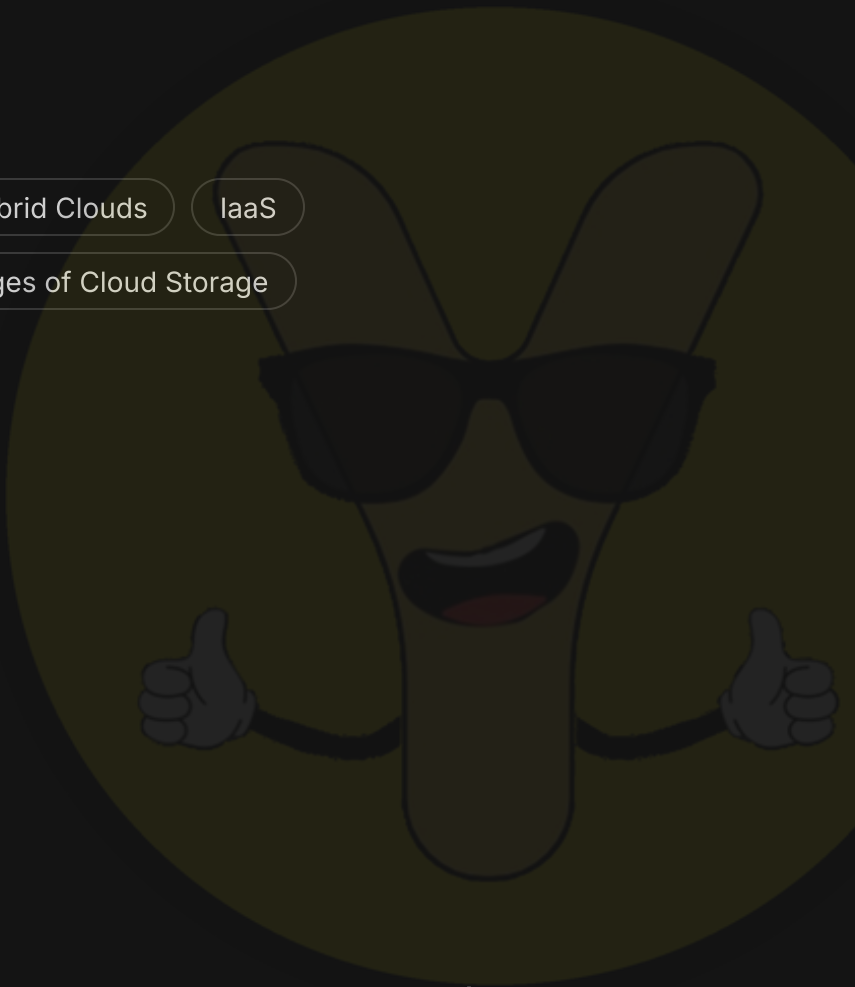
AKTU · 4TH YEAR · SEMESTER 7 · BCS071

Cloud Computing

Unit 3 — Cloud Architecture, Services And Storage

Layered Cloud Architecture Design | NIST Cloud Computing Reference Architecture | Public, Private and Hybrid Clouds | IaaS | PaaS | SaaS | Architectural Design Challenges | Cloud Storage | Storage-as-a-Service | Advantages of Cloud Storage | Cloud Storage Providers | S3



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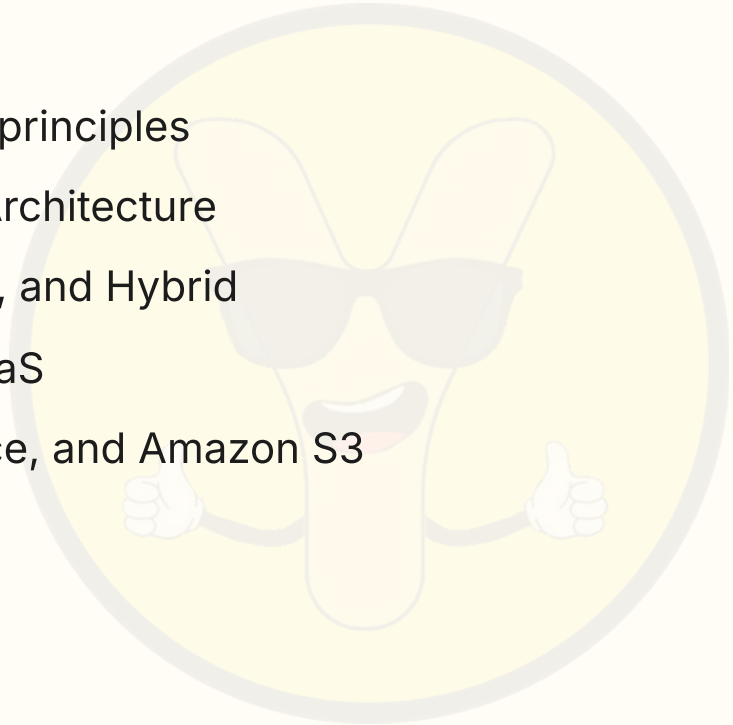
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Unit 3: Cloud Architecture, Services and Storage

Introduction to the structural design, service delivery models, and storage mechanisms in cloud computing.

- Layered Cloud Architecture Design principles
- NIST Cloud Computing Reference Architecture
- Deployment models: Public, Private, and Hybrid
- Service models: IaaS, PaaS, and SaaS
- Cloud storage, Storage-as-a-Service, and Amazon S3

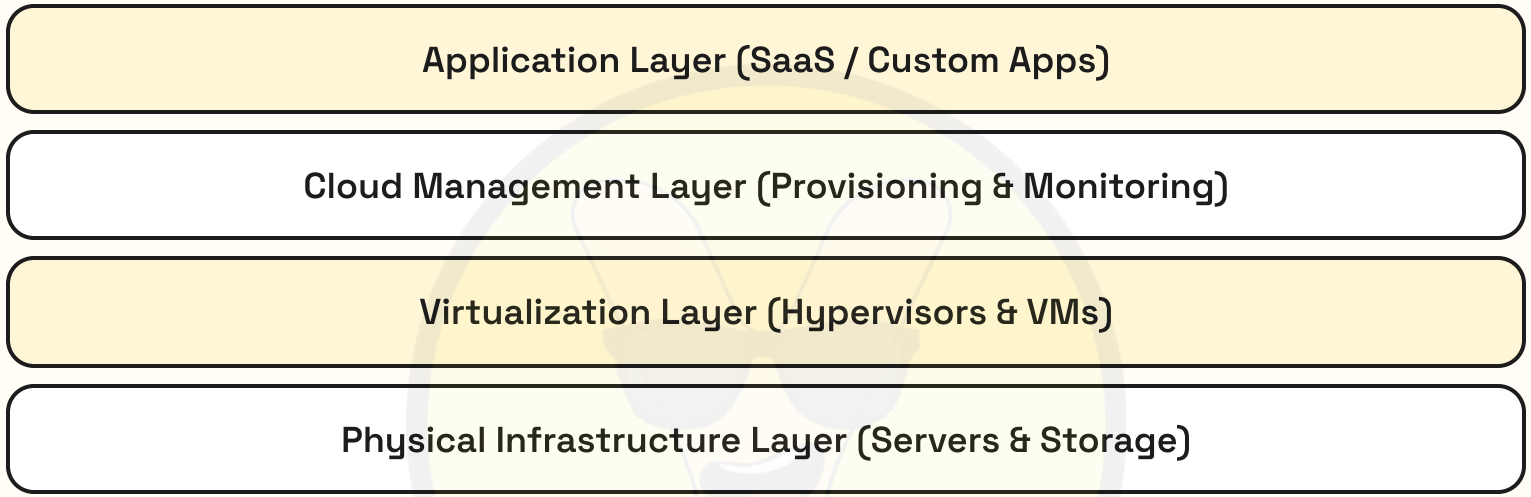


Layered Cloud Architecture Design

Cloud architecture is structured into distinct functional layers to ensure modularity, scalability, and resource abstraction.

- Physical Layer: Hardware, servers, storage devices, and networking infrastructure in datacenters.
- Virtualization Layer: Hypervisors abstracting physical hardware into virtual machines and virtual networks.
- Cloud Management Layer: Resource provisioning, scheduling, monitoring, and metering components.
- Application Layer: End-user applications delivered dynamically over the network.

Layered Cloud Architecture Overview



Top-down structural view of cloud architecture from user applications down to physical hardware.

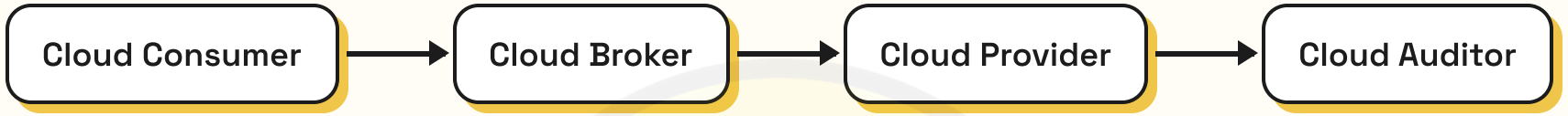
NIST Cloud Computing Reference Architecture

NIST REFERENCE ARCHITECTURE

A conceptual model defined by the National Institute of Standards and Technology that outlines the roles, activities, and interactions of cloud stakeholders.

- Defines five primary actors: Cloud Consumer, Cloud Provider, Cloud Auditor, Cloud Broker, and Cloud Carrier.
- Establishes a standardized framework to design, implement, and govern cloud deployments.

NIST Reference Architecture Actors



Interaction flow among key stakeholders in the NIST reference model.

Deployment Models: Public, Private, Hybrid

Cloud deployment models dictate how infrastructure is hosted, managed, and accessed.

- Public Cloud: Infrastructure owned by a third-party provider (e.g., AWS, Azure) shared among multiple tenants over the public internet.
- Private Cloud: Infrastructure operated solely for a single organization, managed internally or by a third party, offering maximum control and security.
- Hybrid Cloud: A combination of public and private clouds bound together by technology that allows data and application portability.

Comparison of Cloud Deployment Models

Parameter	Public Cloud	Private Cloud	Hybrid Cloud
Ownership	Third-party Provider	Single Organization	Both / Combined
Security/Privacy	Lower (Shared environment)	Highest (Dedicated)	Customizable per workload
Cost	Pay-as-you-go, low upfront	High capital expenditure	Balanced cost efficiency
Scalability	Virtually unlimited	Limited by local hardware	Flexible scale-out to public

Infrastructure-as-a-Service (IaaS)

IAAS

A cloud service model that provides fundamental computing resources such as virtual machines, storage, networks, and operating systems over the internet on a pay-as-you-go basis.

- Consumer controls OS, storage, and deployed applications but not the underlying cloud infrastructure.
- Examples: Amazon EC2, Google Compute Engine, Microsoft Azure VMs.

Platform-as-a-Service (PaaS)

PAAS

A cloud service model that supplies an on-demand environment for developing, testing, delivering, and managing software applications without worrying about underlying hardware or OS maintenance.

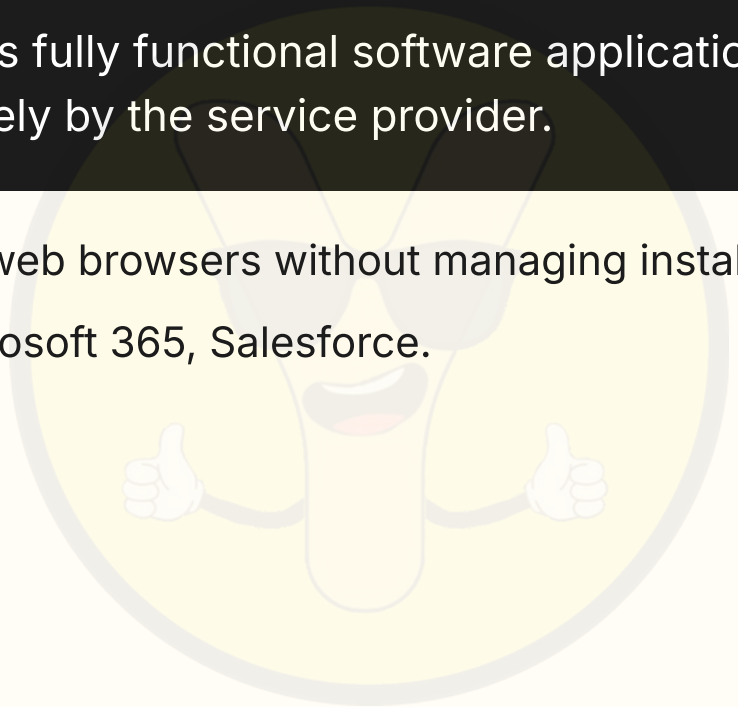
- Provides developers with pre-built tools, database management systems, and middleware.
- Examples: Google App Engine, AWS Elastic Beanstalk, Heroku.

Software-as-a-Service (SaaS)

SAAS

A cloud service model that delivers fully functional software applications over the internet on a subscription basis, managed entirely by the service provider.

- End-users access applications via web browsers without managing installation, updates, or infrastructure.
- Examples: Google Workspace, Microsoft 365, Salesforce.



Service Models Responsibility Matrix

Component	IaaS	PaaS	SaaS
Applications & Data	Customer	Customer	Provider
Runtime & Middleware	Customer	Provider	Provider
Operating System	Customer	Provider	Provider
Servers, Storage, Networking	Provider	Provider	Provider

Architectural Design Challenges in Cloud Computing

Designing robust cloud systems involves overcoming significant technical hurdles.

- Security and Privacy: Ensuring data confidentiality, integrity, and compliance across multi-tenant environments.
- Interoperability and Portability: Avoiding vendor lock-in by enabling seamless workload migration between different clouds.
- Performance and Latency: Managing network bandwidth and latency for distributed applications.
- Reliability and Fault Tolerance: Maintaining high availability and disaster recovery mechanisms against hardware failures.

Cloud Storage and Storage-as-a-Service (STaaS)

CLOUD STORAGE & STAAS

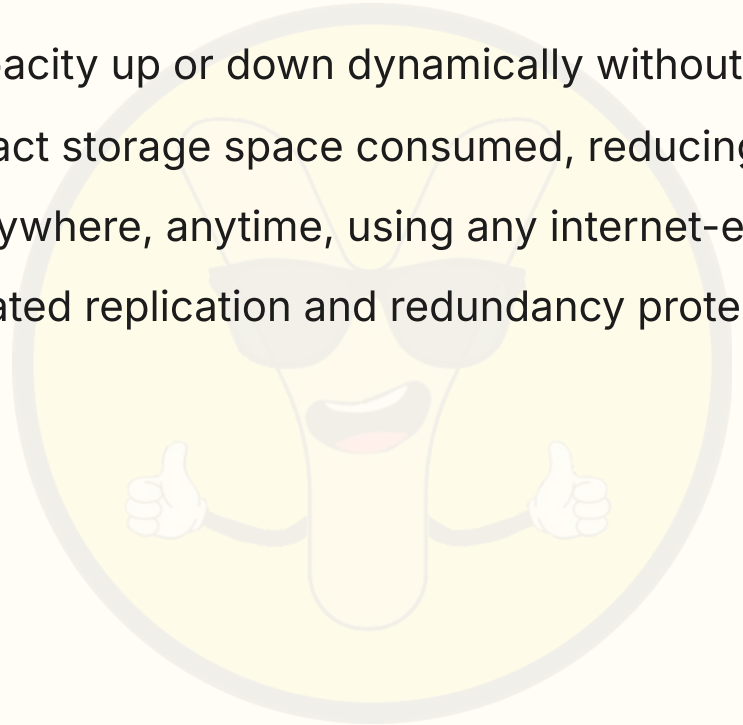
Cloud Storage is a model where data is stored on remote servers accessed via the internet. Storage-as-a-Service (STaaS) is a business model where a provider licenses storage capacity to consumers.

- Data is virtualized and made accessible across multiple distributed physical servers.
- Eliminates the need for organizations to purchase and maintain physical storage area networks (SAN) or hard drives.

Advantages of Cloud Storage

Cloud storage offers major operational and financial benefits over traditional local storage.

- Scalability: Easily scale storage capacity up or down dynamically without hardware upgrades.
- Cost Efficiency: Pay only for the exact storage space consumed, reducing capital expenditure.
- Accessibility: Retrieve data from anywhere, anytime, using any internet-enabled device.
- Data Backup and Recovery: Automated replication and redundancy protect against data loss and hardware failures.



Cloud Storage Providers and Services

Major cloud vendors offer robust, enterprise-grade storage solutions tailored for diverse workloads.

- Amazon Web Services (AWS): Offers Amazon S3 (Object storage), EBS (Block storage), and Amazon EFS (File storage).
- Microsoft Azure: Provides Azure Blob Storage, Azure Disk Storage, and Azure Files.
- Google Cloud Platform (GCP): Offers Google Cloud Storage, Persistent Disk, and Cloud Filestore.
- Enterprise features include tiered storage classes, encryption, and lifecycle management policies.

Amazon Simple Storage Service (S3)

AMAZON S3

An object storage service offered by AWS that provides industry-leading scalability, data availability, security, and performance for storing any amount of data.

- Data is organized into containers called Buckets, and each piece of data is stored as an Object consisting of data, a key, and metadata.
- Designed for 99.999999999% (11 nines) of durability and high availability.

Exam Corner

- **Q1** Explain the Layered Cloud Architecture Design with a neat diagram.
- **Q2** Discuss the NIST Cloud Computing Reference Architecture and its primary actors.
- **Q3** Differentiate between Public, Private, and Hybrid cloud deployment models with examples.
- **Q4** Compare IaaS, PaaS, and SaaS service models highlighting the division of responsibilities.
- **Q5** What are the major architectural design challenges in cloud computing?
- **Q6** Explain Storage-as-a-Service (STaaS) and discuss the key advantages of cloud storage.
- **Q7** Write short notes on Amazon S3 and its core storage concepts.

Unit 3 done. You are exam-ready.

Revise the Exam corner once more, then open Unit 4 on theycotes.com. Every AKTU subject, unit by unit, free. Notes by Chirag Jain, Ycotes.

