



Virtualization Fundamentals

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VOD-3486



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CCIE Routing & Switching



- + An understanding of basic computer architecture

Course Prerequisites

Course Objectives

- + To introduce you to the concepts of virtualization as it applies to virtual machine technology
- + To explain the benefits and challenges of machine virtualization
- + To expose you to common terms related to virtualization of machines
- + Demonstration of virtualization





Introduction To Virtualization

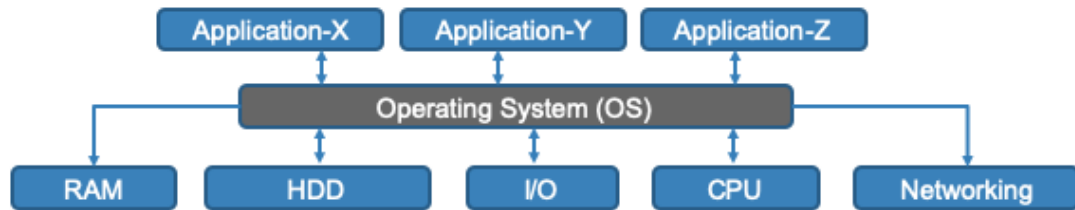
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Topic Overview

- + The Typical Compute Architecture
- + Challenges & Problems Defined
- + What Is Virtualization
- + Benefits Of Virtualization
- + Three Common Virtual Machine Terms

The Typical Compute Architecture

- + Basic computing architecture

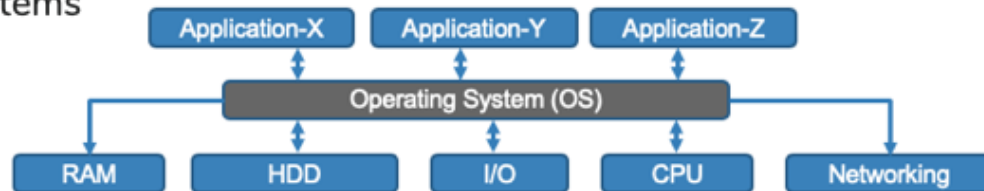


- + Everything is tied together

- + Applications written for certain operating systems
- + Operating systems pre-loaded onto hardware and have exclusive access to that hardware

Challenges With The Norm

- + How do you access two different apps that utilize two different OS's?
 - + Divide HDD into multiple partitions
 - + Purchase separate hardware systems with different operating systems



- + How do you provide groups of users access to a common app but keep them separated?

Divide HDD into multiple partitions

Only one app runs at a time

Apps can't communicate with each other

How do you provide groups of users access to a common app but keep them separated?

-----Multiple, physical machines running the same app

-----Different access credentials

-----Network security implemented with ACLs & firewalls

The Problem Defined

- + Networks prior to virtualization
 - + Dedicated physical devices
 - + Geographically dispersed systems
- + Resource challenges
 - + Application downtime as hardware necessitated upgrades (memory, faster graphics cards, etc)
 - + Hardware underutilized (CPU and memory goes unused)
 - + Hardware quickly became obsolete and recycled
- + What challenges were presented?

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Challenges with monitoring geographically disparate resources

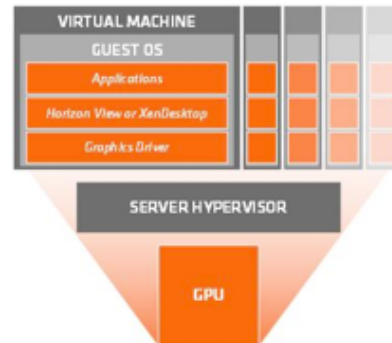
Delays in procuring hardware

Challenges in finding physical locations to house equipment

Challenges in determining power and HVAC budgets

What Is Virtualization?

- + Combining multiple machines into one
- + Sharing of hardware resources via a Hypervisor
- + Maintaining logical separation via virtual switches
- + Terminology
 - + Host OS
 - + Guest OS



Benefits Of Virtualization

- + Reduced hardware costs
- + Efficient utilization of hardware
- + Elasticity
- + Management centralization
- + Redundancy and backups

Virtual Machine Terminology

- + **Snapshot**
 - + A copy of the virtual machine's disk file at a given point in time
 - + Used to restore a VM to a particular point in time when a failure or system error occurs
- + **Cluster**
 - + A group of hosts whose resources are shared
 - + VM's on a failed host can be dynamically restarted on another host within a cluster
- + **Virtual Appliance**
 - + A pre-packaged VM with an application already installed on it



Thanks for Watching!



An Overview Of Hypervisors

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Topic Overview

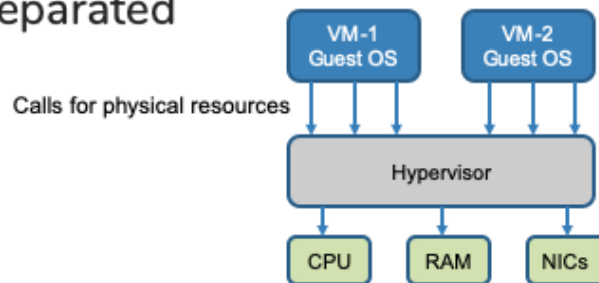
- + Introduction To Hypervisors
- + Type-1 Hypervisors
- + Type-2 Hypervisors
- + Examples Of Each

Introduction To Hypervisors

- + In a non-virtualized environment, an Operating System has exclusive, dedicated access to physical hardware
- + In a virtualized environment there can be multiple OS's on a single physical server
- + A Hypervisor sits between the Guest OS and the physical hardware which:
 - + Has access to the physical hardware of the Host
 - + Provides access to a set of emulated hardware to each VM
 - + Does this in a way that is transparent to the Guest OS

Introduction To Hypervisors

- + A process that separates a computer's operating system and applications from the underlying physical hardware
- + Usually implemented as software
- + Maximizes effective use of computing resources such as memory, network bandwidth and CPU cycles
- + Keeps virtual machines separated



Each virtual machine only “sees” the amount of CPU, RAM and HDD space that has been allocated to that VM. The Hypervisor coordinates the sharing of requests for the physical CPU among all the VMs.

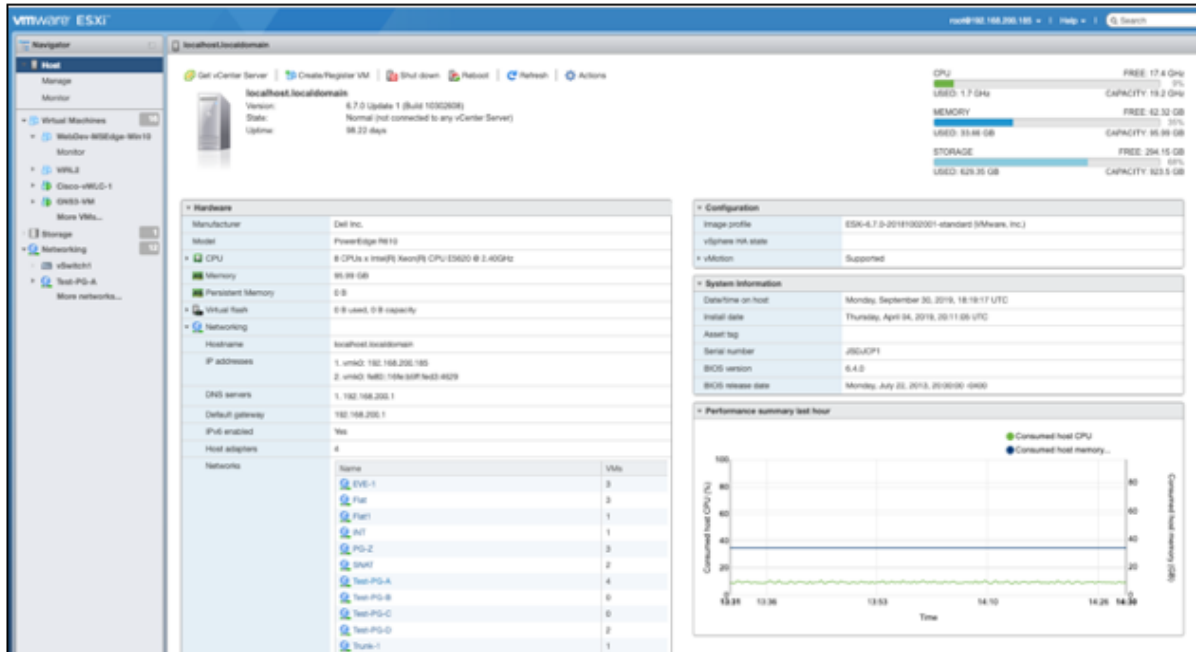
Type-1 Hypervisors

- + Also called “Native” or “Bare Metal” Hypervisors
- + Run directly on the host’s hardware
- + Provide a direct interface between VM’s and hardware resources
- + Examples:
 - + Citrix Xen
 - + Oracle VM Server for SPARC
 - + Oracle VM Server for x86
 - + Microsoft’s Hyper-V
 - + VMwares ESX/ESXi
 - + Kernel-based Virtual Machine (KVM) ...built into Linux



Xen is an open-source hypervisor.

Vmware ESXi

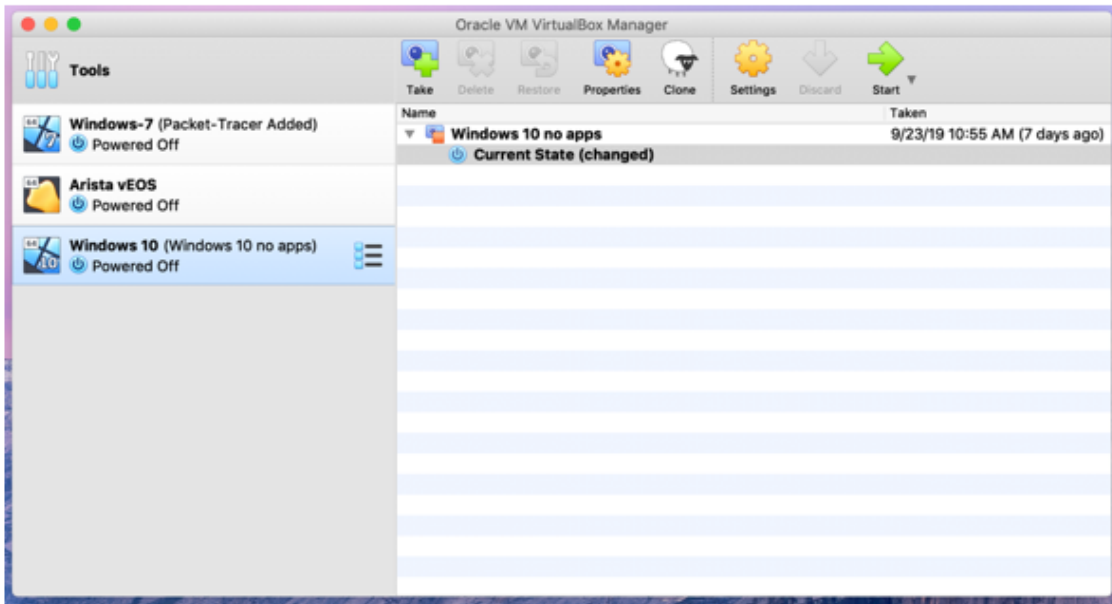


- VMware's ESXi is an example of a Type-1 Hypervisor

Type-2 Hypervisors

- + Also called “Hosted Hypervisor”
- + Run on top of conventional OS as another application
- + Separates the Guest OS from the Host OS
- + Examples:
 - + VMware Workstation
 - + VMware Player
 - + VirtualBox
 - + VMware Fusion for Mac

Oracle's VirtualBox



Virtual box by Oracle is software that you would install on top of your existing OS (such as Windows or Microsoft OSX) and from within VirtualBox you can create virtual machines.

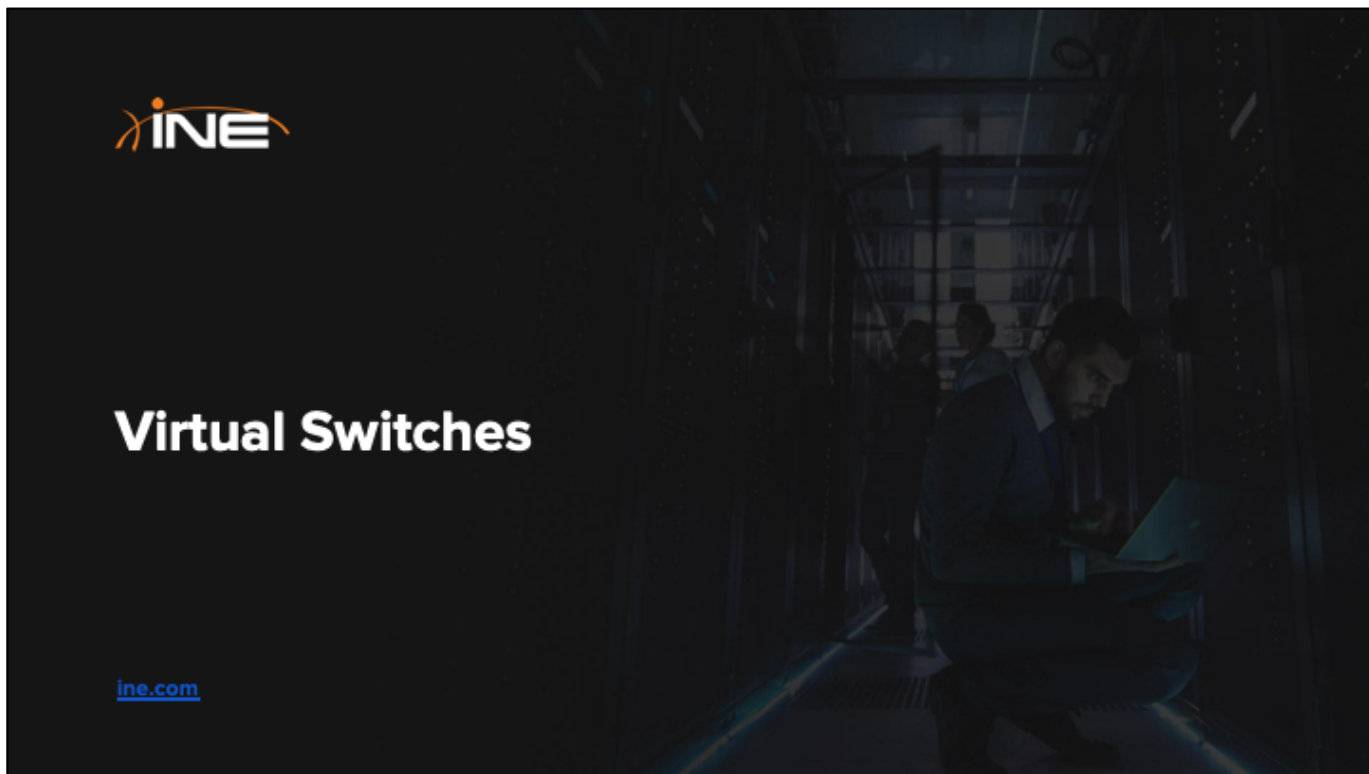


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Virtual Switches

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Topic Overview

- + Virtual Machine Segmentation
- + Virtual Switch Implementation

Virtual Machine Segmentation

- + Connections between VMs governed by virtual switches
- + Virtual switches also provide external network connectivity to VMs
- + Virtual switches contain Mac tables and some can perform security features
- + Examples of virtual switches
 - + Microsoft Hyper-V
 - + VMware's ESXi vSwitch

Virtual switches are a concept typically implemented with Type-1 Hypervisors. A topology with multiple VMs that utilize a Type-2 Hypervisor (such as VirtualBox) can still have VMs interconnected internally...but a virtual switch would not be used for that purpose. Instead you would create point-to-point network connections between VMs by modifying their vnic settings. See this link for an example of this:

<https://www.brianlinkletter.com/how-to-use-virtualbox-to-emulate-a-network/>

Virtual Switch Implementation

- + NICs in a VM environment consist of:
 - + Virtual nics (vnic)
 - + Physical nics of the host machine
- + Quantity of vnics on a VM is not limited like physical devices
- + Connections between virtual switch and vnics can be placed into VLANs
- + Typically a hypervisor will have one, default virtual switch, and others can be created on-demand

Each virtual machine Guest OS will typically tell you what the maximum quantity of vnics that are supported.

VMware vSwitch

VMware vSwitch configuration interface showing details, policies, and topology.

vSwitch1
Type: Standard vSwitch
Port groups: 4
Uplinks: 1

vSwitch Details

MTU	1500
Ports	4096 (4081 available)
Link discovery	Listen / Cisco discovery protocol (CDP)
Attached VMs	8 (1 active)
Beacon interval	1

NIC teaming policy

Notify switches	Yes
Policy	Route based on originating port ID
Reverse policy	Yes
Fallback	Yes

Security policy

Allow promiscuous mode	No
Allow forged transmits	Yes
Allow MAC changes	Yes

Shaping policy

Enabled	No
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vSwitch topology

- EVE-1**
VLAN ID: 0
Virtual Machines (2):
 - CSR-1
 - IOS4-2
- Trunk-1**
VLAN ID: 4095
Virtual Machines (1):
 - CSR-1
- Test-PG-B**
VLAN ID: 3
- Test-PG-A**
VLAN ID: 2
Virtual Machines (4):
 - Ubuntu-Desktop-2
 - EVE-NS_Community_Edition-2
 - Cisco-vWLC-1
MAC Address 08:50:56:80:38:c8
 - APIC-EM

Physical adapters

- vmsw1



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Virtual Machine Resource Considerations

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Topic Overview

- + Virtual Machine Resources
- + Virtual Machine Considerations
- + Where Is Your VM?
- + VM Location Considerations

Virtual Machine Resources

- + Virtual machines consume real resources on the host
- + How many vCPUs are needed?
 - + How many CPU Cores?
 - + How many Sockets?
 - + How many Cores per Socket?
- + How much memory (RAM) is needed?
- + How much hard disk space will be required?

Virtual Machine Considerations

- + Which hypervisors support the VM?
- + What resources are required by the VM?
- + Are enough resources still available on the host machine?
- + Does the host's physical nic have sufficient bandwidth for all VM's?

Where Is Your VM?

- + Hosts running hypervisors can be located in one-of-two places:
 - + On-premises
 - + Cloud-Based
 - + Amazon AWS
 - + Microsoft Azure



Microsoft Azure

VM Location Considerations

- + On-premises VM considerations
 - + No internet connectivity required to reach your VMs
 - + You are fully responsible for all hardware and software
 - + Fixed cost
- + Cloud-based VM considerations
 - + Internet connectivity required
 - + Host maintenance transferred to cloud provider
 - + Incremental costs based on usage/uptime



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Virtualization Networking & Management Considerations

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Topic Overview

- + L2/L3 Addressing
Considerations With VM's
- + Networking Usage
Considerations
- + VM Monitoring Considerations

L2/L3 Addressing Considerations With Virtualization

- + Each Guest OS will require an IP address if networking is required
- + L2/L3 address considerations
 - + Static addresses for VMs?
 - + What happens when the host fails and that VM is replicated on another Host?
 - + If DHCP is required, where will DHCP Server be located?
 - + MAC address allocation considerations

When allocating static IP addresses to VMs ensure you don't accidentally overlap IP addresses.

-

If a host fails and High Availability has been configured in a Host Cluster, will the static address you configured on the VM (on the failed host) be appropriate for the location of the new Host?

-

DHCP can be an option for VMs. In this case, the DHCP Server could be located on a real, physical network segment connected to the Host, or a VM could serve as a DHCP Server for other VMs.

-

VMs can be configured with static, configured MAC addresses or addresses dynamically derived by the Host OS. If a VM has a pre-configured MAC will there be an issue if the host fails, the VM automatically spins-up on another host, but features like DHCP Snooping or Port Security are configured on your physical switches?

-

Networking Usage Considerations

- + Network Usage
 - + All VM's share the physical bandwidth of uplink NIC's on the Host
 - + Oversubscribing these uplinks will cause poor network performance on busy VM's
- + VM Segmentation
 - + VM's on separate IP subnets also need to be separated at Layer-2
 - + VLANs are utilized for this
 - + Physical host uplinks will perform 802.1q trunking
 - + Ensure VLAN trunking configured appropriately on physical switch connected to the host

Remember that all VMs ultimately share the bandwidth of the physical NIC uplinks on the Host. While a single VM might believe it has access to a 100Mbps FastEthernet NIC, that VM might be sharing the physical bandwidth with dozens of other VMs.

VM Monitoring Considerations

- + Virtual Machine Monitoring
 - + Guest Operating Systems only see what the hypervisor wants them to see
 - + Monitoring applications written for Guest OS's don't see the full picture
 - + Network, CPU or memory problems may manifest within the Guest OS, but their root cause may not be visible
 - + Best solution is to utilize a blended approach of network monitoring software that resides on the hypervisor as well as Guest OS's

Monitoring VM Network Traffic

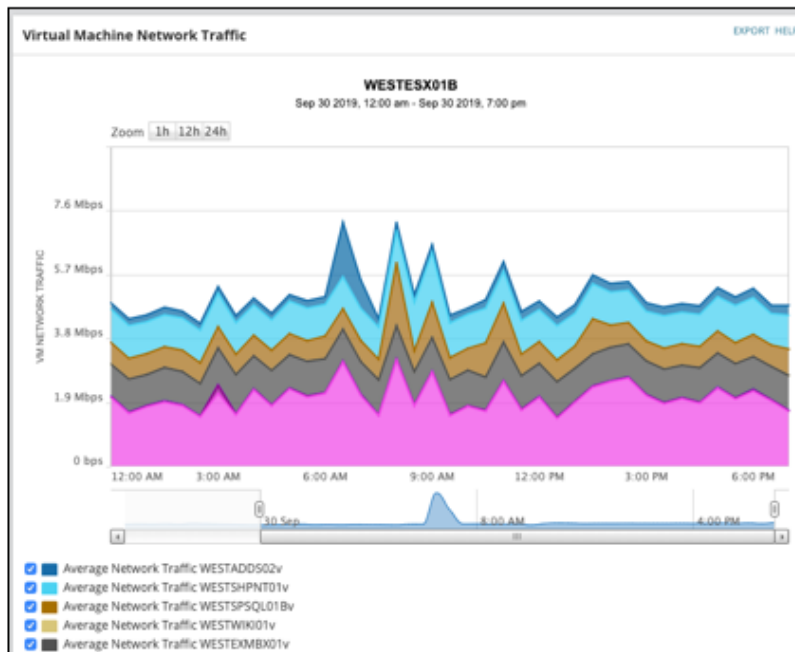


Image courtesy of <https://www.solarwinds.com/virtualization-manager>

- The image shown is a screenshot of a product from Solar Winds called “Virtualization Manager”



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Virtualization Demonstration

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Topics Overview

- + Creating a virtual machine with a Type-2 Hypervisor
- + Networking two virtual machines together

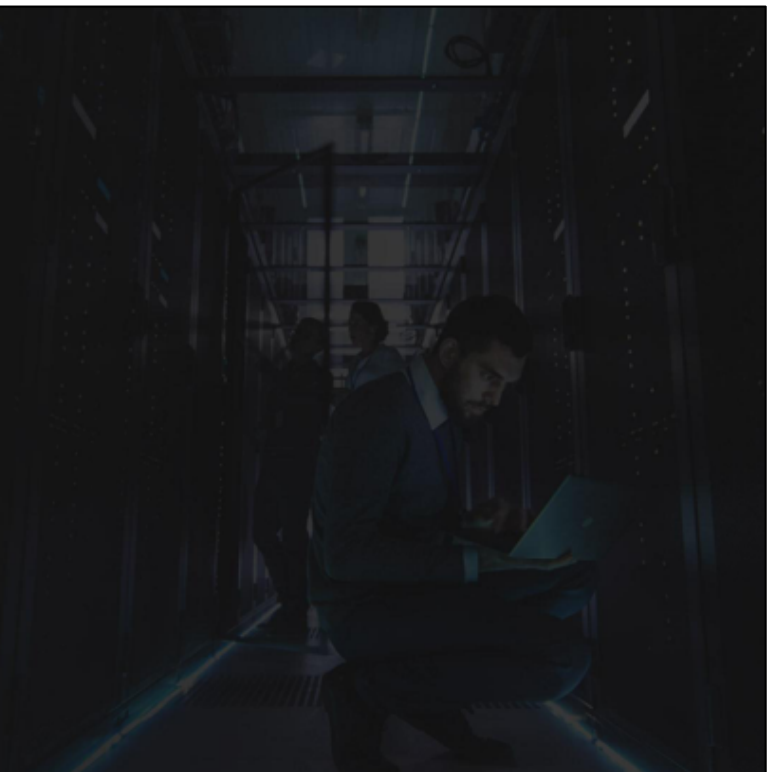


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Course Conclusion

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Topics Covered

- + Introduced virtual machine technology and its benefits
- + Covered the differences between Type-1 and Type-2 Hypervisors
- + Looked at how Virtual Switches could benefit us in a virtualized environment
- + Covered various considerations in creating virtualized environments
- + Performed a demonstration of creating and networking virtual machines

