IT496: Cloud Computing

MODULE 3: PHYSICAL LAYER

LECTURE 6

Based on EMC course materials

Lecture Outline:

1. Lecture objectives.
2. Introduction.
3. Compute system.
4. Storage system.
5. Network system.
6. Products.

1. Lecture objectives

- **Describe** key components of a compute system.
- **Illustrate** the types of compute systems.
- **Discuss** the types of storage devices.
- **What** is Redundant Array of Independent Disks (RAID).
- **Illustrates** the types of network communication.
- **Define** Storage area network (SAN) classification.

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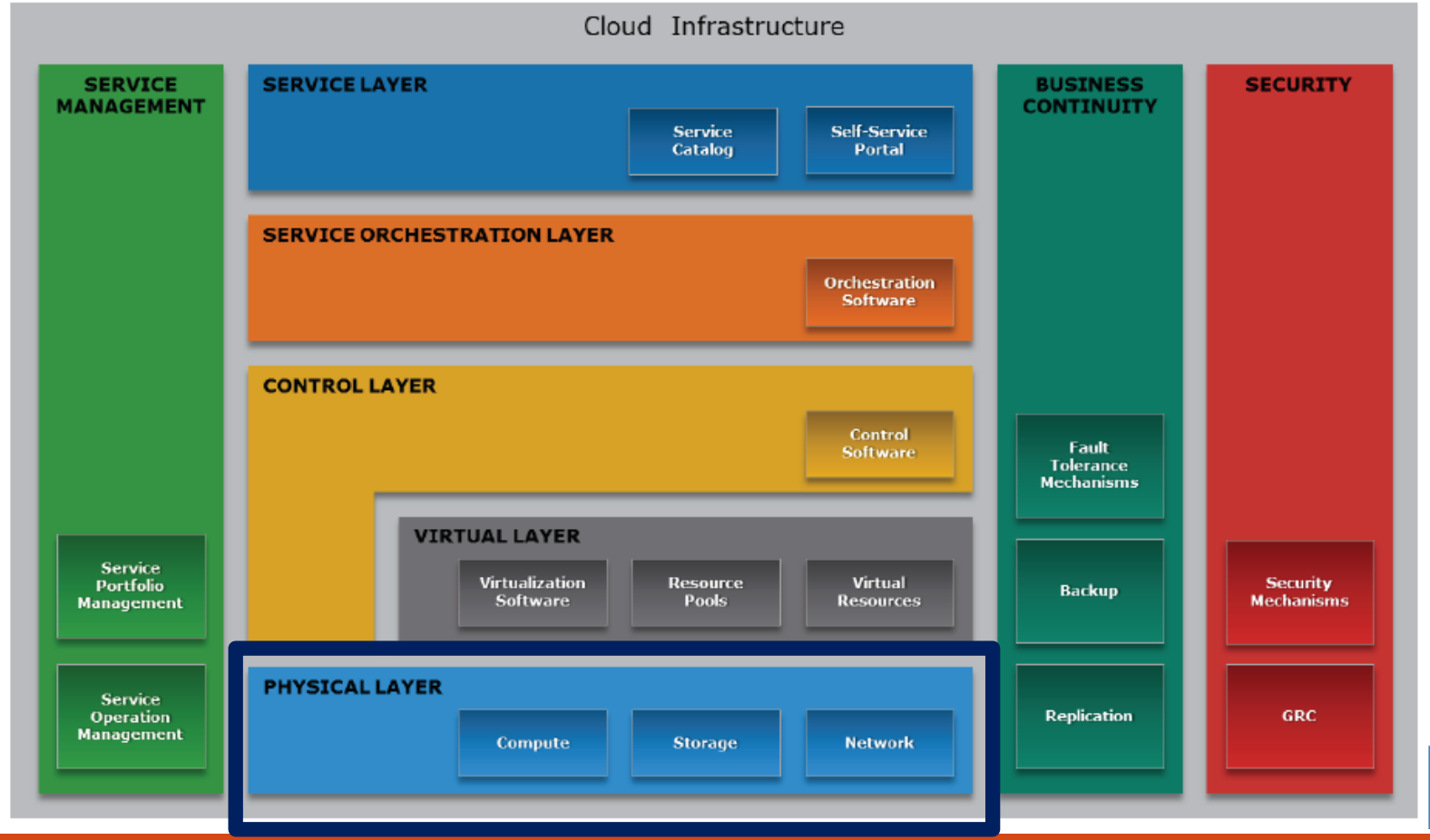
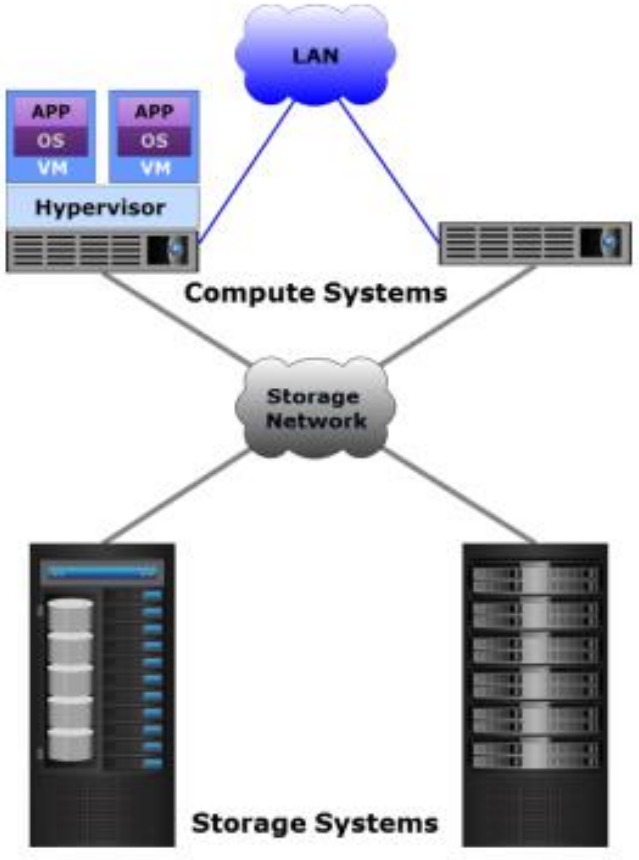
2.1 Introduction



2.1 Introduction

- The physical layer comprises physical compute, storage, and network resources
- **Compute systems** execute software of providers and consumers.
- **Storage systems** store business and application data.
- **Networks** connect compute systems with each other and with storage systems.
  - Networks also connect **multiple data centers** or multiple clouds to one another.

2.1 Introduction



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3. Compute system.

1. Key components of a compute system.
2. Software deployed on compute systems.
3. Types of compute systems.

3.1 Key components of a compute system.

- A computing platform (**hardware, firmware, and software**) that runs platform and application software.
  - Executes the provider's as well as the consumers' software.
  - Typically **x86-based** servers or hosts.

- Typically providers use **compute virtualization** and offer compute systems in the form of virtual machines.

3.2 Key components of a compute system.

Processor	• An IC that executes software programs by performing arithmetical, logical, and input/output operations
Random-Access Memory	• A volatile data storage device containing the programs for execution and the data used by the processor
Read-Only Memory	• A semiconductor memory containing boot, power management, and other device-specific firmware
Motherboard	• A PCB that holds the processor, RAM, ROM, network and I/O ports, and other integrated components, such as GPU and NIC
Chipset	• A collection of microchips on a motherboard to manage specific functions, such as processor access to RAM and to peripheral ports

3. Compute system.

1. Key components of a compute system.
2. Software deployed on compute systems.
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3.2 Software deployed on compute systems.

Self-service portal	• Enables consumers to view and request cloud services
Platform software	• Includes the software that the provider offers through PaaS
Application software	• Includes the applications that the provider offers through SaaS
Virtualization software	• Enables resource pooling and creation of virtual resources
Cloud management software	• Enables a provider to manage the cloud infrastructure and services
Consumer software	• Includes a consumer's platform software and business applications

3. Compute system.

1. Key components of a compute system.
2. Software deployed on compute systems.
3. Types of compute systems.

3.3 Types of compute systems.

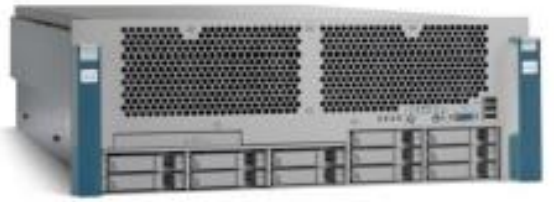
1. Tower compute system.
2. Rack-mounted compute system.
3. Blade compute system.

3.3.1 Tower Compute System

- Built in an upright enclosure called a "**tower**".
- Has integrated power supply and cooling.
- A group of towers occupies significant **floor space, requires complex cabling**, and generates noise from cooling units.
- Deploying in large environments may involve substantial expenditure.

3.3.2 Rack-mounted compute system

- Designed to be fixed on a frame called a "**rack**".



- A rack is a standardized enclosure with mounting slots for **vertically stacking compute systems**.

- Simplifies network cabling, consolidates network equipment, and reduces floor space use.
- Administrators may use a **console mounted** on the rack to manage the compute systems.

3.3.3 Blade compute system

- Comprises an electronic circuit board with only the core **processing components**.

- Multiple blades are housed in a blade chassis
  - – The chassis provides integrated power supply, cooling, networking, and management.

- Blades are interconnected via a high speed bus.

- Modular design increases compute system density and scalability.

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4. Storage system

1. Introduction.
2. Types of storage devices.
3. Redundant Array of Independent Disks (RAID).
4. Storage system architectures.

4.1 Introduction

- A storage system is the repository for **saving and retrieving electronic data**.

- Providers offer storage capacity along with compute systems, or as a service
  - – Storage as a Service enables **data backup and long-term data retention**.

- Typically, a provider uses **virtualization** to create storage pools that are shared by multiple consumers.

4.2 Types of storage devices.

Optical disc drive	• Stores data on a polycarbonate disc with a reflective coating • Write Once and Read Many capability: CD, DVD, BD • Low-cost solution for long-term data storage
Magnetic tape drive	• Stores data on a thin plastic film with a magnetic coating • Provides only sequential data access • Low-cost solution for long term data storage
Magnetic disk drive	• Stores data on a circular disk with a ferromagnetic coating • Provides random read/write access • Most popular storage device with large storage capacity
Solid-state (flash) drive	• Stores data on a semiconductor-based memory • Very low latency per I/O, low power requirements, and very high throughput

4. Storage system

1. Introduction.
2. Types of storage devices.
3. Redundant Array of Independent Disks (RAID).
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4.3 Redundant Array of Independent Disks (RAID).

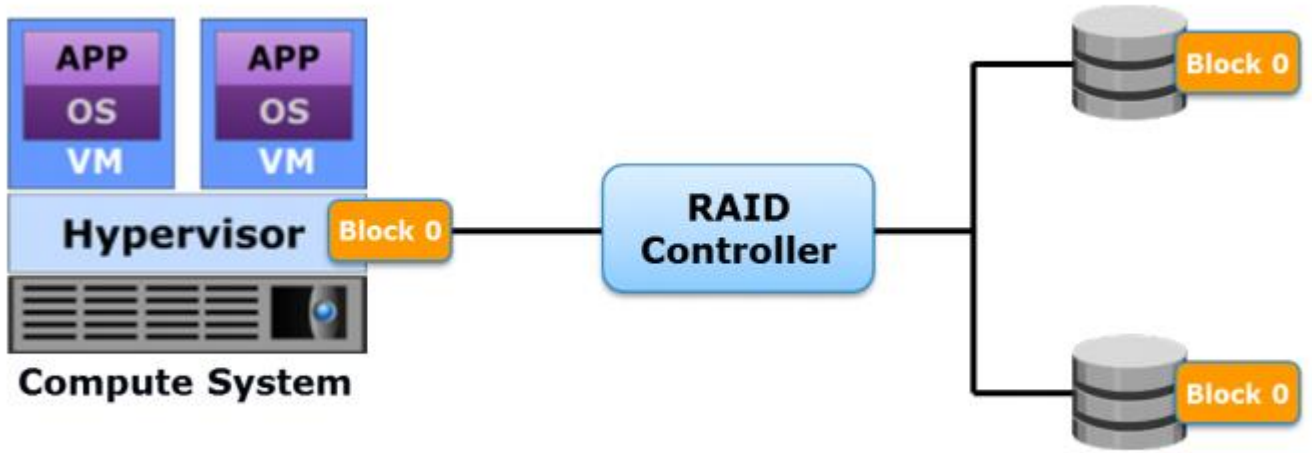
- A **storage technology** in which data is written in blocks across multiple disk drives that are combined into a logical unit called a RAID group.

- Provides data protection against drive failures.

- Three key techniques used for RAID: **mirroring, striping, and parity**

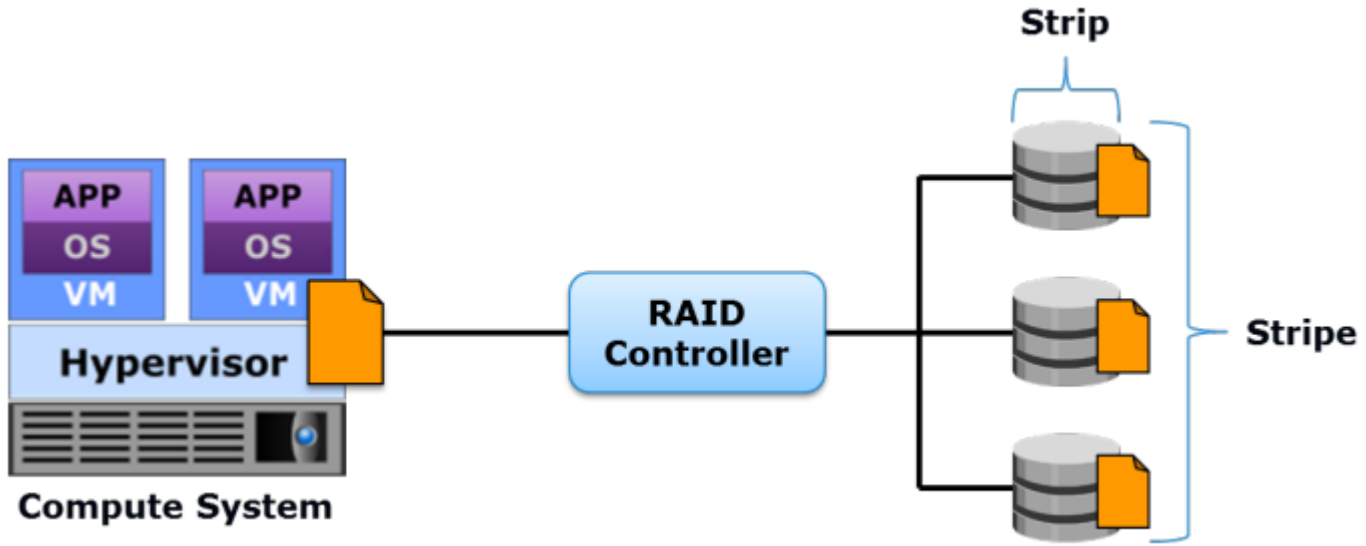
4.3 Redundant Array of Independent Disks (RAID).

- **Mirroring :** A RAID technique to store the same data simultaneously on two different drives, yielding two copies of the data.



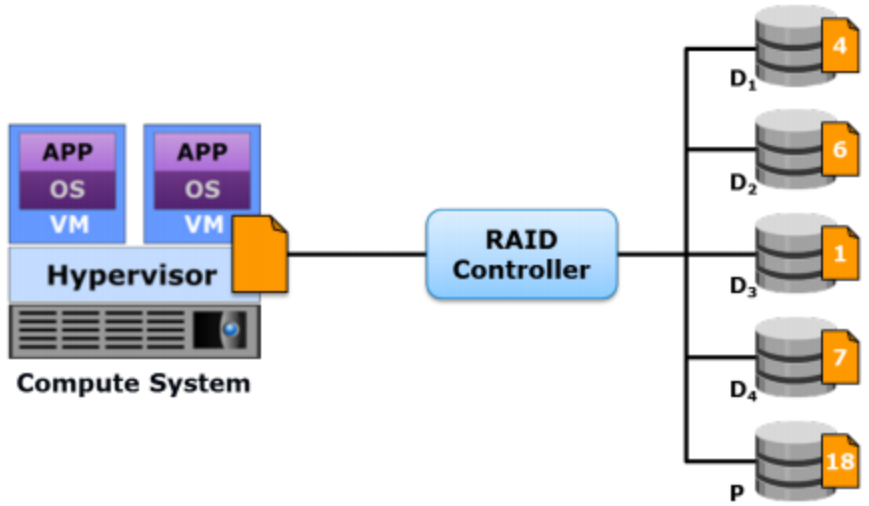
4.3 Redundant Array of Independent Disks (RAID).

- **Striping :** A RAID technique to spread data across multiple drives in order to use the drives in parallel.



4.3 Redundant Array of Independent Disks (RAID).

- **Parity:** A RAID technique to protect striped data from drive failure by performing a mathematical operation on individual strips and storing the result on a portion of the RAID group.



4.3 Redundant Array of Independent Disks (RAID).

RAID 0	• Striped set with no fault tolerance
RAID 1	• Disk mirroring
RAID 1+0	• Nested RAID (striping and mirroring)
RAID 3	• Striped set with parallel access and a dedicated parity disk
RAID 5	• Striped set with independent disk access and distributed parity
RAID 6	• Striped set with independent disk access and dual distributed parity

4. Storage system

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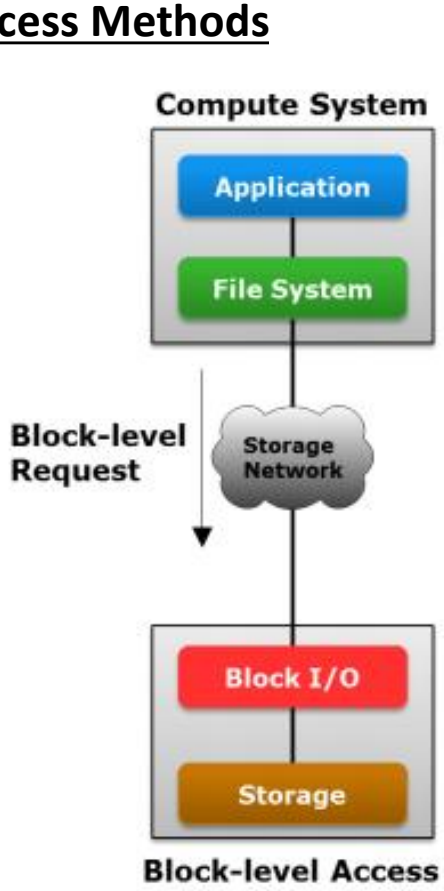
4.4 Storage system architectures.

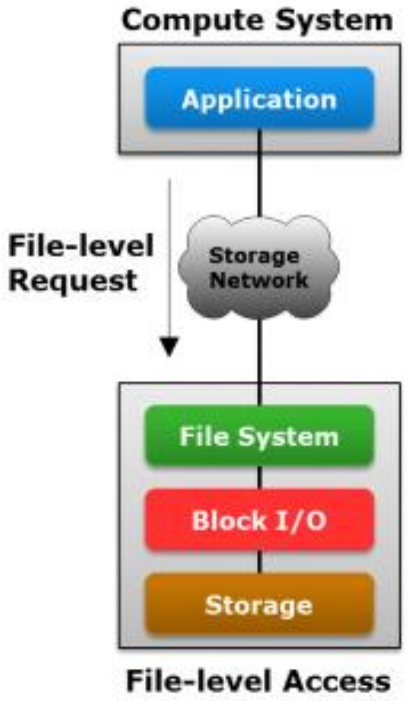
- Storage system architectures are based on the data access methods.

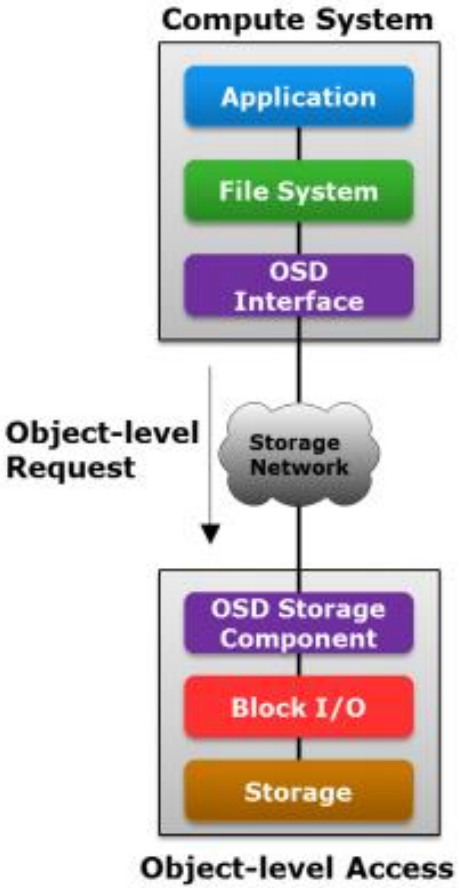
- Common storage system options are:
  - Block-based
  - File-based
  - Object-based
  - Unified

4.4 Storage system architectures.

Data Access Methods

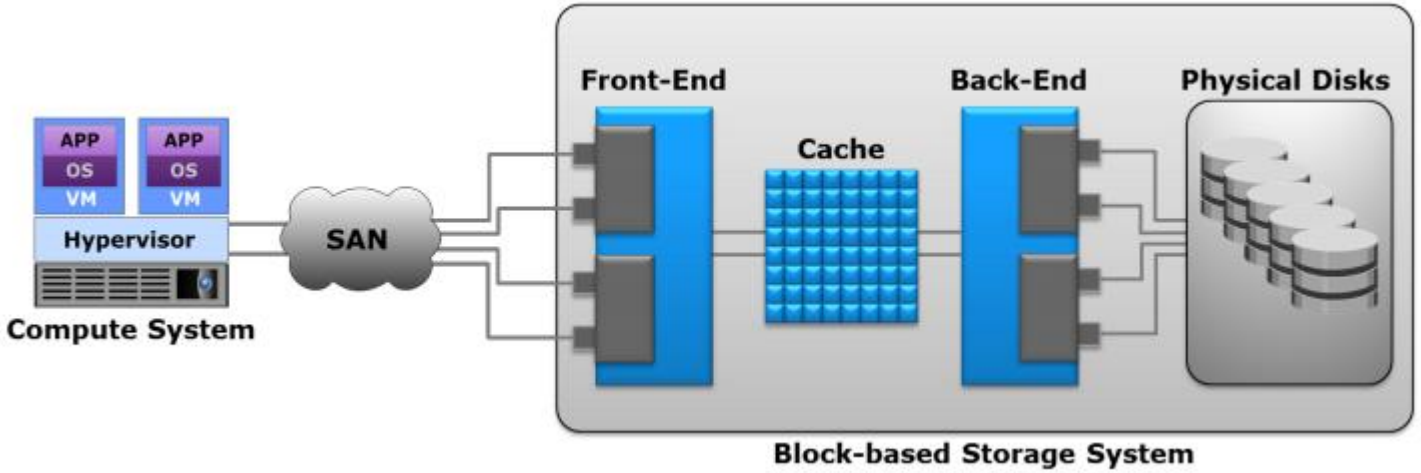






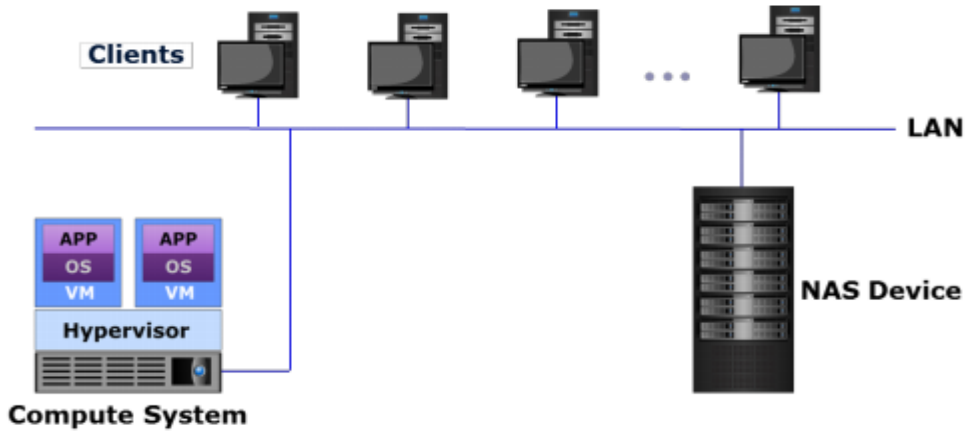
4.4.1 Block-based Storage System.

- Enables creating and assigning storage volumes to compute systems.
  - Compute system discovers the volumes as local drives.



4.4.2 File-based Storage System.

- A dedicated, high performance file server with storage (also known as **Network-attached Storage**)
- Enables clients to share files over an IP network.
  - – Supports data sharing for UNIX and Windows users.



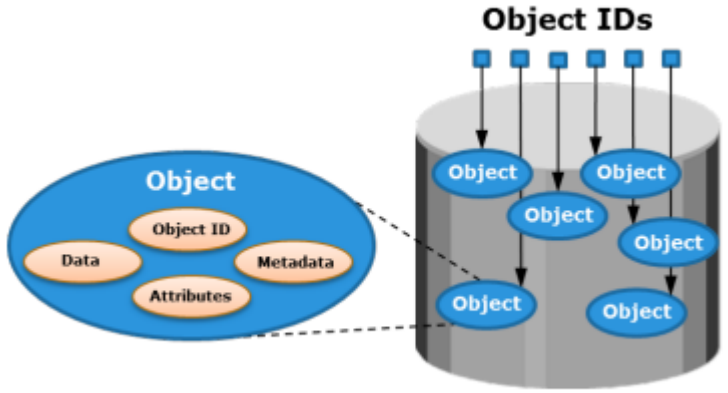
4.4.2 File-based Storage System.

- **Traditional NAS (Scale-Up Nas)**
  - Capacity and performance of a single system is scaled by upgrading or adding NAS components.

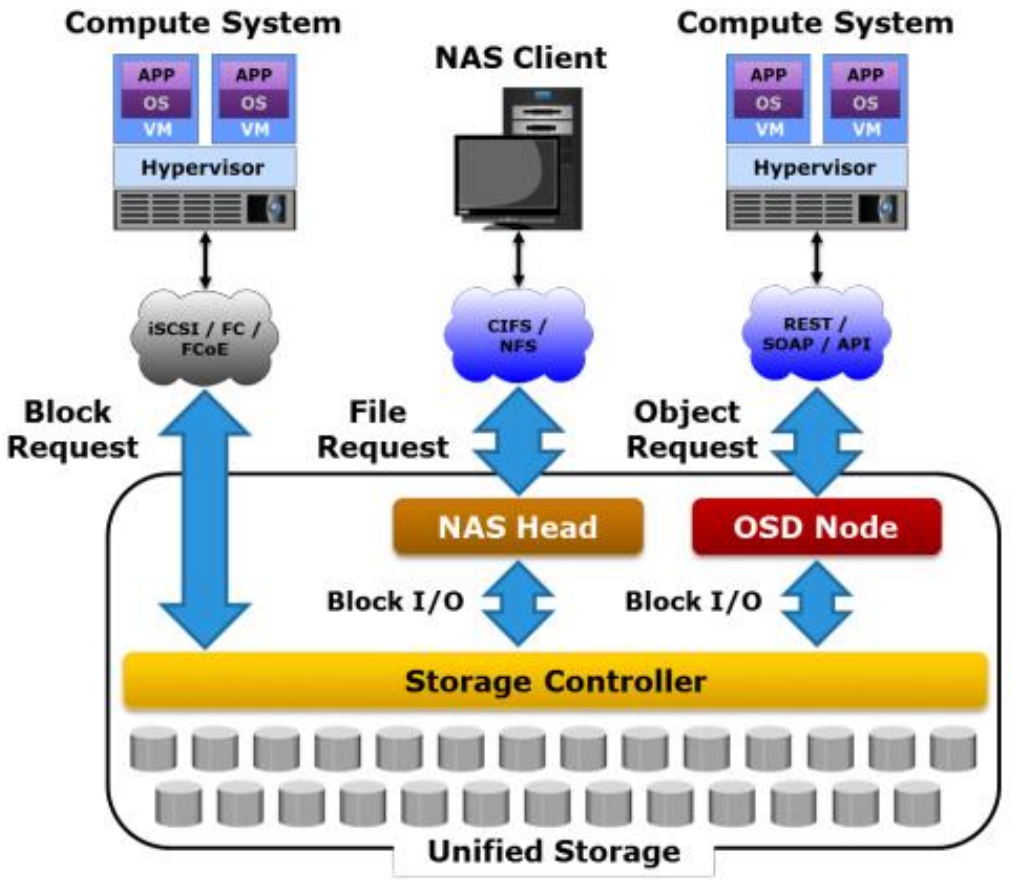
- **Scale-out NAS**
  - Multiple processing and storage nodes are pooled in a cluster that works as a single NAS device.
  - Addition of nodes scales cluster capacity and performance without disruption.

4.4.3 Object-based Storage System.

- Stores file data in the form of objects based on data contents and attributes.
- Object contains Object id, user data, related metadata, and user-defined attributes



4.4.3 Unified Storage



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5. Network system

1. Introduction and types of network communication.
2. Compute-to-compute communication.
3. Compute-to-storage communication.
4. Storage area network (SAN) classification.
5. Inter-cloud communication.

5.1 Introduction and types of network communication

- Networking enables **data transfer and sharing** of IT resources between nodes across geographic regions.
- Cloud consumers require **a reliable and secure** network to connect to a cloud and access cloud services.
- Multiple clouds may be inter-connected to enable workloads to be moved or distributed
  - – For example: cloud bursting in a hybrid cloud model.

5.1 Introduction and types of network communication

- Based on the nodes connected by a network, the network communication is broadly categorized as:

  - Compute-to-compute communication.
  - Compute-to-storage communication.
  - Inter-cloud communication.

5. Network system

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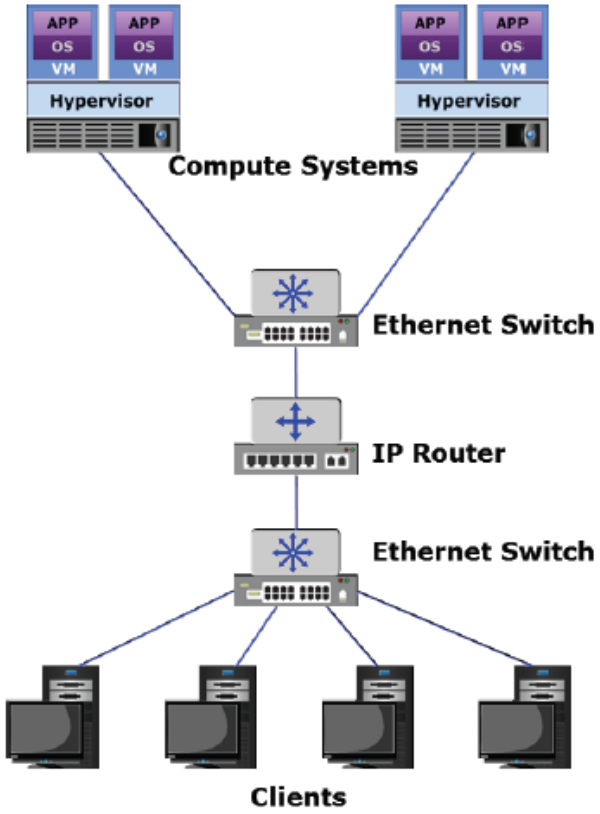
5.2 Compute-to-compute communication.

- Interconnecting physical compute systems enables compute-to-compute communication.
- Compute-to-compute communication typically uses **IP-based protocols**.
- Compute systems connect to a network through physical network card(s).
- Physical switches and routers are common interconnecting devices.



5.3 Compute-to-storage communication.

Storage Area Network

A network that interconnects storage systems with compute systems, enabling the compute systems to access and share the storage systems.

- Based on the protocols they support, SANs can be classified as:
  1. Fiber Channel SAN (FC SAN)
  2. Internet Protocol SAN (IP SAN)
  3. Fiber Channel over Ethernet SAN (FCoE SAN)

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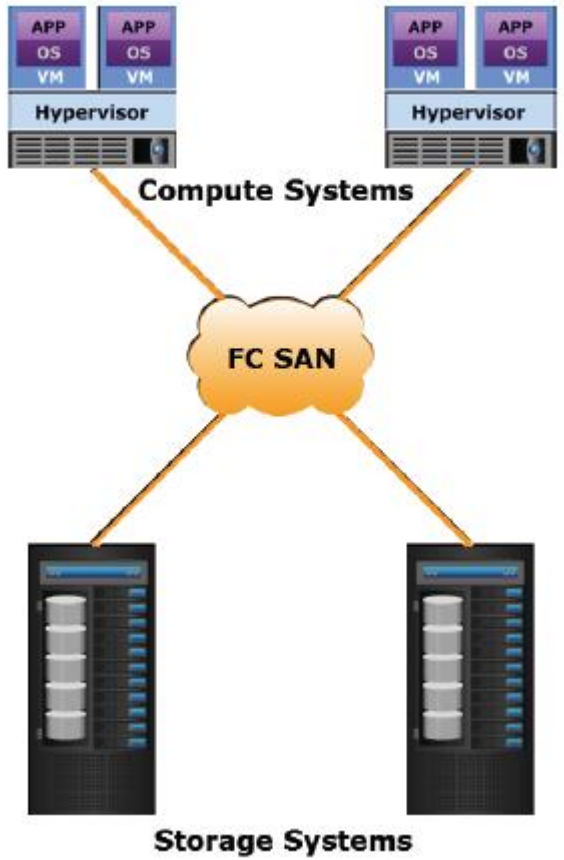
5.4.1 Fiber Channel SAN (FC SAN)

- A SAN that uses Fiber Channel (FC) protocol to transport data, commands, and status information between compute and storage systems.



- FC provides **block-level access to storage**.
- FC offers data transfer speeds up to **16 Gbps**

5.4.1 Fiber Channel SAN (FC SAN)

Components

Network adapters	• Provide physical interface to a node for communicating with other nodes • Examples: FC HBAs and storage system front-end adapters
Cables and connectors	• Optical fiber cables are predominantly used to provide connectivity • Connectors enable cables to be swiftly connected to and disconnected from ports
Interconnecting devices	• FC switches and directors • Directors have a modular design, a higher port count, and better fault-tolerance • Switches either have a fixed port count or a modular design

HBA : Host Bus Adapter

5.4.1 Fiber Channel SAN (FC SAN)

- Each switch in a **fabric** contains a **unique domain identifier (ID).**
- Each **network adapter** is physically identified by a 64-bit World Wide Node Name (WWNN)
- Each **adapter port** is physically identified by a 64-bit World Wide Port Name (WWPN)
- Each adapter port in a fabric has a unique 24-bit FC address
  - – Fabric assigns FC addresses to adapter ports dynamically

5.4.1 Fiber Channel SAN (FC SAN)

Zoning

An FC switch function that enables node ports within a fabric to be logically segmented into groups and to communicate with each other within the group.

- Both node ports and switch ports can be zone members.

- WWN zoning : The zone members are wwnn addresses between nodes and storage.
- Port zoning : The zone members are ports on FC switches.
- Mixed zoning : Mix between wwn and port zoning.

5.4.2 Internet Protocol SAN (IP SAN)

IP SAN

A SAN that uses Internet Protocol (IP) for the transport of storage traffic. It transports block I/O over an IP-based network.

Why ??

- a lot of existing IP-based network instead of building a new FC SAN infrastructure.
- Already mature security options are available for IP networks.

5.4.3 Fiber Channel over Ethernet SAN (FCoE SAN)

FCoE SAN

Network that uses the FCoE protocol to transport FC data along with regular Ethernet traffic over high speed Ethernet links. **FCoE encapsulates FC frames into Ethernet frames.**

Why ??

- Reduces complexity of managing multiple discrete networks.
- Reduces the number of adapters, cables, and switches, along with power and space consumption required in a data center.

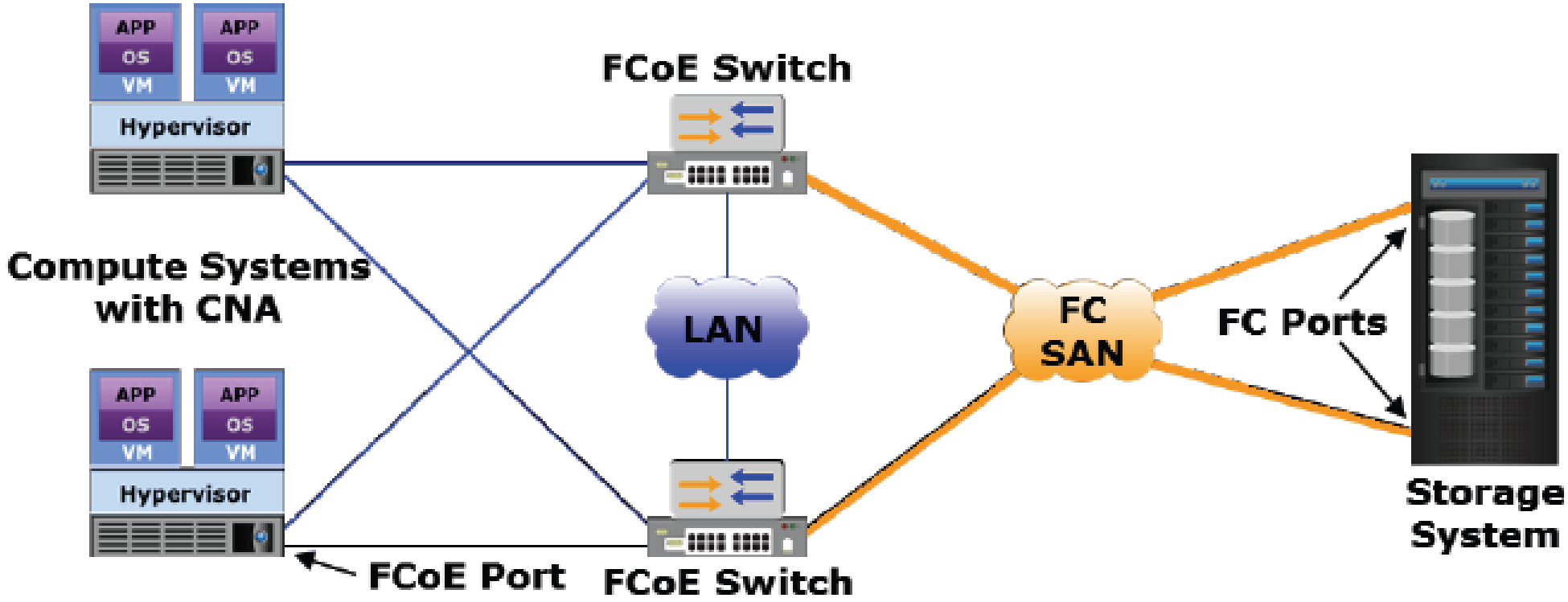
5.4.3 Fiber Channel over Ethernet SAN (FCoE SAN)

- Converged network adapter (CNA)
  - Provides functionality of both NIC and FC HBA in a single device
  - Encapsulates FC traffic onto Ethernet frames (FCoE traffic)

- FCoE switch
  - FCF encapsulates FC frames into Ethernet frames (FCoE frames) and decapsulates FCoE frames to FC frames

- Software FCoE adapter
  - A software on the compute system performs FCoE processing
  - Supported NICs transfer both FCoE and regular Ethernet traffic

5.4.3 Fiber Channel over Ethernet SAN (FCoE SAN)



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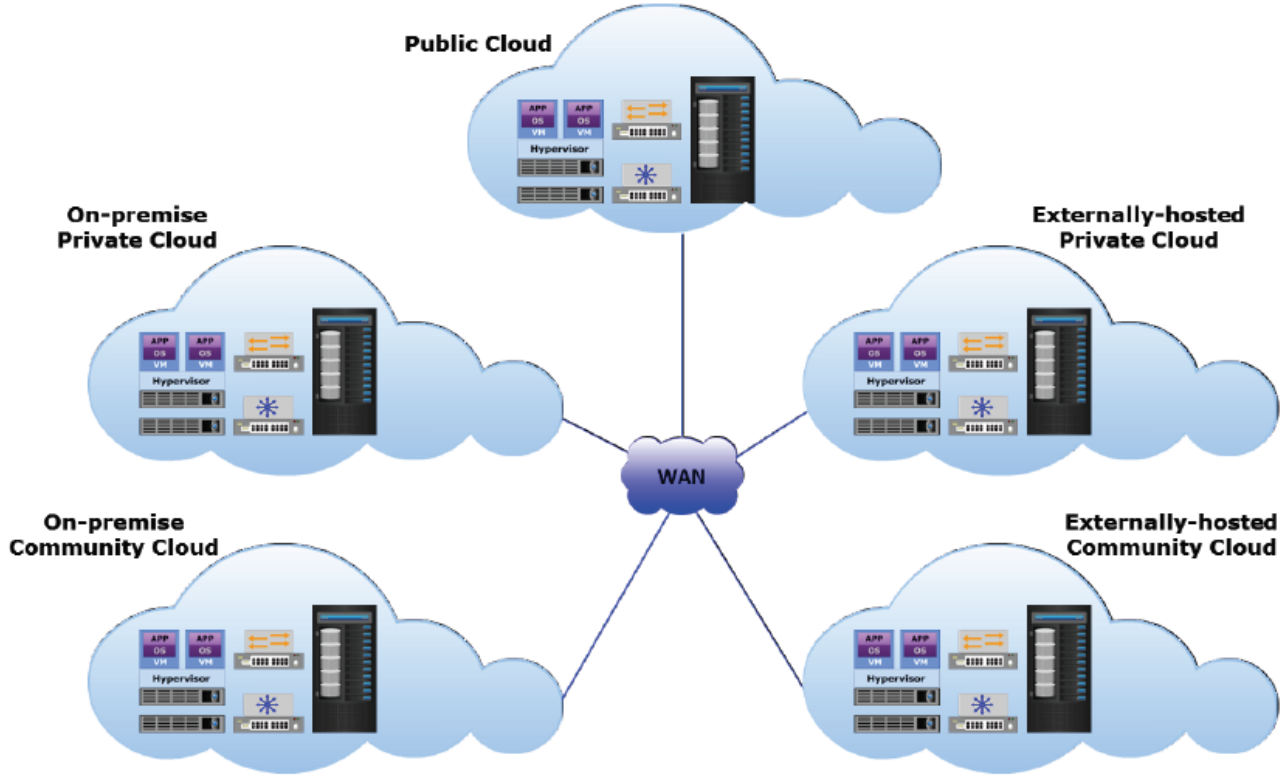
5.5 Inter-cloud communication.



When ??

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5.6 Products.

- **VMAX**
  - Block-based storage systems
- **VNX**
  - Family of unified storage platforms
- **Isilon**
  - Scale-out NAS storage platform
- **XtremIO**
  - All-flash, block-based, scale-out enterprise storage array

Lecture Objectives:

- Key components of a compute system were introduced. ✓
- Types of compute systems. ✓
- Types of storage devices. ✓
- Redundant Array of Independent Disks (RAID). ✓
- Types of network communication. ✓
- Storage area network (SAN) classification. ✓

Thanks