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Specialization - Cloud Computing - I

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DIGITAL LEARNING CONTENT

Unit – 3

Virtualization Concepts

Virtualization - Introduction

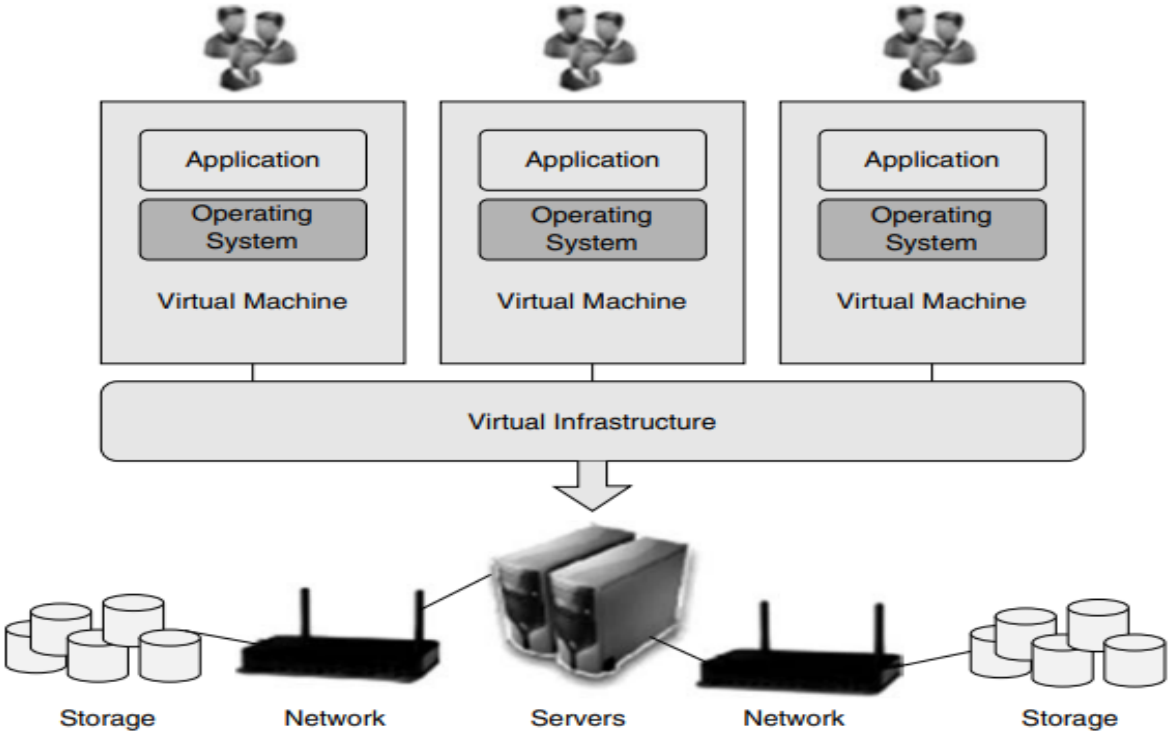

Figure 8.1 Diagrammatic Representation of Virtualization

Virtualization

Definition of Virtualization:

- Virtualization is a methodology for dividing computer resources into multiple execution environments using concepts like partitioning, time-sharing, machine simulation, and emulation.

Emerging IT Trend:

- It is a new trend in IT, encompassing autonomic and utility computing, enabling resource management where clients pay per use.

Workload Management:

- Virtualization centralizes administrative tasks, enhances scalability, and reduces user workload by efficiently managing resources.

Virtualization

Virtualization Layers:

- The concept includes three layers:

- Layer 1: Network
- Layer 2: Virtual infrastructures
- Layer 3: Virtual machines running multiple operating systems and applications.

Resource Optimization:

- Physical resources of multiple machines are shared, enabling efficient resource utilization, improved flexibility, and reduced capital and operational costs.

Components of Virtual Infrastructure:

- It comprises hypervisors, virtual infrastructure services, and automated IT solutions for optimization.

Virtualization Architecture

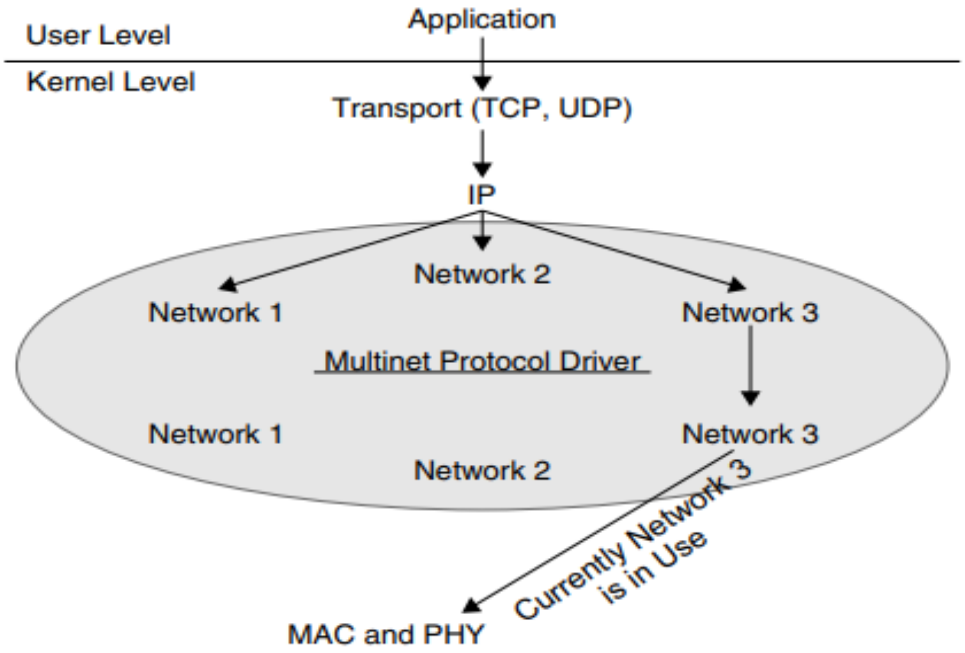

Figure 8.11 Modified Network Stack

MultiNet Protocol Driver (MPD)

- MPD is a tool that helps in virtualizing a wireless network adapter.
- It sits as a middle layer between two main parts of the computer:
  - The MAC layer (which controls the physical network hardware, like Wi-Fi)
  - The IP layer (which manages how data is sent across the internet).
- MPD ensures that a single wireless network adapter can connect to multiple networks at the same time, even though only one network is active at a given moment.

MultiNet Protocol Driver (MPD) - Working

- If an application (like your browser or a game) wants to connect to multiple networks, it sends the request to MPD.
- MPD switches between the networks and allocates the right network and MAC address.
- To the IP layer, it looks like all networks are always active, even though only one network is truly connected.

What is Application Virtualization?

- A software technology that encapsulates applications from their base operating system.
- Virtualized applications are executable without traditional installation.
- Virtualization allows direct interaction with the operating system and necessary resources.
- Application virtualization = encapsulated application.
- Hardware virtualization = abstracted hardware.

Benefits of Application Virtualization

- Execute non-native applications (e.g., Windows apps on Linux).
- Protects the operating system.
- Uses fewer resources.
- Run applications with bugs safely (e.g., accessing read-only locations).
- Simplified migration between operating systems.
- Faster application deployment and on-demand streaming.
- Improved security through OS isolation.
- Easily track license usage.
- Simplified application management with portable media.
- Applications run without installation on client computers.

Limits of Application Virtualization

- Not All Software Can Be Virtualized

  Examples: Device drivers and 16-bit applications.
- Anti-Virus Packages

  Require direct OS integration and cannot be virtualized.
- Legacy Application Issues

  File and registry-level compatibility issues may arise.

  Application compatibility fixes are needed for some scenarios.

  Example: Windows Vista applications that mismanage the heap require fixes to run on newer OS versions

Types Of Virtualization

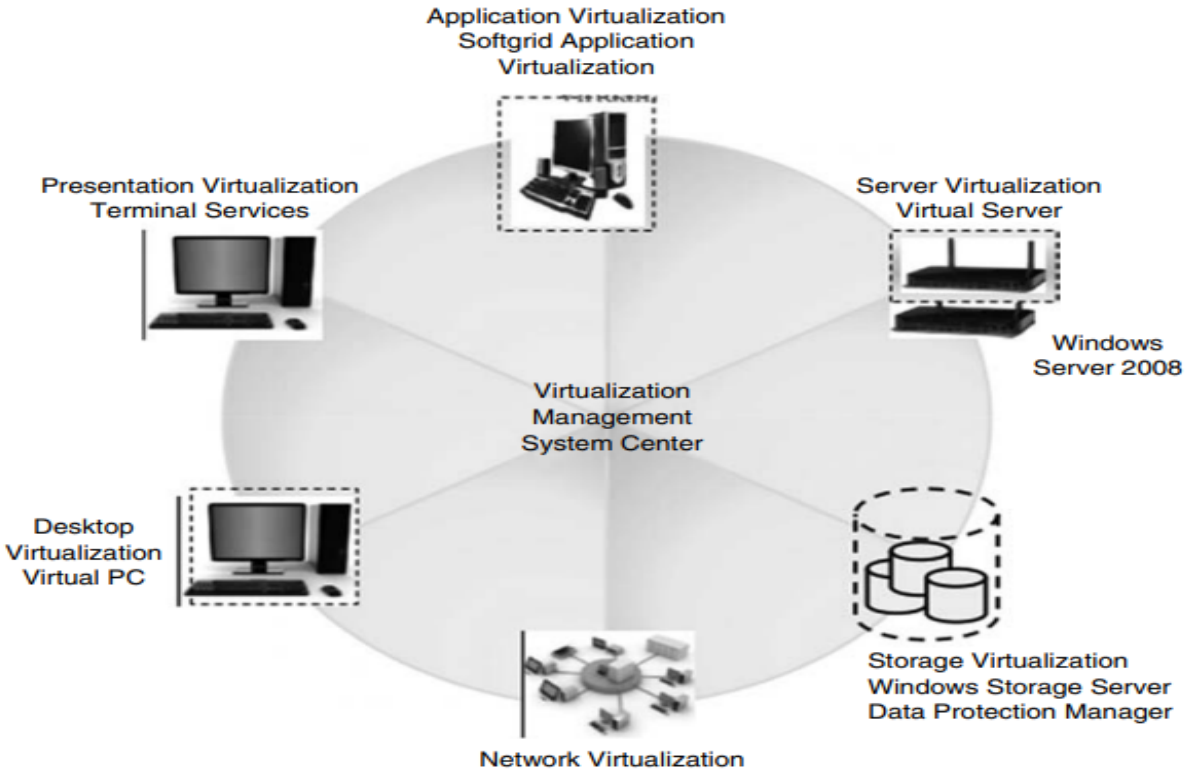

Figure 8.2 Types of Virtualization

Types Of Virtualization

Server Virtualization:

- Creating multiple virtual servers on a single physical server.
- Benefits: Server consolidation, improved resource utilization, reduced hardware costs.

Network Virtualization:

- Creating virtual networks that are independent of the underlying physical network.
- Benefits: Simplified network management, improved network performance, enhanced security.

Types Of Virtualization

Storage Virtualization:

- Pooling physical storage from multiple devices into a single virtual storage pool.
- Benefits: Improved storage utilization, simplified storage management, enhanced data protection.

Desktop Virtualization:

- Delivering virtual desktops to users over a network.
- Benefits: Improved security, centralized management, easier device provisioning.

Types Of Virtualization

Application Virtualization:

- Isolating applications from the underlying operating system.
- Benefits: Simplified application deployment and management, improved application compatibility.

Management Virtualization:

- Centralized management and automation of virtualized environments.
- Benefits: Improved IT efficiency, reduced administrative overhead, enhanced control.

OS Virtualization

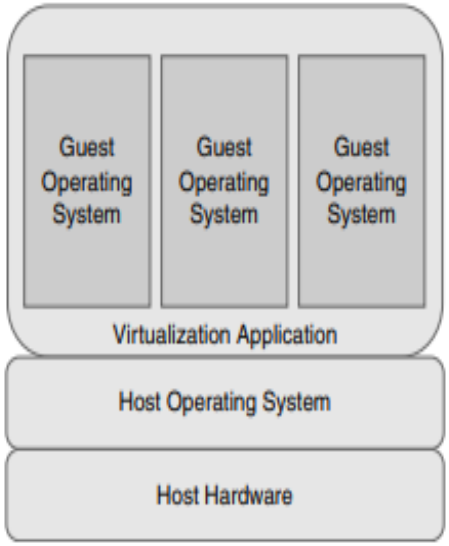

Figure 8.6 OS Virtualization

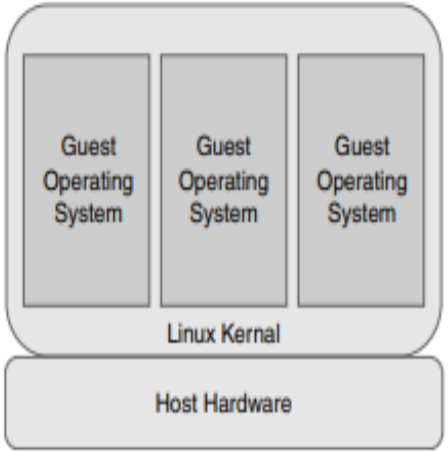

Figure 8.7 Kernel Level Virtualization

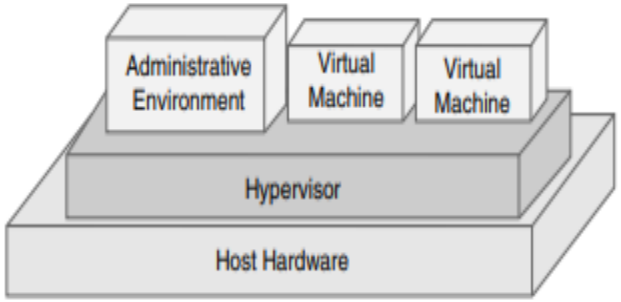

Figure 8.8 Hypervisor Virtualization

OS Virtualization

- Focuses on virtualizing operating system functionalities rather than the entire server hardware.
- Allows multiple users to share a single physical machine and its resources.
- Typically involves a single host OS that provides common services to multiple virtualized OS environments.

Types of OS Virtualization:

Guest OS-based:

- Simplest form.
- Guest OSes run within a virtualization application on top of the host OS.
- Requires no modifications to the host or guest OSes.

Kernel-level:

- Host OS has a modified kernel with extensions for managing multiple guest OSes.
- Each guest OS runs its own kernel.
- Examples: User Mode Linux (UML), Kernel-based Virtual Machine (KVM)

Hypervisor-based:

- A hypervisor (a thin layer of software) sits directly on the hardware.
- Guest OSes run directly on the hypervisor.
- Examples: Xen, VMware ESX Server, Microsoft Hyper-V

Components of OS Virtualization:

- **Server:** Manages the virtualization process, handles virtual disk connections, and may provide storage for virtual disks.
- **Client:** The machine that accesses the virtualized environment.
- **Virtual Disk:** An image file representing a virtual hard drive.
- **Private:** Unique to a specific client, retains settings upon restart.
- **Shared/Common:** Used by multiple clients, changes may not be persistent.

OS Virtualization Process:

- Client connects to the server.
- Server verifies client credentials and allocates a virtual disk.
- Server connects the client to the assigned virtual disk.
- Server streams the OS image to the client.
- Client boots the operating system from the virtual disk.

Benefits of OS Virtualization:

- Resource Sharing: Efficient utilization of hardware resources.
- Reduced Costs: Lower hardware and energy costs.
- Improved Flexibility: Easy provisioning of virtual machines.
- Enhanced Security: Isolation between virtual environments.
- Disaster Recovery: Easy restoration of virtual machines.

Limitations of OS Virtualization:

- **Offline Work Limitations:** Requires a network connection to the virtualization server.
- **High-Speed Network Dependency:** Relies on a fast network connection for optimal performance.
- **Limited OS Support:** Not all operating systems are compatible with OS virtualization.
- **Imaging Limitations:** Inherits the limitations of image-based technologies.

Sample Scenarios:

- Citrix XenApp/Terminal Servers: Centralized management of applications and desktops.
- VDI/DDI Solutions: Delivering virtual desktops to users.
- Back-up Servers: Utilizing idle hardware for backup tasks.
- Development/Test Environments: Providing flexible and isolated testing environments.
- Educational Environments: Offering diverse OS environments to students.

Network Virtualization

Definition:

- Combines resources by splitting bandwidth into channels, assigned to devices/users in real-time.
- Each channel is independently secured.

Benefits:

- Simplifies network management.
- Improves productivity and efficiency.
- Centralized management of files, images, programs, and folders.
- Flexible addition/removal of storage media.

Types of Network Virtualization

External Format:

- Combines/subdivides local networks into virtual networks.
- Components: VLAN, Network Switch.

Internal Format:

- Configures a single system with containers or hypervisors (e.g., Xen/KVM domain).
- Improves system efficiency by isolating applications.

Components of a Virtual Network

- Hardware Components: Network switches, adapters (NIC).
- Network Elements: Firewalls.
- Virtualization Elements: VLANs, VMs.
- Storage Devices: Network storage.
- Media: Ethernet cards, fiber channels.

Storage Virtualization

Definition:

- Virtualizes storage devices for better functionality, maintenance, and backup.

Storage Systems:

- Also known as storage arrays or disk arrays.
- Provide high data protection.

Types of Storage Virtualization

Block Virtualization:

- Separates logical storage from physical storage.
- Allows access without knowing the physical location.

File Virtualization:

- Manages NAS by eliminating file-level dependencies.
- Optimizes storage and facilitates migrations.

Benefits of Storage Virtualization

Non-disruptive Data Migration:

- Enables data migration without interrupting I/O access.

Improved Utilization:

- Pooled storage simplifies management.
- Efficient assignment of disks to users.

Risks and Complexities in Storage Virtualization

Risks in Block Virtualization:

- Backing out failed implementations.
- Interoperability and vendor support issues.

Complexities:

- Managing the environment.
- Infrastructure design challenges.
- Software/device performance and scalability.

Virtualization for Green Data Centers

Impact of Virtualization:

- Reduces hardware and power consumption.
- Enables deployment of 8-15 virtual systems on one physical server.
- Promotes desktop virtualization (thin clients).

Future Outlook:

- Cloud computing as a delivery mechanism.

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Virtual clustering

What are Clusters?

- Collection of organizations/institutions in a geographic area, linked by interdependencies.
- Focus on providing a specific product/service.
- Collection of computers working together as a single system.
- Tasks can be executed on any or all computers in the cluster.

Benefits of Clustering

Scientific Applications:

- Cost-effective alternative to supercomputers.

Large ISPs & E-commerce:

- High availability (reduced downtime).
- Load balancing (improved performance).
- Scalability (handle increased traffic).

Graphics Rendering & Animation:

- Enhanced speed and quality for demanding tasks (e.g., film industry).

Benefits of Clustering

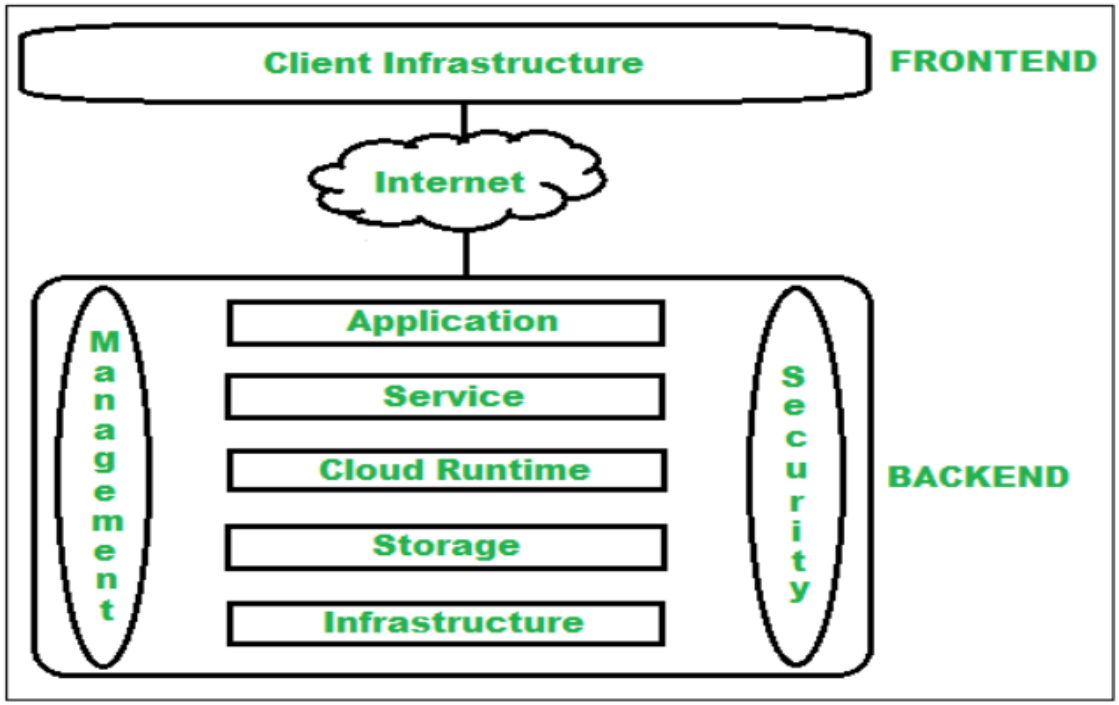
Fail-over Clusters:

- Increased service availability and reliability.
- Automatic failover to redundant systems (e.g., databases, mail servers).

High Availability Load Balancing:

- Improved performance and resource utilization.
- Suitable for stateless applications and concurrent processing.

Anatomy of Cloud Infrastructure



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