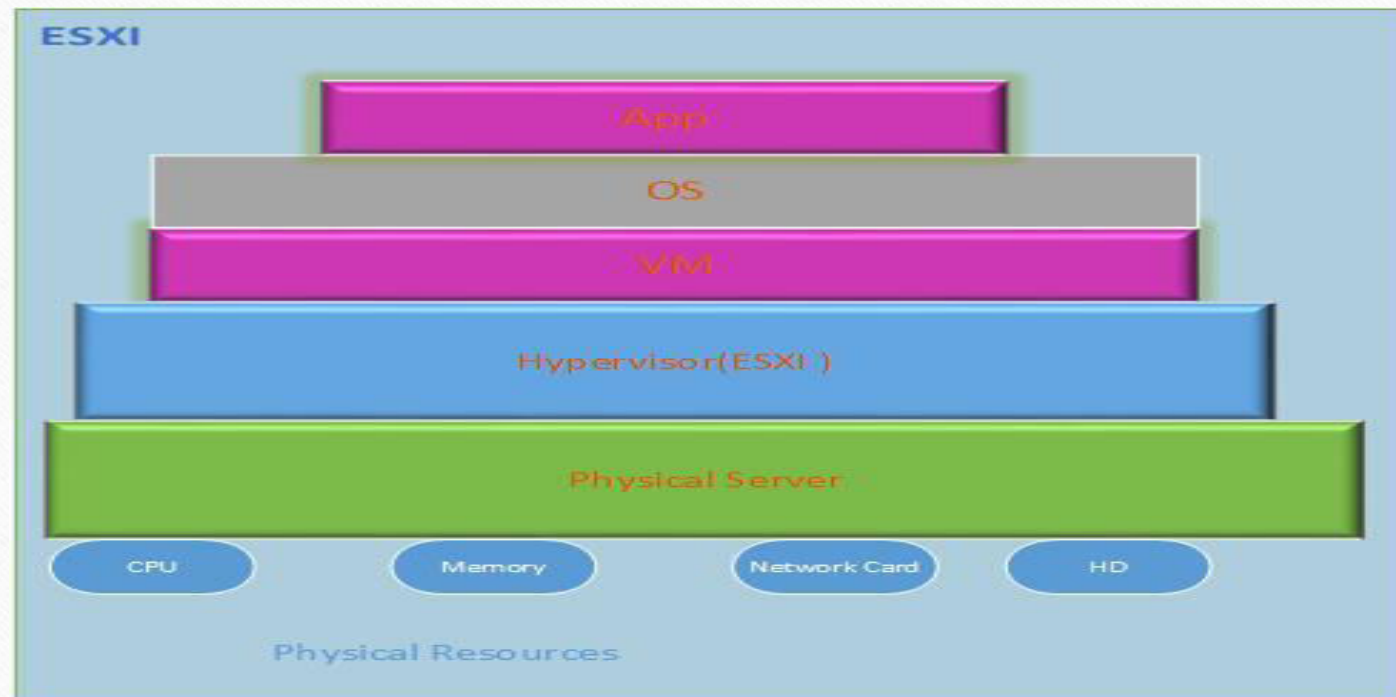
# ESXI



- 
- ESXI is Hypervisor
  - ESXI take physical resource from physical server and assigned to VM
  - Assigned resources from physical server to VM
  - Reduced data center space , power , IT administration services



# ESXI





# ESXi Installation Steps

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# ESXi

## Installation Steps

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- **Topics to be Covered:**

What is ESXI

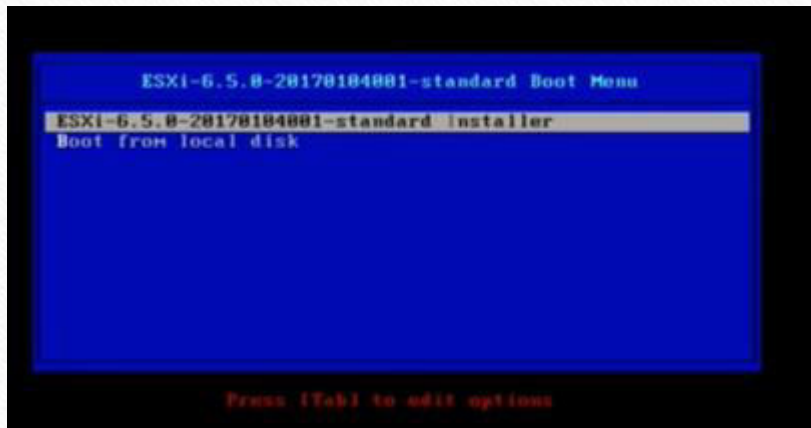
Lab: Installation steps

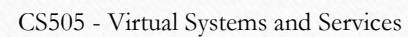


# Installation Steps

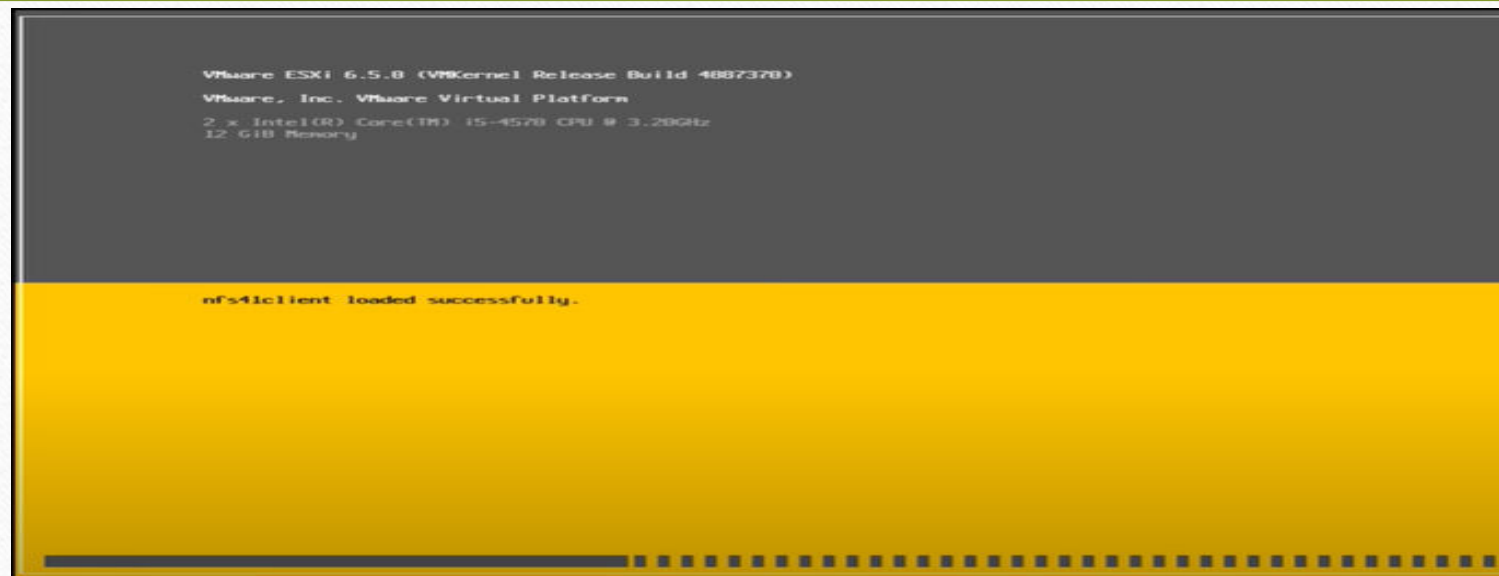


- Download **ESXi 6.5 Image** from VM ware website
- Boot System with Bootable ESXI Image





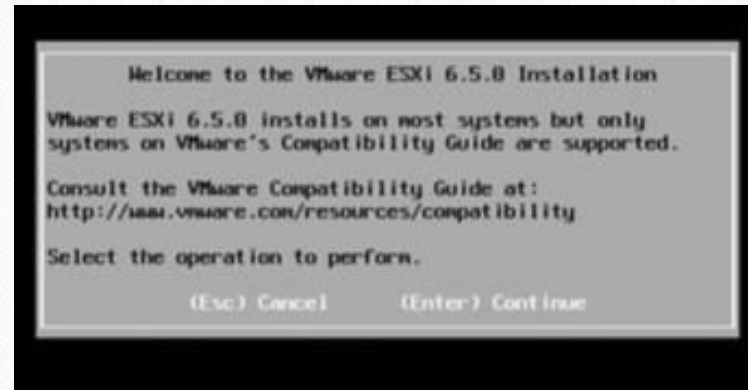
# Installation Steps



- This is not new one

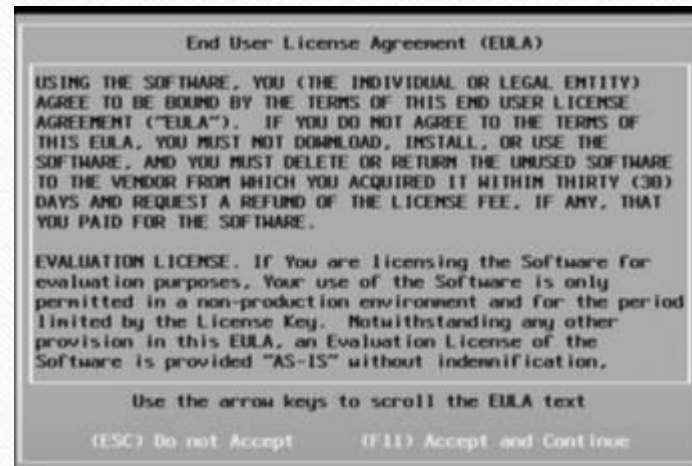


# Installation Steps

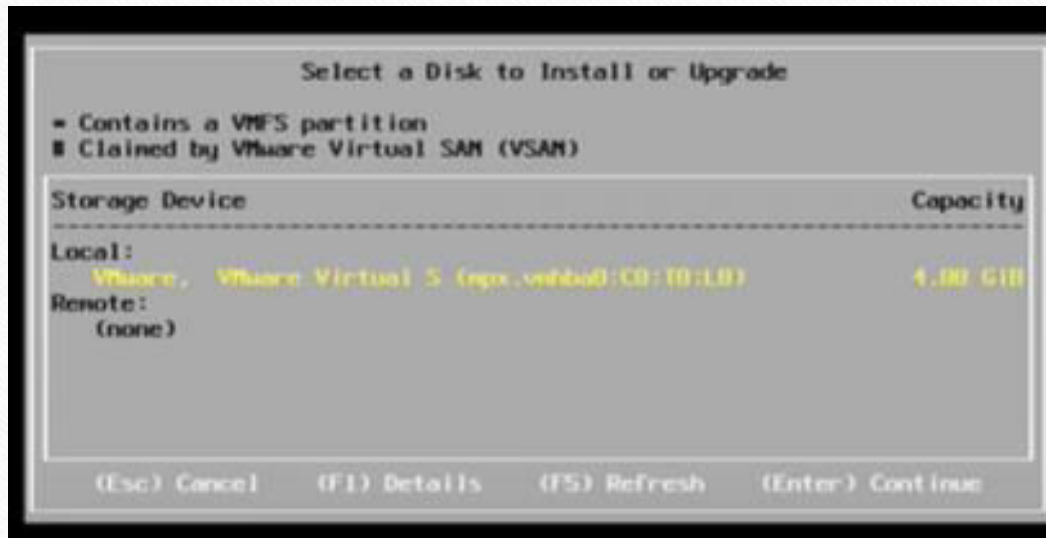


- Find HW and then used that compatible image
- Enter continue

# Installation Steps



# Installation Steps



- Scan disk to install ESXI
- Single disk used by ESXI



# Installation Steps

---



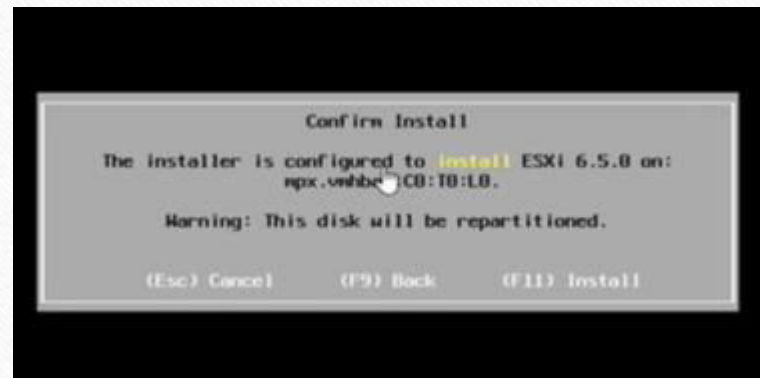
# Installation Steps

---



# Installation Steps

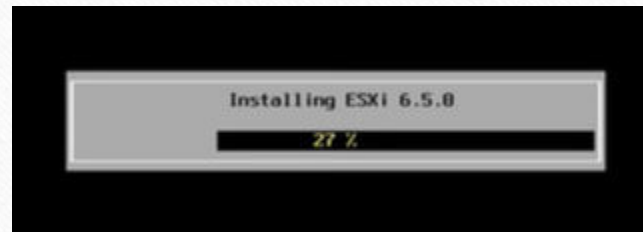
---



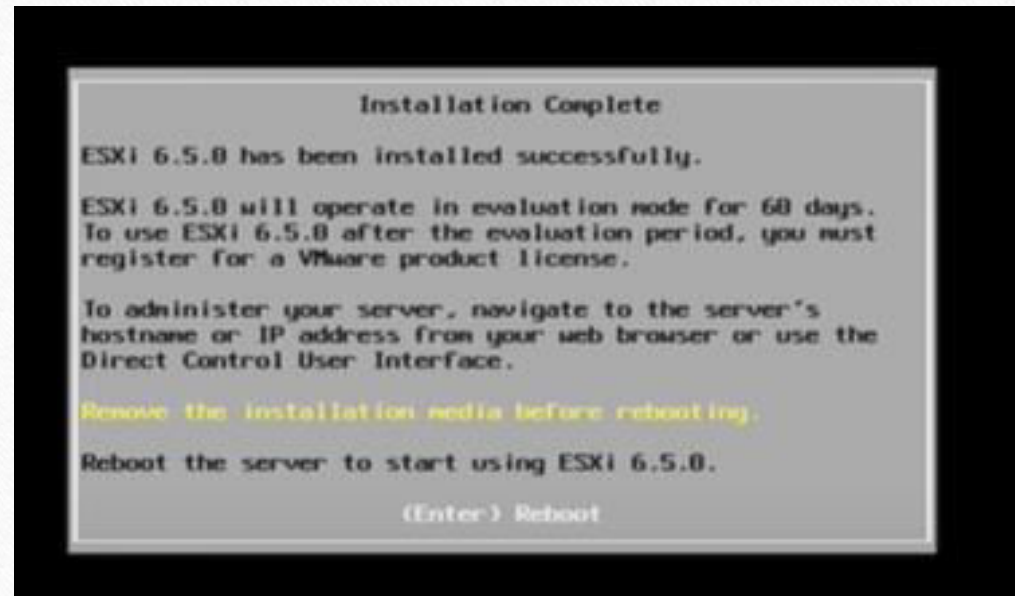


# Installation Steps

---



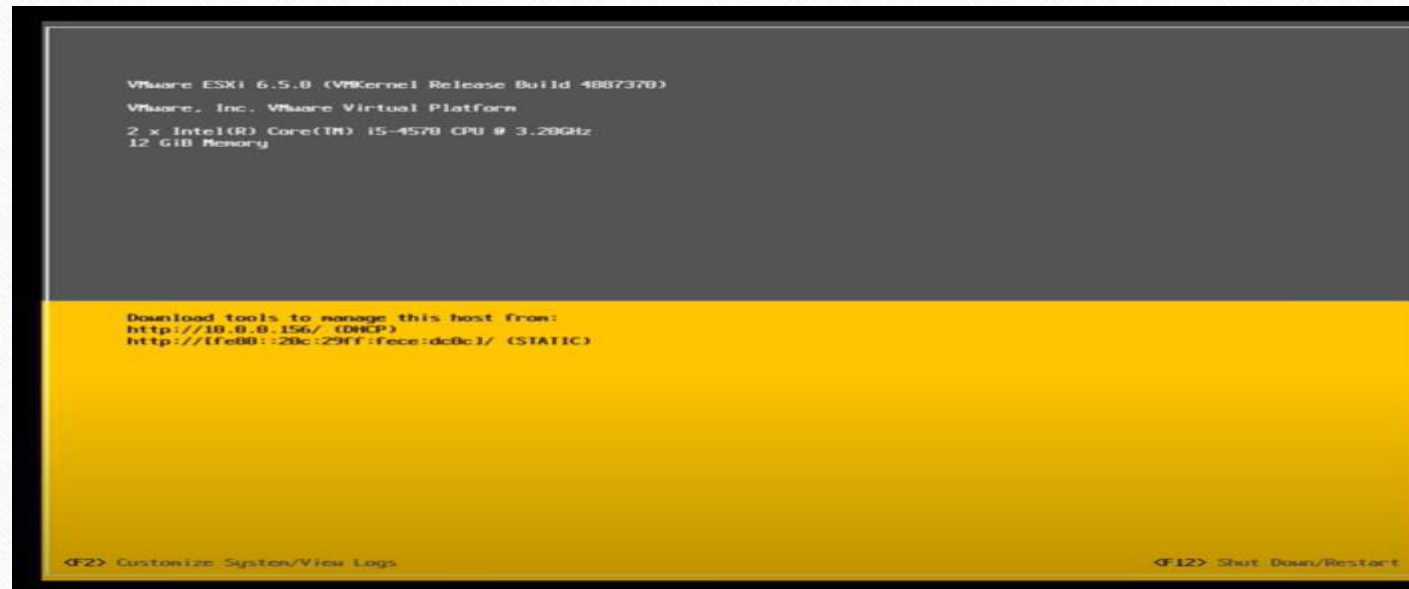
# Installation Steps



# Installation Steps



- Remove IOS image







# ESXi

## Creating Virtual Machine

---

# ESXi

## Creating Virtual Machine

---



- **Topics to be Covered:**

What is ESXI

Lab: Installation steps

Lab: 2 Configuration Steps

**Lab 3: Creating Virtual Machine**



# Recommended Steps

---



- Creating Data Store
- Upload image of OS
- Installing VM



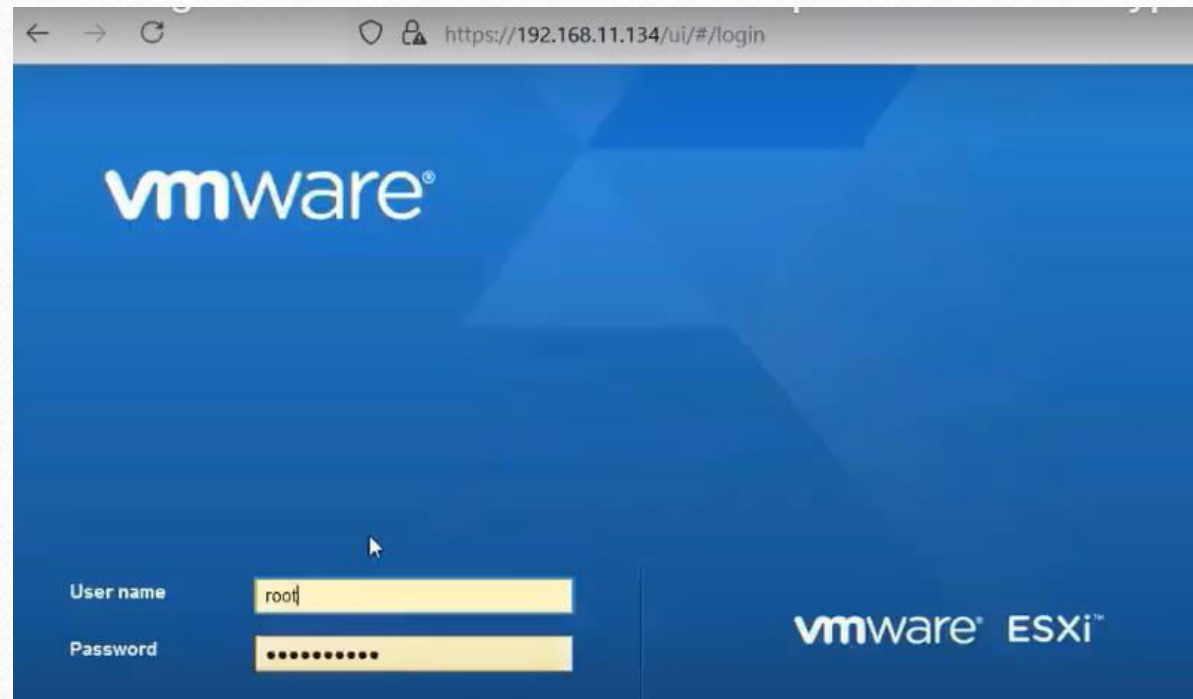
# Creating Data Store



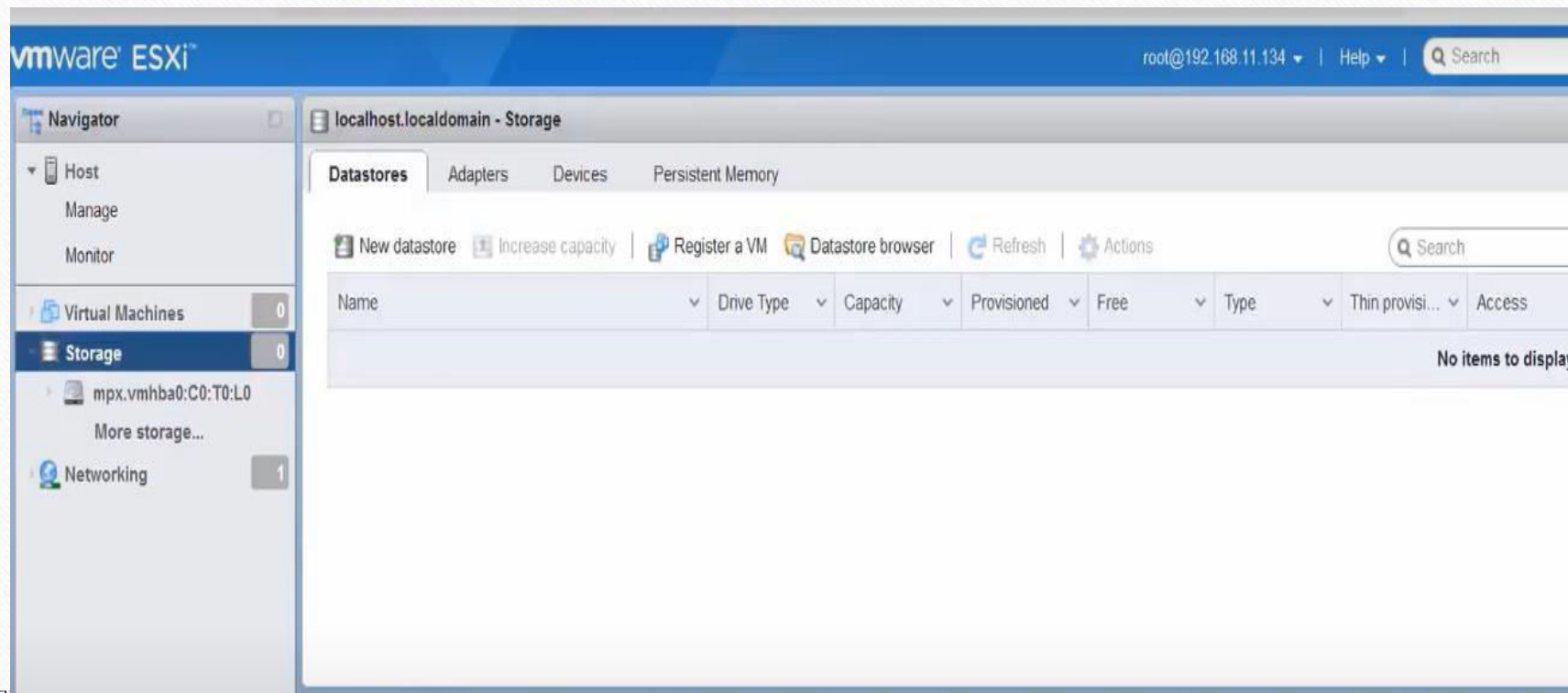
```
VMware ESXi 7.0.1 (VMKernel Release Build 17325551)  
VMware, Inc. VMware7.1  
2 x Intel(R) Core(TM) i5-2400 CPU @ 3.10GHz  
4 GiB Memory
```

```
To manage this host, go to:  
https://192.168.11.134/ (DHCP)  
https://\[fe80::20c:29ff:fedd:c8f1\]/ (STATIC)
```

# Creating Data Store

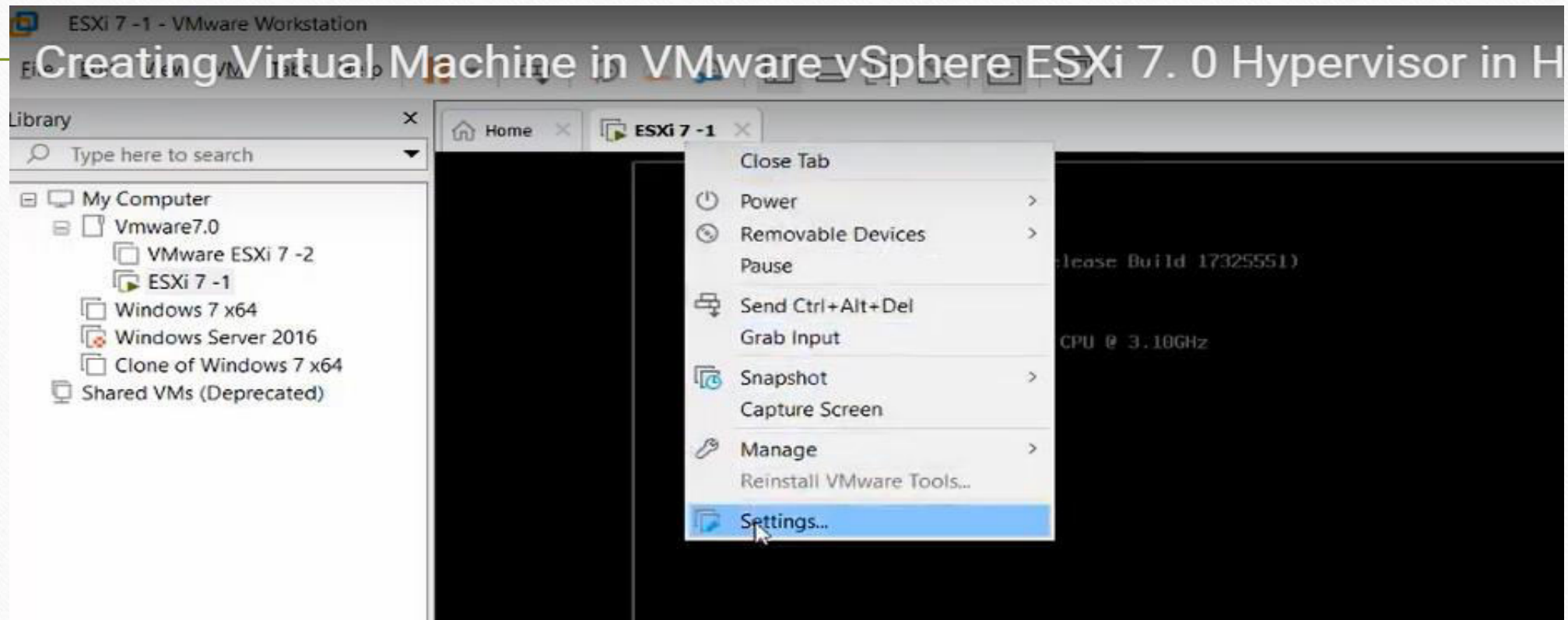


# Creating Data Store

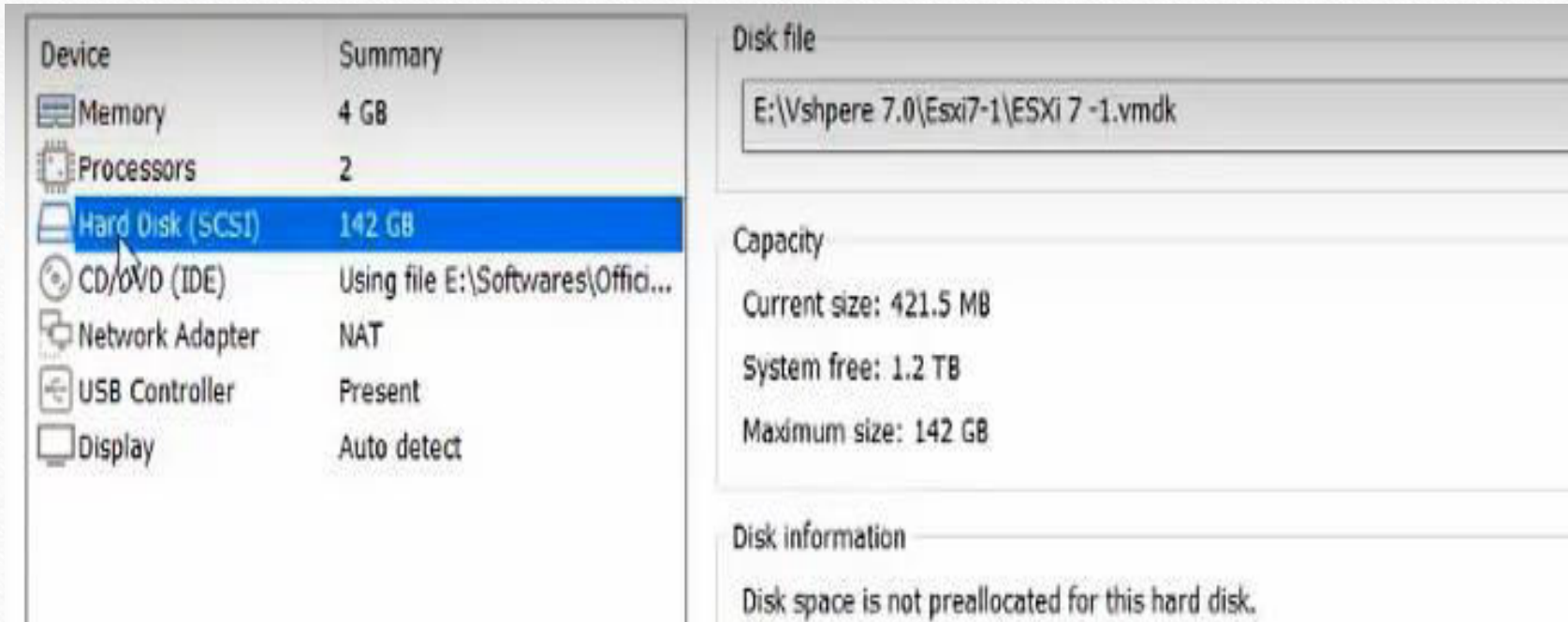




# Creating Data Store



# Creating Data Store

A screenshot of the VMware Workstation hardware configuration window for a virtual machine. The 'Hard Disk (SCSI)' device is selected and highlighted in blue. The 'Summary' tab is active, showing the disk's capacity and file location. The 'Disk file' field displays 'E:\Vshpere 7.0\Esxi7-1\ESXi 7 -1.vmdk'. The 'Capacity' section shows the current size (421.5 MB), system free space (1.2 TB), and maximum size (142 GB). The 'Disk information' section states that disk space is not preallocated for this hard disk.

| Device                  | Summary                           |
|-------------------------|-----------------------------------|
| Memory                  | 4 GB                              |
| Processors              | 2                                 |
| <b>Hard Disk (SCSI)</b> | <b>142 GB</b>                     |
| CD/DVD (IDE)            | Using file E:\Softwares\Offici... |
| Network Adapter         | NAT                               |
| USB Controller          | Present                           |
| Display                 | Auto detect                       |

**Disk file**

E:\Vshpere 7.0\Esxi7-1\ESXi 7 -1.vmdk

**Capacity**

Current size: 421.5 MB

System free: 1.2 TB

Maximum size: 142 GB

**Disk information**

Disk space is not preallocated for this hard disk.

# Creating Data Store





# Creating Data Store



**Add Hardware Wizard**

**Select a Disk Type**  
What kind of disk do you want to create?

Virtual disk type

☐ IDE

☒ SCSI (Recommended)

☐ SATA

☐ NVMe

 IDE disks can be added only while the VM is powered off.

 NVMe disks can be added only while the VM is powered off.

# Creating Data Store



# Creating Data Store



The image shows a screenshot of the 'Add Hardware Wizard' dialog box, specifically the 'Specify Disk Capacity' step. The dialog box has a title bar with 'Add Hardware Wizard' and a close button. The main title is 'Specify Disk Capacity' with the subtitle 'How large do you want this disk to be?'. Below this, there is a text field for 'Maximum disk size (GB):' with the value '142.0' entered. To the right of the text field is a small spinner control. Below the text field, it says 'Recommended size for VMware ESXi 7 and later: 142 GB'. There are two radio button options: 'Allocate all disk space now.' (which is currently selected) and 'Store virtual disk as a single file'. Below the 'Allocate all disk space now.' option, there is a paragraph of text: 'Allocating the full capacity can enhance performance but requires all of the physical disk space to be available right now. If you do not allocate all the space now, the virtual disk starts small and grows as you add data to it.' Below the 'Store virtual disk as a single file' option, there is another paragraph of text: 'Splitting the disk makes it easier to move the virtual machine to another computer but may reduce performance with very large disks.'

Add Hardware Wizard

**Specify Disk Capacity**  
How large do you want this disk to be?

Maximum disk size (GB):

Recommended size for VMware ESXi 7 and later: 142 GB

☒ Allocate all disk space now.  
Allocating the full capacity can enhance performance but requires all of the physical disk space to be available right now. If you do not allocate all the space now, the virtual disk starts small and grows as you add data to it.

☐ Store virtual disk as a single file  
Splitting the disk makes it easier to move the virtual machine to another computer but may reduce performance with very large disks.



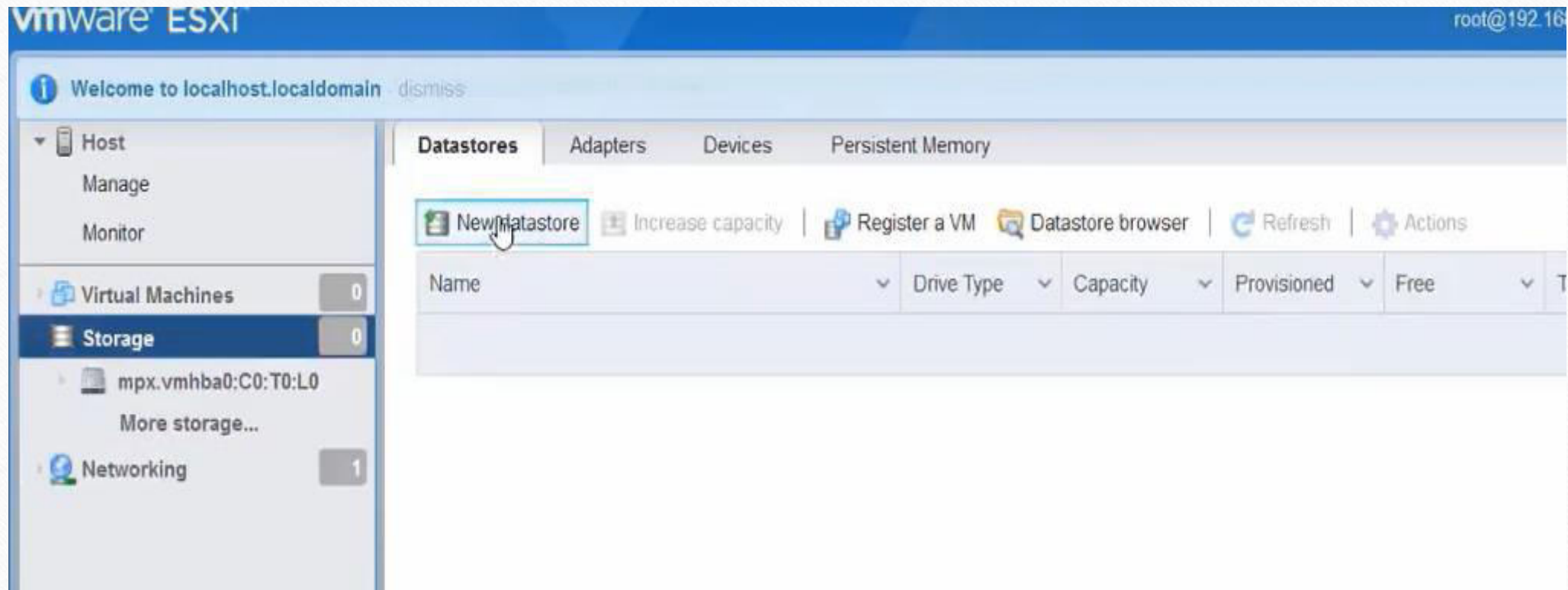
# Creating Data Store Restart



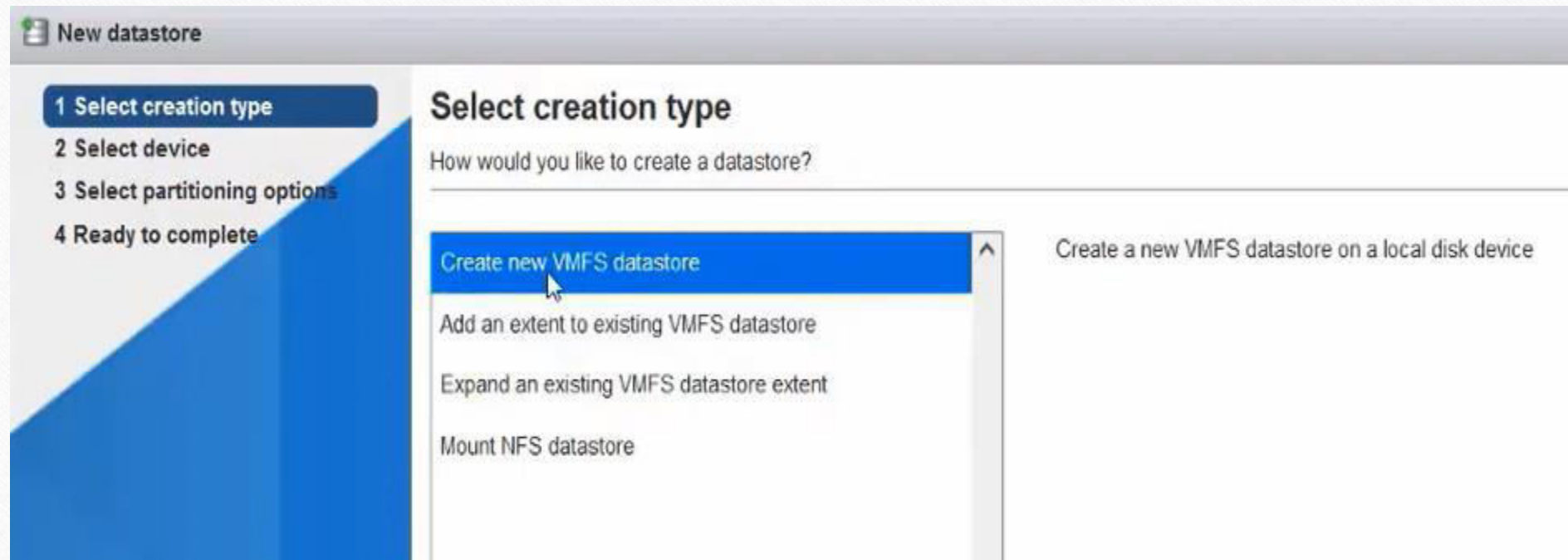
```
VMware ESXi 7.0.1 (VMKernel Release Build 17325551)  
VMware, Inc. VMware7.1  
2 x Intel(R) Core(TM) i5-2400 CPU @ 3.10GHz  
4 GiB Memory
```

```
To manage this host, go to:  
https://192.168.11.134/ (DHCP)  
https://\[fe80::20c:29ff:fedd:c8f1\]/ (STATIC)
```

# Creating Data Store



# Creating Data Store





# Creating Data Store



Name

datastore1

The following devices are unclaimed and can be used to create a new VMFS datastore

| Name                                                                                                                         | Type | Capacity | Free space |
|------------------------------------------------------------------------------------------------------------------------------|------|----------|------------|
|  Local VMware, Disk (mpx.vmhba0:C0:T0:L0)   | Disk | 142 GB   | 14 GB      |
|  Local VMware, Disk (mpx.vmhba0:C0:T1:L0) | Disk | 100 GB   | 100 GB     |
| 2 items                                                                                                                      |      |          |            |

# Create Directory on Data Store



The screenshot shows the VMware vSphere interface. On the left, the navigation pane has 'Host' selected, with 'Virtual Machines' (0) and 'Storage' (1) sub-items. Under 'Storage', 'datastore1' is selected, showing 'Monitor' and 'mpx.vmhba0:C0:T0:L0' options. The main pane shows the 'Datastore browser' tab selected. It displays a database icon and details for 'datastore1':

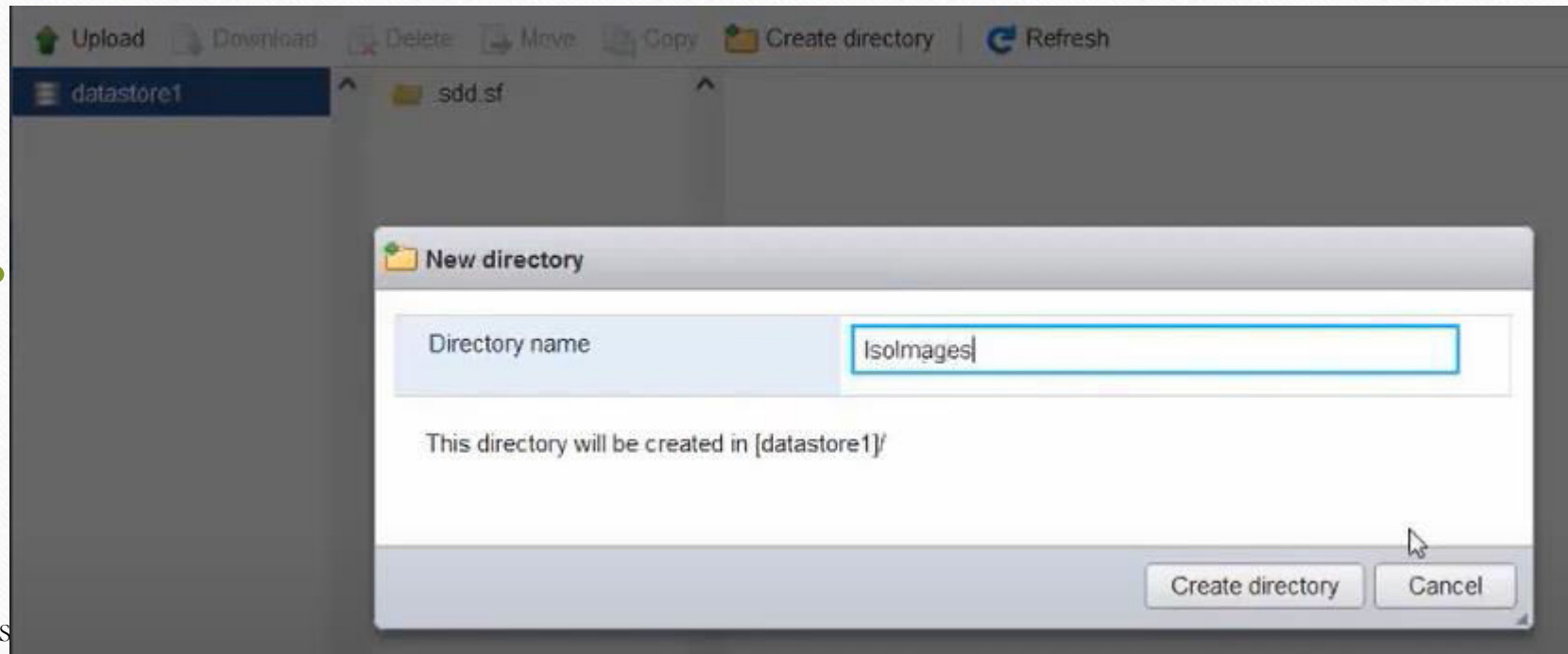
- Type: VMFS6
- Location: /vmfs/volumes/609f8a40-26e5a7a0-ec3d-000c29dd0c8f
- UUID: 609f8a40-26e5a7a0-ec3d-000c29dd0c8f
- Hosts: 1
- Virtual Machines: 0

At the top of the main pane are buttons: 'Register a VM', 'Datastore browser' (highlighted), 'Increase capacity', 'Refresh', and 'Actions'.

Below the details is a 'VMFS details' table:

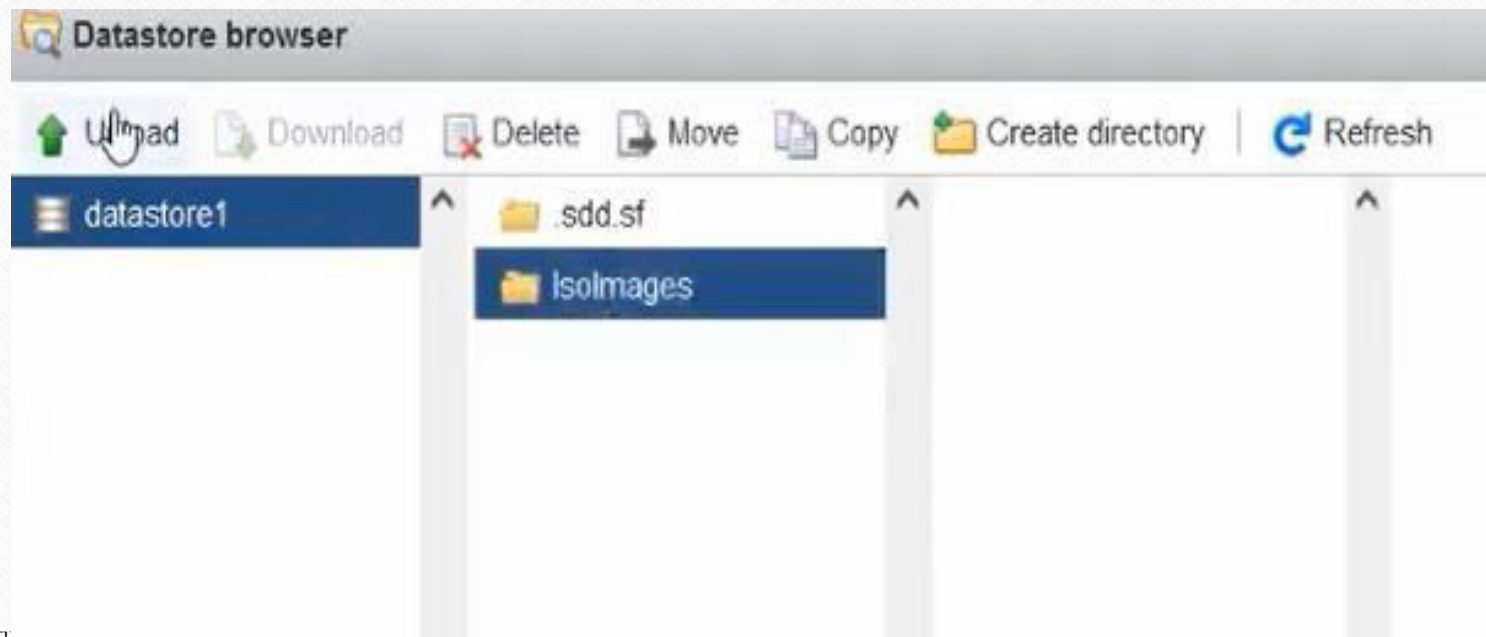
| VMFS details |      |
|--------------|------|
| Version      | 6.82 |
| Local        | Yes  |
| Block size   | 1 MB |

# Create Directory on Data Store

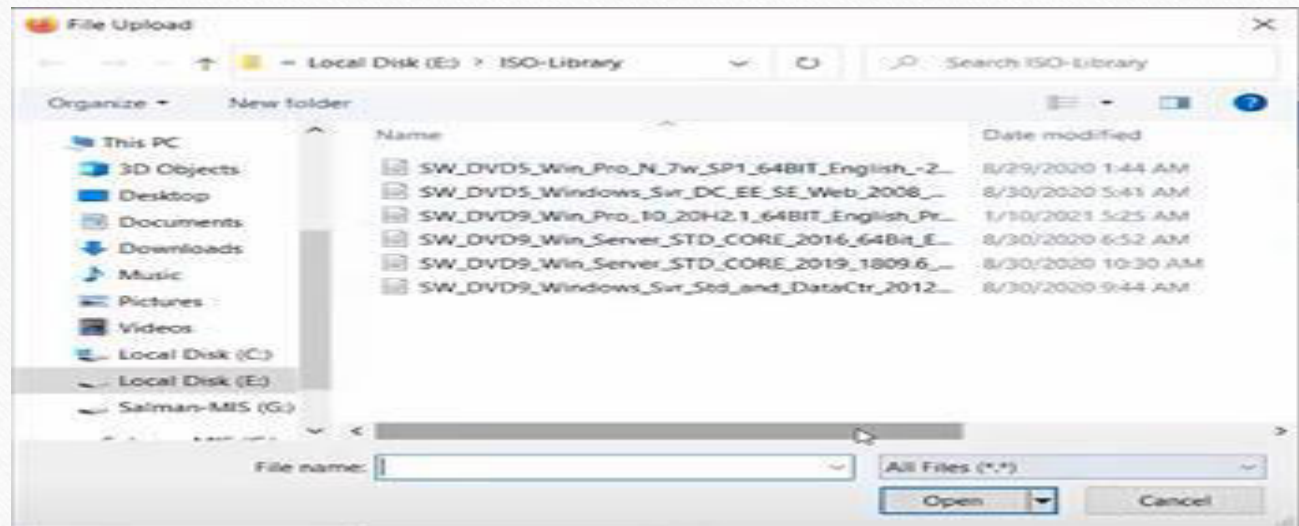




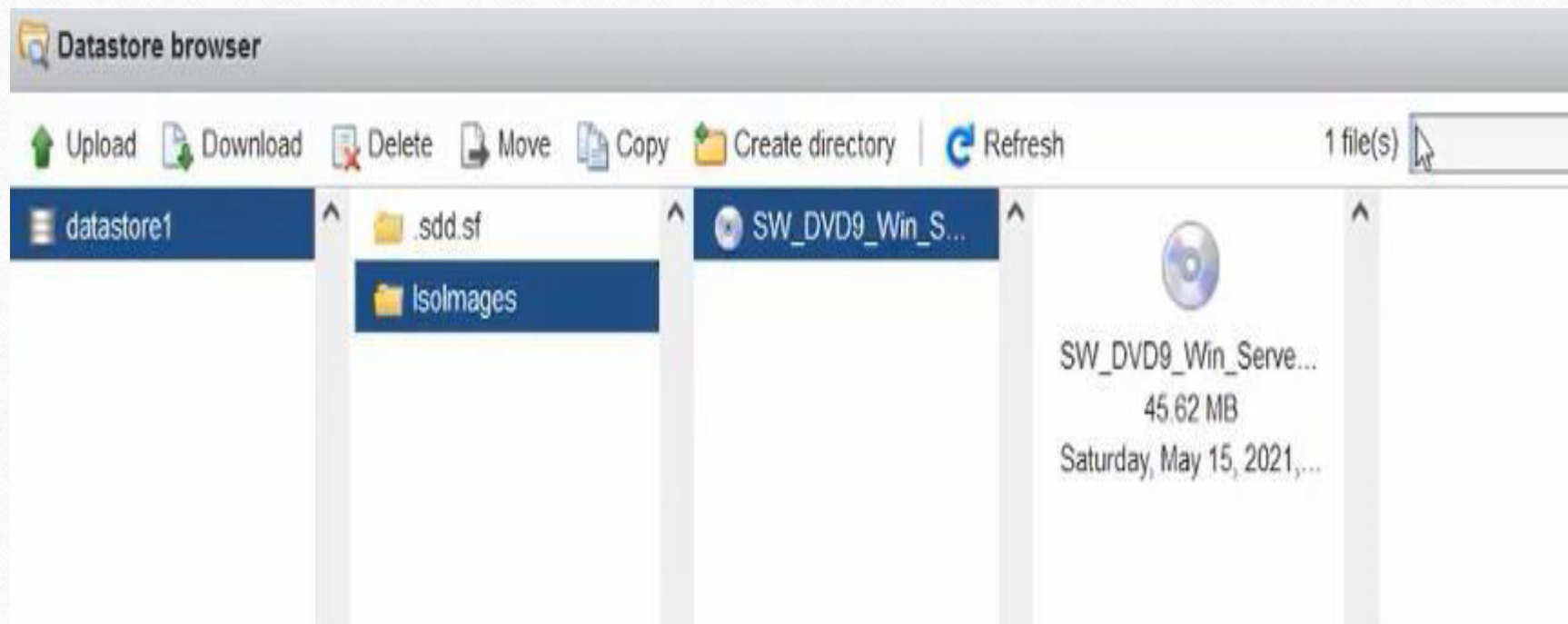
# Upload OS image



# Upload OS image

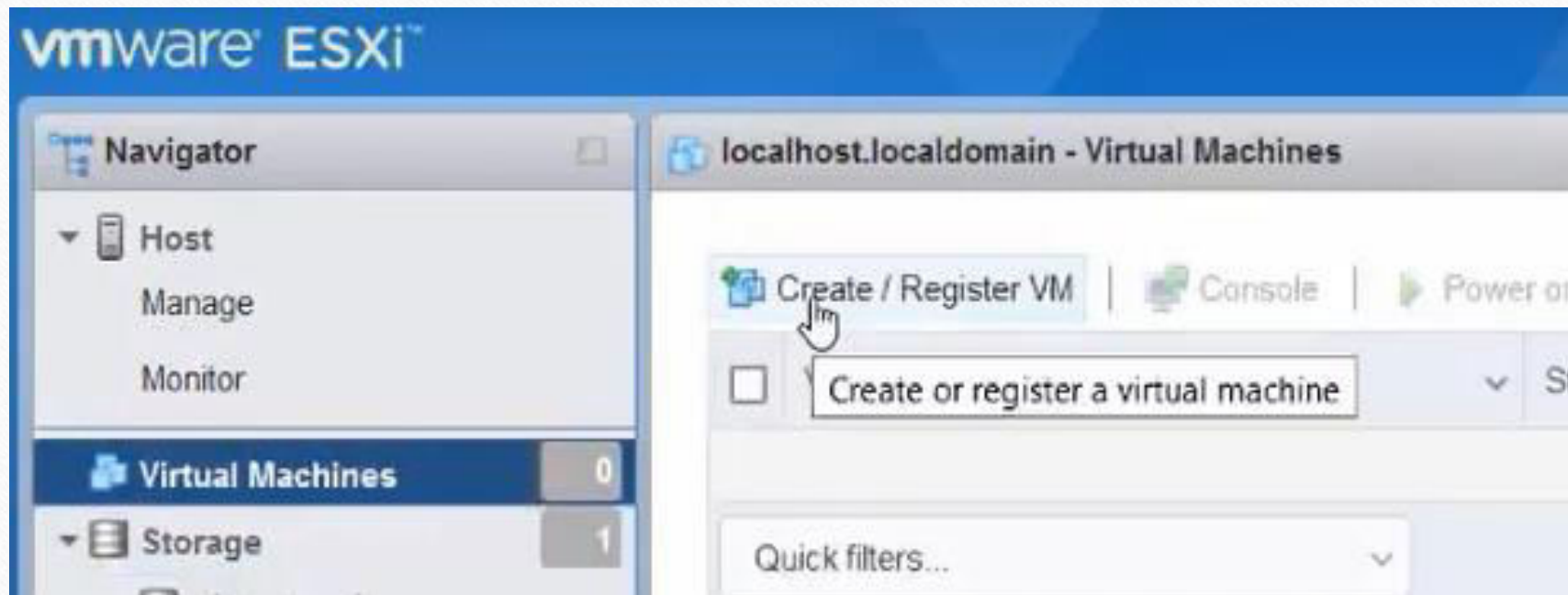


# Upload OS image

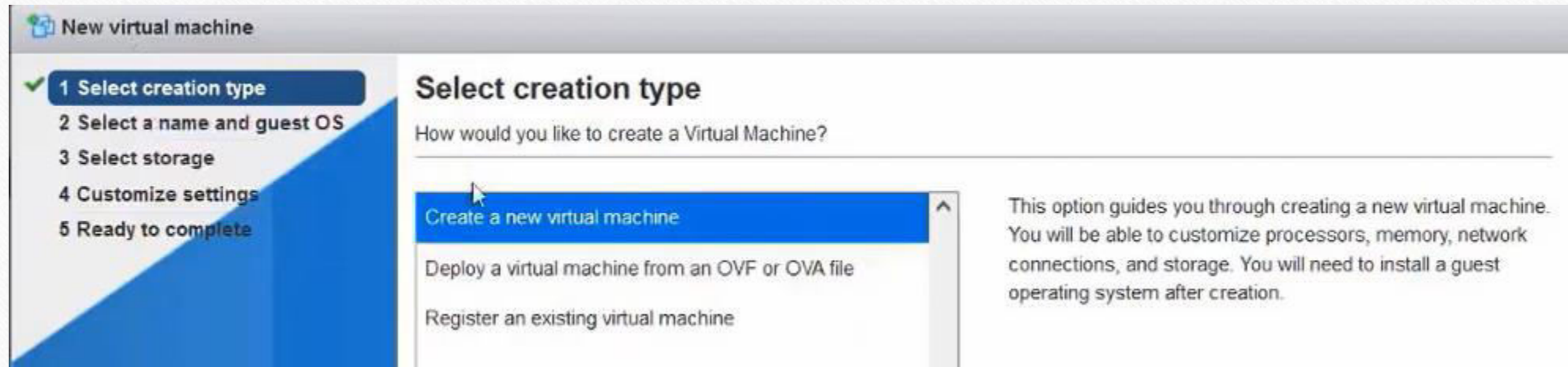




# Installing VM



# Installing VM



# Installing VM



New virtual machine - Win2016Server (ESXi 7.0 U1 virtual machine)

✓ 1 Select creation type

**2 Select a name and guest OS**

3 Select storage

4 Customize settings

5 Ready to complete

## Select a name and guest OS

Specify a unique name and OS

Name

Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.

Identifying the guest operating system here allows the wizard to provide the appropriate defaults for the operating system installation.

|                  |                                        |
|------------------|----------------------------------------|
| Compatibility    | ESXi 7.0 U1 virtual machine            |
| Guest OS family  | Windows                                |
| Guest OS version | Microsoft Windows Server 2016 (64-bit) |

☐ Enable Windows Virtualization Based Security 



# Installing VM



New virtual machine - Win2016Server (ESXi 7.0 U1 virtual machine)

- ✓ 1 Select creation type
- ✓ 2 Select a name and guest OS
- ✓ 3 Select storage
- 4 Customize settings
- 5 Ready to complete

## Select storage

Select the storage type and datastore

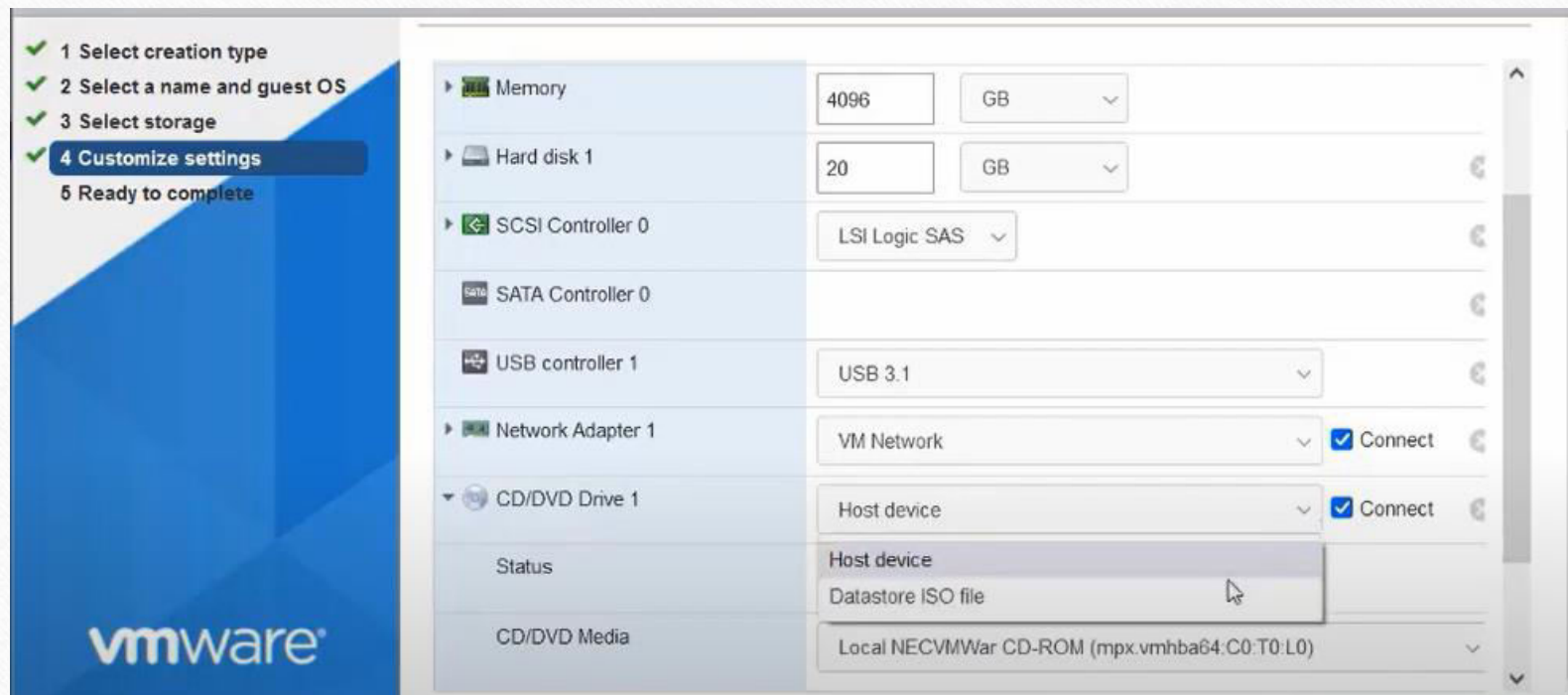
☒ Standard ☐ Persistent Memory

Select a datastore for the virtual machine's configuration files and all of its' virtual disks.

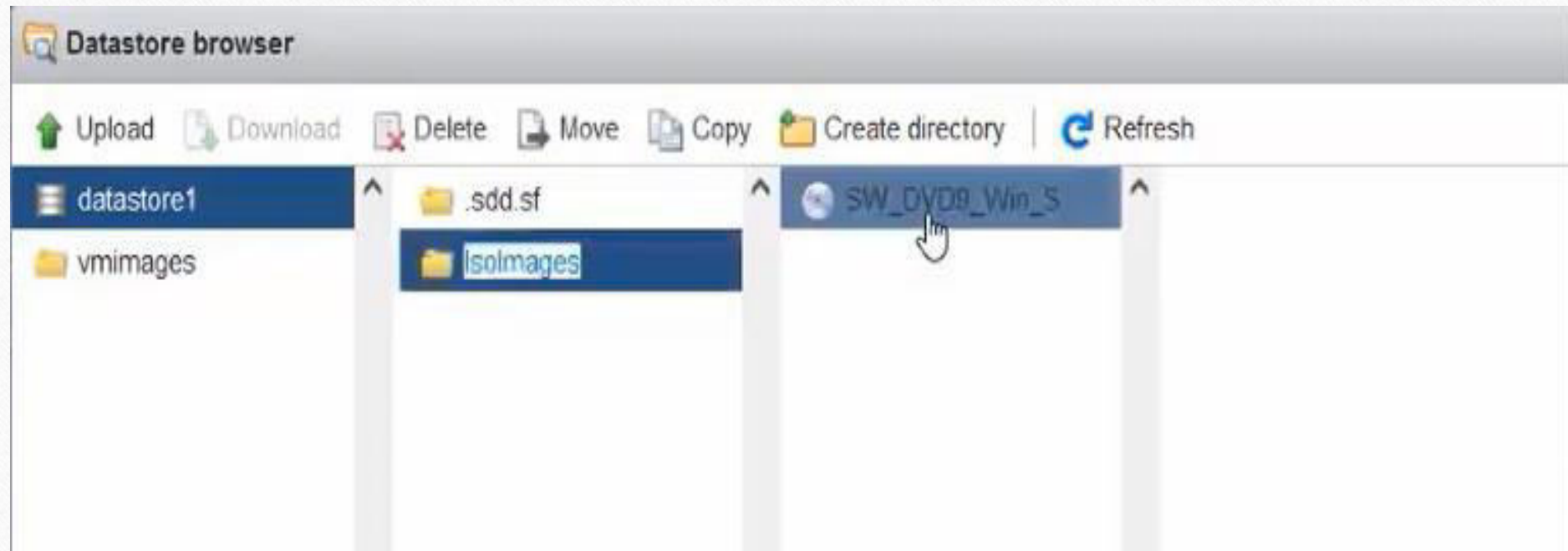
| Name       | Capacity | Free     | Type  | Thin pro... | Access |
|------------|----------|----------|-------|-------------|--------|
| datastore1 | 99.75 GB | 98.34 GB | VMFS6 | Supported   | Single |

1 items

# Installing VM



# Installing VM

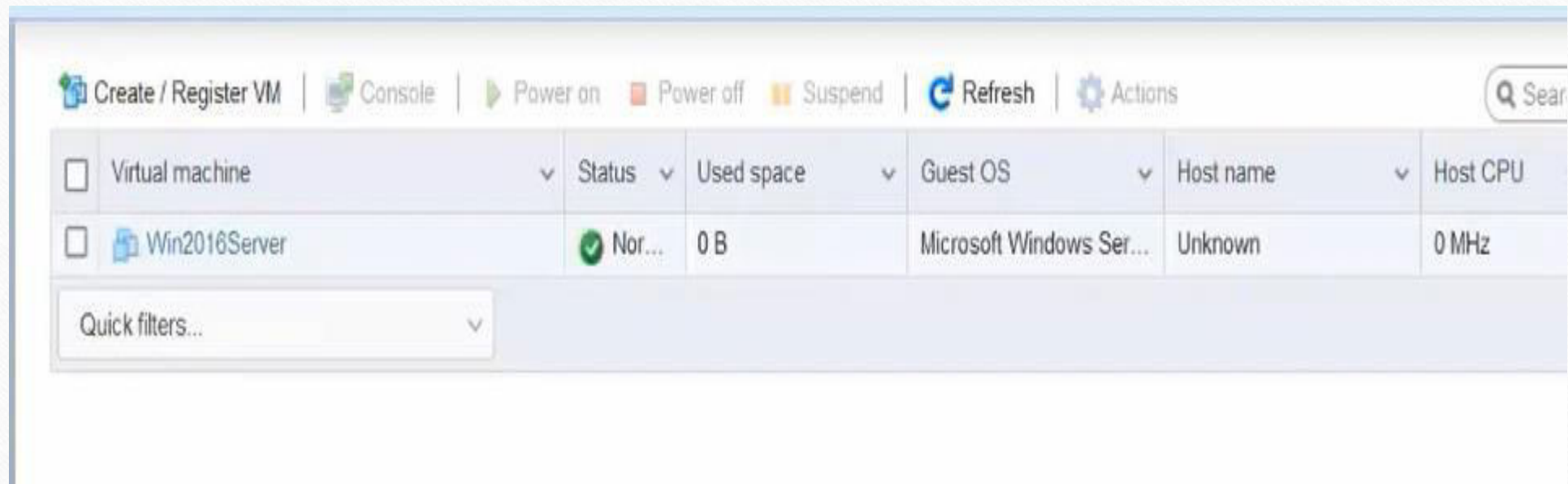




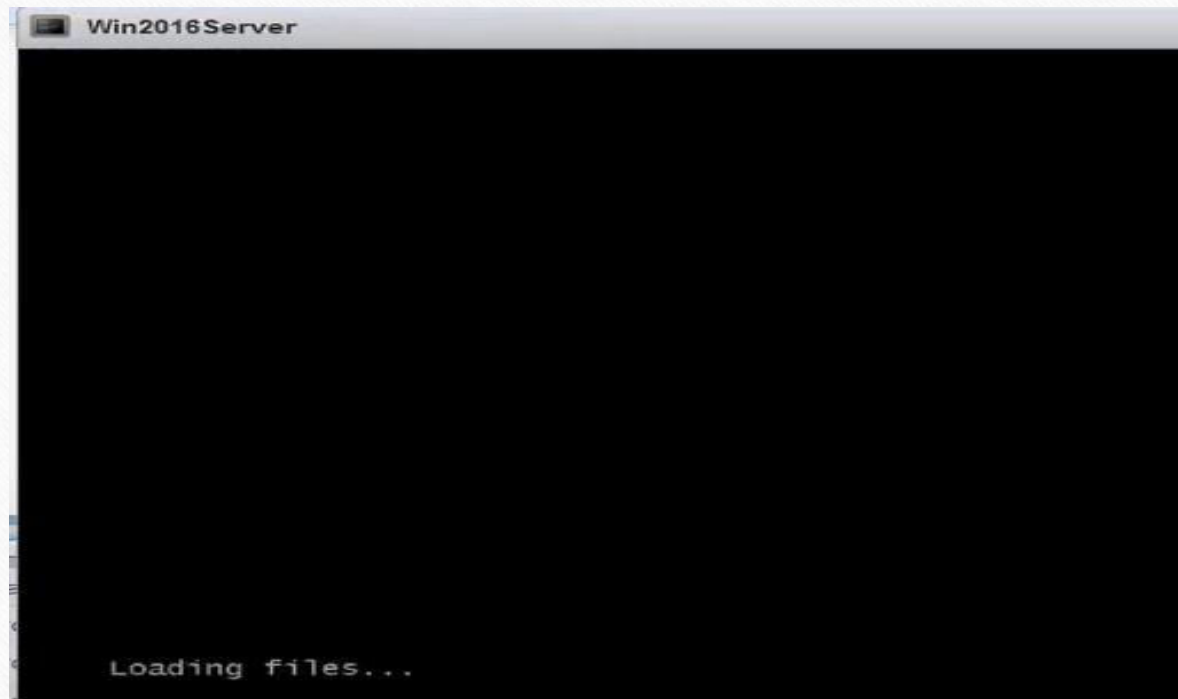
# Installing VM



# Install Window



# Install Window







# VirtualBox



Virtual Systems and Services

# VirtualBox



- Oracle VM VirtualBox is a cross-platform virtualization product
- It is used for virtualizing x86 and AMD64/Intel64 computing architecture
- It is freely available as open source software under the terms of GNU General public license (GPL)
- It runs on all major operating systems including Windows, Linux, Mac and Solaris



# VirtualBox



- Different Versions of Oracle VM VirtualBox exists to install ( for Windows, Linux and Solaris etc.)
- VM VirtualBox is first downloaded and installed on any host OS
- It has both the graphical and Command Line interface (GUI and CLI)
- Using VirtualBox, multiple guest operating systems can be installed as VMs on host OS
- We can install Windows 7 or Linux as guest OS on hosted OS Windows 10



# VirtualBox



- 
- VirtualBox supports both the hardware and software virtualization
  - It is recommended to use VirtualBox for small and mid-range projects

# VMware Vs VirtualBox

---



Virtual Systems and Services





# VMware Vs VirtualBox



## VMware

- It is a virtualization software platform developed by vendor, VMware
- It is a type-1 hypervisor
- VMware supports hardware virtualization
- Its workstation player is free while other VMware products require a paid license.

## VirtualBox

- It is a virtualization software platform developed by Oracle Corporation
- It is a type-2 hypervisor
- VirtualBox supports both software & hardware virtualization
- It is an open source virtualization product



# VMware Vs VirtualBox



## VMware

- VMware workstation works on Windows and Linux. For macOS, we need to install VMWare Fusion/Fusion Pro
- It supports VMDK disk format

## VirtualBox

- VirtualBox can install on Windows, Linux, Solaris, MacOS, FreeBSD
- It supports VDI, VHD, VMDK disk formats

# VMware Vs VirtualBox



## VMware

- VMware supports snapshots on its paid products
- VMware Virtual Machines run faster
- For enterprise projects, VMware is recommended

## VirtualBox

- VirtualBox supports snapshots free of cost
- VirtualBox Virtual Machines run slower comparatively.
- For small and mid-level projects, VirtualBox is recommended





# Hyper-V



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Virtual Systems and Services





# Hyper-V

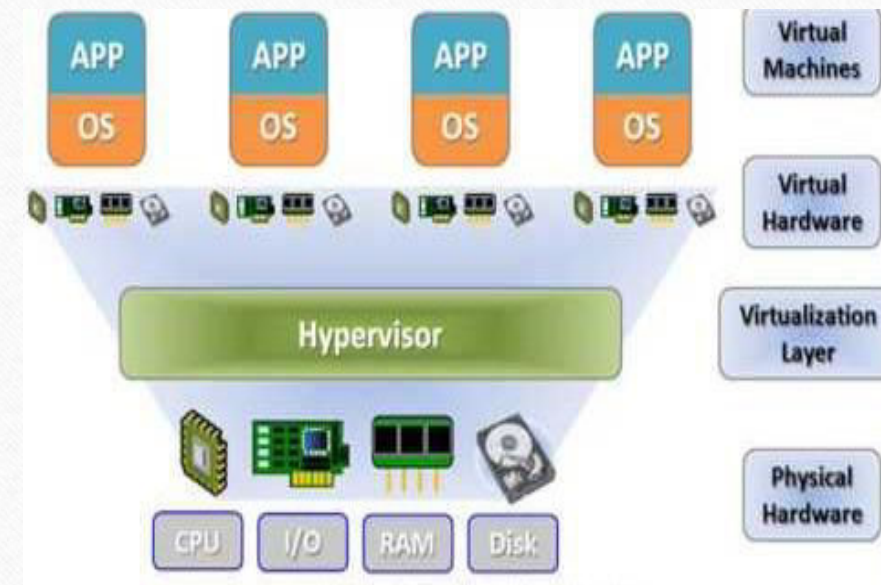
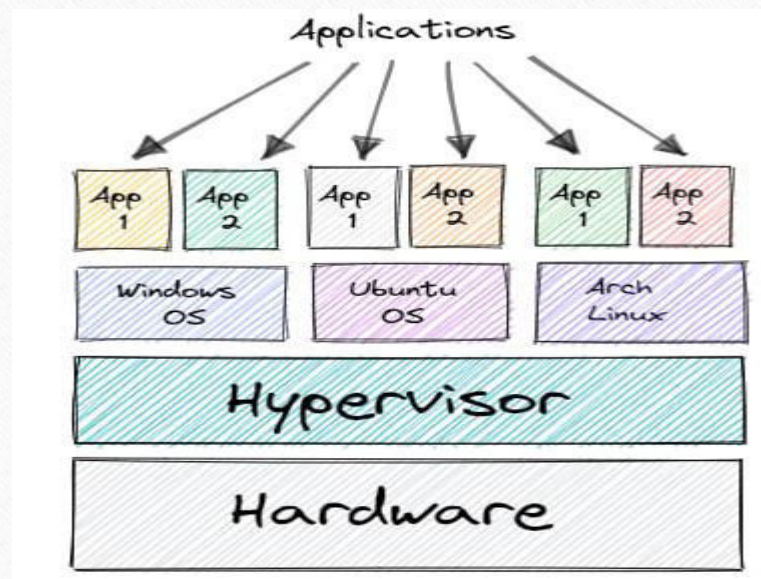


- Hyper-V is a virtualization platform through which multiple isolated environments can be created on single physical server.
- Hyper-V is the product of Microsoft
- Hyper-V can be enabled from the Windows operating system
- Hyper-V is type 1 hypervisor



# Type 1 Hypervisor

- Hyper-V is type 1 hypervisor







# Advantages of Hyper-V

---



- Cost can be reduced
- Hardware can be utilized with full capacity
- Provide flexibility
- Different environments like testing and production environment can be created
- Power consumption can be reduced too







# Compare



- 
- Hyper-V
    - Microsoft dependent
    - Checkpoints
    - Hyper-V live migration tool for migrating workload
    - Hyper-V provide support for Linux
  - VMware
    - Complete ecosystem for virtualization
    - Snapshots
    - VMware vMotion for migration of work load
    - Fault tolerance and disaster recovery





# Conclusion



- 
- Hyper-V is Virtualization platform
  - All advantages of virtualization can be achieved with the help of Hyper-V
  - Both VMware and Hyper-V are the market players of Virtualization
  - Hyper-V is type 1 hypervisor

# Image sources



- 
- <https://www.youtube.com/watch?v=tlL1W9MLobo>
  - <https://dev.to/kcdchennai/virtual-machines-101-2gmg>
  - <http://www.greenit-monaco.com/en/software/hyper-v.html>



# Hyper-V Architecture



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# Hyper-V Architecture



## Hyper-V

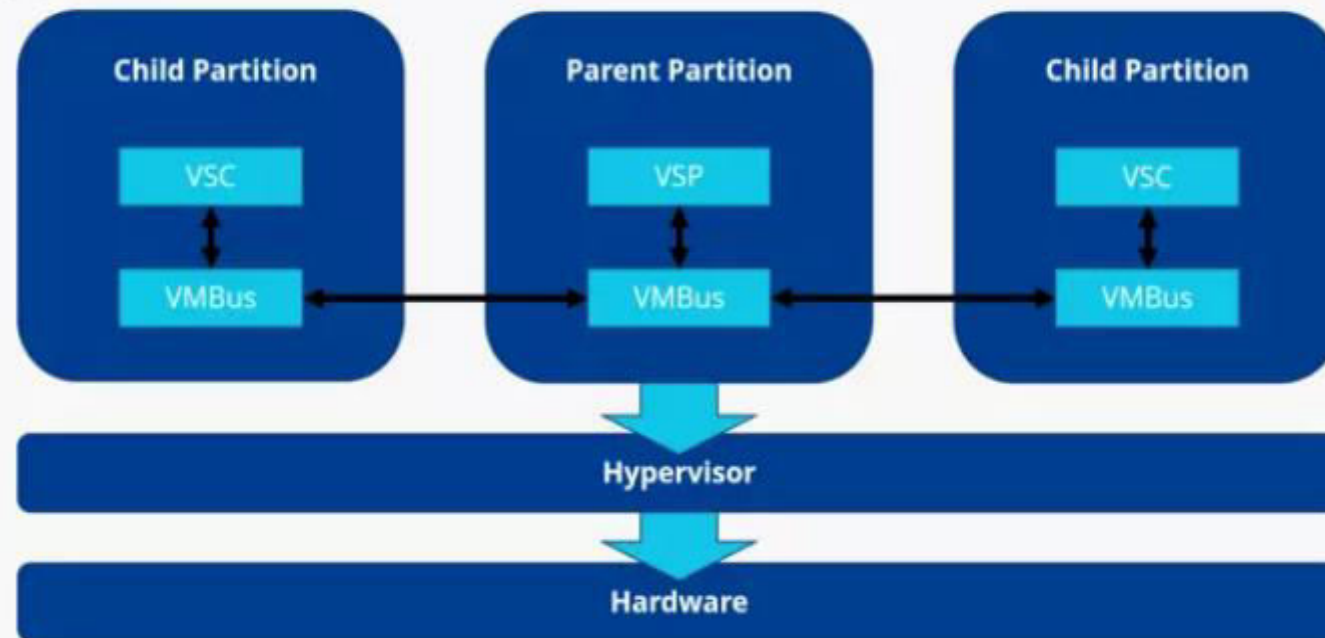


Image Source: <https://www.ionos.com/digitalguide/server/know-how/what-is-hyper-v/>



# Hyper-V Lab



---

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Virtual Systems and Services





# Hyper-V Lab

---



- Hyper-V is a Microsoft Product for Virtualization
- Hardware Virtualization
- Flexibility
- Modify your infrastructure according to your workload

# Step 1



- 
- Enable Hyper-V in Windows 10 pro or Windows Server
  - Go to Apps & features
    - Then Programs & Features
    - Turn Windows features on or off
    - Check Hyper-V option from the list so that it needs to be selected .
  - Now Hyper-V will be accessible from the search bar in windows

# Step 2



- Create a Virtual Machine
  - Search Hyper-V Manager open it
  - From Hyper-V Manager Dashboard in Actions Click on New
  - Click on Create Virtual Machine
  - Configure it according to your needs



# Step 3



- 
- Install Operating system in the Virtual Machine
  - Select Virtual Machine you just created in step 2 which will be shown in the center
  - From the menu bar Click on Actions and then on Connect then proceed with Start option on Screen
  - Now your Operating System installation step will start

# Step 4



- 
- Play with Virtual Machine state
  - Either turn it off if its running
  - Or turn it on if its off
  - Also check Shutdown status
  - Right click on the Virtual Machine and Look for above Options

# Step 5



- 
- Explore the setting option of the Virtual Machine
  - Increase the memory or CPU according to your workload from the setting option of VM



# Try it Yourself



- 
- Now its your turn explore and apply all options covered in this Lab

# Merits and Demerits of Virtual Machine

---



# Merits of Virtual Machine

---

- **Virtualization**
  - Virtual Machine transforms traditional hardware into virtual environment
- **Run Multiple Operating Systems**
  - VMs allow us to run multiple operating systems on a single host
- **Reducing cost:**
  - Several VMs can host on a single physical server, reducing the cost of data center



# Merits

---

- **Portability**
  - VM can be easily migrated across the Virtual Environment
- **Security:** VMs run in isolation. If security is compromised in one VM, then no effect on other VMs
- Runs incompatible Software
- If one VM fails, then other machines will not be affected
- Virtual Machine enables administrators to simplify backup, disaster recovery, new deployment

# Demerits of Virtual Machine

---

- **Cost**
  - Running VMs with cloud computing is expensive
- **Low Performance**
  - VM performance is less than the real machine
- **Less Efficiency**
  - Less efficient than real machine
- **Single point dependency**
  - If physical host down, then all the hosted VMs becomes useless

- 
- Performance: runs independently but still relies on resources of host machine that are shared among the VMs
  - Efficiency: VM access hardware indirectly, will make a request for hardware access
  - Reducing cost: reduce data center cost by reducing cost of physical resources, space and power
  - Security: VMs run in isolation from one another. If security is compromised in one VM, then no effect on other VMs.
  - Run incompatible software: OS and applications are decouple from the underlying OS



# Virtual Machine

---



CS505 - Virtual Systems and Services

# Topics to be covered

---



- What is Virtual Machine?
- Uses of Virtual Machine
- Virtual Machine's Files



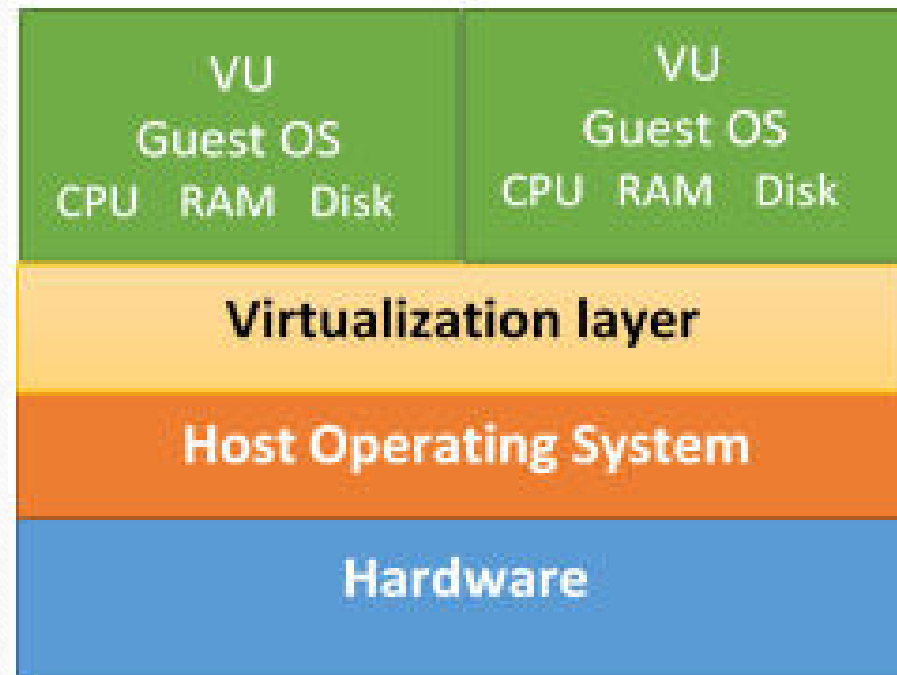
# Virtual Machine



- Virtual Machine is a virtual representation of a Physical machine
- It is called as Guest machine or Virtual Server
- It provides same functionalities as Physical machine or Server
- It uses the resources of physical machine through virtualized software
- Each Virtual Machine has its own operating system called as Guest Operating System



# Virtual Machine



# Uses of Virtual Machine



- 
- VM uses as a substitute of Physical Server in a Data Center
  - Reduce Data Center Cost
  - VM provides different types of Virtualization like Hardware virtualization, desktop virtualization etc.
  - Provides Scalability (add new VM or upgrade existing one)
  - Migration is quite easier

# Virtual Machine Files



| File         | Brief Description                                                     |
|--------------|-----------------------------------------------------------------------|
| vmname.nvram | VM BIOS Configuration file                                            |
| .vmx         | Configuration file of VM. It contains information of hardware setting |
| .vmsn        | VM snapshot data files                                                |
| .vmem        | Virtual Machine Paging backup file                                    |
| .vmdk        | Virtual disk characteristics                                          |
| vmware.log   | Stores the log activities of VM                                       |





# Virtual Networking

---

CS505 - Virtual Systems and Services

# What is Virtual Networking



---

- **Topics to be Covered:**

- Creation of virtual versions of networking components
  - Like virtual switches, virtual routers, and virtual firewalls
- Enables the use of software-based solutions for networking tasks
- Simplifies network management and improve network agility



# What is Virtual Networking...



- 
- Allows data centers to stretch across different physical locations
  - Enables Network Administrators to easily modify the network as required
  - No need to switch out or buy more hardware
  - Greater flexibility in provisioning the network to specific needs



# Tools of Virtual Network

---



# Tools of Virtual Network:



- 
- **Virtual switches:** Emulate physical switches and allow virtual machines to communicate with each other and with the physical network.
  - **Virtual routers:** Provide routing capabilities between virtual subnets and can also be used to implement network security policies.
  - **Virtual firewalls:** Offer firewall protection for virtual networks and can be used to enforce security policies.



# Tools of Virtual Network:



- 
- **Virtual load balancers:** Distribute network traffic across multiple virtual machines to improve performance and availability.
  - **Virtual VPNs:** Provide secure remote access to virtual networks from remote locations.
  - **Virtual network adapters:** Connect virtual machines to virtual networks, just like physical network adapters connect physical machines to physical networks.



# Tools of Virtual Network:



- 
- **Virtual network security groups:** Provide security for virtual networks by defining access controls for incoming and outgoing network traffic.
  - **Virtual network monitoring tools:** Monitor virtual network performance, identify network issues and provide network visibility.

# Virtual Switch & its Types

---





# Virtual Switch



- 
- Same as physical switches connect physical machines
  - Software-based switch that provides network connectivity to VMs
  - Allows virtual machines to communicate with each other
  - Can be created and managed within a virtualization platform



# Types of vSwitch



- 
- There are three types of vSwitches provided by Hyper-V
  - External vSwitch
  - Internal vSwitch
  - Private vSwitch

# Internal vSwitch



- 
- Provides communication between virtual machines and the Hyper-V host
  - Used to isolate virtual machines from each other
  - Allow communication within the same host



# Private vSwitch



- 
- Provides network connectivity only between virtual machines running on the same hypervisor host.
  - Does not provide access to the physical network
  - Used to isolate virtual machines from each other for security or testing purposes



# External vSwitch



- 
- Provides network connectivity between virtual machines and the physical network.
  - Used for virtual machines that need access to the physical network

# Standard Switch Architecture

---





# Standard Switch Architecture...



- 
- Refers to the traditional design and structure of a network switch. The architecture typically consists of the following components:
  - Input/Output (I/O) interfaces
  - Switch Fabric
  - Processor
  - Memory
  - Power supply
  - Operating system
  - Management interface



# Standard Switch Architecture...



- 
- **Input/Output (I/O) interfaces:** The ports on a switch where data enters and exits the switch.
  - **Switch Fabric:** The internal component of a switch responsible for forwarding and switching packets between the I/O interfaces.
  - **Processor:** The component of a switch responsible for managing the switch and its configuration, as well as performing packet forwarding decisions.

# Standard Switch Architecture...



- 
- **Memory:** Used to store the switch's configuration and forwarding information.
  - **Power supply:** Provides power to the switch components.
  - **Operating system:** The software that runs on the switch



# Standard Switch Architecture...



- 
- **Management interface:** The interface used to configure and manage the switch, such as a command-line interface (CLI) or web-based graphical user interface (GUI).



# Central Aspects of Network Security and Compliance

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# Central Aspects of Network Security and Compliance

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1. Network Policies
2. Security
3. Traffic shaping
4. NIC teaming
5. Failover



# Central Aspects of Network Security and Compliance



- 
- **Network policies:** A set of rules and procedures that govern the use of the network and help ensure that data and devices are protected.
  - **Security:** Measures such as firewalls, intrusion detection and prevention systems, encryption, and access controls to prevent unauthorized access and protect against security threats.
  - **Traffic shaping:** Techniques used to manage and control the flow of network traffic to ensure that critical applications receive sufficient bandwidth and to prevent network congestion.



# Central Aspects of Network Security and Compliance



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- **NIC Teaming:** The process of combining multiple network interfaces into a single logical interface to provide increased bandwidth, failover protection, and load balancing.
  - **Failover:** A backup solution that provides automatic failover to an alternate system or device in the event of a failure or outage.

# Overview of Virtual Storage

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# Overview of Virtual Storage



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- Refers to the creation of a virtual representation of storage devices
  - a software layer acts as an intermediary between the operating system and the physical storage
  - enables the creation of multiple virtual storage devices from a single physical storage resource
  - Provides improved resource utilization, enhanced data protection, and simplified data management.



# Overview of Virtual Storage



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- **Improved resource utilization:** Virtual storage enables the efficient use of storage resources by pooling physical storage and allocating it to virtual storage devices as needed.
  - **Enhanced data protection:** Virtual storage provides features such as data snapshots, replication, and backups that help protect data and ensure its availability.

# Overview of Virtual Storage



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- Simplified data management: Virtual storage abstracts the physical storage, making it easier to manage, provision, and allocate storage resources. This reduces the time and effort required for tasks such as adding or removing storage, or resizing storage devices.
  - Increased scalability: Virtual storage makes it easier to scale storage resources as needed, allowing for the seamless addition of storage capacity as required.

# Overview of Virtual Storage



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- **Flexibility:** Virtual storage enables the creation of multiple virtual storage devices, each with its own characteristics, such as size, performance, and availability, from a single physical storage resource.
  - **Improved performance:** Virtual storage can improve the performance of storage-intensive applications by providing features such as caching, data compression, and de-duplication.



# Overview of Virtual Storage



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- Improved disaster recovery: Virtual storage makes it easier to create and manage disaster recovery solutions, as virtual storage devices can be quickly moved to alternate locations or stored in the cloud for easy access in the event of a disaster.
  - **Simplified data management:** Virtual storage abstracts the physical storage, making it easier to manage, provision, and allocate storage resources. This reduces the time and effort required for tasks such as adding or removing storage, or resizing storage devices.

# Overview of Virtual Storage

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# Overview of Virtual Storage



- **Relational databases:** These store data in tables with rows and columns and use structured query language (SQL) to access and manipulate data. Examples include MySQL, Oracle, and Microsoft SQL Server.
- **NoSQL databases:** These databases store data in a non-relational format, such as key-value pairs, document-based, or graph-based. NoSQL databases are often used for handling large amounts of unstructured or semi-structured data. Examples include MongoDB, Cassandra, and CouchDB.



# Overview of Virtual Storage



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- **Object-oriented databases:** These store data as objects, which are instances of classes, rather than as tables with rows and columns. Examples include MongoDB and CouchDB.
  - **Time-series databases:** These databases are optimized for storing and querying time-stamped data. Examples include InfluxDB and OpenTSDB.

# Overview of Virtual Storage



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- **Columnar databases:** These databases store data in columns rather than rows, allowing for faster data retrieval for certain types of queries. Examples include Apache Cassandra and Hbase.
  - **Key-value stores:** These databases store data as a collection of key-value pairs, where each key is unique and is associated with a value. Examples include Redis and Riak.

# Overview of Virtual Storage



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- **File-based databases:** These databases store data as files on a file system. Examples include JSON or XML files.



# Full Virtualization vs Para Virtualization

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# Full Virtualization vs Para Virtualization



## Full Virtualization

- In Full Virtualization, the Guest OS in a VM is completely decoupled from the underlying hardware and Virtualization layer
- In this technique, the unmodified Guest OS is installed.

## Para Virtualization

- In Para Virtualization, the Guest OS in a VM is partially isolated from the underlying hardware and Virtualization layer
- In this technique, the modified Guest OS is installed.



# Full Virtualization vs Para Virtualization



## Full Virtualization

- It allows the Guest OS to execute independently.
- The Guest OS is unaware of the virtualization
- In this technique, Guest OS issues hardware calls to access hardware

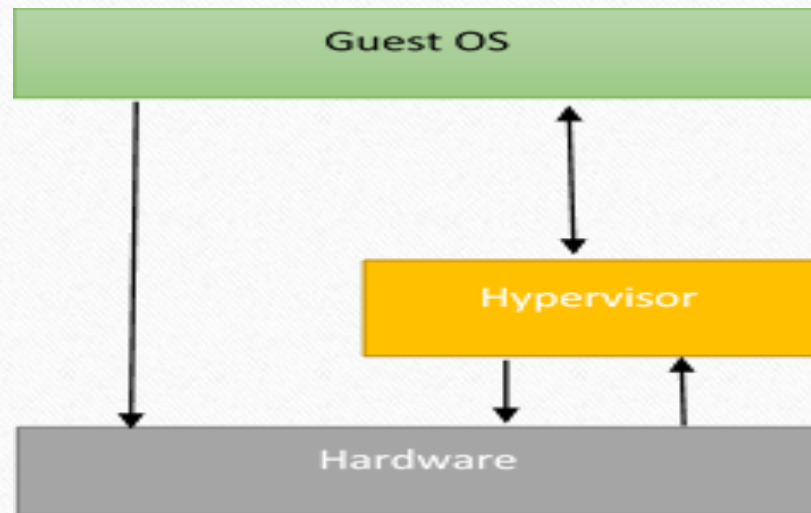
## Para Virtualization

- It allows the guest OS to interact with the hypervisor
- The Guest OS is aware that it is being virtualized
- In this technique, Guest OS issues hyper calls to hypervisor to access hardware

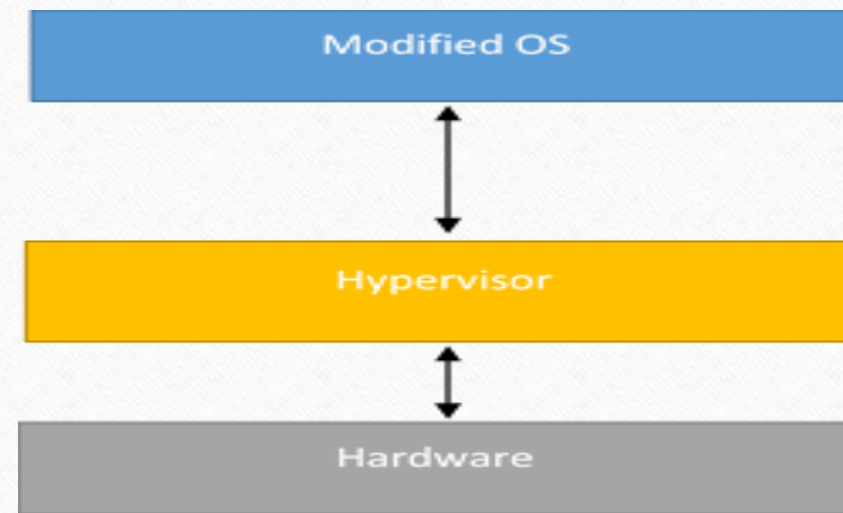


# Full Virtualization vs Para Virtualization

## Full Virtualization



## Para Virtualization



# Full Virtualization vs Para Virtualization



## Full Virtualization

- In Full Virtualization, performance is low.
- Full virtualization is less secure
- It is more portable and compatible

## Para Virtualization

- In Para Virtualization, performance is comparatively high.
- Para virtualization is more secure
- It is less portable and compatible



# Full Virtualization

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# Full Virtualization

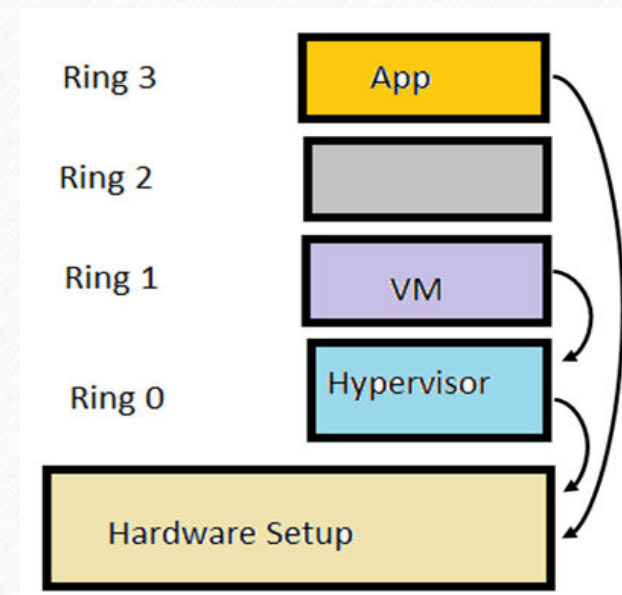


- Full Virtualization is a virtualization technique in which VMs or Virtual Servers are created and run on a single physical server.
- Each VM has its own OS and runs independently
- The software layer providing the virtualization is called as Hypervisor or Virtual Machine Monitor (VMM).
- The hypervisor is inserted b/w the hardware and VMs

# Full Virtualization



- The guest OS is completely decoupled from the underlying hardware
- Each guest OS is unmodified and unaware that it is being virtualized
- The application/user level instructions are directly executed by underlying hardware
- The OS level requests are translated by Hypervisor at run time



# Full Virtualization



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- Examples of full virtualization are VMware ESX<sub>i</sub>, Virtual Box and Microsoft Virtual Server.



# Disadvantages



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- The performance of full virtualization may not be ideal as the Binary translation of OS requests takes place at run time
  - Any physical server fault or failure can effect all the VMs

# Containers



Virtual Systems and Services



# Container



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- A Container is a software unit in which Application code, its libraries and dependencies are packaged together
  - Unlike Virtual machine, it doesn't include Operating System
  - It is a small, fast and light weight unit
  - It sits on top of physical server and virtualizes the OS only.

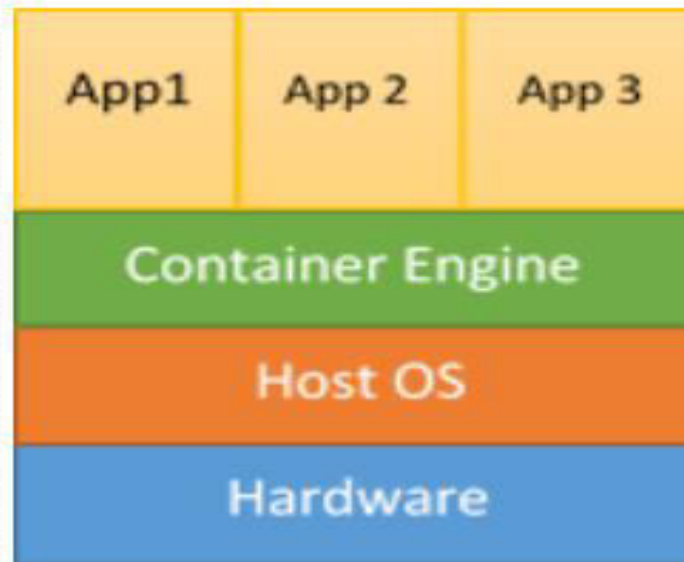


# Container



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- It accesses the operating system kernel via container engine
  - It uses the physical resources of hosting machine through container engine
  - It is portable unit because each container image includes all the dependencies to execute
  - Multiple independent containers can run on a single OS
  - Cloud applications are built on containers

# Container



# Container Software



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- Docker
  - Microsoft Azure
  - Amazon ECS
  - Google Cloud Platform



# Merits and Demerits of Container

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# Merits of Container



- **Containers are most light weight**
  - Their image include only the application related data (in MB instead of GB)
- **Less overhead**
  - Requires less system resources to deploy, run and manage
- **Boot Fast:** takes less time in boot up due to less overhead
- **Operational Efficiency**
  - Operationally efficient than VM



# Merits of Container



- **Portability**

- Container encapsulates all dependencies, own runtime environment; runs on different platforms. It is write once and runs anywhere

- **Isolation**

- Containers run in isolation

- **Security**

- Security improve due to isolation, each container runs in self-contained environment



# Demerits of Container



- **Need Dependencies**

- Packaging workload with supporting dependencies is one of the limitations.

- **Issue with Stateful Applications**

- It is difficult to containerize stateful applications. They need parallel system to run like database access.

- **Security**

- Since application layer and host OS is shared across the containers, it opens the door to security breaches across containers

# Virtualization vs Containerization

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# Virtualization vs Containerization



- Virtualization makes use of Virtual Machines to convert a traditional hardware into a virtual environment
- Virtualization allows us to run multiple virtual servers on top of a single physical machine
- Containerization makes use of containers to convert a traditional hardware into a virtual environment
- Containerization allows us to run multiple applications on top of a single physical machine



# Virtualization vs Containerization



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- Virtualization enables us to efficiently utilize the computer's hardware resources
  - Virtualization uses Virtualized software to create an abstract layer over hardware
  - Containerization enables us to efficiently utilize the computer's host operating system
  - Containerization uses Container Engine to create an abstract layer over hardware

# Virtualization vs Containerization



- Virtualization allows developers to create and deploy VMs faster & more securely
- In Virtualization, an OS is a part of VM
- Use of Virtual Servers or VMs reduces the hardware cost
- Containerization allows developers to create and deploy applications faster & more securely
- In containerization, an OS is not a part of container
- Use of Containers reduces the software cost

# Virtualization vs Containerization



- 
- VMs take more time to boot up
  - Containers take less time to boot up