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***Unit I Basics of Cloud Computing***

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- CLOUD SYSTEM ARCHITECTURE,
- CLOUD DEPLOYMENT MODELS.

# What is Cloud Computing?

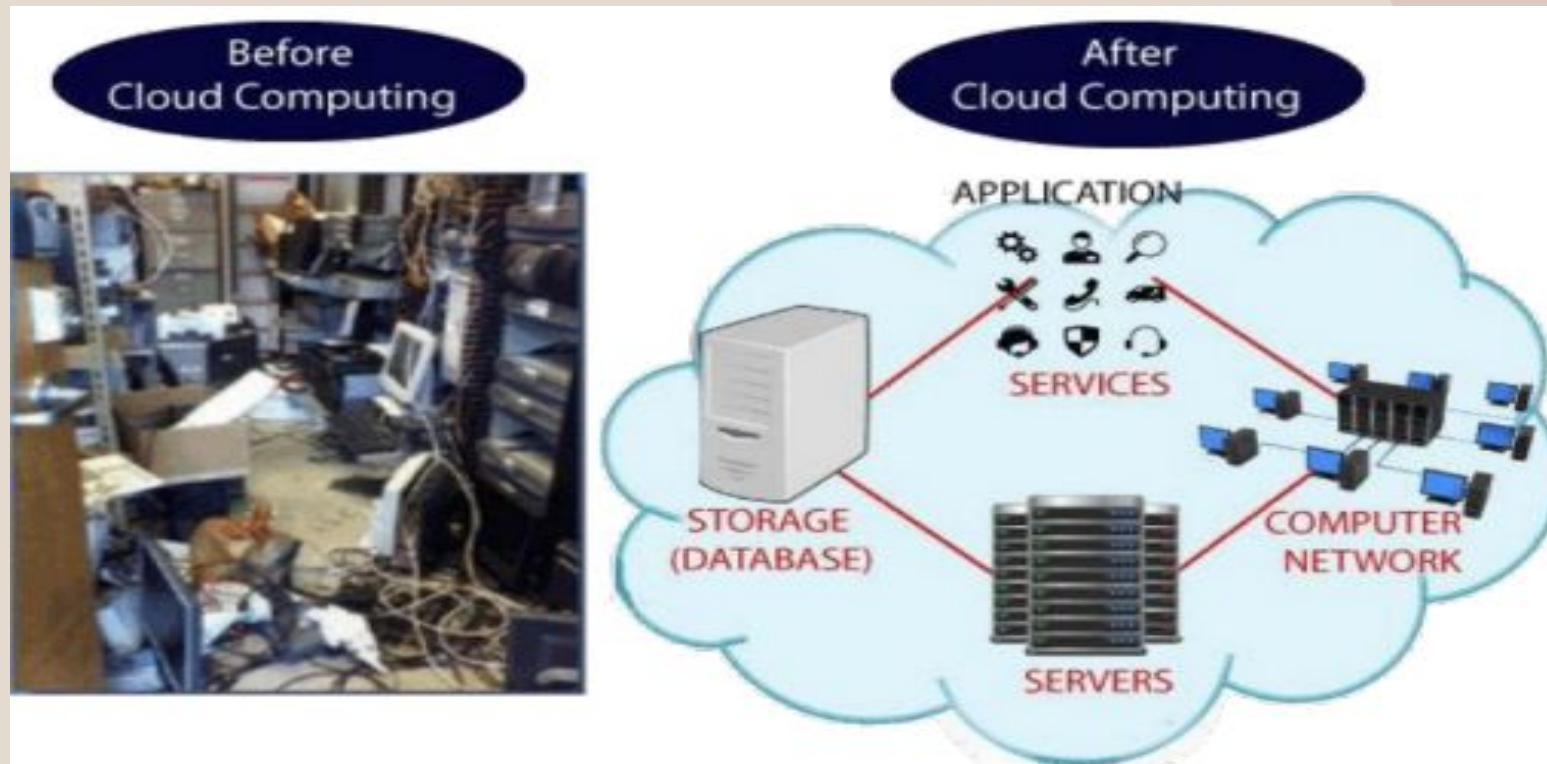
- Storing and accessing the data and programs on remote servers that are hosted on the internet instead of the computer's hard drive or local server.
- It is also referred to as Internet-based computing.
- It refers to the delivery of computing services—including servers, storage, databases, networking, software, analytics, and more—over the internet ("the cloud") on a pay-as-you-go basis.
- Companies can access the computational assets they need, when they need them, without needing to purchase and maintain a physical, on-premise IT infrastructure.

# Key aspects of Cloud Computing

1. On-Demand Access
2. Scalability
3. Resource Pooling
4. Broad Network Access
5. Measured Service

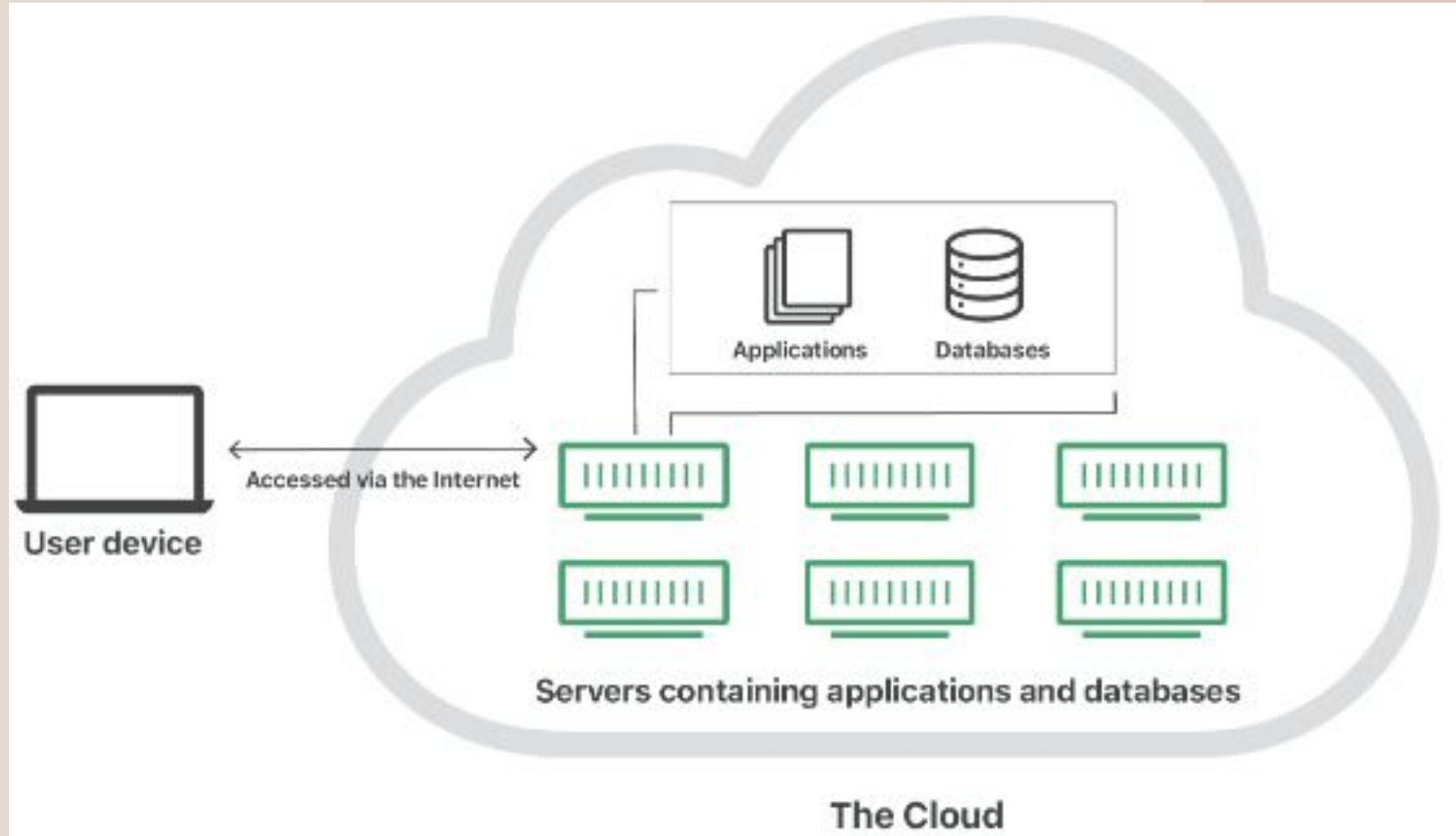
# Why Cloud Computing?

1. Reduces Cost
2. More Storage
3. Employees using cloud computing having better work-life balance



# Basic Concepts & Terminology

- Clouds



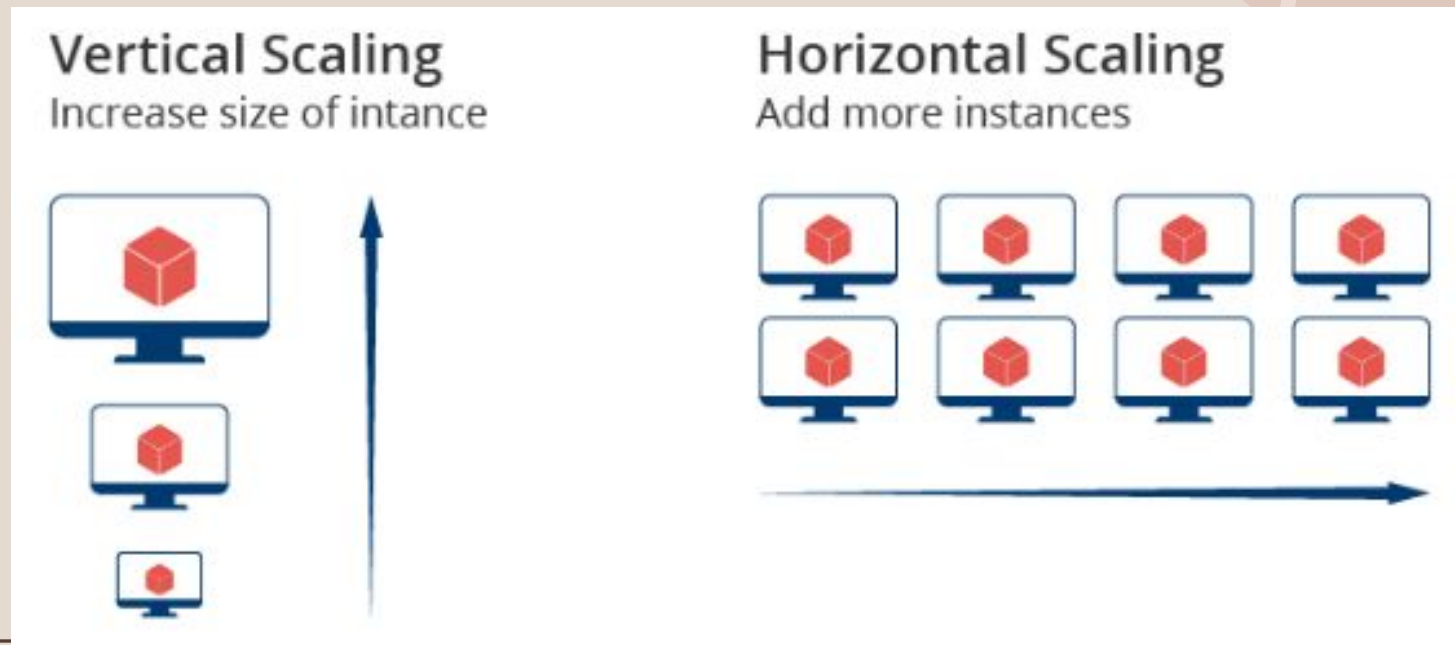
- IT Resource



- Cloud Consumers & Cloud Providers

- Scaling

- Cloud Service



# Evolution of Cloud Computing

- **1960s-1970s:** The early roots of cloud computing trace back to the development of mainframe computers, where multiple users accessed a centralized system.
- **1980s-1990s:** Telecommunications companies began offering Virtual Private Network (VPN) services, allowing remote access to centralized computing resources.
- **1990s:** Internet Service Providers (ISPs) began offering web hosting services, enabling businesses to host their websites on remote servers.
- **Early 2000s:** Salesforce introduced Software as a Service (SaaS) in 1999, delivering enterprise applications over the internet. Amazon Web Services (AWS) launched in 2006, introducing Elastic Compute Cloud (EC2) and providing scalable computing resources.



- **Mid-2000s:** Google launched Google Apps (now G Suite) in 2006, offering cloud-based office productivity tools. Microsoft launched Azure in 2010, entering the cloud computing market.
- **Late 2000s-2010s:** Cloud computing gained significant traction, with more providers offering Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Cloud adoption increased due to scalability, cost-efficiency, and flexibility.
- **2010s-2020s:** The cloud became an integral part of IT strategies for businesses globally. Major providers like AWS, Microsoft Azure, and Google Cloud expanded their services, offering a wide array of solutions from storage and computing to AI/ML and serverless computing.

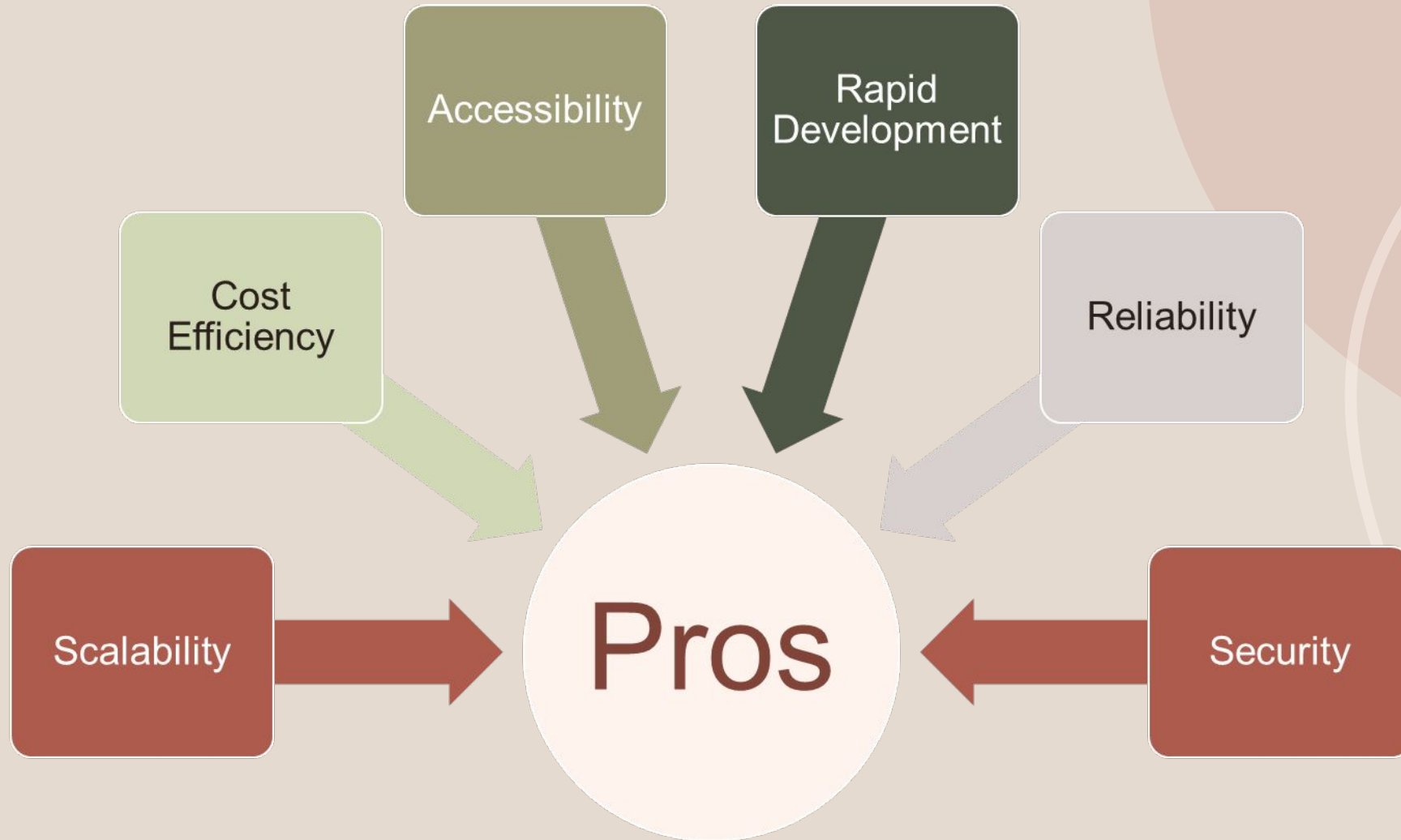
# Importance of Cloud Computing

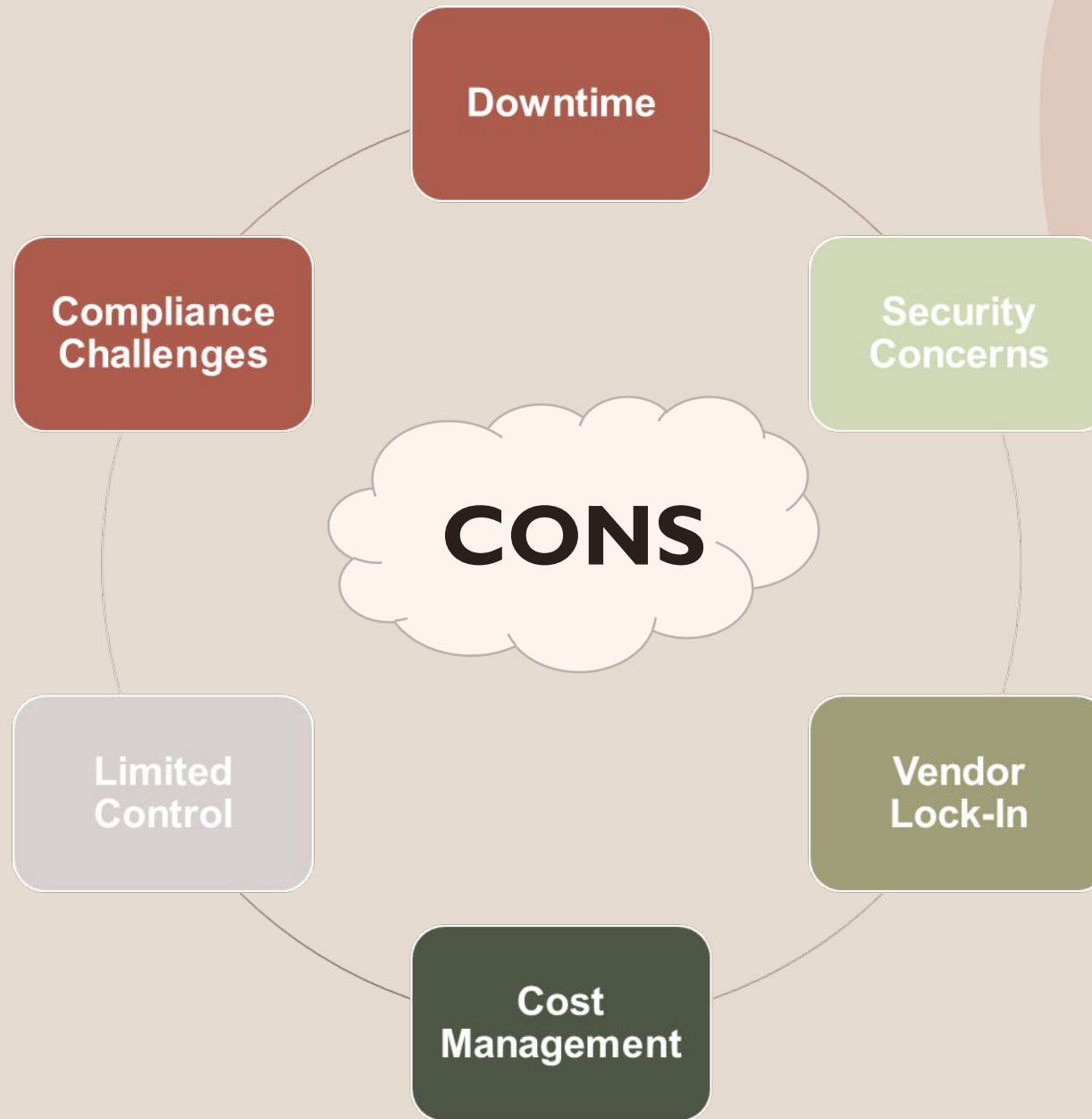
1. Flexibility
2. Scalability
3. Data Recovery
4. Cost-Effectiveness
5. Accessibility & Flexibility
6. Rapid Innovation
7. Reliability & Redundancy
8. Advanced Security Measures
9. Data Analytics and AI
10. Environmental Impact

# Characteristics of Cloud Computing

1. On-demand self-services
2. Broad network access
3. Rapid elasticity
4. Resource Pooling
5. Measured Service
6. Multi-tenancy
7. Virtualization
8. Resilient computing
9. Flexible pricing models
10. Security
11. Automation
12. Sustainability

# Pros and Cons of Cloud Computing





# Migrating into the Cloud

When a company moves some or all of its data center capabilities into the cloud, usually to run on the cloud-based infrastructure provided by a cloud service provider such as AWS, Google Cloud, or Azure.



# Migrating into Cloud

## Benefits

- Scalability
- Cost
- Performance
- Flexibility

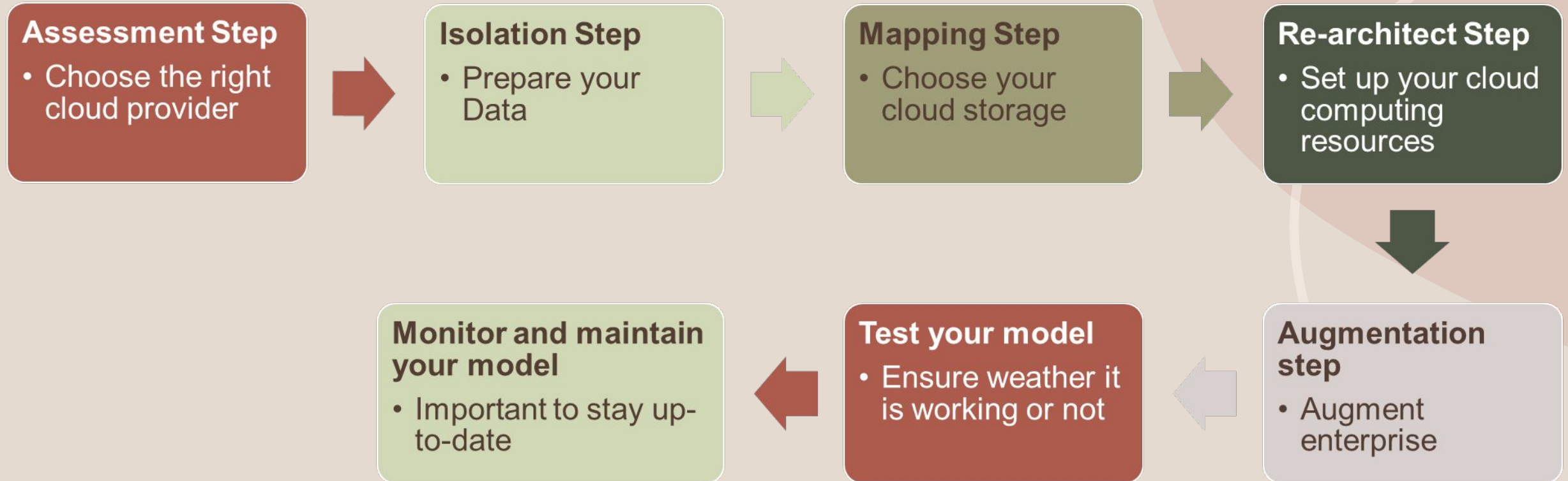
## Challenges

- Migrating Large Databases
- Data Integrity
- Continued Operation
- Security

## Strategies

- Rehost
- Refactor
- Revise
- Rebuild
- Replace

# 7 Steps of Migrating Model in Cloud





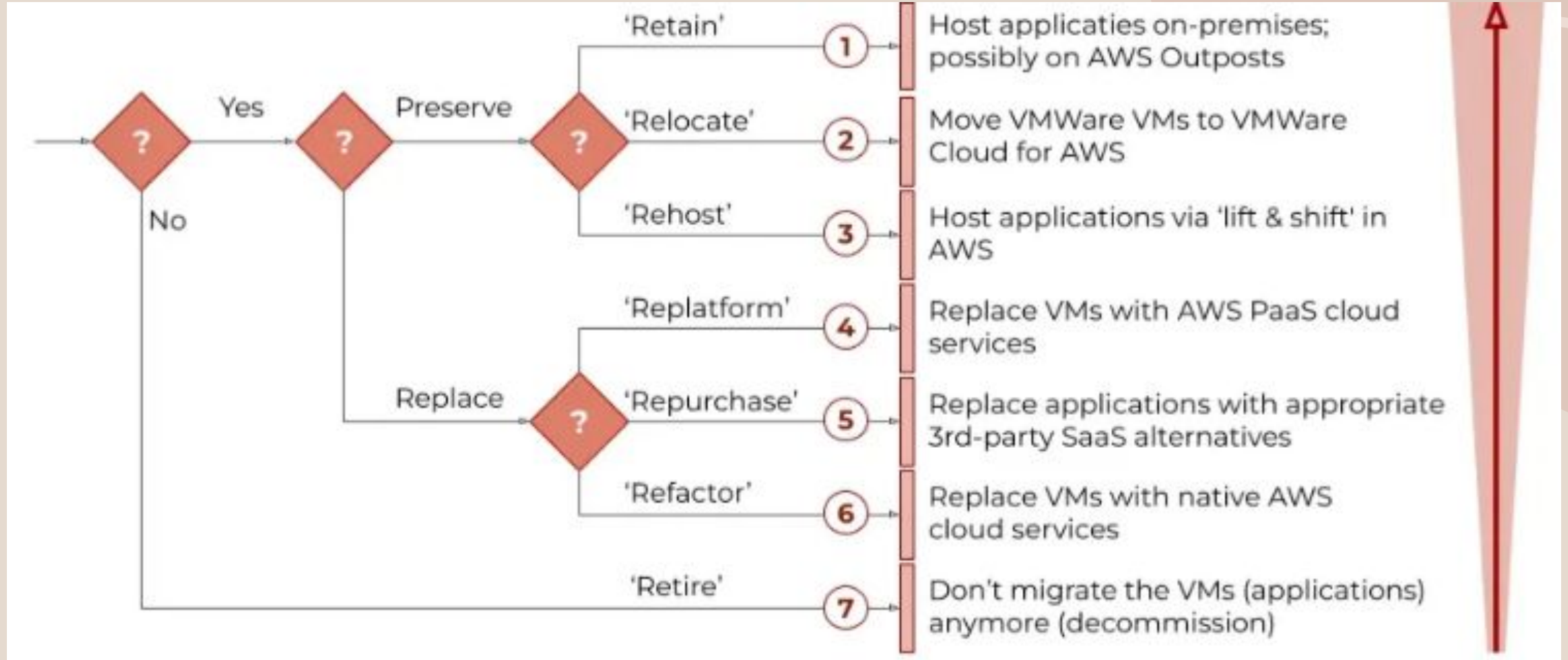
# The R Models

- The concept of using R Models in cloud migration strategies originated from Gartner in 2010 when they introduced the \*5 Rs migration strategy, which provided a framework for organizations to classify their applications based on their suitability for migration to the cloud.
- **Gartner 5 R's migration strategy:** Rehost (lift-and-shift), Refactor (re-architect), Revise (re-platform), Rebuild (re-develop), Replace (drop and shop).
- **AWS 6 R's migration strategy:** Rehost (lift-and-shift), Replatform (lift-tinker-and-shift), Repurchase, Refactor (re-architect), **Retire**.
- After that comes the **AWS 7 R's Model**.

# AWS 7 Rs Model

- As cloud computing has continued to mature, and organizations have become more sophisticated in their approach to migration, AWS introduced the 7 Rs model.
- This latest iteration of the migration framework adds the **Retain** strategy, which recognizes that not all applications and data can or should be moved to the cloud.
- By including the option to retain workloads on-premises, the 7 Rs model provides organizations with even greater flexibility in their migration planning.
- **AWS 7 Rs migration strategy:** Rehost (lift-and-shift), Replatform (lift-tinker-and-shift), Repurchase, Refactor (re-architect), Retire, **Retain**.

# The “7 Rs” in Detail



# Real-Life Examples Using R Models

- **Netflix (Streaming):** They embraced the rehost (lift-and-shift) approach to migrate its massive infrastructure from on-premises data centers to Amazon Web Services (AWS) which allowed them to scale quickly, improve reliability, and reduce costs.
- **Capital One (Banking):** They opted for the repurchase model, replacing its legacy systems with AWS marketplace solutions, leading to improved agility and faster time-to-market for new products and services.
- **Airbnb (Rental Platform):** They utilized the rebuild (re-develop) approach to modernize its infrastructure and embrace a microservices architecture, allowing them to improve scalability, enhance performance, and introduce new features quickly.
- **Expedia (Travel):** They adopted a hybrid approach, leveraging the refactor (re-architect) and repurchase strategies, allowing them to optimize its applications for AWS while also taking advantage of pre-built solutions.

# Trends in Computing

□ IT Maturity Analysis – technologies are compared based on two parameters:

- ❖ Current Investment Rate
- ❖ Current Adoption Rate

□ Technology Trends to Watch

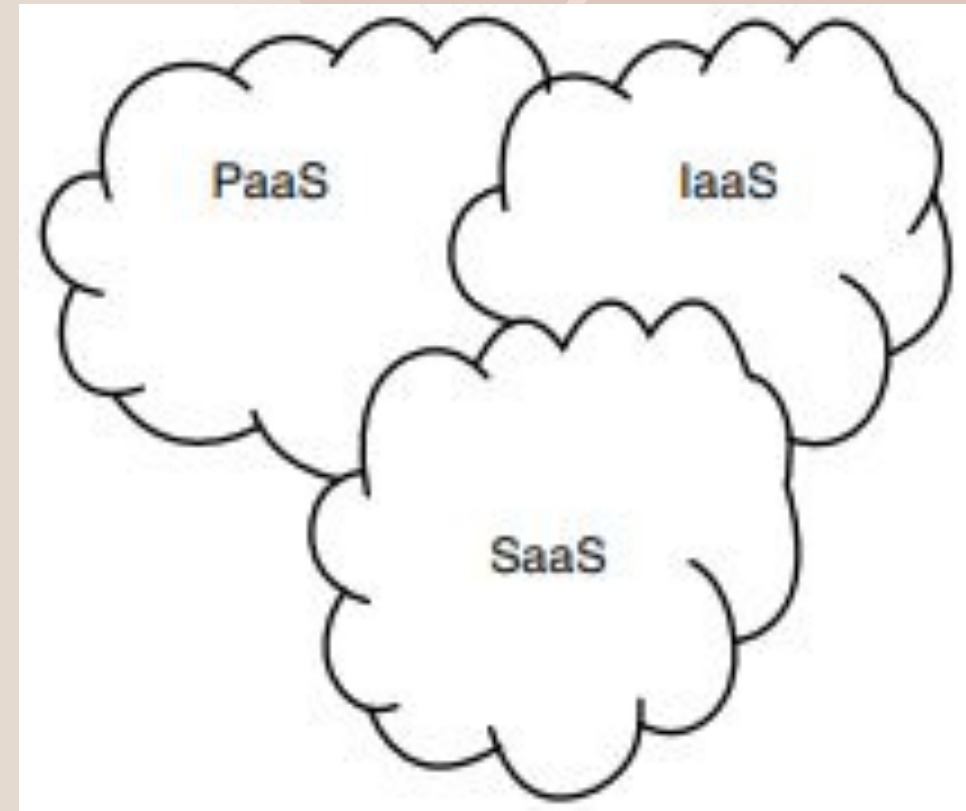
- ❖ Virtualization
- ❖ Data Growth
- ❖ Energy and Green IT
- ❖ Complex Resource Tracking
- ❖ Consumerization & Social Software

# Cloud Service Models

- Cloud Computing can be defined as the practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.
- Cloud services are designed to provide easy, scalable access to applications, resources and services, and are fully managed by a cloud services provider.
- Companies offering such kinds of cloud computing services are called cloud providers and typically charge for cloud computing services based on usage.

# Cloud Service Models (contd.)

- Service models describe the type of service that the service provider is offering. The best known service models are
- **SaaS (Software as a Service)** applications are designed for end-users, delivered over the web.
  - **PaaS (Platform as a Service)** is the set of tools and services designed to make coding and deploying those applications quick and efficient.
  - **IaaS (Infrastructure as a Service)** is the hardware and software that powers it all – servers, storage, networks, operating systems.





## On-Premises

Applications  
Data  
Runtime  
Middleware  
O/S  
Virtualization  
Servers  
Storage  
Networking

You Manage

## Infrastructure as a Service

Applications  
Data  
Runtime  
Middleware  
O/S  
Virtualization  
Servers  
Storage  
Networking

## Platform as a Service

Applications  
Data  
Runtime  
Middleware  
O/S  
Virtualization  
Servers  
Storage  
Networking

Other Manages

## Software as a Service

Applications  
Data  
Runtime  
Middleware  
O/S  
Virtualization  
Servers  
Storage  
Networking



# 1 SaaS

- SaaS is cloud-hosted, ready-to-use application software.
- Instead of installing and maintaining software, we simply access it via the Internet, freeing ourselves from the complex software and hardware management.
- SaaS provides a complete software solution that you purchase on a pay-as-you-go basis from a cloud service provider.
- Most SaaS applications can be run directly from a web browser without any downloads or installations required.
- The SaaS applications are sometimes called Web-based software, on-demand software, or hosted software.

# Characteristics of SaaS

- Applications stored remotely.
- Access services through internet.
- No installation required.
- Application delivery from one-to-many model.

# Advantage & Disadvantage of SaaS

## Advantages

- **Cost-Effective**
- **Reduced Time**
- **Accessibility**
- **Automatic updates**
- **Scalability**

## Disadvantages

- **Limited customization**
- **Dependency on internet connectivity**
- **Security concerns**
- **Limited control over data**

## 2 PaaS

- It provides a platform and environment to allow developers to build applications and services over the internet.
- PaaS services are hosted in the cloud and accessed by users simply via their web browser.
- A PaaS provider hosts the hardware and software on its own infrastructure.
- The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage.

# Characteristics of PaaS:

1. Builds on virtualization technology, so computing resources can easily be scaled up (Auto-scale) or down according to the organization's needs.
2. Support multiple programming languages and frameworks.
3. Integrates with web services and databases.

# Advantages & Disadvantages of PaaS

## Advantages

- Simple & Convenient for users
- Cost-effective
- Efficiently managing the lifecycle
- Efficiency

## Disadvantages

- Limited control over infrastructure
- Dependence on the provider
- Limited flexibility

# 3. IaaS

- IaaS is on-demand access to cloud-hosted computing infrastructure - servers, storage capacity and networking resources - that customers can provision, configure and use in much the same way as they use on-premises hardware.
- IaaS customers can choose between virtual machines (VMs) hosted on shared physical hardware (the cloud service provider manages virtualization) or bare metal servers on dedicated (unshared) physical hardware.
- Every major cloud service provider - Amazon Web Services, Google Cloud, IBM Cloud, Microsoft Azure - began by offering some form of IaaS.

# Characteristics of IaaS

1. Resources are available as a service
2. Services are highly scalable
3. Dynamic and flexible Cloud Service Model
4. GUI and API-based access
5. Automate the administrative tasks



# Advantages & Disadvantages of IaaS

## Advantages

- Cost-effective
- Website hosting
- Security
- Maintenance

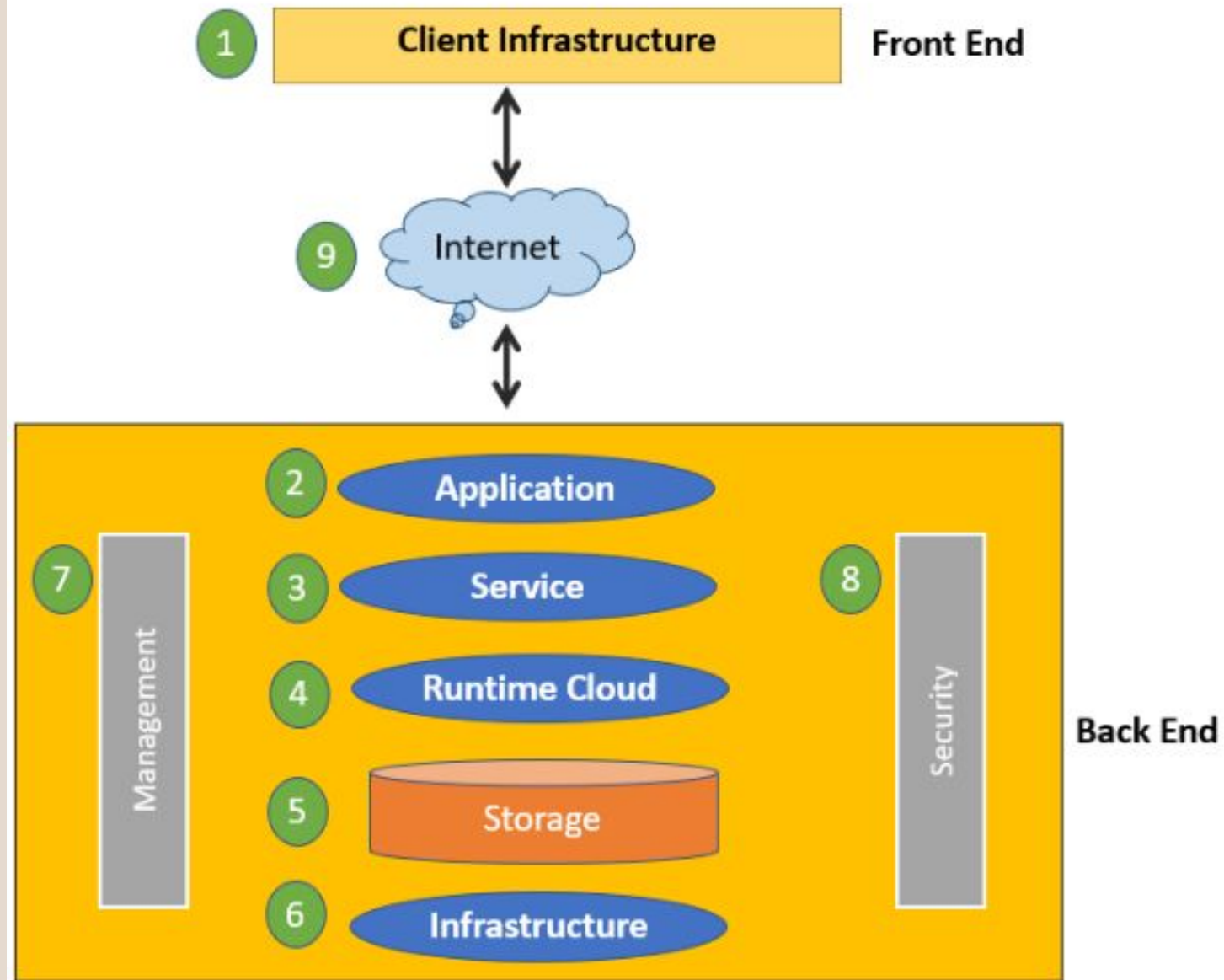
## Disadvantages

- Limited Control over Infrastructure
- Security concerns
- Limited Accesses

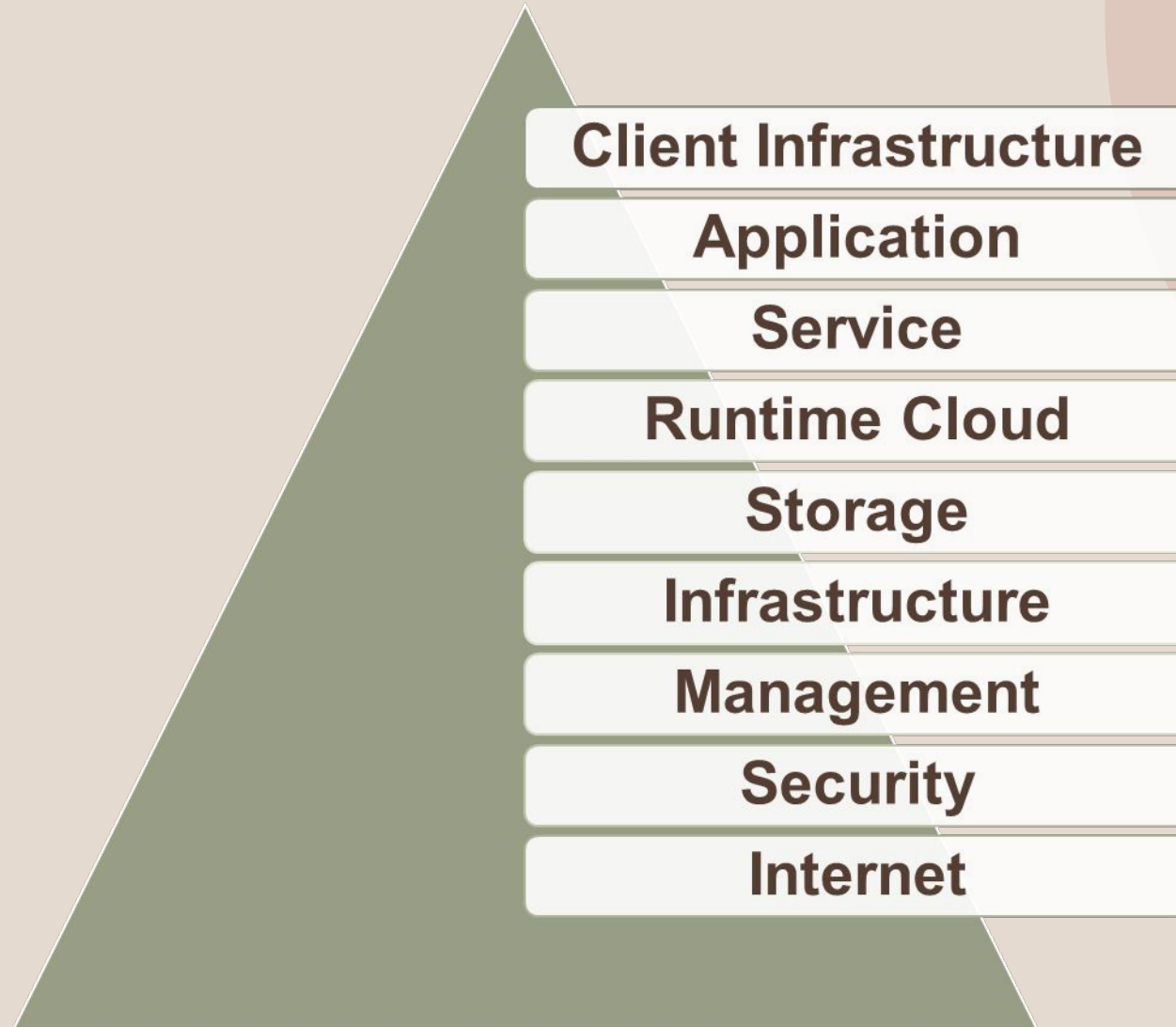
# Cloud Computing Logical Architecture

- Cloud computing system can be divided into two parts: front end and back end. The interconnection between them is done via the Internet.
  - Front end is used by the customers and
  - Back end refers to the service providers.
- Front end refers to the interface through which a customer can make use of the services rendered by the cloud computing system.
- The backend part helps you manage all the resources needed to provide Cloud computing services.

## Architecture of Cloud Computing



# Important Components of Cloud Computing Architecture



# Developing Holistic Cloud Computing Reference Model

- **Cloud Computing Reference Model**

1. Cloud enablement model
2. Cloud deployment model
3. Cloud governance and operations model
4. Cloud ecosystem model

- **Cloud Computing Reference Model has 4 sub model**

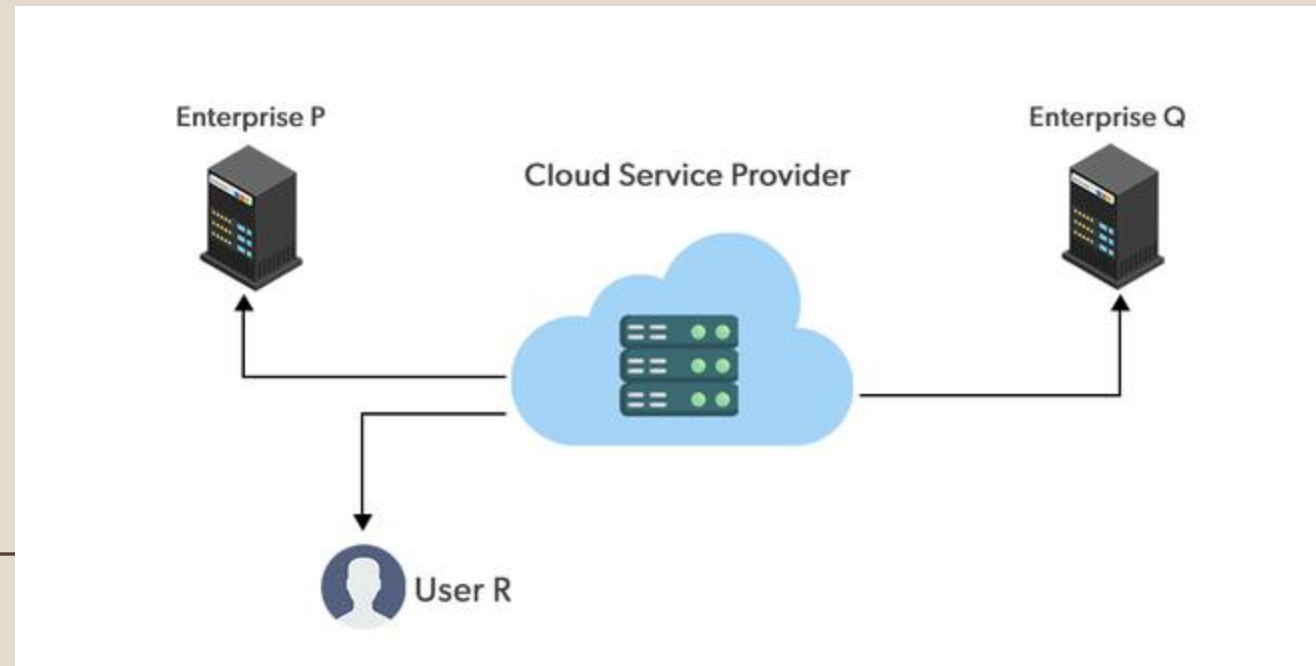
1. Cloud virtualization tier
2. Cloud operating system tier
3. Cloud platform tier
4. Cloud business tier

# Cloud Deployment Model

- Cloud deployment models are refers to the location and management of the cloud's infrastructure.
- Deployment models are defined by the ownership and control of architectural design and the degree of available customization.
- Cloud deployment models are of following type private, public, hybrid and community clouds.

# 1. Public Cloud

- The public cloud makes it possible for anybody to access systems and services.
- The infrastructure in this cloud model is owned by the entity that delivers the cloud services, not by the consumer.
- It is a type of cloud hosting that allows customers and users to easily access systems and services.



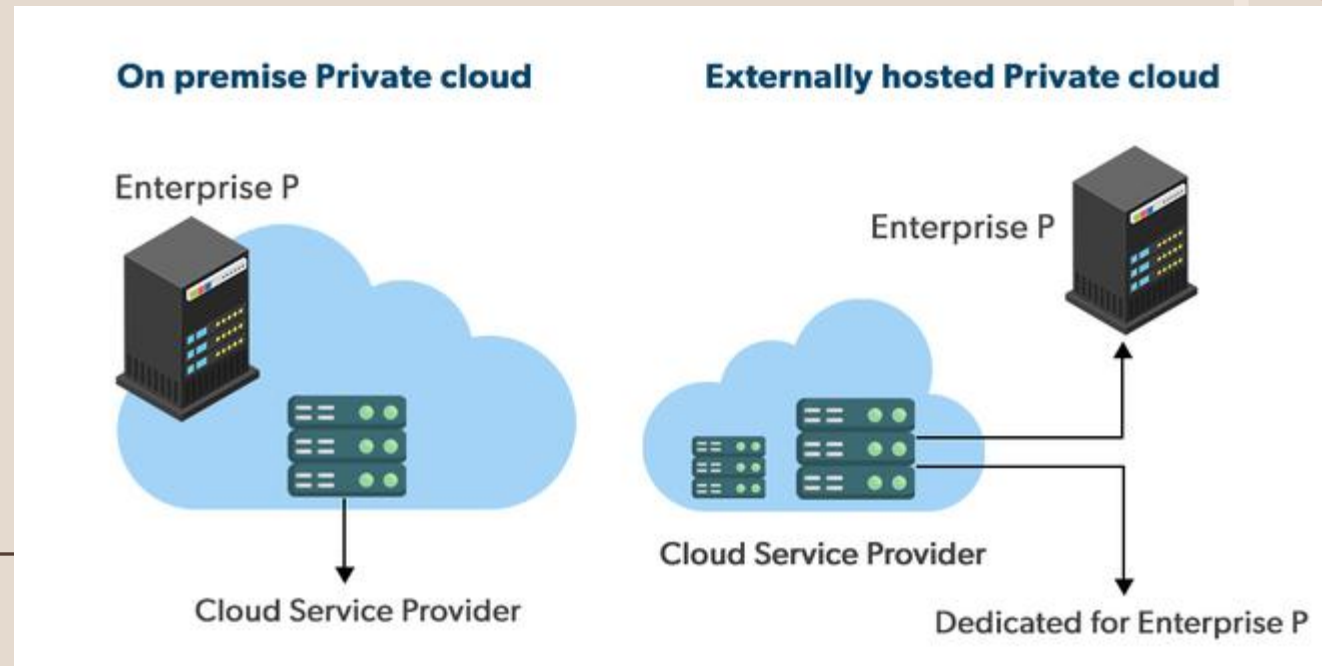
# Advantage & Disadvantage of Public Cloud

Advantages	Disadvantage
Minimal Investment	Less Secure
No Setup cost	Low customization
Infrastructure management is not required	
No maintenance	
Dynamic scalability	



## 2. Private Cloud

- It's a one-on-one environment for a single user (customer).
- There is no need to share your hardware with anyone else.
- The cloud platform is implemented in a cloud-based secure environment that is protected by powerful firewalls and under the supervision of an organization's IT department.
- The private cloud gives greater flexibility of control over cloud resources.

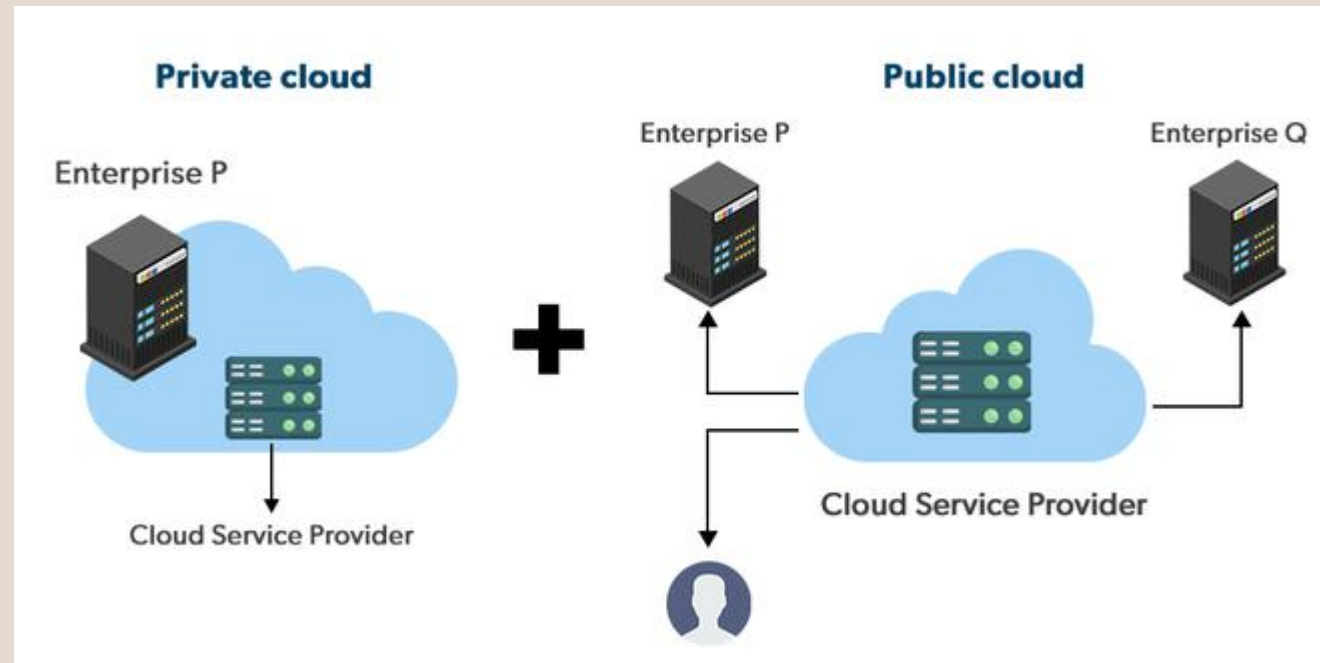


# Advantage & Disadvantage of Private Cloud

Advantages	Disadvantage
Better Control	Less scalable
Data Security & Privacy	Costly
Supports Legacy systems	
Customization	

# 3. Hybrid Cloud

- With a hybrid solution, you may host the app in a safe environment while taking advantage of the public cloud's cost savings.
- Organizations can move data and applications between different clouds using a combination of two or more cloud deployment methods, depending on their needs.

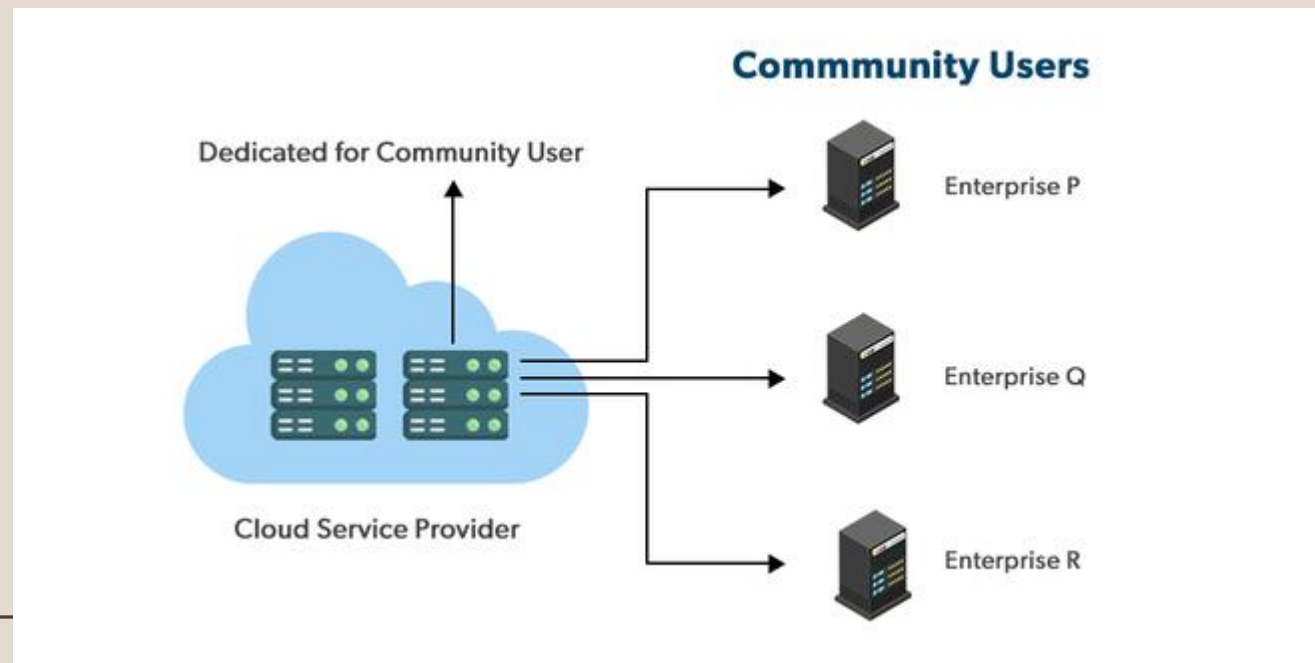


# Advantage & Disadvantage of Hybrid Cloud

Advantages	Disadvantage
Flexibility and control	Difficult to manage
Cost	Slow data transmission
Security	

## 4. Community Cloud

- It allows systems and services to be accessible by a group of organizations.
- The infrastructure of the community could be shared between the organization which has shared concerns or tasks. It is generally managed by a third party or by the combination of one or more organizations in the community.



# Advantage & Disadvantage of Community Cloud

<b>Advantages</b>	<b>Disadvantage</b>
Cost-Effective	Limited scalability
Security	Rigid in customization
Shared resources	
Collaboration & data sharing	

# On Premises VS On Cloud

- **On Premises** : In on-premises, from use to the running of the course of action, everything is done inside; whereby backup, privacy, and updates moreover should be managed in-house.
- **On Cloud** : Cloud refers to the delivery of on-demand computing services over the internet on “Pay As U Use “services, in simple words rather than managing files and Services on the local storage device you can do the same over the Internet in a cost-efficient manner.

# Difference between On-Premises and On Cloud :

- The differences can be defined on the basis of following parameters:
  - Scalability
  - Server Storage
  - Data Security
  - Data Loss or recovery
  - Maintenance



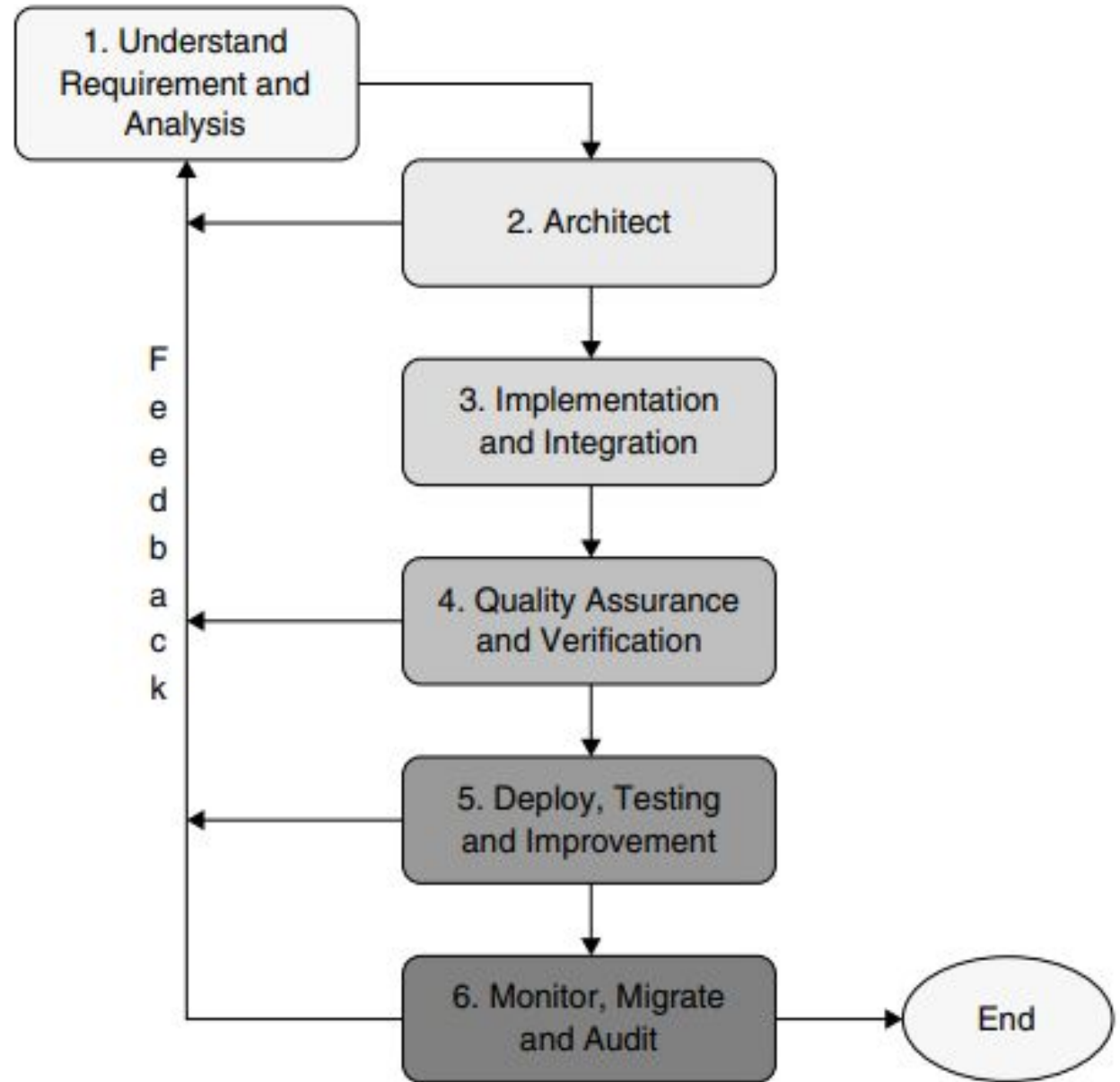


# Cloud Lifecycle Model

- The lifecycle should have the ability to consider the requirements of the business providing elasticity to deliver user-configured, multitier cloud services.
- The lifecycle management of cloud is so efficient that the IT sector can easily achieve the primary goals of a cloud environment such as agility, cost savings and optimal use of resources.
- Currently, many know-how associations are trying to adopt cloud computing for applying virtualization in their data centres.
- It provides a flawless and customized service for both the IT and the business.

- Cloud lifecycle management provides:
  - Ease in administrating cloud and service portal
  - Manageable service
  - Established multi-tenancy
  - Include performance and capacity management
  - Support heterogeneity
- Cloud computing is an effective model which enables convenient on-demand network access for the shared resources thus reducing the burden of the management.
- The scope of cloud computing is to offer scalable and inexpensive on-demand computing infrastructures with high quality services.
- A cloud engineering discipline has its own lifecycle model like other engineering disciplines, for a systematic and scientific development of the cloud known as cloud development lifecycle model.

- The Cloud Life Cycle (CDLC) is the repeated life cycle model for growth, deployment and delivery of cloud.
- In this lifecycle model, feedback is used in which a phase gives the necessary information to the preferred upper phase.



# Phases of CDLC

## 1. Requirement and Analysis

- Used to evaluate and understand the requirements of an end user.
- Done by taking up the significant complaints from the user, network solution, management and customers of the present system.
- Solution such as computing cost, scalability, organizational agility and benefits can be assessed through this phase. Cloud computing results such as privacy, security, maturity of the organization, risk involvement, reliability, performance and portability are different aspects to be considered before adoption.

## 2. Architect

- Solution to the cloud system which comprises of on-premise resource, cloud resources, cloud services, cloud middleware, software components, data server location and externally visible properties of data server location.

## 3. Implementation and Integration

- Third phase of CDLC is the actual formation and enablement of the private, public, community, hybrid, inter and hosted cloud solutions to a computing problem.

#### 4. Quality Assurance and Verification

- In this phase, cloud auditing is done to ensure the quality of the cloud network.
- It also confirms the performance, reliability, availability, elasticity and safety of cloud network at the service level.

#### 5. Deploy, Testing and Improvement

- Different platform service providers drastically reduce the deployment cost of the application by pre-building and pre-configuring a stack of application infrastructure in this phase.

#### 6. Monitor, Migrate and Audit

- This phase is marked by periodically monitoring the cloud environment and measuring the performance of the system.
- The extra cost and worth that a client incurs moving to cloud from the traditional SOA method and furthermore integration with the existing methods are considered in this phase.

# Applications of Cloud Computing in real-world

1. **Online Data Storage**
2. **Backup & Recovery**
3. **Big data Analysis**
4. **Testing and development**
5. **Anti-virus Applications**
6. **E-commerce Application**
7. **Cloud computing in education**
8. **E-Governance Application**
9. **Medical Fields**
10. **Entertainment Applications**



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Thank you