

# Virtualization in Cloud Computing

## • Basics

1. Virtualization means creating a virtual version of hardware or software.
2. It allows multiple operating systems to run on one physical machine.
3. Cloud computing uses virtualization to share resources.
4. Virtualization improves **resource utilization**.
5. It provides **isolation** between applications and users.

## • Types of Virtualization

6. **Server Virtualization** – dividing one physical server into many virtual servers.
7. **Storage Virtualization** – combining multiple storage devices into one logical unit.
8. **Network Virtualization** – creating multiple virtual networks over a single physical network.
9. **Desktop Virtualization** – allowing desktops to run remotely on a server.
10. **Application Virtualization** – running applications in a virtual environment.

## • How it Works

11. A software called **hypervisor** manages virtualization.
12. Hypervisor sits between hardware and virtual machines.
13. Each virtual machine (VM) behaves like a separate computer.
14. VMs share the same hardware resources.
15. Hypervisor allocates CPU, memory, and storage to each VM.

## • Hypervisor Types

16. **Type 1 (Bare-metal)** – runs directly on hardware (e.g., VMware ESXi, Microsoft Hyper-V).
17. **Type 2 (Hosted)** – runs on top of an OS (e.g., VirtualBox, VMware Workstation).
18. Type 1 is used in **cloud data centers**.
19. Type 2 is used in **personal systems/testing**.
20. Hypervisors ensure **security and efficiency**.

## • Advantages

- 21. Reduces cost by using fewer physical machines.
- 22. Saves space in data centers.
- 23. Provides **better scalability** in cloud services.
- 24. Improves **disaster recovery**.
- 25. Enables **load balancing** of workloads.

## • Role in Cloud

- 26. Cloud providers use virtualization to share resources among many users.
- 27. Helps in **multi-tenancy** (different users sharing same infrastructure).
- 28. Enables **on-demand resource allocation**.
- 29. Supports **pay-as-you-use model**.
- 30. Provides **elasticity** (scaling up/down easily).

## • Challenges

- 31. Requires powerful hardware.
- 32. Performance may be slower compared to dedicated machines.
- 33. Needs skilled administrators.
- 34. Security risks exist if hypervisor is attacked.
- 35. Licensing and software costs may be high.

## • Examples

- 36. VMware vSphere
- 37. Microsoft Hyper-V
- 38. Oracle VirtualBox
- 39. Citrix XenServer
- 40. KVM (Kernel-based Virtual Machine)

## • Use Cases

- 41. Running multiple OS on one system.
- 42. Cloud hosting services.

43. Development and testing environments.

44. Virtual desktop infrastructure (VDI).

45. Backup and recovery solutions.

- **Future & Trends**

46. Widely used in **private, public, and hybrid clouds**.

47. Plays a role in **containerization** (like Docker, Kubernetes).

48. Helps in **edge computing** and IoT.

49. AI and ML workloads often use virtualized cloud environments.

50. It is the **foundation of cloud computing**.