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Department of Cyber Security

Subject: Virtualization

Class: Third stage

Lecture: (3)

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Virtualization

1. Introduction

Virtualization is a foundational technology in modern computing and cloud environments. It allows multiple virtual instances of computing resources—such as servers, storage, networks, or operating systems—to run on a single physical system. Virtualization abstracts hardware resources from the software, enabling efficient resource utilization and isolation.

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2. Definition of Virtualization

Virtualization can be defined as:

"The process of creating a virtual version of a physical computing resource, including servers, storage devices, networks, or operating systems, that behaves as if it were a separate physical entity."

Key points:

- Provides abstraction between hardware and software
- Enables multiple operating systems or applications to run on the same physical hardware
- Forms the foundation of cloud computing and data center efficiency

Virtualization Vs **Cloud Computing**

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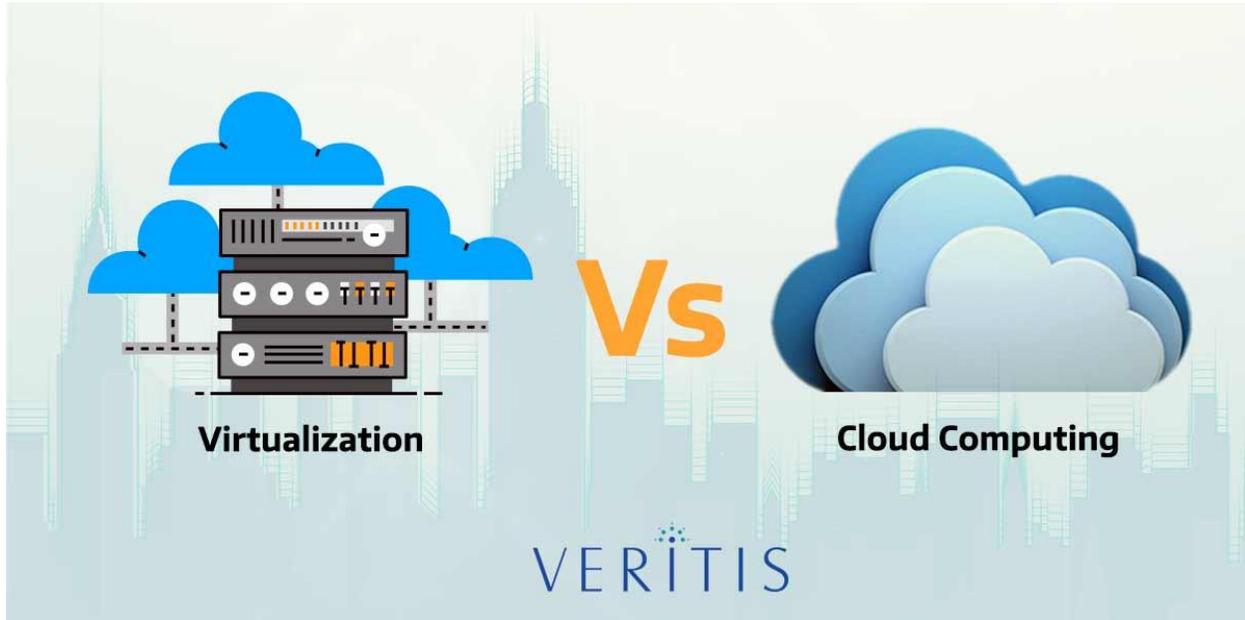
3. Importance of Virtualization

Virtualization offers several critical benefits in modern IT infrastructure:

- **Resource Optimization:** Maximizes use of physical hardware
- **Cost Savings:** Reduces capital expenditure on hardware
- **Flexibility:** Quickly deploy and scale applications
- **Isolation:** Each virtual instance is independent and secure
- **Disaster Recovery:** Simplifies backup and system recovery

4. Types of Virtualization

4.1 Server Virtualization

- Splits a physical server into multiple virtual servers
- Each virtual server operates independently with its own OS

4.2 Storage Virtualization

- Aggregates multiple physical storage devices into a single logical storage unit
- Simplifies storage management and improves utilization

4.3 Network Virtualization

- Combines network resources into a virtual network
- Allows flexible, scalable, and secure network configurations

4.4 Desktop Virtualization

- Provides virtual desktops to users from a central server
- Enables remote access to applications and OS

4.5 Application Virtualization

- Runs applications in isolated containers without installing them on the local system
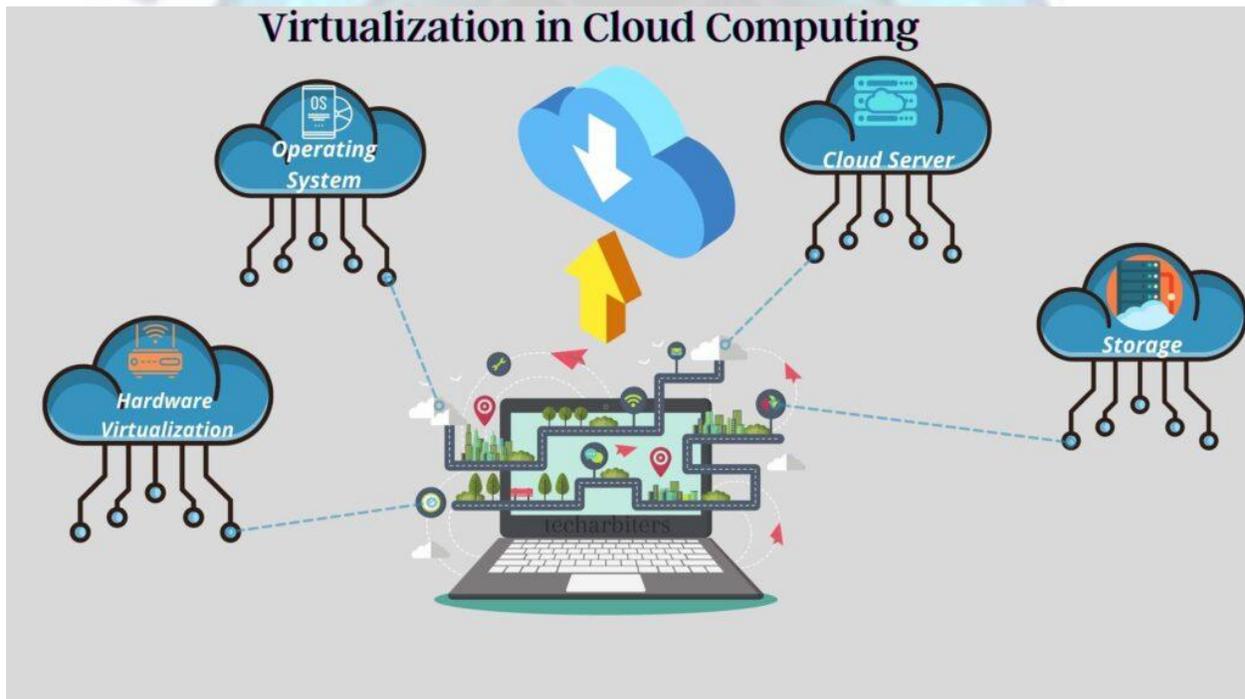
5. Key Components of Virtualization

- **Hypervisor:** Software that creates and manages virtual machines
- **Virtual Machine (VM):** A virtual representation of a physical computer
- **Host Machine:** The physical hardware that runs VMs
- **Guest OS:** The operating system installed on a virtual machine
- **Virtual Network & Storage:** Enables VMs to communicate and store data

6. Virtualization Technologies

- **Type 1 Hypervisor (Bare-metal):** Installed directly on physical hardware (e.g., VMware ESXi, Microsoft Hyper-V)
- **Type 2 Hypervisor (Hosted):** Installed on top of a host OS (e.g., VMware Workstation, Oracle VirtualBox)
- **Containerization:** Lightweight virtualization for applications (e.g., Docker, Kubernetes)

7. Benefits of Virtualization

- Reduced hardware costs and energy consumption
- Faster deployment of applications and systems
- Simplified IT management and maintenance
- Better disaster recovery and business continuity
- Enhanced testing and development environments

8. Challenges of Virtualization

- Performance overhead due to abstraction layer
- Security risks if isolation fails
- Complex management in large-scale environments
- Licensing issues for multiple virtual instances

9. Virtualization in Cloud Computing

Virtualization is the backbone of cloud computing:

- Enables **IaaS** by providing virtual servers and storage
- Supports **PaaS** by delivering virtual platforms for developers
- Powers **SaaS** by isolating applications for multiple users
- Offers **elastic scalability** by dynamically allocating resources based on demand

10. Use Cases of Virtualization

- **Data Centers:** Consolidation of multiple servers
- **Software Testing:** Running multiple OS environments simultaneously
- **Disaster Recovery:** Quick recovery through VM snapshots
- **Cloud Services:** Provides scalable and flexible resources