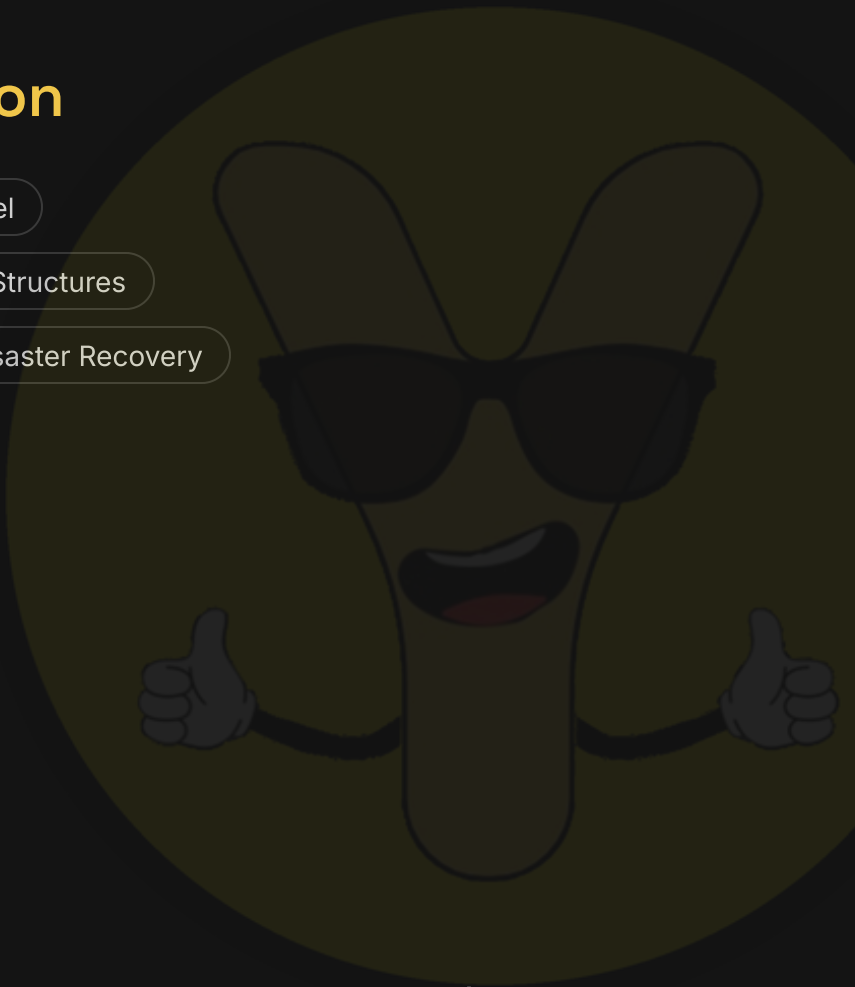
AKTU · 4TH YEAR · SEMESTER 7 · BCS071

Cloud Computing

Unit 2 — Cloud Enabling Technologies And Virtualization

- Service Oriented Architecture
- REST and Systems of Systems
- Web Services
- Publish, Subscribe Model
- Basics of Virtualization
- Types of Virtualization
- Implementation Levels of Virtualization
- Virtualization Structures
- Tools and Mechanisms
- Virtualization of CPU
- Memory
- I/O Devices
- Virtualization Support and Disaster Recovery



DECODED BY

Chirag Jain

Founder, Ycotes · Gold Medalist in Artificial Intelligence, IIT Madras · taught 10,000+ students

theycotes.com

Service Oriented Architecture (SOA)

SOA is an architectural style where services are provided to other components via a communication protocol over a network.

- Services are self-contained, modular, and loosely coupled.
- Core components: Service Provider, Service Consumer, and Service Registry.
- Communication is typically platform-independent.
- Promotes reusability and interoperability in distributed systems.
- Enables business agility by allowing services to be composed into complex workflows.

REST and Systems of Systems

Representational State Transfer (REST) is an architectural style for designing networked applications.

- REST uses standard HTTP methods: GET, POST, PUT, DELETE.
- Stateless: Each request from client to server must contain all necessary information.
- Resources are identified by URIs (Uniform Resource Identifiers).
- Systems of Systems (SoS) refers to the integration of independent, distributed systems.
- REST facilitates SoS by providing a uniform interface for disparate system components.

Web Services

Web services are software systems designed to support interoperable machine-to-machine interaction over a network.

- SOAP (Simple Object Access Protocol): XML-based protocol for exchanging structured information.
- WSDL (Web Services Description Language): XML format for describing network services.
- UDDI (Universal Description, Discovery, and Integration): Directory service for registering and searching web services.
- Web services allow applications to communicate regardless of programming language or OS.

Publish-Subscribe Model

A messaging pattern where senders (publishers) do not program messages to be sent directly to specific receivers.

- Decouples the publisher from the subscriber.
- Messages are categorized into topics or classes.
- Subscribers express interest in one or more topics.
- The message broker handles the routing of messages from publishers to subscribers.
- High scalability and flexibility for distributed cloud environments.

Basics of Virtualization

VIRTUALIZATION

The process of creating a software-based (virtual) representation of something, such as applications, servers, storage, and networks.

- It abstracts hardware from the operating system.
- Allows multiple virtual machines (VMs) to run on a single physical host.
- Increases resource utilization and hardware efficiency.
- Provides isolation between different virtual environments.

Types of Virtualization

Type	Description
Full Virtualization	Hardware is completely simulated; guest OS is unaware.
Para-virtualization	Guest OS is modified to communicate with the hypervisor.
OS-level	Virtualization at the kernel level; containers share the host kernel.
Hardware-assisted	Uses CPU features (Intel VT-x, AMD-V) to improve performance.

Implementation Levels of Virtualization

Virtualization Structures

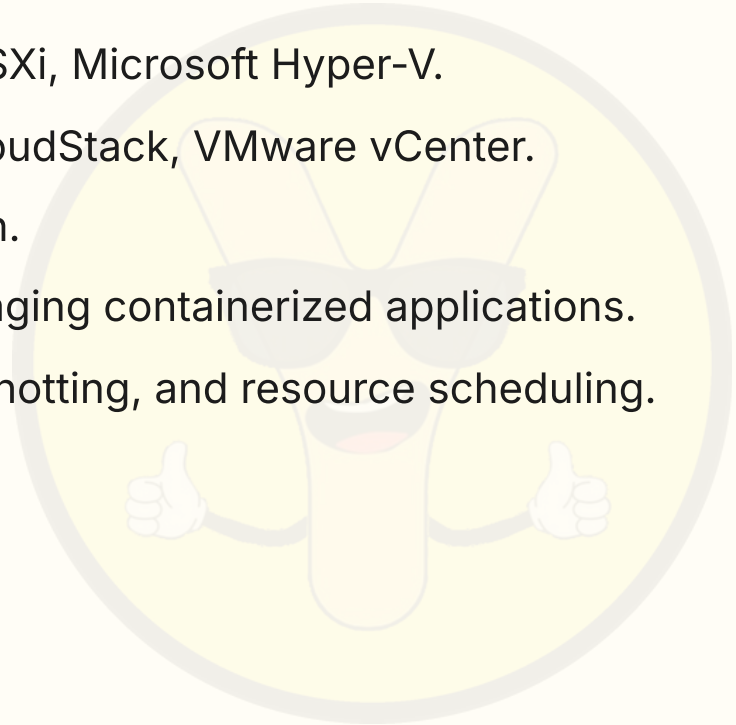
Virtualization structures define how the hypervisor interacts with hardware.

- Type 1 Hypervisor (Bare-metal): Runs directly on the physical hardware (e.g., Xen, VMware ESXi).
- Type 2 Hypervisor (Hosted): Runs on top of a conventional OS (e.g., VirtualBox, VMware Workstation).
- Type 1 is more efficient for data centers.
- Type 2 is preferred for testing and development environments.

Tools and Mechanisms

Essential tools used for managing virtualized cloud environments.

- Hypervisors: Xen, KVM, VMware ESXi, Microsoft Hyper-V.
- Management Tools: OpenStack, CloudStack, VMware vCenter.
- Container Engines: Docker, Podman.
- Orchestration: Kubernetes for managing containerized applications.
- Mechanisms: Live migration, snapshotting, and resource scheduling.



Virtualization of CPU

CPU virtualization allows multiple guest OSs to share the physical CPU.

- Hypervisor intercepts privileged instructions from the guest OS.
- Binary translation: Translating non-virtualizable instructions into safe equivalents.
- Hardware-assisted virtualization: Uses special CPU instructions to reduce overhead.
- Time-slicing: Allocating CPU cycles to different VMs based on scheduling algorithms.

Virtualization of Memory

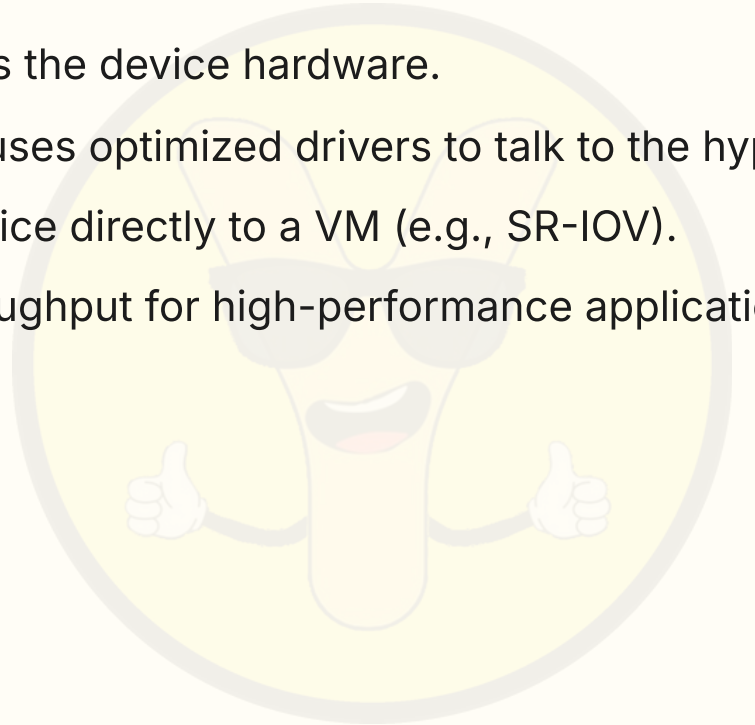
Memory virtualization maps guest physical memory to host physical memory.

- Uses a Shadow Page Table or Extended Page Tables (EPT).
- Hypervisor manages the mapping between Guest Physical Address (GPA) and Host Physical Address (HPA).
- Memory ballooning: Reclaiming unused memory from one VM to provide to another.
- Memory overcommitment: Allocating more memory to VMs than physically available.

Virtualization of I/O Devices

I/O virtualization allows VMs to access physical hardware devices.

- Full emulation: Hypervisor simulates the device hardware.
- Para-virtualized drivers: Guest OS uses optimized drivers to talk to the hypervisor.
- Direct I/O: Assigning a physical device directly to a VM (e.g., SR-IOV).
- Reduces latency and improves throughput for high-performance applications.



Virtualization Support and Disaster Recovery

Virtualization enhances disaster recovery (DR) capabilities in cloud computing.

- Snapshotting: Capturing the state of a VM at a specific point in time.
- Live Migration: Moving a running VM from one host to another without downtime.
- High Availability (HA): Automatically restarting VMs on healthy hosts if a physical server fails.
- Reduced RTO (Recovery Time Objective) and RPO (Recovery Point Objective) compared to physical servers.

Exam corner

- **Q1** Explain the role of Hypervisor in cloud computing. Differentiate between Type 1 and Type 2.
- **Q2** What is SOA? How does it contribute to the development of cloud services?
- **Q3** Describe the Publish-Subscribe model with a suitable diagram.
- **Q4** Explain the concept of Memory Virtualization and the role of Shadow Page Tables.
- **Q5** How does virtualization facilitate Disaster Recovery in cloud environments?
- **Q6** Differentiate between Full Virtualization and Para-virtualization.
- **Q7** Discuss the challenges in I/O virtualization and how they are addressed.

Unit 2 done. You are exam-ready.

Revise the Exam corner once more, then open Unit 3 on theycotes.com. Every AKTU subject, unit by unit, free. Notes by Chirag Jain, Ycotes.

