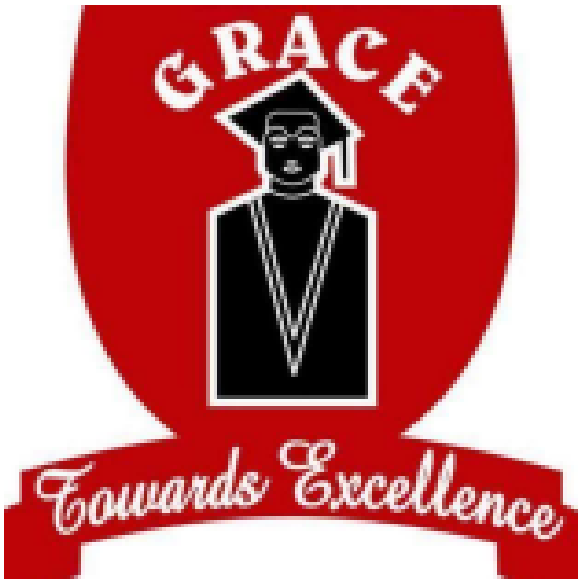


GRACE COLLEGE SHREE N.P. VEKARIYA EDUCATION & CHERITABLE TRUST

B.C.A.

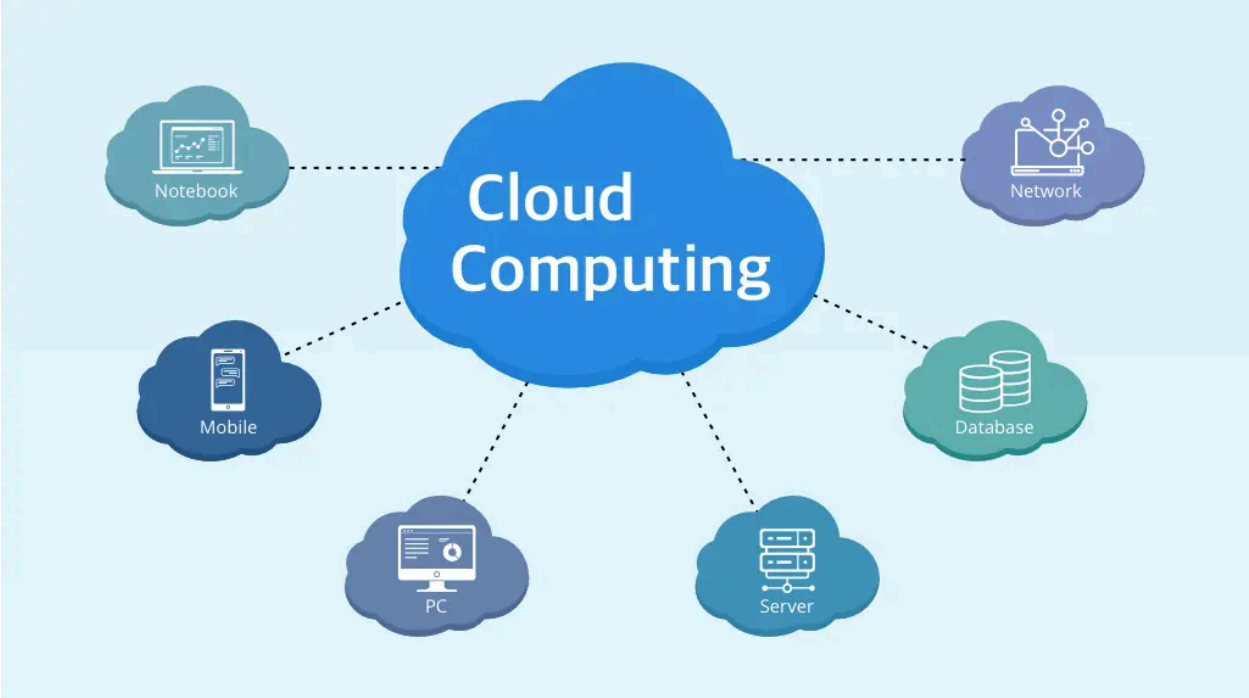
Bachelor of Computer Application (Honours)

(Semester – 6)

CS-39 Introduction of Cloud Computing

Unit–1: Introduction to Cloud Computing

☁️ 1. Introduction to Cloud Computing



Cloud Computing is a technology that provides **computing resources** such as servers, storage, databases, networking, and software **over the Internet** instead of using local machines or physical servers.

🔹 Key Points

- Resources are provided **on-demand**
- No need to buy or maintain hardware
- Pay only for what you use
- Accessible anytime, anywhere

Definition (Exam-Oriented):

> Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort.

☁️ 2. Evolution of Cloud Computing

Cloud computing evolved through several stages:

🕰️ Evolution Stages

1. **Mainframe Computing**

Mainframe Computing refers to the use of large, powerful, and centralized computers (called *mainframes*) that can process huge amounts of data and support hundreds or thousands of users simultaneously.

It was the earliest form of centralized computing and is the foundation of modern cloud concepts like resource sharing and centralized control.

2. **Personal Computing**

Personal Computing refers to the use of individual computers (PCs) designed for single-user operation.

Unlike mainframe computing, where many users shared one powerful system, personal computing gave direct control of computing resources to an individual.

3. **Client–Server Computing**

Client–Server Computing is a distributed computing model where multiple client computers (users) request services or resources from a central server over a network.

It acts as a bridge between personal computing and cloud computing, enabling resource sharing, centralized control, and better collaboration.

4. **Distributed Computing**

   Distributed Computing is a computing model where multiple independent computers (nodes) work together over a network to achieve a common goal.

   Each node has its own processing power and memory, but they coordinate to behave like a single system.

5. **Virtualization**

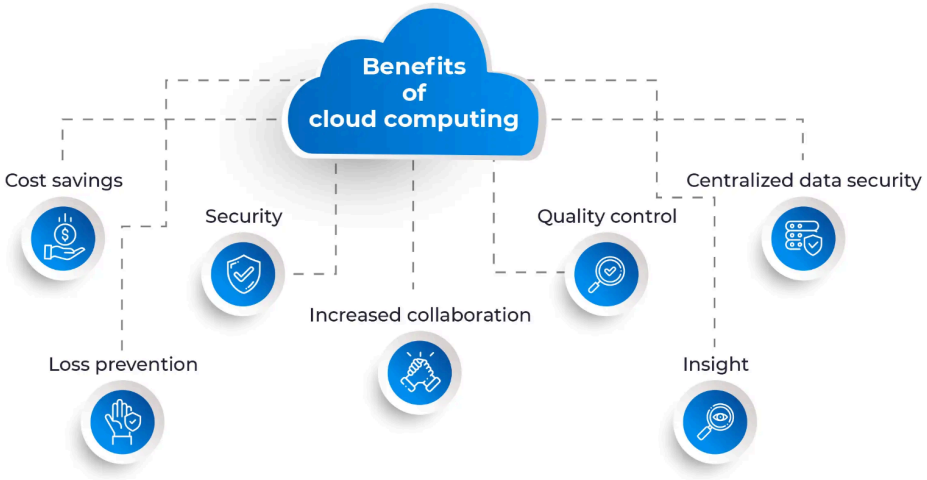
   Virtualization is a technology that allows multiple virtual machines (VMs) to run on a single physical computer by abstracting (separating) the hardware from the operating system.

   Each virtual machine behaves like a real computer with its own OS, applications, CPU, memory, and storage.

6. **Cloud Computing**

Cloud Computing is a modern computing paradigm that enables users to access computing resources over the Internet instead of owning and maintaining physical hardware or software.

☁️ 3. Benefits and Barriers of Cloud Computing



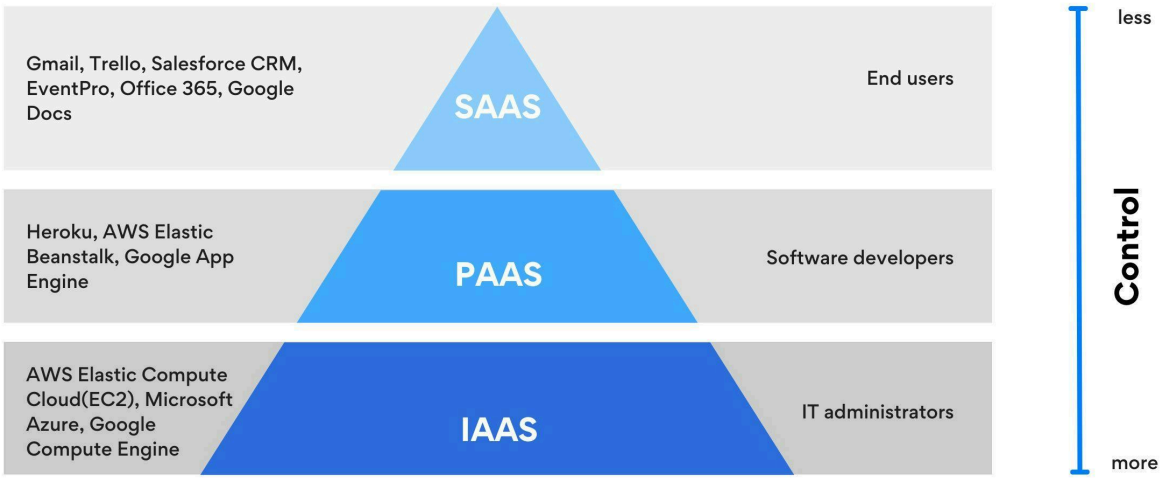
Benefits

- **Cost Reduction** – No hardware investment
- **Scalability** – Easy to increase or decrease resources
- **Accessibility** – Global access via internet
- **High Availability** – Data backup and recovery
- **Automatic Updates** – Managed by provider
- **Environment Friendly** – Shared infrastructure

Barriers (Limitations)

- **Security & Privacy Issues**
- **Internet Dependency**
- **Limited Control**
- **Vendor Lock-in**
- **Downtime Risks**
- **Legal & Compliance Issues**

☁️ 4. Cloud SPI Models



SPI stands for **Software, Platform, Infrastructure**.

1. IaaS (Infrastructure as a Service)

- Provides virtual machines, storage, networks
- User controls OS and applications

  Example: Virtual servers

2. PaaS (Platform as a Service)

- Provides development platform
- No need to manage hardware

  Example: App development platforms

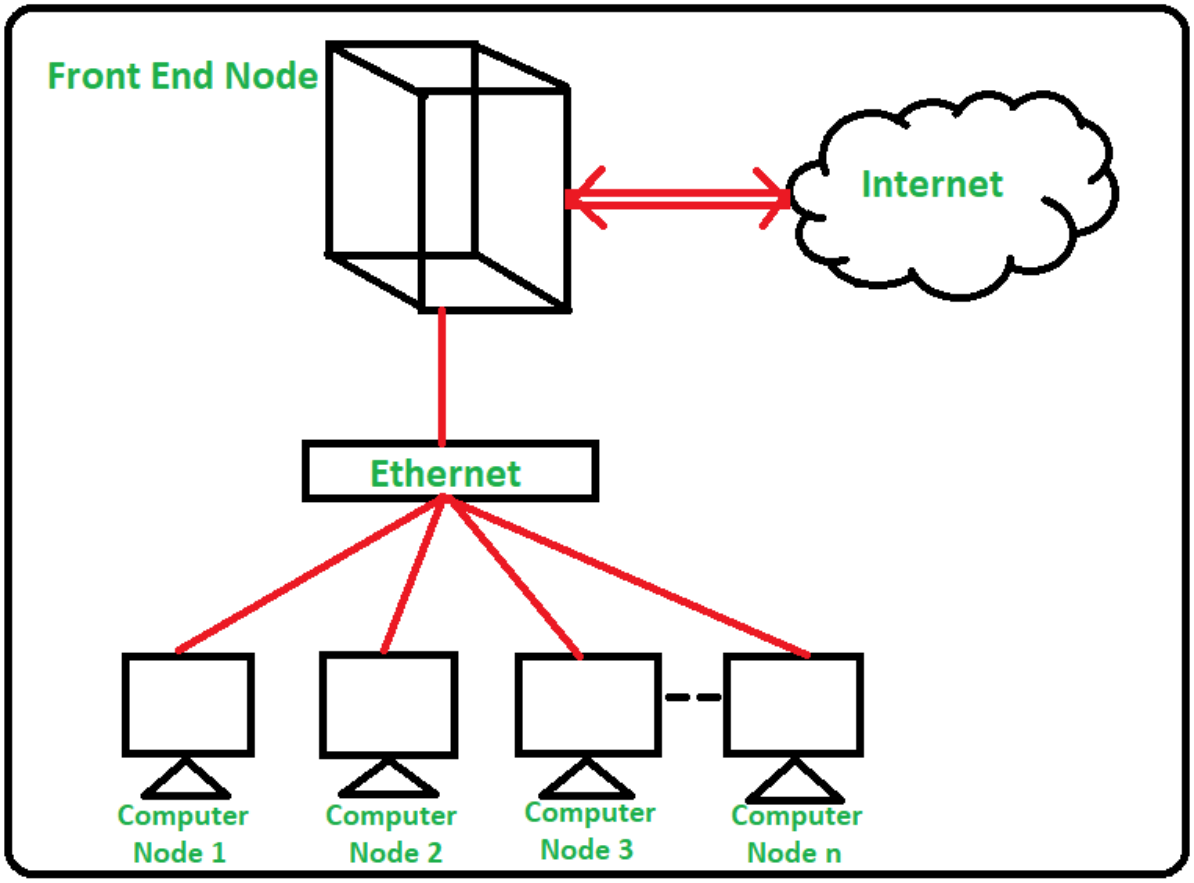
3. SaaS (Software as a Service)

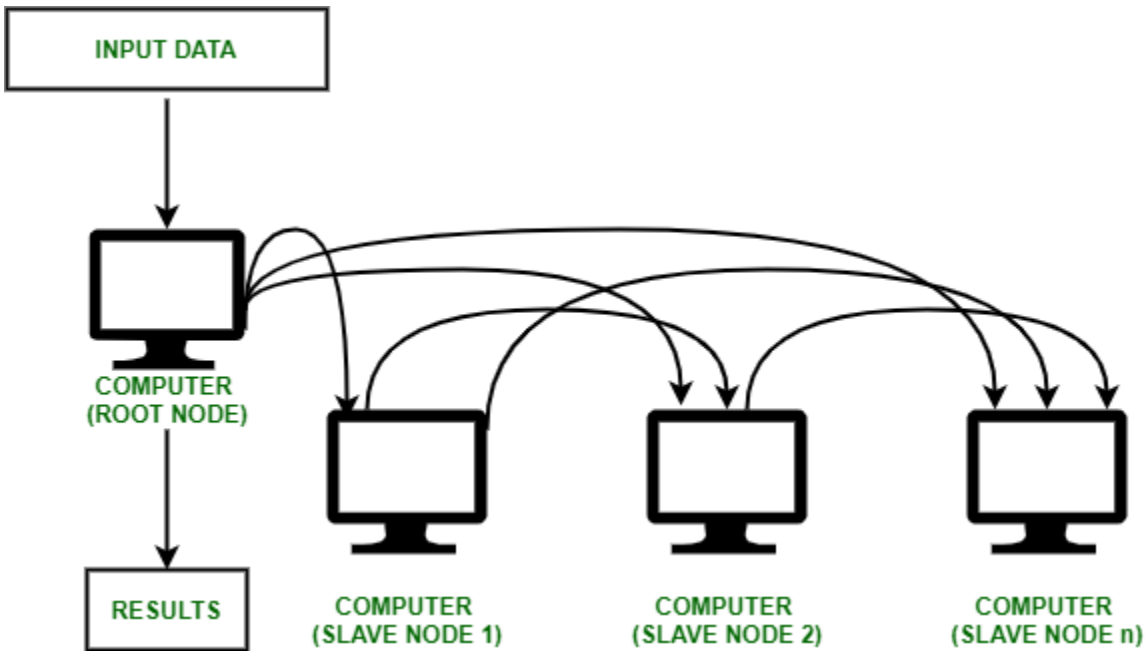
- Complete software delivered via browser
- No installation required

  Example: Email, cloud storage

☁️ 5. Cloud Computing vs Cluster Computing

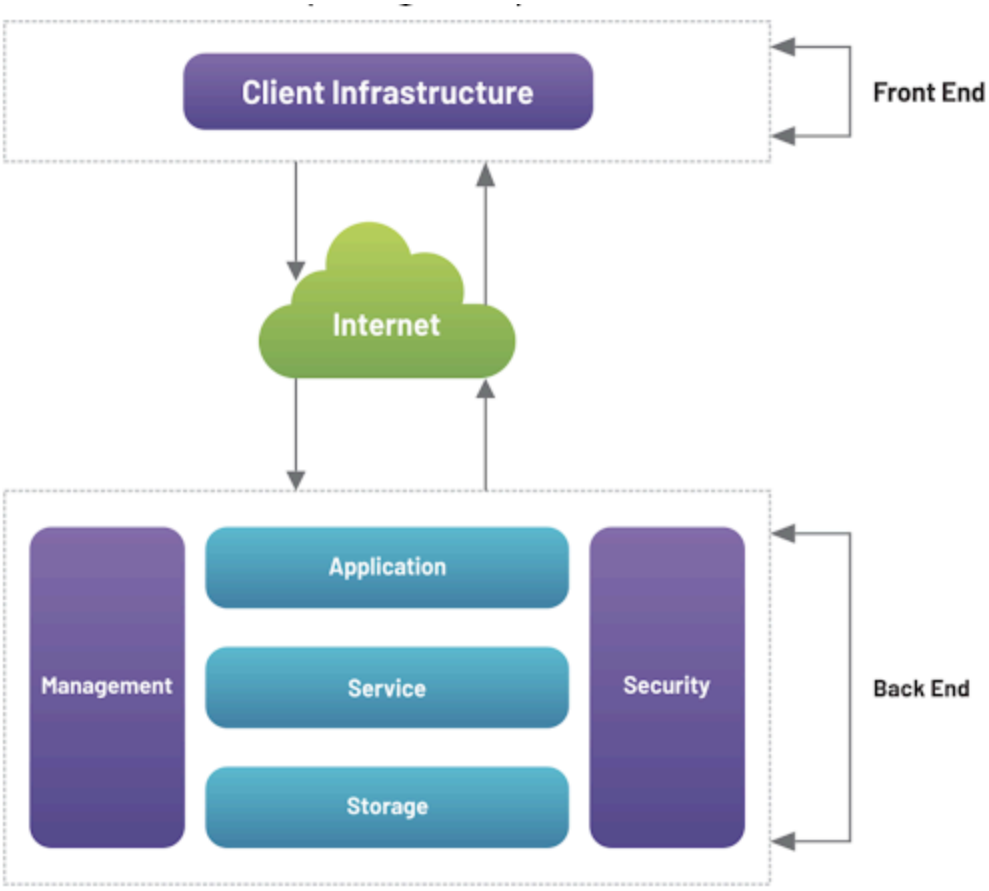
Cloud computing / Cluster computing


Front End Node
Internet
Ethernet
Computer Node 1
Computer Node 2
Computer Node 3
Computer Node n


INPUT DATA
COMPUTER (ROOT NODE)
RESULTS
COMPUTER (SLAVE NODE 1)
COMPUTER (SLAVE NODE 2)
COMPUTER (SLAVE NODE n)

Feature	Cloud Computing	Cluster Computing
Ownership	Third-party provider	Single organization
Scalability	Highly scalable	Limited scalability
Cost Model	Pay-as-you-use	High upfront cost
Access	Internet-based	Local network
Management	Provider-managed	Self-managed

☁️ 6. Cloud Architecture



Cloud architecture defines how cloud services are designed and delivered.

Main Components

1. Front End

- User interface (browser, app)
- Client-side applications

2. Back End

- Cloud servers
- Storage systems

- Databases
- Virtual machines

3. Network

- Internet connection
- Connects front end and back end

4. Cloud Service Provider

- Manages infrastructure and services

Unit–1 Summary

- Cloud computing provides **on-demand IT resources**
- Evolved from **mainframes to virtualized systems**
- Offers **cost efficiency and scalability**
- SPI models define **service levels**
- Cloud differs from cluster computing in **ownership & scalability**
- Architecture includes **front end, back end, and network**

Unit–2: Management in Cloud Computing

☁️ Introduction to Cloud Management

Cloud Management refers to the **administration, monitoring, control, and optimization** of cloud computing resources and services.
Its main goal is to ensure **performance, availability, security, and cost efficiency** of cloud services.

1. Service Level Agreements (SLAs)

📌 What is SLA?

A **Service Level Agreement (SLA)** is a **formal contract** between a **cloud service provider** and a **customer** that defines the **quality, availability, and responsibilities** of the service.

🔹 Key Objectives of SLA

- Ensure service reliability
- Define performance standards
- Protect customer interests

- Avoid misunderstandings

🔹 **Components of SLA**

- **Service Availability** – e.g., 99.9% uptime
- **Performance Metrics** – response time, latency
- **Responsibilities** – provider vs customer
- **Security Terms** – data protection measures
- **Penalty Clauses** – compensation if SLA is violated
- **Support & Maintenance** – response time for issues

🔹 **Importance of SLA**

- Builds **trust**
- Ensures **accountability**
- Helps in **risk management**

🔹 **2. Quality of Service (QoS)**

📌 **What is QoS?**

Quality of Service (QoS) refers to the **overall performance level** of cloud services delivered to users.

QoS Parameters

- **Availability** – service uptime
- **Latency** – delay in response
- **Throughput** – amount of data processed

- **Reliability** – error-free service
- **Scalability** – ability to handle load
- **Security** – data safety

Role of QoS in Cloud

- Guarantees consistent performance
- Improves user experience
- Helps providers meet SLA commitments

3. Scaling Cloud Hardware

📌 **What is Scaling?**

Scaling is the process of **increasing or decreasing cloud resources** based on demand.

🔹 **Types of Scaling**

1. Vertical Scaling (Scale Up / Down)

- Increase CPU, RAM, storage of a server
- Example: Upgrading server capacity

Limitation: Hardware limits

2. Horizontal Scaling (Scale Out / In)

- Add or remove servers

- Load distributed across systems

Advantage: Better fault tolerance

Auto Scaling

- Automatically adjusts resources
- Based on traffic or workload
- Reduces cost and improves efficiency

4. Managing Data in Cloud Computing

Importance of Data Management

Cloud systems handle **huge volumes of data**, so efficient management is critical.

Data Management Activities

- **Data Storage** – object, block, file storage
- **Data Backup** – regular data copies
- **Data Recovery** – restore data after failure
- **Data Replication** – duplicate data across locations
- **Data Migration** – moving data between clouds

Benefits

- High availability
- Disaster recovery
- Data consistency
- Scalability

5. Cloud Security and Privacy

Cloud Security

Cloud security involves **policies, technologies, and controls** to protect data and applications.

Security Challenges

- Data breaches

- Unauthorized access
- Insider threats
- Insecure APIs

Security Measures

- **Encryption** – data protection
- **Authentication** – user identity verification
- **Authorization** – access control
- **Firewalls** – network security
- **Intrusion Detection Systems**

Cloud Privacy

Cloud privacy ensures **personal and sensitive data** is not misused.

Privacy Concerns

- Data stored in foreign locations
- Legal and compliance issues
- Data ownership ambiguity

Privacy Protection Techniques

- Data encryption
- Access control policies
- Compliance with laws (GDPR, IT Act)
- Data anonymization

Unit–2 Summary

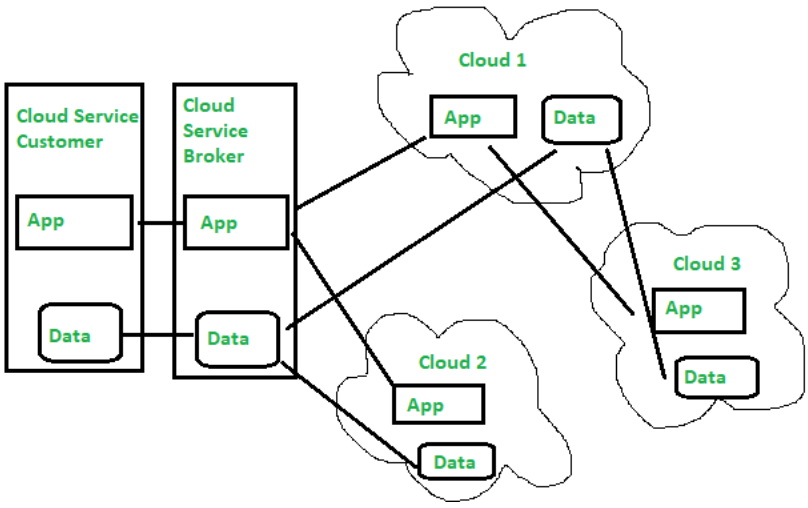
Topic	Key Focus
SLA	Service guarantee and responsibility
QoS	Performance measurement
Scaling	Resource flexibility
Data Management	Storage, backup, recovery
Security & Privacy	Data protection and compliance

Unit–3: Cloud Computing Standards

☁️ Introduction to Cloud Computing Standards

Cloud computing standards are **rules, guidelines, and specifications** that ensure **compatibility, security, interoperability, and quality** among cloud services offered by different providers.
Without standards, cloud systems would become **vendor-specific**, difficult to migrate, and insecure.

1. Cloud Computing Standards and Interoperability



📌 What are Cloud Computing Standards?

Cloud computing standards define **how cloud services should be designed, delivered, managed, and secured** so that different cloud platforms can work together smoothly.

📌 Meaning of Interoperability

Interoperability is the ability of **different cloud systems, platforms, and providers** to:

- Exchange data
- Use shared services
- Work together without compatibility issues

Why Standards are Needed?

- Avoid **vendor lock-in**
- Ensure **data portability**
- Improve **security and compliance**
- Enable **multi-cloud and hybrid cloud**
- Maintain **service quality**

Major Cloud Standard Organizations

- **NIST**
    - Defines cloud computing models and architecture
    - Widely accepted definitions of IaaS, PaaS, SaaS
- **ISO**
    - Develops international cloud security and privacy standards
    - Example: ISO/IEC 27001
- **IEEE**
    - Focuses on cloud interoperability and portability
- **OASIS**
    - Works on cloud service management standards

Levels of Cloud Interoperability

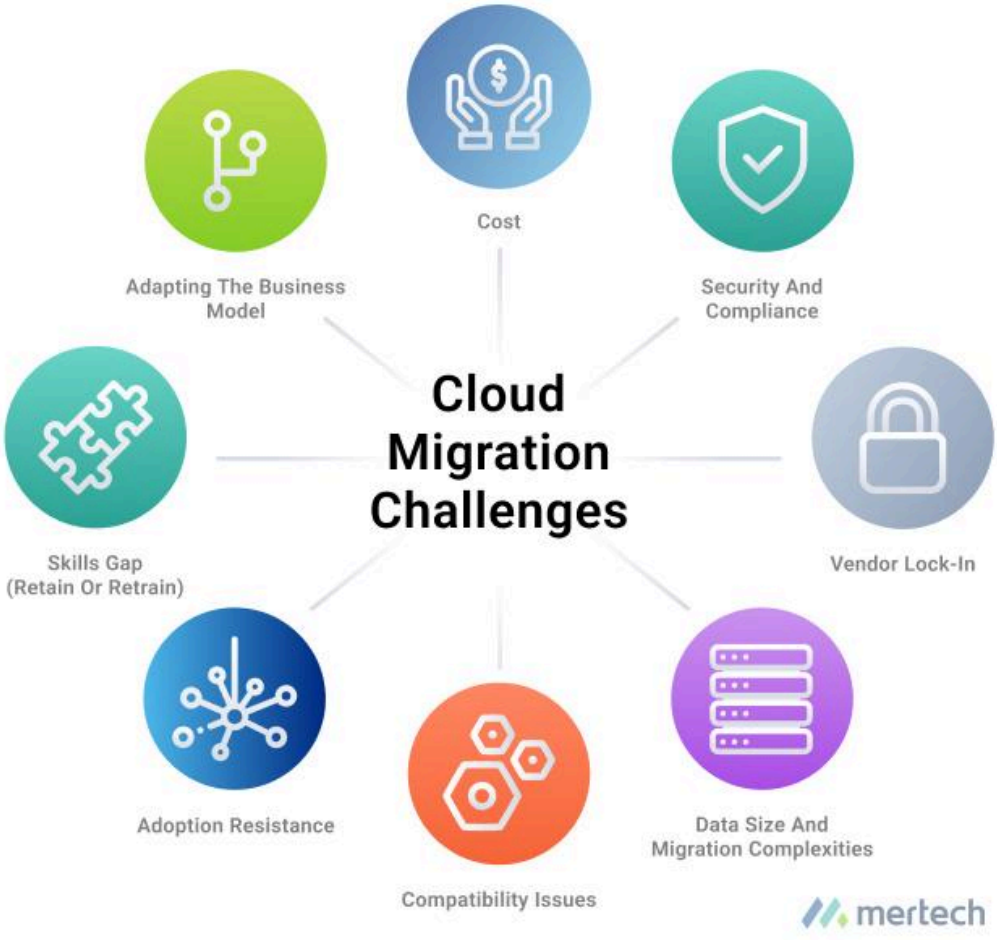
1. **Application Interoperability**
    - Applications can run across different cloud platforms
2. **Data Interoperability**
    - Data formats are compatible
    - Easy data transfer between clouds

3. **Management Interoperability**
    - Unified monitoring and control tools
4. **Service Interoperability**
    - Services from different providers work together

Challenges in Interoperability

- Proprietary APIs
- Different data formats
- Security policy differences
- Performance inconsistency

2. Technical Considerations for Migration to the Cloud



What is Cloud Migration?

Cloud Migration is the process of **moving applications, data, and workloads** from:

- On-premise systems → Cloud
- One cloud → Another cloud

Key Technical Considerations

1. Application Architecture

- Monolithic vs Microservices
- Compatibility with cloud environment
- Refactoring may be required

2. Data Migration

- Data volume and format
- Downtime during migration
- Data consistency and integrity

3. Network Requirements

- Bandwidth availability
- Latency issues
- Secure network connections (VPN)

4. Security and Compliance

- Data encryption
- Identity and access management
- Regulatory requirements (GDPR, IT laws)

5. Performance Expectations

- Load handling
- Response time
- Scalability requirements

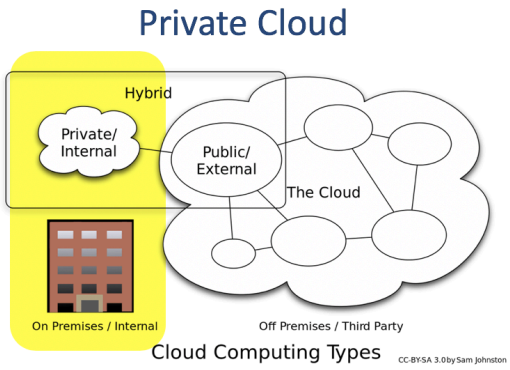
6. Cost Estimation

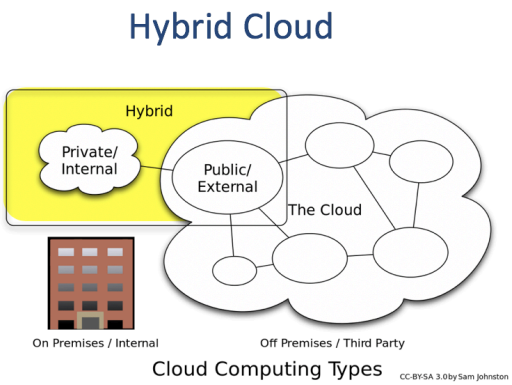
- Storage cost
- Compute usage
- Data transfer charges

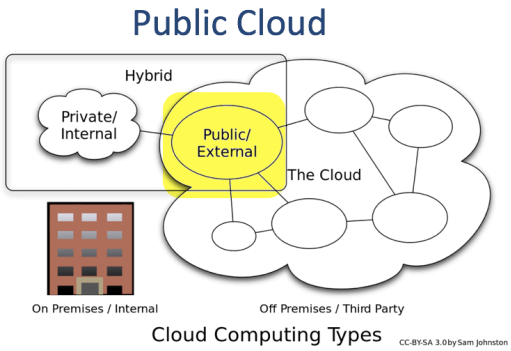
🔹 Migration Strategies (6 R's)

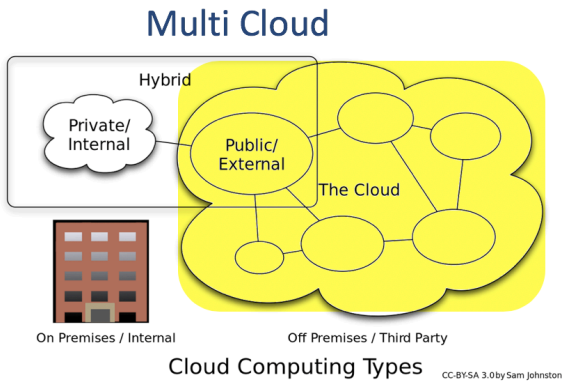
1. **Rehost** – Lift and shift
2. **Refactor** – Modify application
3. **Revise** – Minor changes
4. **Rebuild** – Recreate application
5. **Replace** – Use SaaS
6. **Retire** – Remove unused apps

🔹 3. Cloud Services









Cloud services refer to **IT services delivered over the internet**.

🔹 Cloud Service Models

1. Infrastructure as a Service (IaaS)

- Virtual machines
- Storage
- Networking
- User controls OS and applications

Use Case: Hosting servers

2. Platform as a Service (PaaS)

- Development platform
- Runtime environment
- Database services

Use Case: Application development

3. Software as a Service (SaaS)

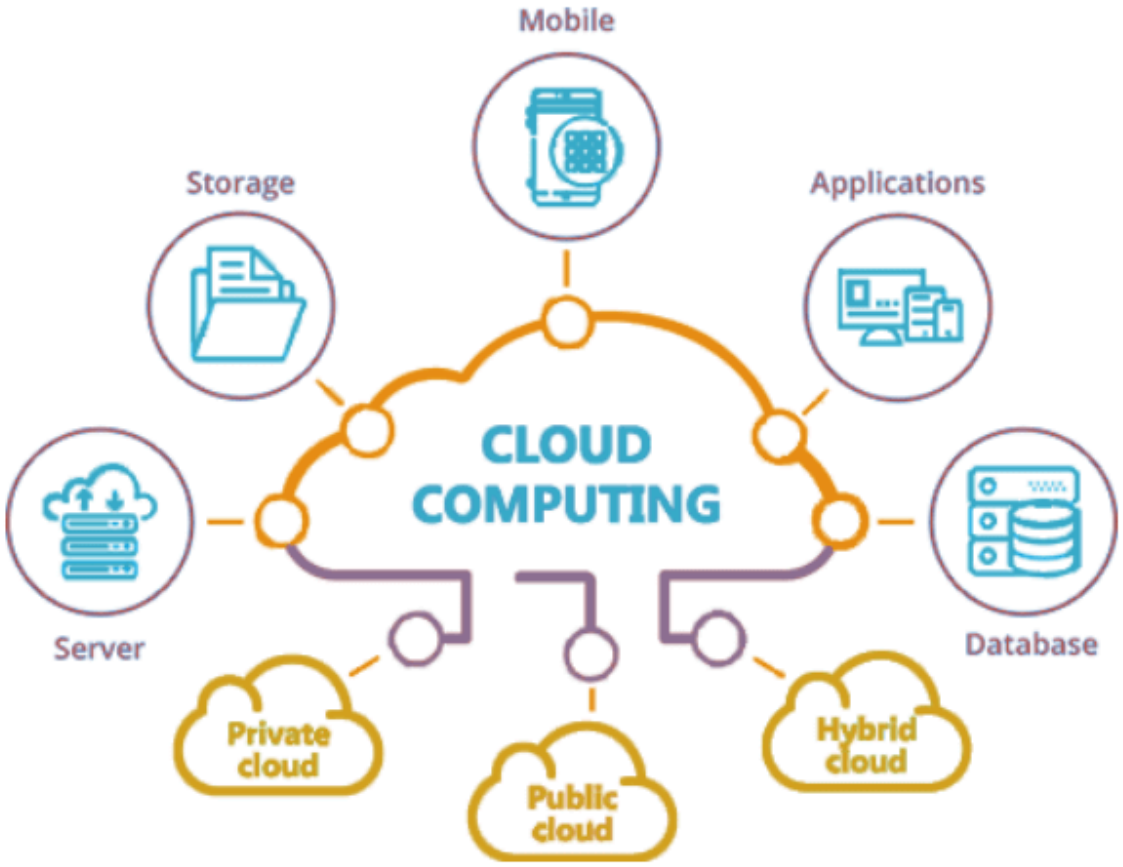
- Complete software
- Accessible via browser
- No installation required

Use Case: Email, CRM systems

🔹 Cloud Deployment Models

- **Public Cloud** – Shared infrastructure
- **Private Cloud** – Dedicated infrastructure
- **Hybrid Cloud** – Combination of public & private
- **Community Cloud** – Shared by organizations with common goals

4. Case Studies



case study

Cloud Power to Save Lives of the Poor

Concern, a global humanitarian NGO, build its worldwide email platform on the cloud in order to reduce IT costs, and to insure efficient communication when providing disaster relief and support.

CHALLENGES

30 Countries

CENTRAL AMERICA
ASIA
AFRICA
With 4,000 Staff

EMAIL PRIORITY

PRODUCTIVITY
DAILY OPERATION
REMOTE WORKING

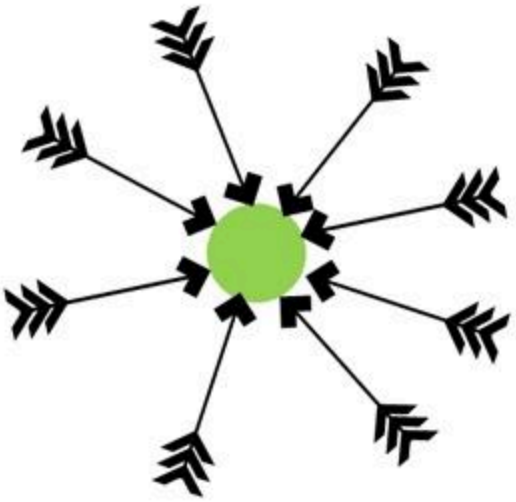
120 CLIENTS vs **1** SERVER

BUSINESS GAPS
SERVER CRASHES
WORK INTERRUPTION
span to weeks

CONCERN WORLDWIDE

Get connected!

OLD EMAIL SYSTEM



GOING TO THE CLOUD?

SOLUTION

Microsoft Office 365

email system

SMB Cloud Adoption

Case Study 1: E-Learning Platform

Problem:

- High traffic during exams
- Server crashes

Cloud Solution:

- Auto-scaling servers
- Cloud storage for video lectures

Benefits:

- High availability
- Reduced infrastructure cost
- Smooth user experience

Case Study 2: Healthcare Data Management

Problem:

- Sensitive patient data
- Compliance requirements

Cloud Solution:

- Encrypted cloud storage
- Access control policies

Benefits:

- Secure data access
- Disaster recovery
- Regulatory compliance

Case Study 3: Startup Application Hosting

Problem:

- Limited budget
- Rapid growth

Cloud Solution:

- Pay-as-you-use model
- Managed cloud services

Benefits:

- Cost efficiency
- Scalability
- Faster deployment

Unit–3 Summary

Topic	Key Points

Standards	Ensure security and compatibility
Interoperability	Enables multi-cloud usage
Migration	Requires technical planning
Cloud Services	IaaS, PaaS, SaaS
Case Studies	Real-world cloud adoption
