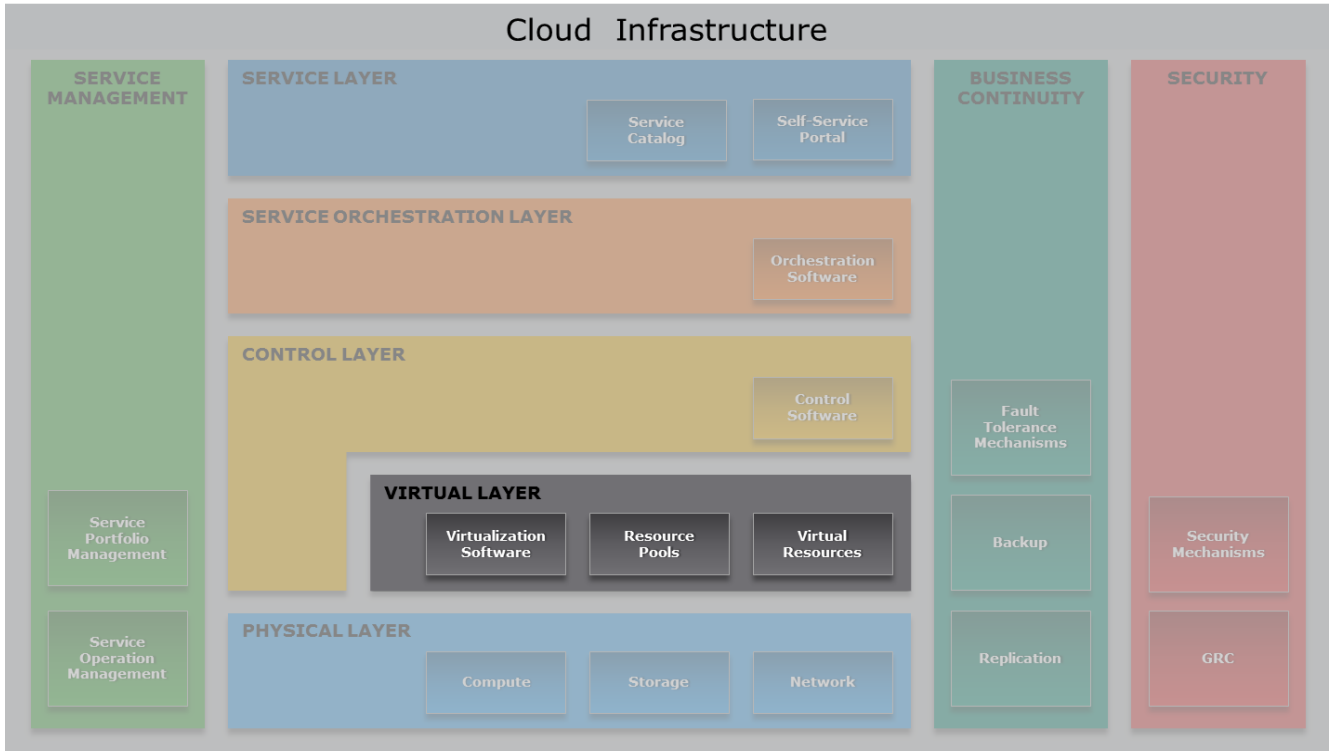
Module: Virtual Layer

Upon completion of this module, you should be able to:

- Describe the virtual layer and virtualization software
- Describe a resource pool and virtual resources

Cloud Computing Reference Model

Virtual Layer



Lesson: Virtual Layer Overview

This lesson covers the following topics:

- Virtual layer
- Virtualization software
- Resource pool
- Virtual resources

Introduction to Virtualization

Virtualization

Refers to the logical abstraction of physical resources, such as compute, network, and storage that enables a single hardware resource to support multiple concurrent instances of systems or multiple hardware resources to support single instance of system.

- Enables a resource to appear larger or smaller than it actually is
- Enables a multitenant environment improving utilization of physical resources

Benefits of Virtualization

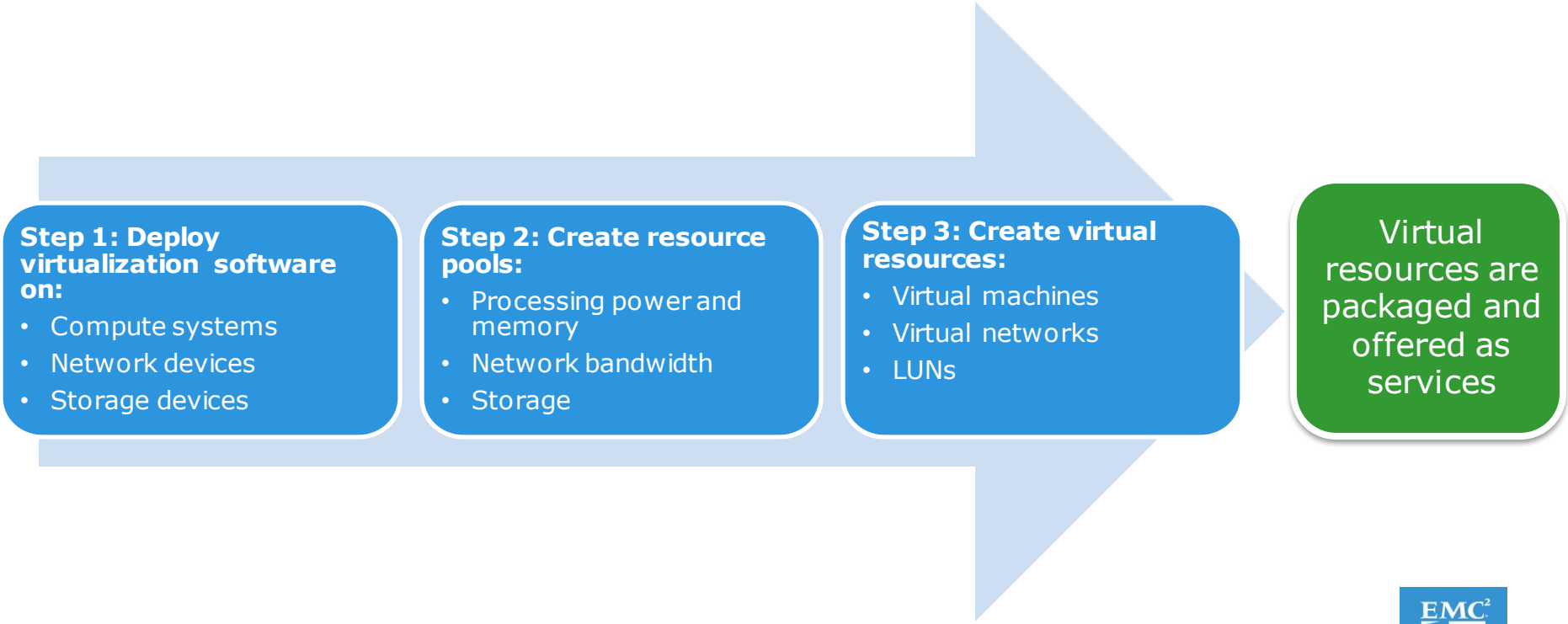
- Optimizes utilization of IT resources
- Reduces cost and management complexity
- Reduces deployment time
- Increases flexibility

Virtual Layer Overview

- Virtualized compute, network, and storage forms the virtual layer
- Enables fulfilling two characteristics of cloud infrastructure
  - Resource pooling
  - Rapid elasticity
- Specifies the entities operating at this layer
  - Virtualization software
  - Resource pools
  - Virtual resources

Virtual Layer

Virtualization Process and Operations



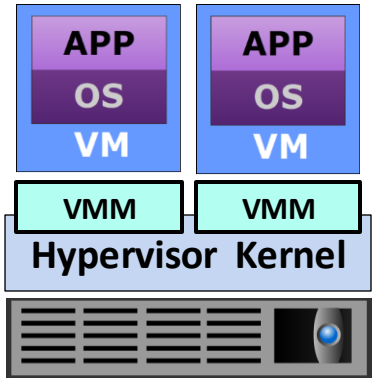
Compute Virtualization Software

Hypervisor

Hypervisor

Software that is installed on a compute system and enables multiple OSs to run concurrently on a physical compute system.

- Hypervisor kernel
  - Provides functionality similar to an OS kernel
  - Designed to run multiple VMs concurrently
- Virtual machine manager (VMM)
  - Abstracts hardware
  - Each VM is assigned a VMM
  - Each VMM gets a share of physical resources



Compute Virtualization Software (Cont'd)

Types of Hypervisor

Bare-metal Hypervisor

- It is an operating system
- Installed on a bare-metal hardware
- Requires certified hardware
- Suitable for enterprise data centers and cloud infrastructure

Hosted Hypervisor

- Installed as an application on an OS
- Relies on OS, running on physical machine for device support
- Suitable for development, testing, and training purposes

Network Virtualization Software

- Abstracts physical network resources to create virtual resources:
  - Virtual LAN/virtual SAN
  - Virtual Switch
- Network virtualization software can be:
  - Built into the operating environment of a network device
  - Installed on an independent compute system
    - Fundamental component for deploying software defined network
  - Hypervisor's capability

Storage Virtualization Software

- Abstracts physical storage resources to create virtual resources:
  - Virtual volumes
  - Virtual disk files
  - Virtual arrays
- Storage virtualization software can be:
  - Built into the operating environment of a storage device
  - Installed on an independent compute system
    - Fundamental component for deploying software defined storage
  - Hypervisor's capability

Lesson Summary

During this lesson the following topics were covered:

- Virtual layer
- Virtualization software
- Resource pool
- Virtual resources

Lesson: Resource Pool

This lesson covers the following topics:

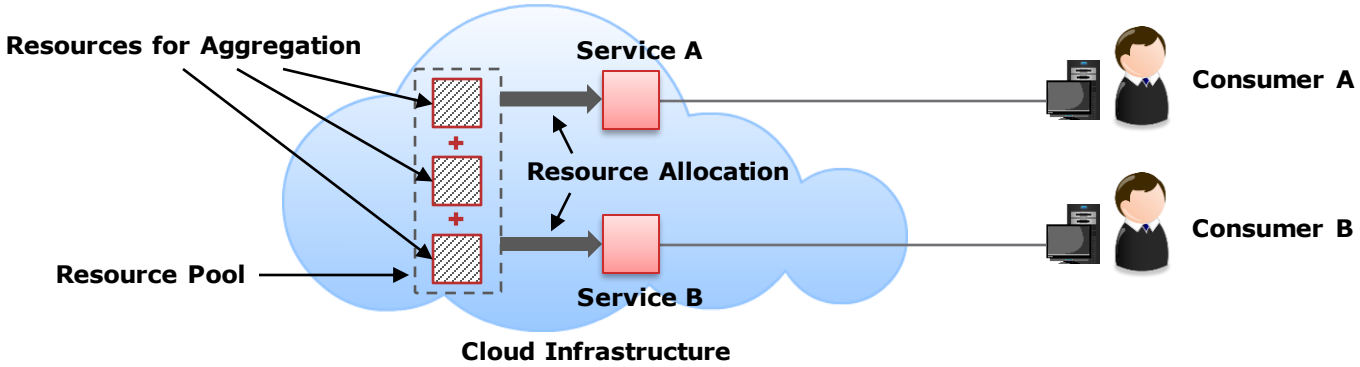
- Resource pool
- Examples of resource pooling
- Identity pool

Introduction to Resource Pool

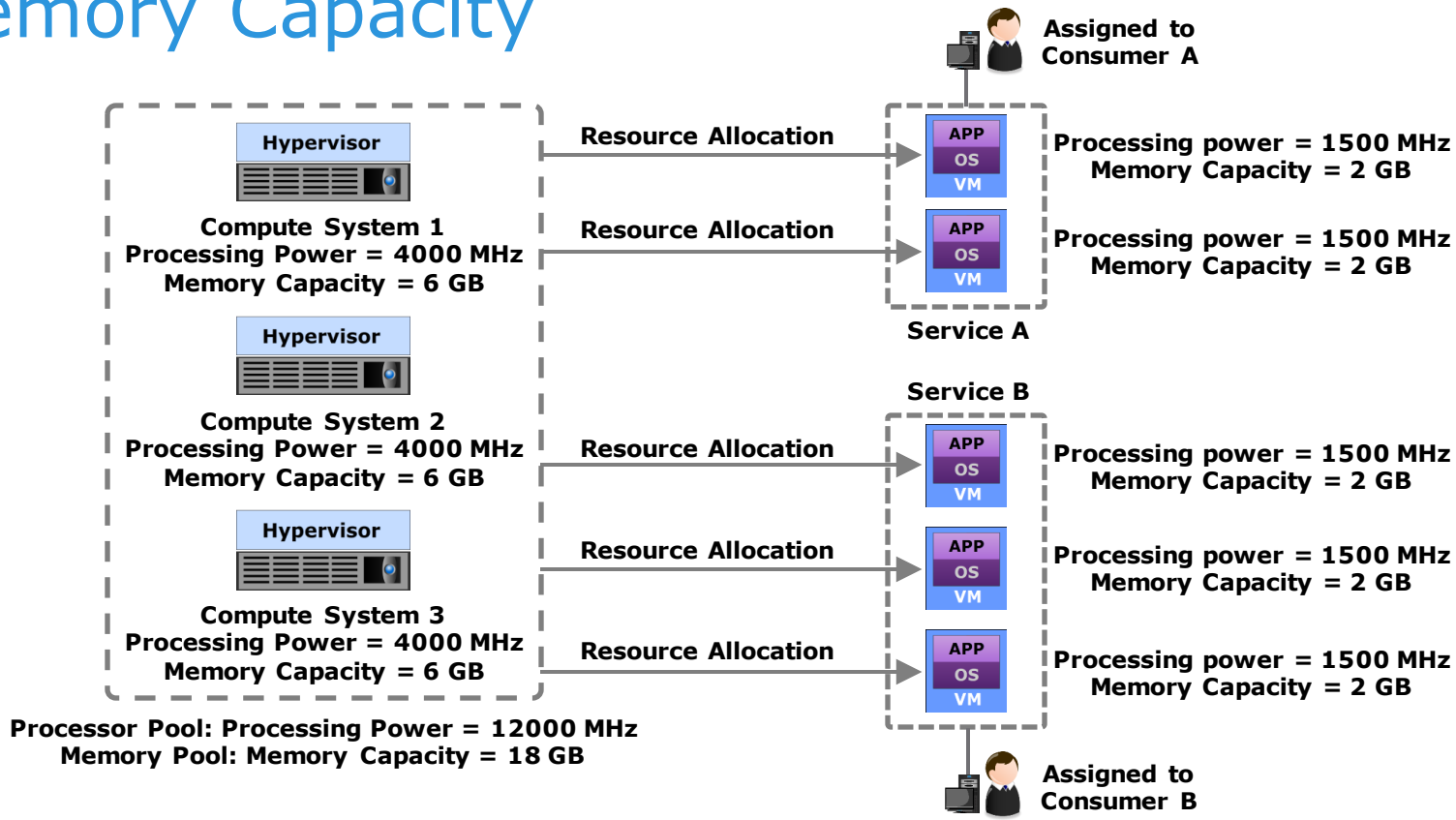
Resource Pool

A logical abstraction of the aggregated computing resources, such as processing power, memory capacity, storage, and network bandwidth that are managed collectively.

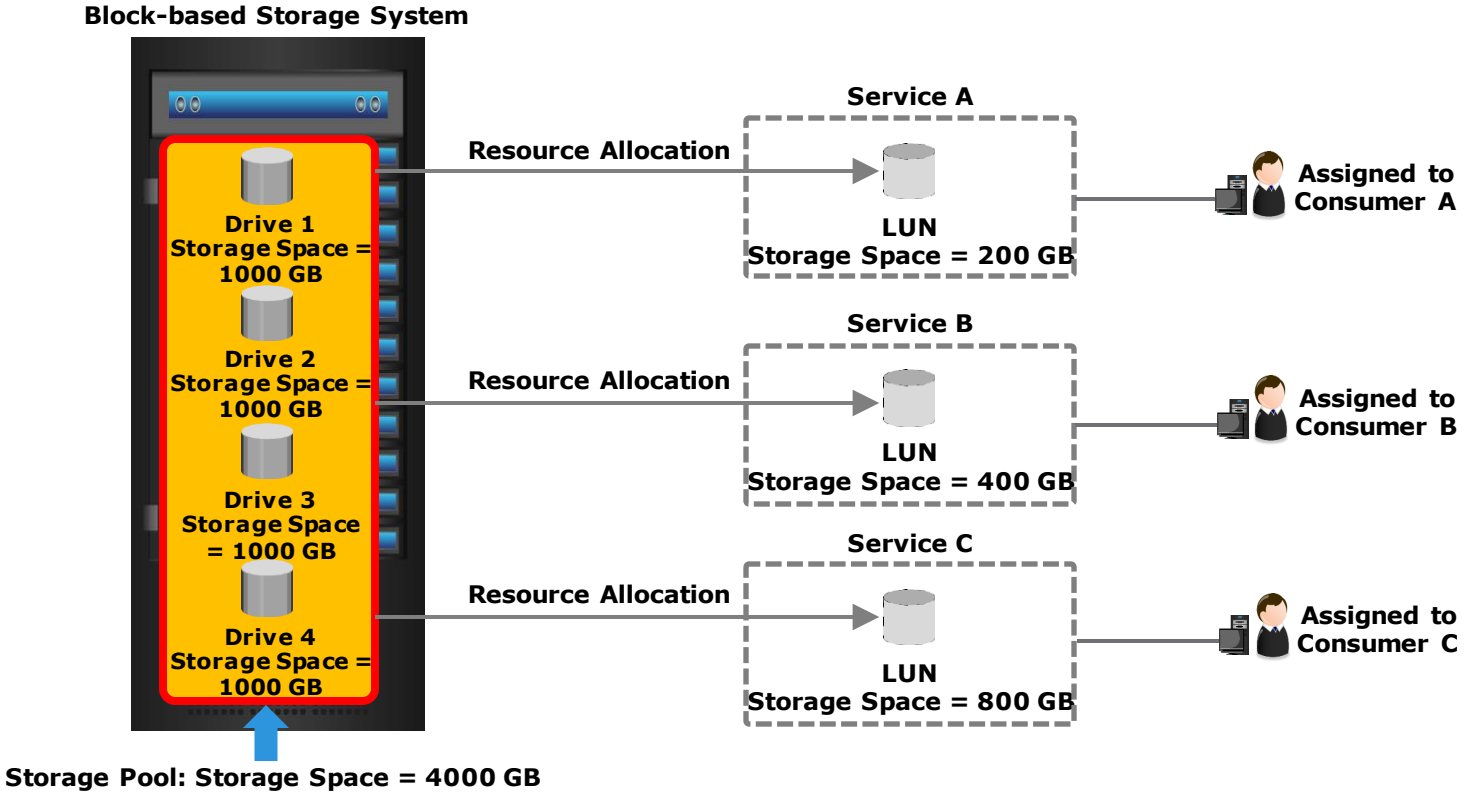
- Cloud services obtain computing resources from resource pools
  - Resources are dynamically allocated as per consumer demand
- Resource pools are sized according to service requirements



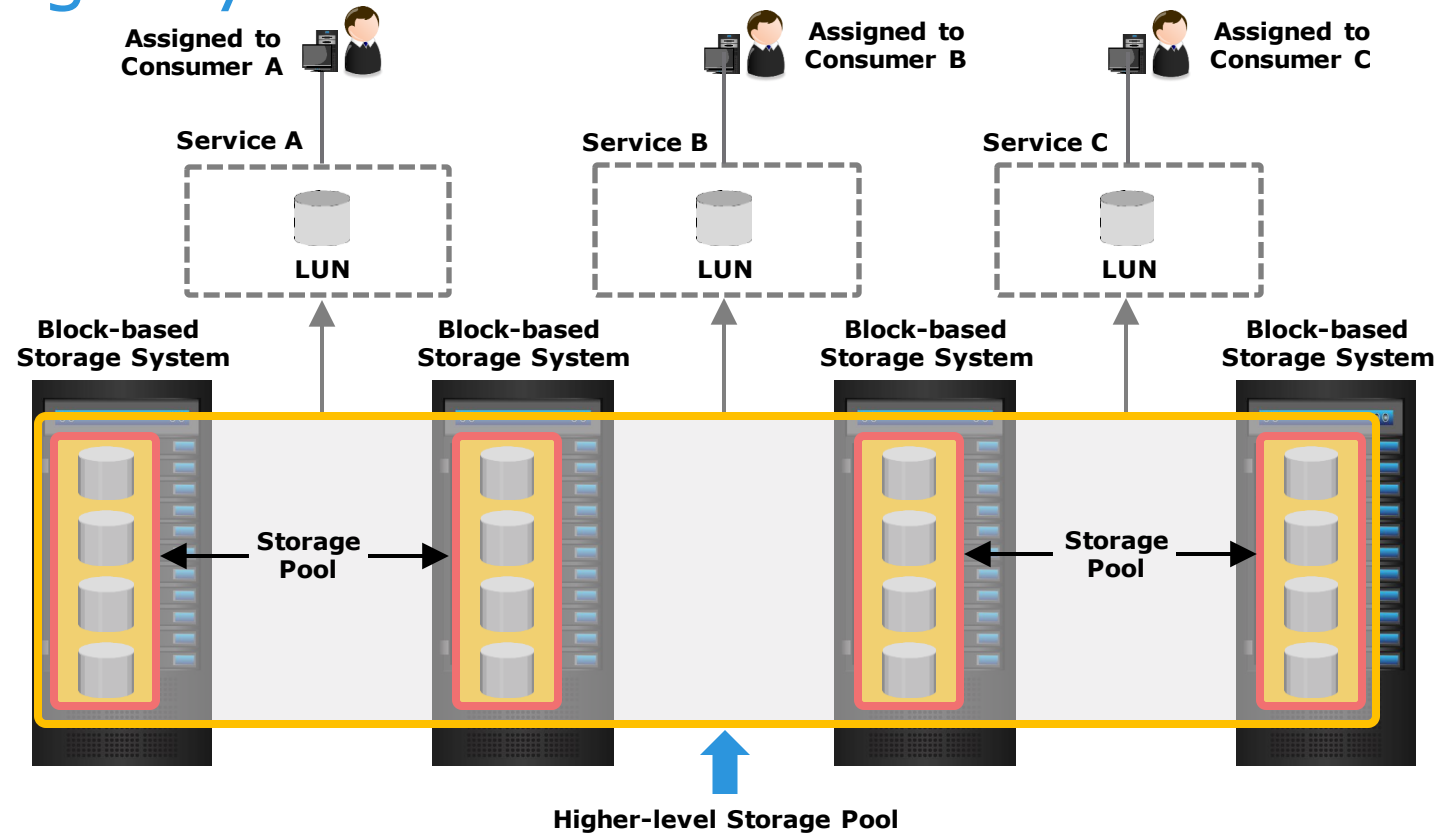
Example: Pooling Processing Power and Memory Capacity



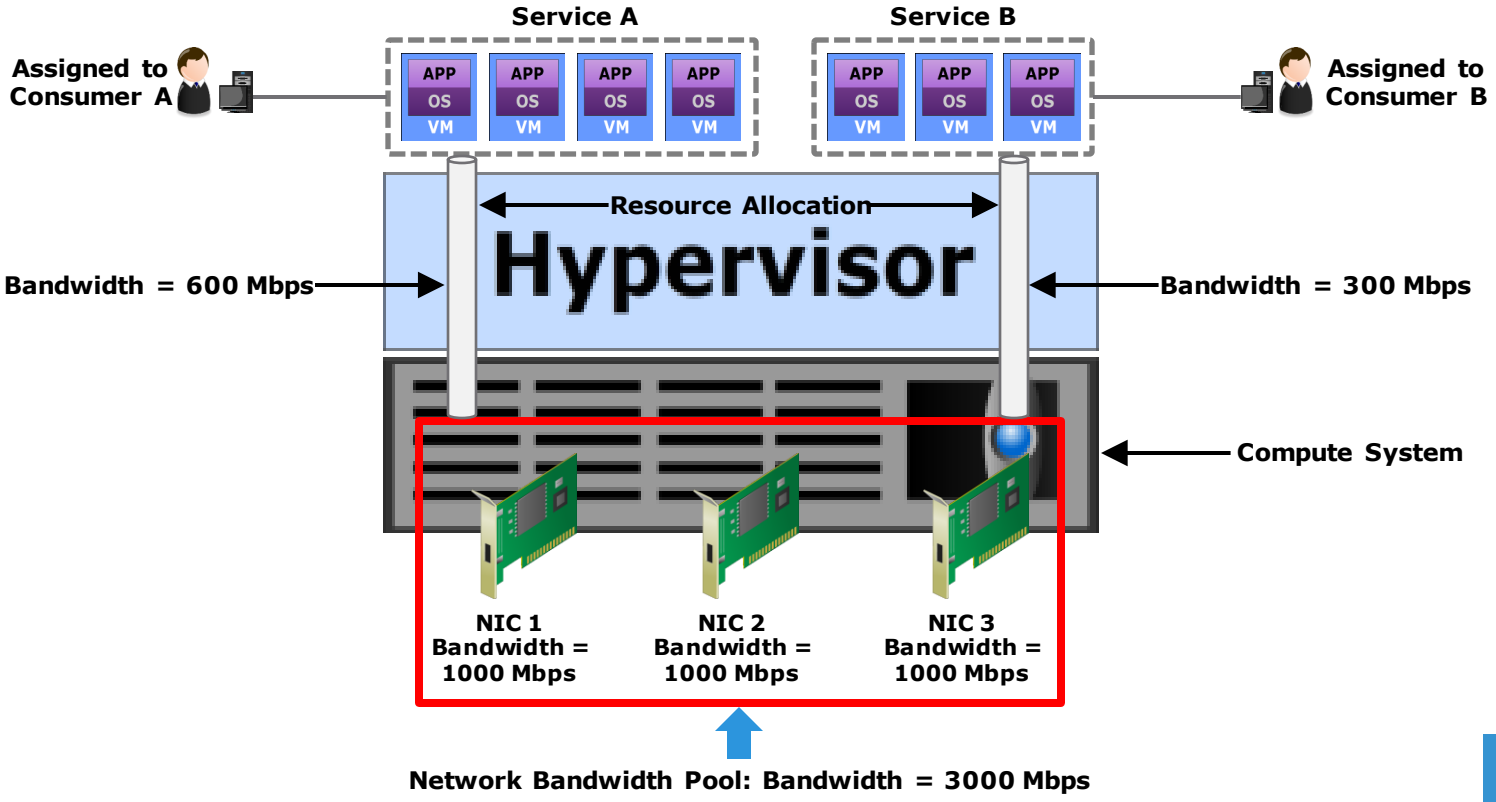
Example: Pooling Storage in a Block-based Storage System



Example: Pooling Storage Across Block-based Storage Systems

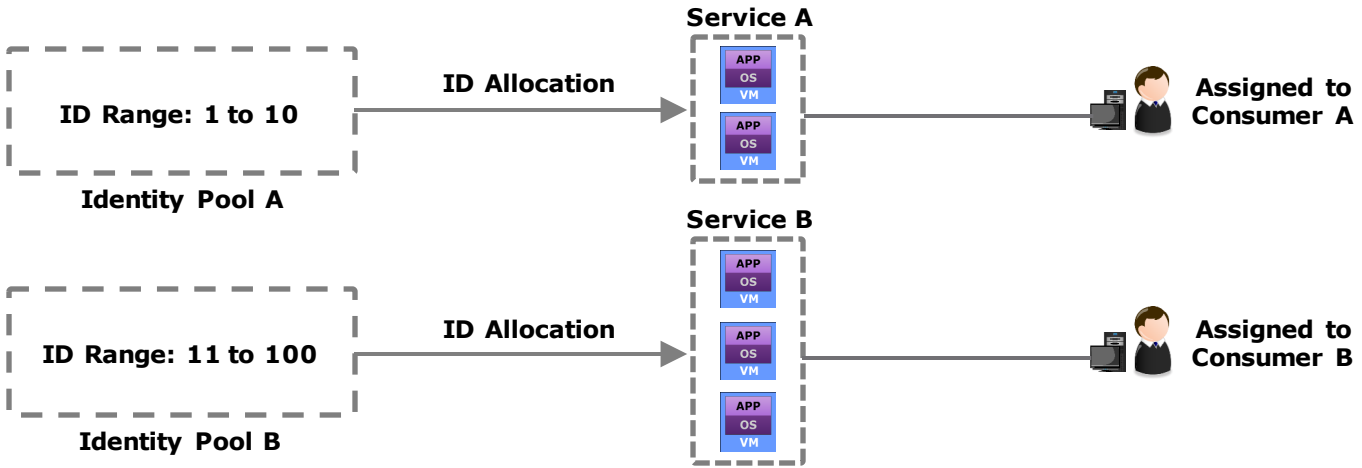


Example: Pooling Network Bandwidth of NICs



Identity Pool

- Specifies a range of network identifiers (IDs) such as virtual network IDs and MAC addresses
  - IDs are allocated from the identity pools to the elements of cloud services
- An identity pool may map to a particular service or to a group of services



Lesson Summary

During this lesson the following topics were covered:

- Resource pool
- Examples of resource pooling
- Identity pool

Lesson: Virtual Resources – I

This lesson covers the following topics:

- Virtual machine (VM) and VM hardware
- VM files and file system to manage VM files
- VM console
- VM template
- Virtual appliance
- VM network and its components

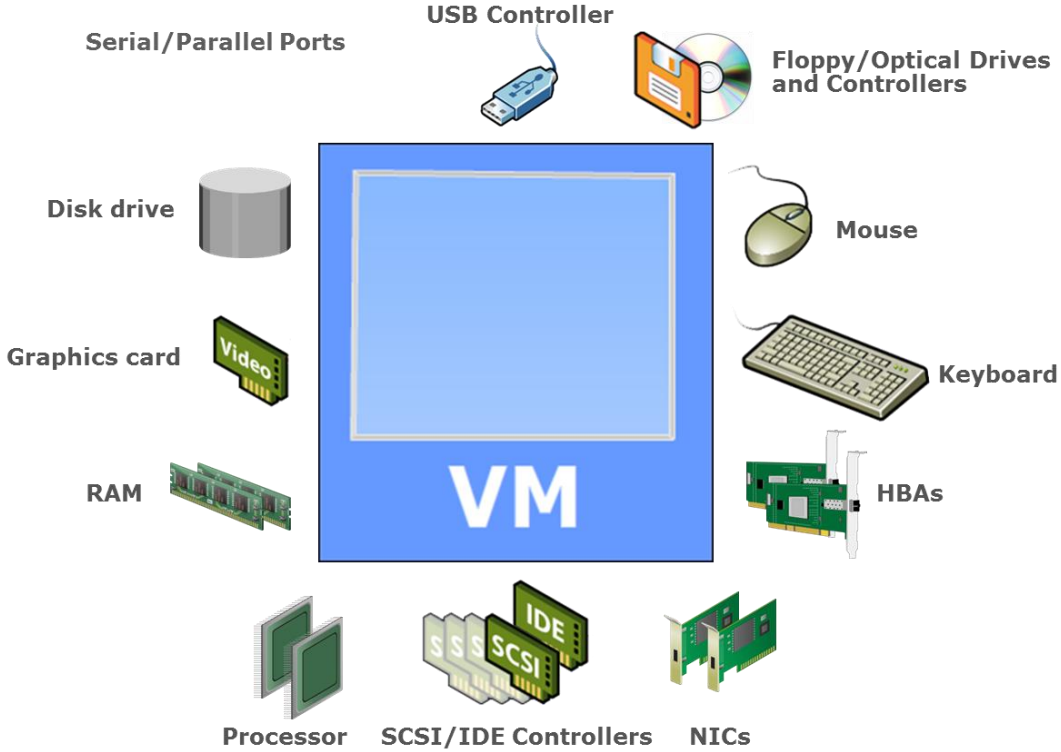
Virtual Machine (VM)

Virtual Machine

A logical compute system that, like a physical compute system, runs an OS and applications.

- Created by a hypervisor installed on a physical compute system
- Comprises virtual hardware, such as virtual processor, memory, storage, and network resources
  - Appears as a physical compute system to the guest OS
  - Hypervisor maps the virtual hardware to the physical hardware
- Provider provisions VMs to consumers for deploying applications
  - VMs on the same compute system or cluster run in isolation

VM Hardware



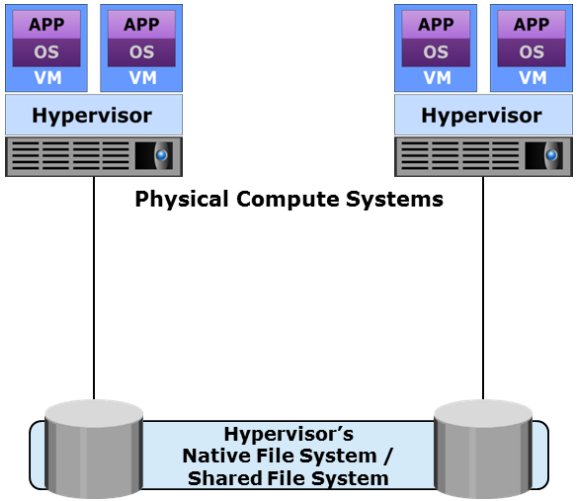
VM Files

- From a hypervisor's perspective, a VM is a discrete set of files such as:

Configuration file	• Stores information, such as VM name, BIOS information, guest OS type, memory size
Virtual disk file	• Stores the contents of the VM's disk drive
Memory state file	• Stores the memory contents of a VM in a suspended state
Snapshot file	• Stores the VM settings and virtual disk of a VM
Log file	• Keeps a log of the VM's activity and is used in troubleshooting

File System to Manage VM Files

- Hypervisor's native file system
  - Clustered file system deployed on local or external storage
  - Enables multiple hypervisors to perform concurrent reads and writes
  - Enables high availability to protect against hypervisor or compute system failure
- Shared file system
  - Enables storing VM files on remote file servers or NAS devices
  - Hypervisors have built-in NFS or CIFS clients



VM Console

- VM console is an interface to view and manage the VMs on a compute system or a cluster
- VM console may be:
  - Installed locally on a compute system
  - Web-based
  - Accessed over a remote desktop connection
- Used to perform activities such as:
  - Installing a guest OS and accessing VM BIOS
  - Powering a VM on or off
  - Configuring virtual hardware and troubleshooting

VM Template

VM Template

A master copy of a VM with standardized virtual hardware and software configuration that is used to create new VMs

- Created in two ways:
  - Converting a VM into a template
  - Cloning a VM to a template
- Steps involved in updating a VM template are:
  1. Convert the template into VM
  2. Install new software or OS/software patches
  3. Convert the VM back to a template

Virtual Appliance

Virtual Appliance

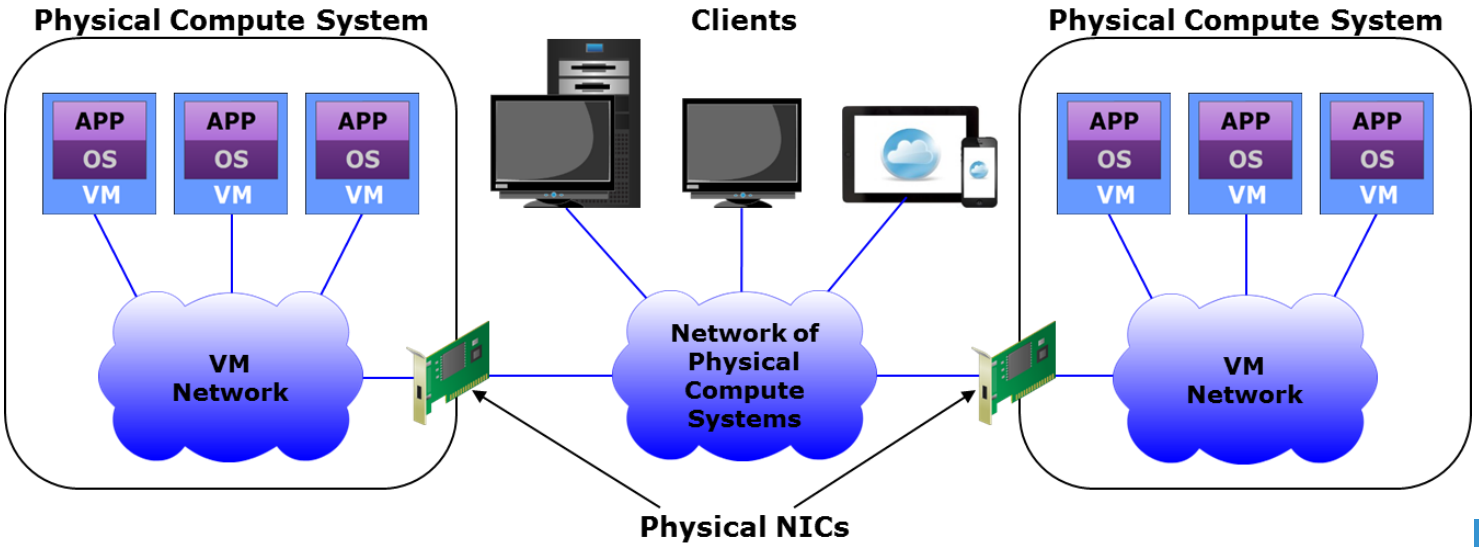
Preconfigured virtual machine(s) preinstalled with a guest OS and an application dedicated to a specific function.

- Used for functions, such as providing SaaS, routing packets, or deploying a firewall
- Simplifies the delivery and operation of an application
  - Simplifies installation and eliminates configuration issues
  - The application is protected from issues in other virtual appliances
- Typically created using Open Virtualization Format (OVF)

VM Network

VM Network

A logical network that provides Ethernet connectivity and enables communication between VMs within a compute system.



VM Network Components

Component	Description
Virtual switch	• A logical OSI Layer 2 Ethernet switch created in a compute system • Connects VMs locally and also directs VM traffic to a physical network • Forwards frames to a virtual switch port based on destination address • A distributed virtual switch can function across multiple physical compute systems
Virtual NIC	• Connects a VM to a virtual switch and functions like a physical NIC • Has unique MAC and IP addresses • Forwards the VM's network I/O in the form of Ethernet frames to the virtual switch
Uplink NIC	• A physical NIC connected to the uplink port of a virtual switch • Functions as an ISL between virtual and physical Ethernet switches • Not addressable from the network

Lesson Summary

During this lesson the following topics were covered:

- Virtual machine and VM hardware
- VM files and file system to manage VM files
- VM console
- VM template
- Virtual appliance
- VM network and its components

Lesson: Virtual Resources – II

This lesson covers the following topics:

- Logical unit number (LUN)
- Creating LUN from RAID set
- Creating LUN from storage pool

Logical Unit Number (LUN)

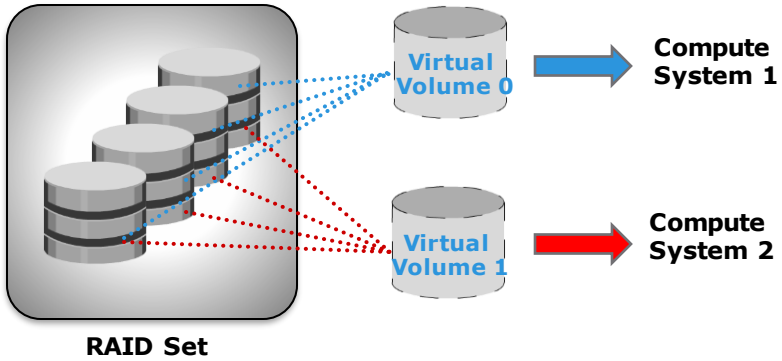
Logical Unit Number (LUN)

Abstracts the identity and internal functions of storage system(s) and appear as physical storage to the compute system.

- Mapping of virtual to physical storage is performed by the virtualization layer.
- Provider provisions LUN to consumers for storing data
  - Storage capacity of a LUN can be dynamically expanded or reduced
- LUN can be created from
  - RAID set (traditional approach)
  - Storage pool

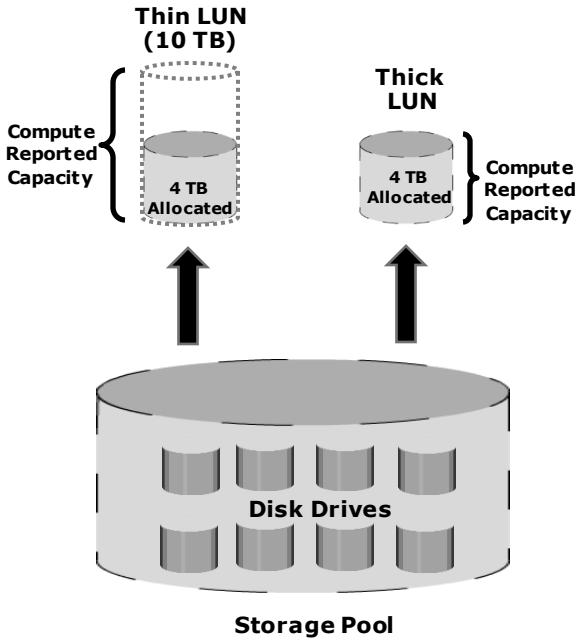
Creating LUNs from RAID Set

- LUNs are created from a RAID set by partitioning the available capacity into smaller units
  - Spread across all the physical disks that belong to a RAID set
- Suited for applications that require predictable performance



Creating LUNs from Storage Pool

- Two types of volumes are created from storage pool:
  - Thin LUN
    - Does not require physical storage to be completely allocated at the time of creation
    - Consumes storage as needed from the underlying storage pool in increments called thin LUN extents
  - Thick LUN
    - Physical storage is completely allocated at the time of creation



Use of Thin LUN

- Thin LUNs are appropriate for applications that can tolerate performance variations
  - In some cases, performance improvement is seen when using a thin volume due to striping across large number of drives in the pool
- Environments where cost, storage utilization, space, and energy efficiency is paramount
- For applications where storage space consumption is difficult to forecast
- Environment that needs optimized self provisioning

Lesson Summary

During this lesson the following topics were covered:

- LUN
- Creating LUN from RAID set
- Creating LUN from storage pool

Lesson: Virtual Resources – III

This lesson covers the following topics:

- Virtual network
- Types of virtual networks: VLAN and VSAN
- Mapping between VLANs and VSANs in an FCoE SAN

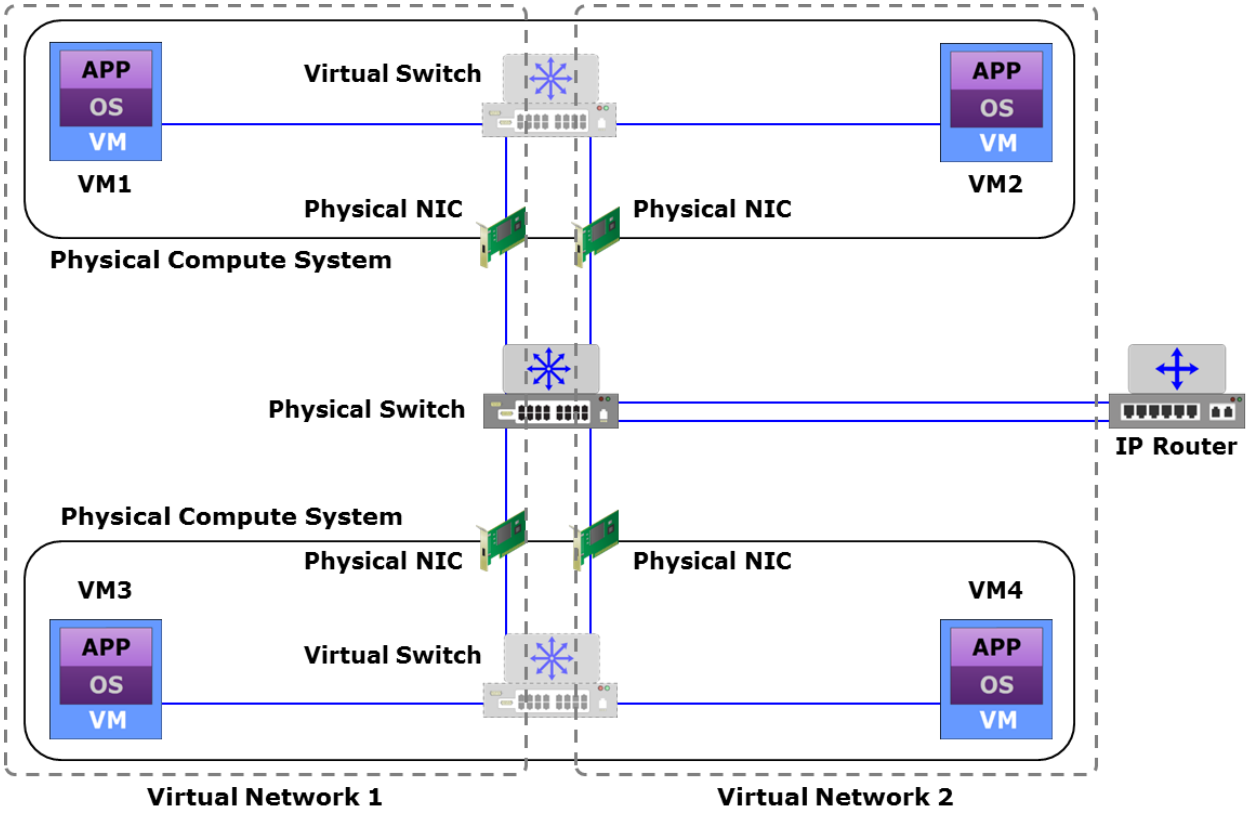
Virtual Network

Virtual Network

A software-based logical network that is either a segment of a physical network or spans across multiple physical networks.

- Appears as a physical network to the connected nodes
- Virtual networks share network components without leaking information between them
- Network traffic is routed only when two nodes in different virtual networks are communicating
- All types of networks can be virtualized, such as compute network, SAN, and VM network

Virtual Network Example



Common Types of Virtual Networks

- Virtual LAN (VLAN)
- Private VLAN (PVLAN)
- Stretched VLAN
- Virtual extensible LAN (VXLAN)
- Virtual SAN (VSAN)

Virtual LAN (VLAN)

Virtual LAN (VLAN)

A virtual network created on a LAN enabling communication between a group of nodes with a common set of functional requirements, independent of their physical location in the network.

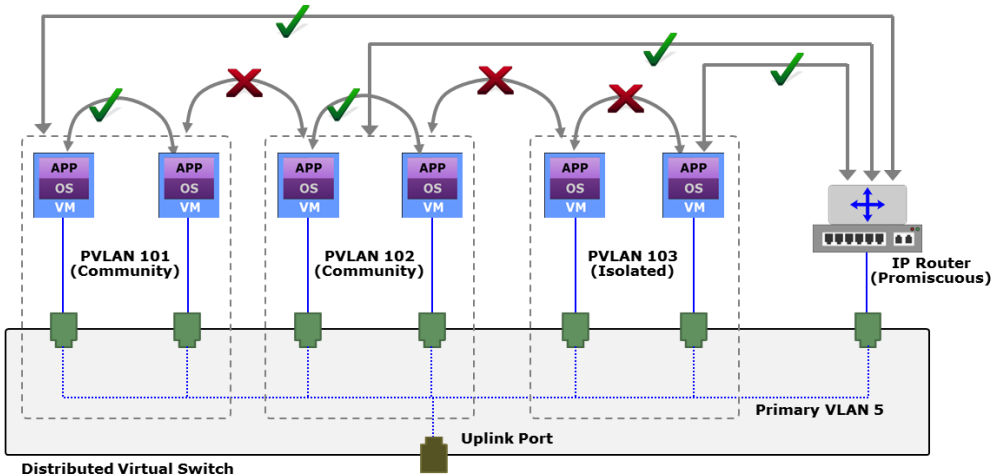
- A VLAN is identified by a unique 12-bit VLAN ID
- Configuring a VLAN:
  - Define VLAN on physical and virtual switches and assign VLAN ID
  - Configure VLAN membership based on port, MAC address, protocol, IP subnet address, or application

Private VLAN (PVLAN)

Private VLAN

A sub-VLAN that segregates the nodes within a standard VLAN, called as primary VLAN. A PVLAN can be configured as either isolated or community.

- Enables a provider to support a larger number of consumers
- Provides security between nodes on the same VLAN
- Simplifies network management

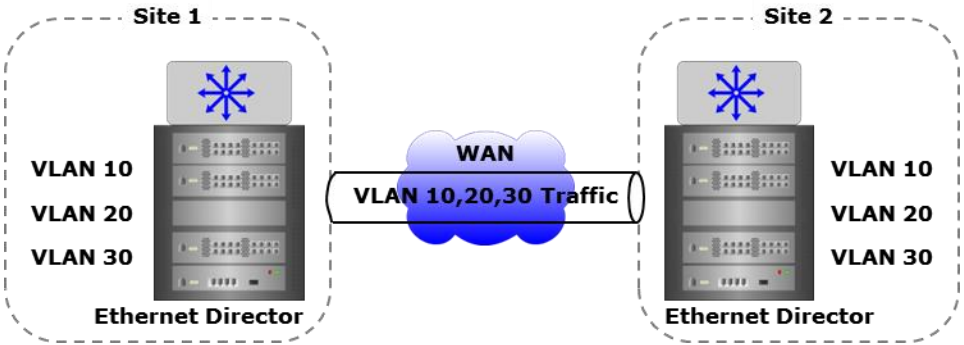


Stretched VLAN

Stretched VLAN

A VLAN that spans multiple sites and enables Layer 2 communication between a group of nodes over a Layer 3 WAN infrastructure, independent of their physical location.

- Layer 2 WAN frames are encapsulated in Layer 3 WAN packets
- Enables movement of VMs across locations without changing their network configuration



Virtual Extensible LAN (VXLAN)

Virtual Extensible LAN

A logical Layer 2 overlay network built on a Layer 3 network, which uses MAC-in-UDP encapsulation to enable communication between a group of nodes, independent of their physical location.

- VXLAN header is added to a Layer 2 frame, which is placed in a UDP-IP packet and tunneled over a Layer 3 network
  - Enables transparent Layer 2 communication between nodes over physical networks spanning Layer 3 boundaries
  - Encapsulation and decapsulation are performed by Virtual Tunnel Endpoints (VTEPs)
- 24-bit VXLAN ID provides up to 16 million VXLANs

Virtual SAN (VSAN)

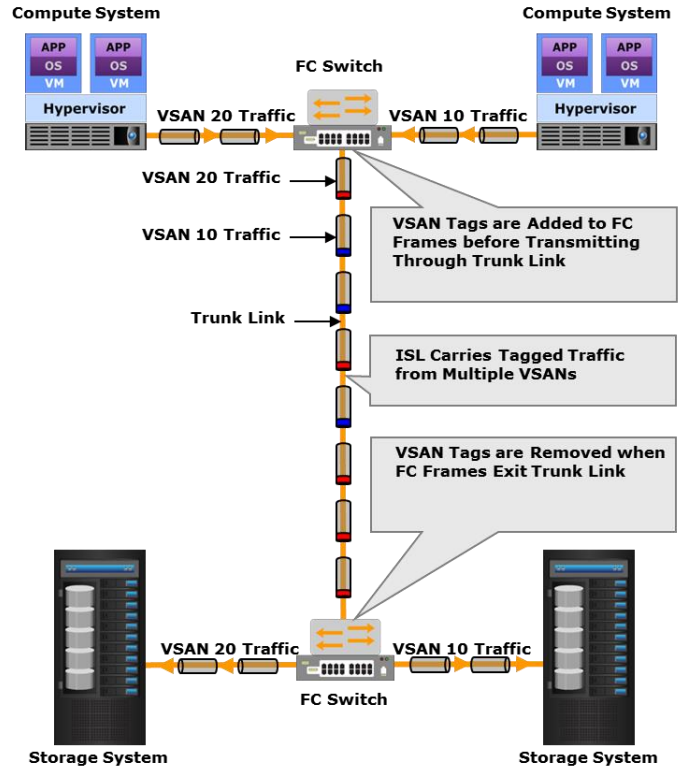
Virtual SAN

A logical fabric, created on a physical FC or FCoE SAN enabling communication between a group of nodes with a common set of requirements, independent of their physical location in the fabric.

- A VSAN has its own fabric services, configuration, and set of FC addresses
- Traffic disruptions in one VSAN do not affect other VSANs
- A VSAN may be extended across sites similar to a stretched VLAN

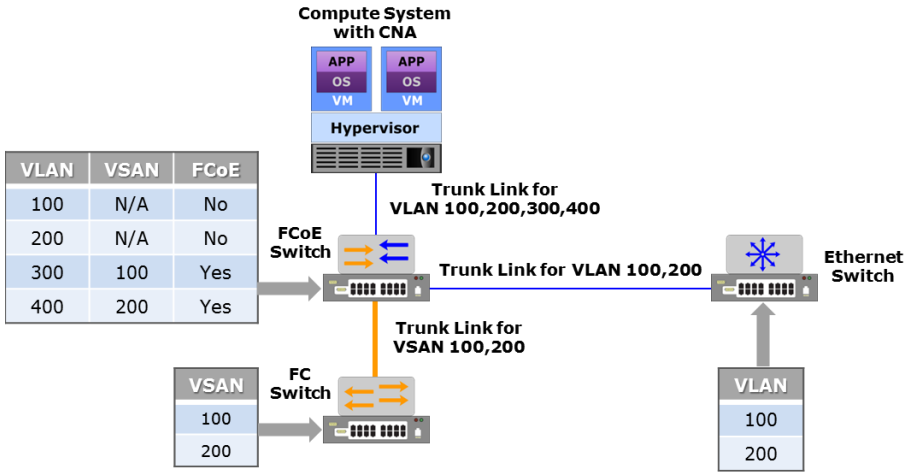
Virtual SAN (VSAN) (Cont'd)

- Configuring VSAN:
  - Define VSANs on fabric switch with specific VSAN IDs
  - Assign VSAN IDs to F_Ports to include them in the VSANs
- An N_Port connecting to an F_Port in a VSAN becomes a member of that VSAN



Mapping VLANs and VSANs in an FCoE SAN

- Mapping determines which VLAN carries a VSAN traffic
- Mapping considerations:
  - Configure a dedicated VLAN for each VSAN
  - VLANs configured for VSANs should not carry regular LAN traffic



Lesson Summary

During this lesson the following topics were covered:

- Virtual network
- Types of virtual network: VLAN, private VLAN, stretched VLAN, VXLAN, and VSAN
- Mapping between VLANs and VSANs in an FCoE SAN

Concepts in Practice

- VMware ESXi

VMware ESXi

ESXi
• Bare-metal hypervisor • Abstracts processor, memory, storage, and network resources into multiple VMs • Comprises underlying VMkernel OS that supports running multiple VMs - VMkernel controls and manages compute resources

Module Summary

Key points covered in this module:

- Virtual layer
- Virtualization software
- Resource pool
- Virtual resources