



**MAILAM**  
**Engineering College**

Approved by AICTE, New Delhi, affiliated to Anna University, Chennai, Accredited by NBA & TCS

**CCS336 – CLOUD SERVICE MANAGEMENT**

**[REGULATION-2021]**

**STUDY MATERIAL**

**DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

**NAME OF THE STUDENT:.....**

**REGISTER NUMBER:.....**

**YEAR / SEM:.....**

**ACADEMIC YEAR:.....**

**PREPARED BY**

**Mrs.V.SANKARI AP/AI&DS**



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## **DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE**

### **CCS336 - CLOUD SERVICES MANAGEMENT**

**III Yr. / VI SEM**

#### **SYLLABUS**

#### **COURSE OBJECTIVES:**

- Introduce Cloud Service Management terminology, definition & concepts
- Compare and contrast cloud service management with traditional IT service management
- Identify strategies to reduce risk and eliminate issues associated with adoption of cloud services
- Select appropriate structures for designing, deploying and running cloud-based services in a business environment
- Illustrate the benefits and drive the adoption of cloud-based services to solve real world problems

#### **UNIT I CLOUD SERVICE MANAGEMENT FUNDAMENTALS 6**

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models

#### **UNIT II CLOUD SERVICES STRATEGY 6**

Cloud Strategy Fundamentals, Cloud Strategy Management Framework, Cloud Policy, Key Driver for Adoption, Risk Management, IT Capacity and Utilization, Demand and Capacity matching, Demand Queueing, Change Management, Cloud Service Architecture

#### **UNIT III CLOUD SERVICE MANAGEMENT 6**

Cloud Service Reference Model, Cloud Service LifeCycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management

#### **UNIT IV CLOUD SERVICE ECONOMICS 6**

Pricing models for Cloud Services, Freemium, Pay Per Reservation, Pay per User, Subscription based Charging, Procurement of Cloud-based Services, Capex vs Opex Shift, Cloud service Charging, Cloud Cost Models

**UNIT V CLOUD SERVICE GOVERNANCE & VALUE**

**6**

IT Governance Definition, Cloud Governance Definition, Cloud Governance Framework, Cloud Governance Structure, Cloud Governance Considerations, Cloud Service Model Risk Matrix, Understanding Value of Cloud Services, Measuring the value of Cloud Services, Balanced Scorecard, Total Cost of Ownership

**COURSE OUTCOMES:**

CO1:Exhibit cloud-design skills to build and automate business solutions using cloud technologies.

CO2: Possess Strong theoretical foundation leading to excellence and excitement towards adoption of cloud-based services

CO3: Solve the real world problems using Cloud services and technologies

**30 PERIODS**

**TEXT BOOKS**

1. Cloud Service Management and Governance: Smart Service Management in Cloud Era by Enamul Haque, Enel Publications
2. Cloud Computing: Concepts, Technology & Architecture by Thomas Erl, Ricardo Puttini, Zaigham Mohammad 2013
3. Cloud Computing Design Patterns by Thomas Erl, Robert Cope, Amin Naserpour

**REFERENCES**

1. Economics of Cloud Computing by Praveen Ayyappa, LAP Lambert Academic Publishing
2. Mastering Cloud Computing Foundations and Applications Programming Rajkumar Buyya, Christian Vechhiola, S. Thamarai Selvi

**ANNA UNIVERSITY UPDATED QP - AP 2023, ND 2023, AP 2024, ND 2024**

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*7/2/2025*

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**PRINCIPAL**

**UNIT - I****UNIT I - CLOUD SERVICE MANAGEMENT FUNDAMENTALS**

Cloud Ecosystem, The Essential Characteristics, Basics of Information Technology Service Management and Cloud Service Management, Service Perspectives, Cloud Service Models, Cloud Service Deployment Models.

**PART A****1. Define Cloud Computing.**

- Applications and services that run on a distributed environment using virtualized resources and accessed by common internet protocol and networking standards.
- It is a virtualization-based technology that allows us to create, configure, and customize applications via an internet connection.

**2. Define Cloud Ecosystem.**

- The term "cloud ecosystem" refers to the interconnected set of services, technologies, and platforms that make up the cloud computing environment.
- Cloud computing enables the delivery of various computing services over the internet, and it has become a fundamental part of modern IT infrastructure.

**3. What is the role of Cloud Ecosystem?**

- It is a complex system of interdependent components working together to enable cloud services.
- It encompasses the entire cloud computing landscape, including infrastructure, platform, software, and other related components.
- Cloud ecosystems are designed to support various use cases, meet diverse business needs, and foster innovation within the cloud computing environment.

**4. What is cloud Storage?**

- Cloud storage services provide scalable, reliable, and often geographically distributed data storage.
- Users can store and retrieve data in the cloud, making it accessible from anywhere with an internet connection.

- Popular cloud storage solutions include Amazon S3, Google Cloud Storage, and Microsoft Azure Blob Storage.

**5. Define NIST.**

- **NIST**- National Institute of Standard and technology.
- Cloud computing is a model for enabling ubiquitous, convenient, on- demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

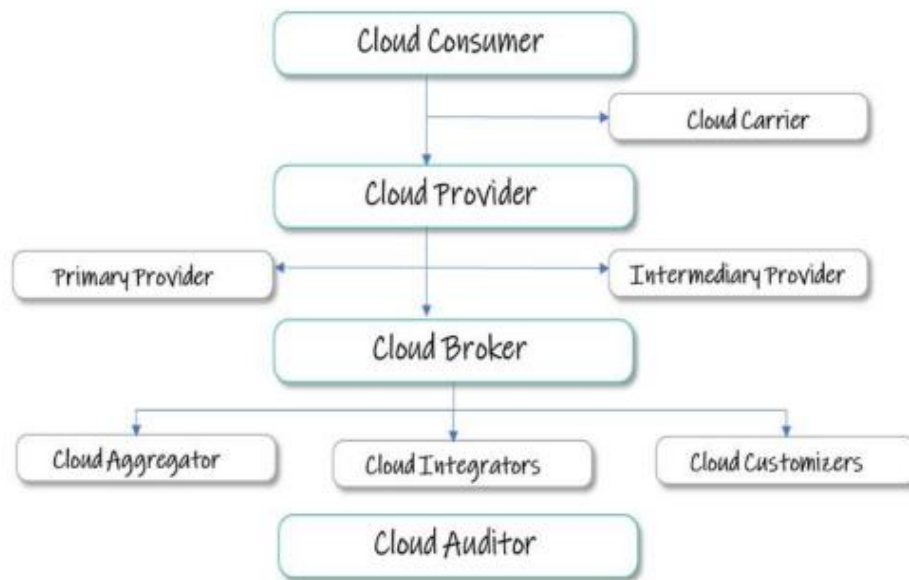
**6. List out the Cloud service Paradigm.**

1. Characteristics
2. Service Models
3. Deployment Models

**7. List out the layers of Cloud ecosystem.****4 Layers (partition)**

1. Business Process (SOA)
2. Application Services – provides a basis for SaaS
3. Platform Services – forms a basis for PaaS
4. Infrastructure Services – forms a basis for IaaS

**8. What are the different roles within the cloud ecosystem?**



**Fig: Different roles within the cloud Ecosystem**

### 9. Define Cloud consumer.

- It is party who uses services offered by cloud providers, cloud brokers and cloud carriers during the business.
- A person or organization that maintains a business relationship with, and uses service from, cloud providers.

### 10. What is Cloud provider and their roles?

It is an entity responsible for making a service available to cloud consumers (either directly or indirectly).

#### **Roles:**

1. Acquire and maintain necessary computing infrastructure.
2. Supports various services (run different software applications) –SaaS and PaaS
3. Arrangement for the delivery of the cloud services to the cloud consumers via network access.

### 11. What are the two types of cloud service provider (CSP)?

#### **Two types:**

#### **1. Primary Cloud Service Provider**

- Services provided by the company itself



- They won't outsource the production of their services to third parties

**Example:** Google Cloud, Microsoft Azure, and Amazon Web Services (AWS), etc...

## **2. Intermediary Cloud Service Provider**

- Communicate with other providers without disclosing information about the primary provider(s).
- Integrates the services of one or more primary providers into the service it offers to customers.

## **12. Define Cloud Service Providers (CSPs) with an example.**

**CSPs** are companies that offer cloud computing services and infrastructure.

**Example:** Some of the major CSPs include Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), and IBM Cloud.

## **13. Define Cloud Carrier.**

- It is an organization uses the infrastructure like internet and telecommunications to connect with the end users (or) consumers.
- Cloud providers negotiate Service Level Agreements (SLAs) with a cloud carrier to ensure that cloud consumers receive a service level commensurate (adequate) with the requirements stated in SLAs. It enables the deployment of highly complex application in cloud.

## **14. What is Cloud Broker?**

- It is an organization that controls,
  - ✓ Usage
  - ✓ Performance of cloud services
  - ✓ Delivery of Cloud services
- Negotiates Partnership between cloud providers and cloud consumers.

## **15. List out the services of cloud broker.**

1. Aggregation
2. Arbitrage
3. Intermediation

**16. Define Cloud Auditor.**

- It is a third party that evaluates cloud services independently and provides an opinion based on those findings.
- It examines controls of cloud computing service providers.

**17. What is Content Delivery Networks (CDNs)?**

**CDNs** optimize the delivery of web content and media by caching it on servers located in various regions. This reduces latency and enhances the performance of web applications and media streaming.

**18. What is Serverless Computing?**

- Serverless computing allows developers to run code without managing servers.
- Cloud providers automatically scale and manage the infrastructure, making it easier to build event-driven, highly scalable applications.

**19. Define Cloud Security.**

Security is a critical aspect of the cloud ecosystem. CSPs offer a range of security services, and organizations implement security practices to protect their data and applications in the cloud.

**20. What is Infrastructure as a Service (IaaS)?**

- IaaS providers offer virtualized computing resources over the internet, such as virtual machines, storage, and networking.
- Users can rent these resources on-demand, which is useful for businesses that want to scale their infrastructure without investing in physical hardware.

**21. Define Platform as a Service (PaaS).**

- PaaS providers offer platforms and tools for developers to build, deploy, and manage applications.
- These services abstract much of the underlying infrastructure complexity, allowing developers to focus on coding.

**22. Define Software as a Service (SaaS) with an example.**



- SaaS providers deliver software applications over the internet on a subscription basis.
- Users can access these applications without the need for local installations. Examples include Salesforce, Microsoft 365, and Google Workspace.

**23. What are the essential Characteristics of Cloud?**

The essential Characteristics of Cloud are,

1. On demand
2. Broad Network
3. Resource Pooling
4. Rapid Elasticity
5. Measured Service

**24. What is Broad Network Access?**

- Cloud services are accessible over the internet from a variety of devices, such as laptops, smartphones, and tablets.
- This accessibility promotes remote access and fosters user mobility.

**25. Define Resource Pooling. With an Example? (April/May 2024)**

- A resource pool is a group of resources that can be assigned to users.
- Resources of any kind, including computation, network, and storage, can be pooled.
- It adds an abstraction layer that enables uniform resource use and presentation. In cloud data centers, a sizable pool of physical resources is maintained and made available to consumers as virtual services.

**Example: servers, storage, and networking**

**26. What is meant by Rapid Elasticity?**

It is one of the important and critical characteristics of cloud computing.

**Rapid Elasticity:** Scale the cloud resources as per the need of the consumers. Cloud resources can be rapidly and elastically scaled up or down to meet varying workloads. Users can quickly scale resources as needed, often with automatic provisioning.

**27. Difference between Scalability and Elasticity.**

**Elasticity** is used to meet dynamic changes, where the resources need can increase or decrease.

**Scalability** is always used to address the increase in workload in an organization.

**28. What is Information Technology Service Management (ITSM) and its goal?**

- ITSM is a set of practices, processes, and policies used to design, plan, deliver, manage, and improve IT services for an organization. It is about ensuring that IT services meet the needs of the business and its users.
- **Goal of IT Service Management:** IT teams manage the end-to-end delivery of IT services to customers.

**29. What are the Requirements needed for ITSM software and Tool?**

- Easy to use and setup.
  - Enable collaboration (Provides a platform for developers and cross functional teams to work together for faster issue resolution).
- Adapts to your needs.

**30. Mention the Key Components of ITSM.**

1. **Service Desk:** A central point of contact for users to report issues, make service requests, and seek IT assistance.
2. **Incident Management:** The process of managing and resolving unplanned interruptions or issues in IT services.
3. **Change Management :** The systematic approach to managing and controlling changes to IT infrastructure and services.
4. **Problem Management:** Identifying and addressing the root causes of recurring incidents.
5. **Service Level Management:** Ensuring that IT services meet agreed-upon service levels and performance metrics.
6. **Configuration Management:** Maintaining an accurate and up-to-date record of IT assets and configurations.
7. **IT Asset Management:** Managing and tracking IT assets throughout their lifecycle.
8. **Release and Deployment Management:** Planning and controlling the rollout of new IT services and updates.

9. **ITIL (Information Technology Infrastructure Library):** A widely used framework for ITSM that provides best practices for service management.

### **31.What are the benefits of ITSM?**

ITSM helps organizations improve the quality of their IT services, reduce operational costs, enhance customer satisfaction, and ensure compliance with regulations and standards.

#### **Benefits:**

- Improve efficiency.
- Reduce operational costs.
- Risk-free implementation of IT changes.
- Improve accountability through standardization.
- Improve accountability within business functions.
- Improve effectiveness
- Enhance visibility into operations
- Improve visibility into performance.

### **32. Define Cloud Service Management.**

- Cloud Service Management is a subset of ITSM that specifically focuses on managing and optimizing cloud services.
- It includes practices and processes related to the delivery, operation, and improvement of cloud-based services.

### **33. What are the key Aspects of Cloud Service Management?**

1. Cloud Deployment Models
2. Cloud Service Models
3. Cloud Security and Compliance
4. Resource Scaling
5. Service Level Agreements
6. Cloud Governance

**34. Define the term Service Perspectives.**

- Service perspectives refer to different viewpoints or approaches for understanding and managing services.
- In the context of business and IT services, there are several key perspectives that organizations consider to ensure the effective delivery and management of services.
- These perspectives help organizations align their services with business objectives, customer needs, and operational efficiency.

**35. List out the service Perspective related to cloud services.**

- Business perspective
- Technical Perspective
- Security Perspective
- Economic Perspective
- User Perspective
- Legal and Compliance Perspective
- Scalability and Elasticity Perspective
- Interoperability Perspective
- Environmental Perspective
- Future Perspective

**36. What are the types of cloud models?****Two set of Models:**

1. **Deployment Model** – Location and management of cloud infrastructure.
2. **Service Models** – Accessing the particular type of services on cloud computing platform.

**37. What is the different deployment model of cloud computing?**

Various deployment model of cloud computing are

1. Public Cloud
2. Private Cloud
3. Hybrid Cloud
4. Community Cloud

**38. Write short notes on Public Cloud.****Public cloud**

- Services and Infrastructure are hosted on premise of cloud provider and are provisioned for open use by general public.
- The end users can access the services via public network like internet.

**39. Write short notes on Private cloud.****Private cloud**

- Private clouds are designed and maintained by a single enterprise to meet the specific needs of that enterprise.
- Private clouds need to set up a structure that is entirely built for a single business cloud solutions and that are either hosted on-site or in a specific service provider's data center.

**40. Write short notes on Hybrid cloud.**

- Hybrid cloud computing is an environment that combines public clouds and private clouds by allowing data and applications to be shared between them.
- A hybrid cloud is ideal for scalability, flexibility, and security.
- A perfect example of this scenario would be that of an organization who uses the private cloud to secure their data and interacts with its customers using the public cloud.

**41. What are the types of Cloud service model?**

1. Infrastructure as a Service
2. Platform as a Service
3. Software as a Service

**42. What is Community Cloud?**

- A community cloud is shared by several organizations with similar interests or compliance requirements. It is a hybrid cloud that is tailored to the needs of a specific community.
- **Key Characteristics:** Shared infrastructure, shared management, and a focus on a particular industry or community, such as healthcare or finance.

**43. Define Multi-Cloud.**

- A multi-cloud strategy involves using services from multiple cloud providers. Organizations may use different providers for specific tasks, applications, or geographic regions.
- **Key Characteristics:** Ensures redundancy, mitigates vendor lock-in, and leverages specialized services from different providers.

**44. What is Distributed Cloud?**

- Distributed cloud is an emerging concept where cloud resources are distributed to different physical locations and data centers. These resources are managed centrally but located closer to the end-users or IoT devices.
- **Key Characteristics:** Low-latency access, reduced data transfer costs, and the ability to support edge computing use cases.

**45. What are the Advantages and Disadvantages of Infrastructure as a Service (IaaS)?****Advantages:**

- Speed
- Performance
- Reliability
- Back u p and recovery
- Competitive pricing
- Shared infrastructure
- It allows to access the resources through web
- It follows Pay – as – per - use model
- It supports on-demand scalability

**Disadvantages:**

- Security
- Maintenance and upgrade (no 100% upgradation for all software)
- Interoperability issues

**46. What are the Advantages and Disadvantages of Platform as a Service (PaaS)?**

**Advantages:**

- Simplified development
- Pre-build business functionality
- Scalability
- Support geographically distributed development teams
- Efficiently manage the application lifecycle.
- Cut coding time.
- Develop for multiple platforms—including mobile—more easily.
- Increase productivity
- Maintain security measures
- Use existing skills and investments.

**Disadvantages:**

- Vendor lock – in (migration of platform)
- Data privacy depends on the service providers
- Integration with local machine is difficult

**47. What are the Advantages and Disadvantages of Software as a Service (SaaS)?****Advantages:**

- It supports efficient data management
- It supports robust cloud infrastructure
- Automatic updation of software versions
- Scalable usage
- Better customization support
- One to many model (single instance shared by multiple users)
- Less hardware required
- Low maintenance cost
- No installation of software required
- It offers Multi device support (access using laptop, mobile, desktop, tablets)

**Disadvantages:**

- Security depends on CSP
- Latency issue (Speed of delivery)
- Entire services are depends on the internet
- Switching between different vendors are difficult (Portability)



- Customer lose control over version
- Browser based issues

**48. Define Gaia-X.**

- Gaia-X - Global Architecture for Interoperable Analytics and Applications.
- It is a modern data infrastructure developed by Germany's government which is fast, reliable, secure and competitive cloud model

**49. List out the Public cloud offers PaaS.**

Public cloud offers PaaS examples: Products and vendors.

- Google Cloud.
- Microsoft Azure.
- AWS.
- IBM Cloud.
- Red Hat Open Shift.
- VMware (Pivotal) Cloud Foundry.
- Oracle Cloud Platform (OCP).

**50. Why does one choose public cloud over private cloud?**

- Public clouds have better utilization rates: With private cloud, your organization still has to build and maintain all kinds of servers to meet spikes in demand across various divisions or functions.
- Public cloud offers the same spare demand on a pay-as-you-need-it basis.

**51. Differentiate cloud consumer and provider.**

- A cloud consumer represents a person or organization that maintains a business relationship with, and uses the service from a cloud provider.
- A cloud consumer browses the service catalog from a cloud provider, requests the appropriate service, sets up service contracts with the cloud provider, and uses the service.

**52. Differentiate Public cloud and Private cloud.**

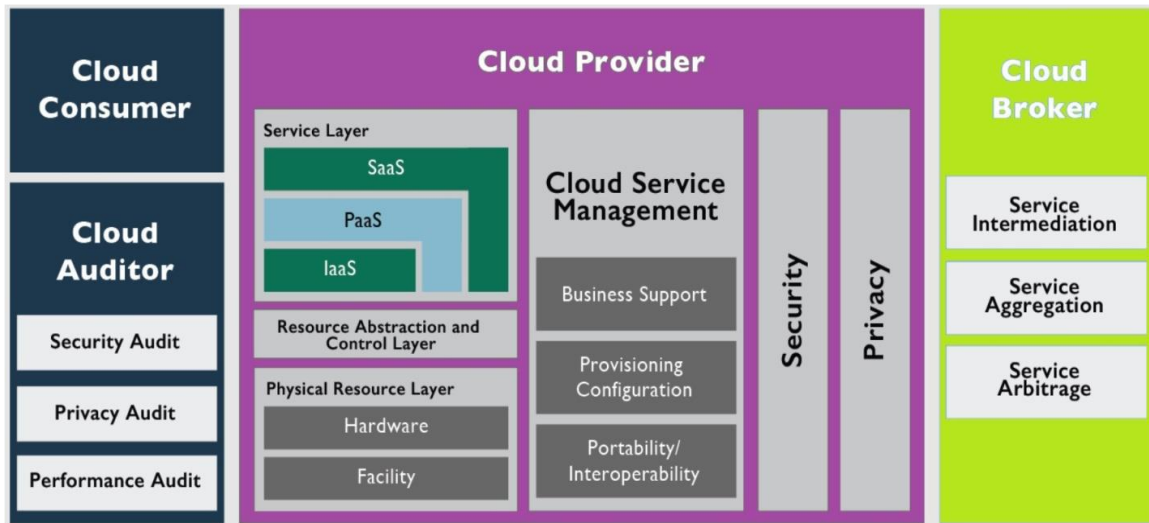
**53. What are the types of Private Cloud?**

1. Virtual private cloud (stored in public cloud but the resources are private)
2. Hosted (servers are not shared with others)
3. Managed (hosted + provider management)

**54. Define Pay-as-you-go in cloud.**

- Pay-as-you-go cloud computing is a flexible pricing model that allows users to access technology services such as server space, software, and processing power, and pay only for what they use.
- The amount fluctuates depending on how much resource it really uses (charging based on time and usage).

**55. Draw the diagram for conceptual reference model for cloud.**



**Fig:Reference model for cloud**

**56. List the companies who offer cloud service development.**

- Amazon
- Google App Engine
- IBM
- Salesforce.com

**57. What is on demand of cloud computing?**

- On-demand (OD) computing is an increasingly popular enterprise model in which computing resources are made available to the user as needed.
- The resources may be maintained within the user's enterprise, or made available by a service provider.

**58. What are the advantages and disadvantages of Cloud Computing?**

**Advantages:**

- Lower-Cost Computers for Users
- Improved Performance
- Lower IT Infrastructure Costs
- Fewer Maintenance Issues
- Lower Software Costs
- Instant Software Updates
- Increased Computing Power

- Unlimited Storage Capacity
- Increased Data Safety
- Improved Compatibility Between Operating Systems
- Improved Document Format Compatibility
- Easier Group Collaboration
- Universal Access to Documents
- Latest Version Availability
- Removes the Tether to Specific Devices

**Disadvantages:**

- Requires a Constant Internet Connection
- Doesn't Work Well with Low-Speed Connections
- Can Be Slow
- Features Might Be Limited
- Stored Data Might Not Be Secure

**59. Define Abstraction.****Abstraction:**

Abstract details of system implementation from users and developers

- No specified details of the physical devices to run the application
- Unknown data storage location
- Outsourced Administration
- Ubiquitous (universal or global) user access
- Platform independent

**60. Define Virtualization.****Virtualization:**

Virtualize system by using pooling and sharing resources

- Centralized infrastructure for storage.
- Cost estimation.
- Enabled Multi-tenancy (mode of operation of software where multiple independent instances of one or multiple applications operate in a shared environment).

- Dynamic and Scalable resources.

**61. Give brief note on digital transformation strategy. (April/May-2024)**

Digital transformation strategy is a comprehensive plan that organizations implement to leverage digital technologies and processes to fundamentally change how they operate and deliver value to customers.

Digital transformation is a dynamic and essential process for modern organizations.

Digital transformation strategy are :

- Assessment and Planning
- Cloud Adoption
- Security and Compliance
- Risk Management
- Automation and Optimization
- Continuous Improvement

**62. Depict the benefits of adapting cloud services for health care services. ( Nov/Dec-2024)**

- Enhanced Data Security and
- Scalability and Cost Efficiency
- Streamlined Collaboration and Communication
- Data Analytics and Insights

**63. How deployment model varies from a service model in cloud environment? (Nov/Dec-2024)**

In cloud computing, **deployment models** and **service models** represent distinct aspects of how cloud services are structured and delivered.

**Deployment Models** define the cloud environment's setup, ownership, and access parameters. The primary deployment models include:

**Public Cloud:** Services are offered over the public internet and shared among multiple organizations.

**Private Cloud:** Exclusive cloud environment dedicated to a single organization, offering enhanced control and security.

**Hybrid Cloud:** Combines public and private clouds, allowing data and applications to be shared between them.

**Community Cloud:** Shared infrastructure for a specific community with common interests or requirements.

These models determine where data is stored, who manages it, and who has access to it.

**Service Models**, on the other hand, categorize the types of services provided by cloud platforms. The main service models are:

**Infrastructure as a Service (IaaS):** Offers virtualized computing resources over the internet, such as virtual machines and storage.

**Platform as a Service (PaaS):** Provides a platform allowing customers to develop, run, and manage applications without dealing with the underlying infrastructure.

**Software as a Service (SaaS):** Delivers software applications over the internet on a subscription basis.

These models define the level of control and management users have over the cloud services.

In summary, while **deployment models** focus on the **where** and **how** of cloud infrastructure setup and access, **service models** concentrate on the **what** services are provided and the extent of them.

**PART B****1. Explain briefly about Cloud Computing.**

- Defining cloud computing
  - Definition
  - Gartner Definition
  - Forrester Definition
- Concepts of cloud computing
  - Abstraction
  - Virtualization
- Cloud service paradigm

**DEFINING CLOUD COMPUTING****Definition:**

- Applications and services that run on a distributed environment using virtualized resources and accessed by common internet protocol and networking standards.
- It is a virtualization-based technology that allows us to create, configure, and customize applications via an internet connection.

**NIST Definition:** Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

**Gartner Definition:** Cloud computing is a style of computing where massively scalable IT-related capabilities are provided as a service across the Internet to multiple external customers.

**Forrester Definition:** Cloud computing is a pool of abstracted, highly scalable and managed infra structure capable of hosting end-customer applications and billed by consumption.



- Cloud computing is web-based processing, whereby shared resources, software and information are provided to computers and other devices on-demand over the internet.
- No limit for resources (virtual) – the user having abstract details about the software that runs on the physical system It takes
  1. Technology
  2. Services
  3. Applications This turns into self-service utility

**Concepts of cloud computing:****1. Abstraction**

- Abstract details of system implementation from users and developers
    - No specified details of the physical devices to run the application.
    - Unknown data storage location Outsourced Administration.
    - Ubiquitous (universal or global) user access
- Platform independent.

**2. Virtualization**

- Virtualize system by using pooling and sharing resources
  - Centralized infrastructure for storage
  - Cost estimation
  - Enabled Multi-tenancy (mode of operation of software where multiple independent instances of one or multiple applications operate in a shared environment)
  - Dynamic and Scalable resources

**Cloud Service Paradigm**

1. Characteristics
2. Service Models
3. Deployment Models

**2. Explain in detail about the Cloud Computing Ecosystem?**

**Write about cloud architecture with relevant diagram.**

Write down the essential characteristics of cloud ecosystem with example.(6) (April/May – 2024) /Formulate the complete architecture with neat diagrammatic representation.(6) (Nov/Dec-2024)

- **Cloud Computing Ecosystem**
  - Four Layers of cloud computing ecosystem
- **Different Roles within the Cloud Ecosystem**
- **Cloud Reference Architecture**
  1. Cloud Consumer
  2. Cloud Service provider(CSP)
  3. Cloud Carrier
  4. Cloud Service Broker(CSB)
  5. Cloud Auditor

## CLOUD COMPUTING ECOSYSTEM

### 4 Layers (partition) – Refer Fig 1.1

1. Business Process (SOA)
2. Application Services – provides a basis for SaaS
3. Platform Services – forms a basis for PaaS
4. Infrastructure Services – forms a basis for IaaS

### Diagrammatic Representation:

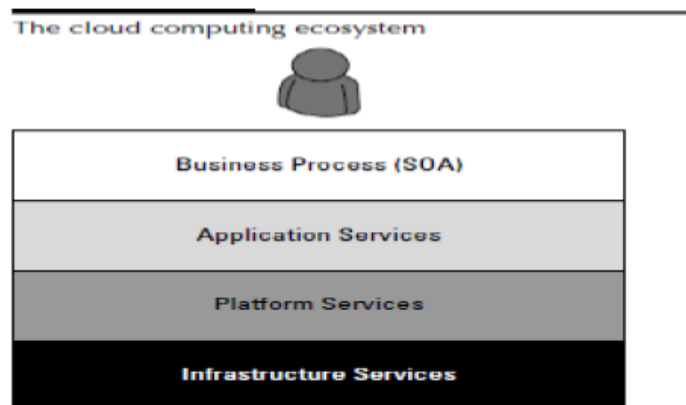


Fig 1.1 Layers of Cloud Computing Ecosystem

**Role of Cloud Ecosystem:**

It is a complex system of interdependent components working together to enable cloud services.

**End – to End Management:**

It creates challenges in terms of managing different layers for an end-to-end cloud adoption strategy of an organization.

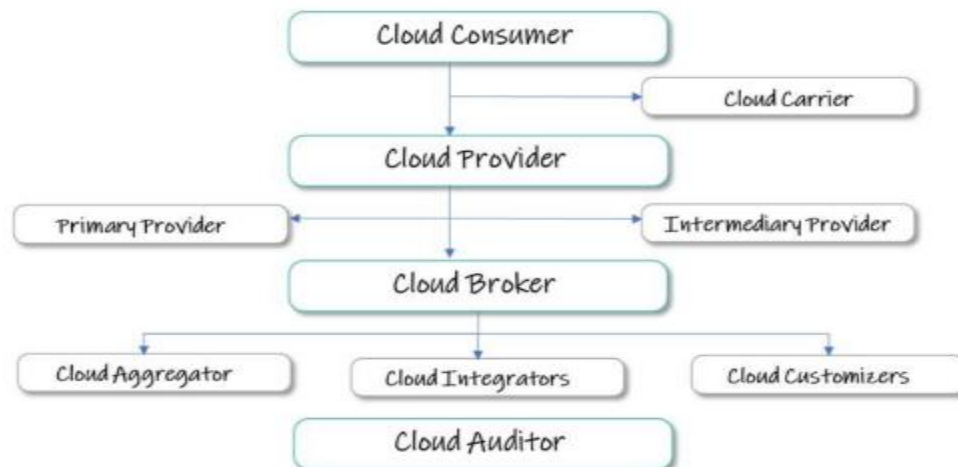
**Functionalities:**

CIO must arrange

1. On-boarding
2. Managing
3. Delivering IT and business services

**Performance Parameters:**

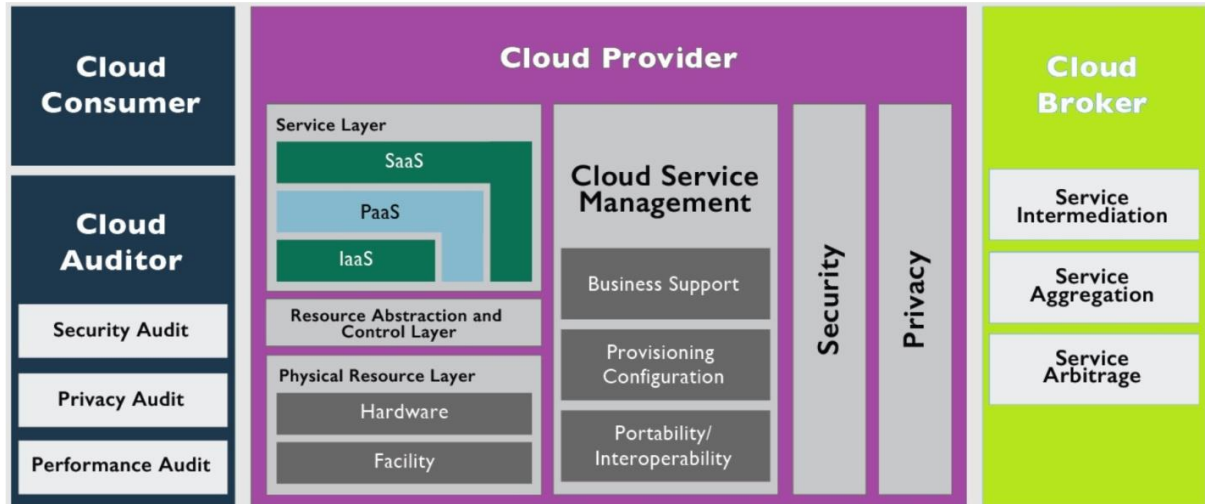
1. Consistent Performance
2. Security
3. Control

**Different Roles within the Cloud Ecosystem:**

**Fig 1.2 Different Roles within the Cloud Ecosystem**

**Cloud Reference Architecture:**

**From the Fig 1.2 & 1.3** With respect to cloud eco-system



**Fig 1.3 Cloud Architecture**

#### **Cloud Consumer:**

- It is party who uses services offered by cloud providers, cloud brokers and cloud carriers during the business.
- A person or organization that maintains a business relationship with, and uses service from, cloud providers.

#### **Steps:**

1. Browse the list of services (catalogue of available resources) offered by cloud service providers or cloud broker's.
2. Request the desired services.
3. Negotiates the terms of the service contract with the cloud provider.

#### **Cloud Providers of Cloud Service Provider (CSP):**

It is an entity responsible for making a service available to cloud consumers (either directly or indirectly).

#### **Roles in cloud service provider:**

1. Acquire and maintain necessary computing infrastructure
2. Supports various services (run different software applications) –SaaS and PaaS
3. Arrangement for the delivery of the cloud services to the cloud consumers via network access

**Example:** Google Cloud, Microsoft Azure, and Amazon Web Services (AWS), etc...

**Two types of cloud service provider:****1. Primary Cloud Service Provider**

- Services provided by the company itself
- They won't outsource the production of their services to third parties

**Example:** Google Cloud, Microsoft Azure, and Amazon Web Services (AWS), etc...

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- It enables the deployment of highly complex application in cloud.

**Cloud service Broker(CSB):**

It is an organization that controls

- ✓ Usage
- ✓ Performance of cloud services
- ✓ Delivery of Cloud services
- ✓ Negotiates Partnership between cloud providers and cloud consumers

**Three types of services:**

1. Aggregation
2. Arbitrage
3. Intermediation

It choose from different cloud solutions

**Example:** Azure, Pax8, AWS Service Catalog, AppDirect Monetization Suite, IBM Cloud Broker, Interworks.

**Cloud Auditor:**

- It is a third party that evaluates cloud services independently and provides an opinion based on those findings.
- It examines controls of cloud computing service providers.
- **Assessment parameters:**
  - i. Security
  - ii. Privacy
  - iii. Performance
- Compliance with guidelines can be confirmed by audits by examining observable evidence. (verify the compliance with the standard)

### 3.Explain in detail about the Essential

**Characteristics of cloud?april/may 2024) Exemplify in detail about the essential characteristics of cloud computing.(6) (April/May-2024)**

**Depict the essential characteristics of cloud environment and illustrate how they are important in delivering quality service to the cloud customer's end users. (7) (Nov/Dec-2024)**

#### **Essential Characteristics of cloud**

- On demand
- Broad Network
- Resource Pooling
- Rapid Elasticity
- Measured Service

#### **1. On-demand:**

- It is an important and valuable features of cloud computing.
- It is enterprise-level delivery model that allows users to easily provision and de-provision cloud resources when needed or “on-demand.
- **Self-service mode:** Consume storage and server time as required without intervening with the service provider. (control the usage, add or delete services)

- **Example:** AWS, Microsoft, Google, IBM, Salesforce.com

## 2. Broad Network:

- Resources are allowed to access through any network from multiple locations.
- It allows to access the functionality across a range of devices and permitting remote connectivity from anywhere with an internet connection.
- Cloud resources can be accessed by using any digital device (mobile phones, laptops, tablets etc..) from anywhere in the world where internet connection exists.
- **Parameters** : (for effective usage)
  - a. Fast connection (bandwidth)
  - b. No latency (No delay)
  - c. Excellent Quality of Service (QoS)

## 3. Resource Pooling

**Resources:** Hardware or Software (Computation, Storage or network ).

**Resource Pool:** A resource pool is a group of resources that can be assigned to users as shown in **Fig 1.4**.

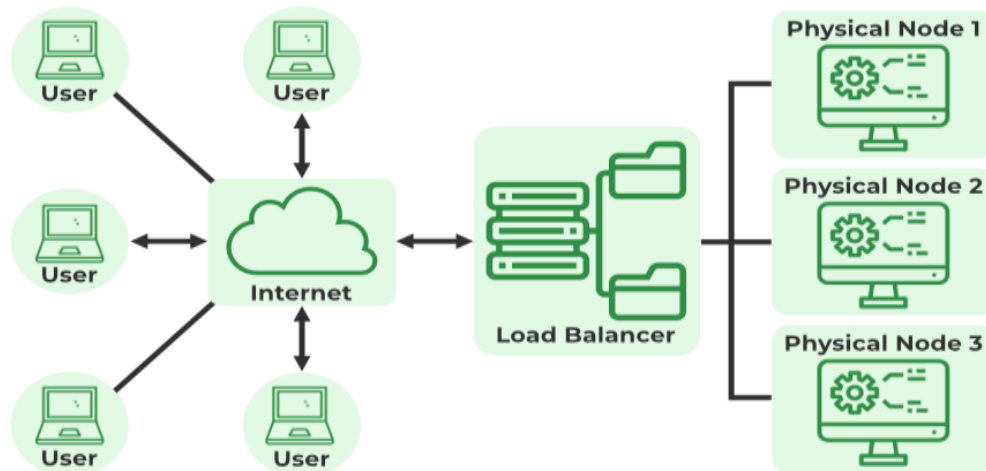
**Resource Pooling:** Serving the several consumers with a shared set of material assets (service to the consumers simultaneously).

**Data security** should not be compromised while sharing the resources (multitenancy-> maintain individual space for every user).

**Dynamic Allocation:** Resources are dynamically provided according to need rather than being permanently allocated to users.

**Efficient Utilization:** As load or demand fluctuates over time, this results in inefficient resource usage.





**Fig :1.4 Resource Pooling**

#### 4. Rapid Elasticity

It is one of the important and critical characteristics of cloud computing.

**Elasticity:** Scale the cloud resources as per the need of the consumers.

**Resource Provision:**

- Cloud computing can quickly provision resources when the organization needs and pay for that portion of consumption (pay-per-use services).
- Consumers benefit from rapid elasticity because they can expand or reduce their resources based on their needs.

**Example:** ecommerce platform, Amazon Web Services, Microsoft Azure, and Google Cloud support rapid elasticity in cloud computing.

**Difference between Scalability and Elasticity:**

- Elasticity is used to meet dynamic changes, where the resources need can increase or decrease.
- Scalability is always used to address the increase in workload in an organization.

**Advantages:**

- High availability and reliability
- Growth supporting
- Automation capability

- Cost effective

**Disadvantages:**

- Learning Curve (learning new programming tools)
- Security (authentication, incident response, root cause analysis)
- Cloud lock-in (vendors lock the resources into the service)

**5. Measured Service**

- It is a essential service or function in cloud computing (connected to payments)
- It is a delivery model in which a utility provider monitors how much of a particular service each customer consumes within a designated time period.
- **Pay-as-you-go:** The amount fluctuates depending on how much resource it really uses (charging based on time and usage).
- Cloud computing automatically regulate and optimize resource utilization.
- Resource usage can be monitored, controlled and reported, providing transparency for both the providers and consumers of the utilized service.

**Advantages:**

- Increase in revenue margin
- Improve quality of user experience
- Improve elastic scaling cost
- Improve level of automation
- Improve transaction latency and throughput
- Increase open source adoption

**4.Explain in detail about the Basics of Information Technology Service Management and Cloud Service Management.****BASICS OF INFORMATION TECHNOLOGY SERVICE MANAGEMENT AND CLOUD SERVICE MANAGEMENT**

- Information Technology Service Management (ITSM)
- Practices involved in entire life cycle
- IT services incorporates
- Requirements needed for ISTM software and tools
- Situation enables ISTM
- Cloud service management

**Service management:** It includes the operational aspects of the applications and services as shown in **Fig 1.5**.

**Goal of IT Service Management:** IT teams manage the end-to-end delivery of IT services to customers.

**Definition:** It define an approach towards IT processes and service delivery, strictly aligned with business objectives.

**Core Concept of IT Management:** IT should be delivered as a Service.

**Services:** It includes all the processes and activities to design, create, deliver, and support IT services.

**Practices involved in entire life cycle:**

- Designing
- Developing
- Managing
- Optimizing

**IT services incorporates**

- Best Practices
- Technology
- People
- Processes

**Requirements needed for ISTM software and Tools:**

- Easy to use and setup
- Enable collaboration (Provides a platform for developers and cross-functional teams to work together for faster issue resolution.)
- Adapts to your needs

**Situation Enables ITSM:** Need streamlining to maximize the business value

- Service Management
- Asset Management
- Service Lifecycle
- Incident Management
- Change Management
- Problem Management
- Service Level Management - Defining and maintaining service level agreements (SLAs) to ensure service quality.



**Fig 1.5 IT Service Management**

- **Example:** Submitting ticket to resolve a laptop issue ( fill and submit a pre defined form in the service catalog – assign an any IT team – solve the issue)

**Cloud Service Management**

- **Activities:** It includes all the activities that an organization does to plan, design, deliver, operate, and control the IT and cloud services that it offers to customers.
- **Definition of cloud service Management:** The management of cloud infrastructure products and services as shown in **Fig 1.6**.



**Fig 1.6 Cloud Service Management**

- Cloud service providers are no different to traditional IT service providers in relation to their need to provide quality, cost-effective, secure and available IT services.
- Cloud based service providers is the provision of IT infrastructure and services under a utility or pay-per-use model.
- **Key Aspects:**
  - 1) Cloud Deployment Models
  - 2) Cloud Service Models
  - 3) Cloud Security and Compliance
  - 4) Resource Scaling

- 5) Service Level Agreements
- 6) Cloud Governance

**5.Explain Briefly About Service Perspectives?****SERVICE PERSPECTIVES****Common Perspective related to cloud services**

1. Business perspective
2. Technical perspective
3. Security perspective
4. Economic perspective
5. User perspective
6. Legal and compliance perspective
7. Scalability and Elasticity perspective
8. Interoperability perspective
9. Environmental perspective
- 10.Future perspective

**1. Business perspective**

- Cloud services offer cost-effective solutions by eliminating the need for physical infrastructure and maintenance.
- Scale resources as needed, enhance flexibility, and focus on core business activities.

**2. Technical Perspective**

- Cloud services involve virtualization, distributed computing, and resource pooling.

- It helps in implementing, managing, and optimizing cloud-based systems efficiently.

**3. Security Perspective:**

- It is a critical aspect of cloud services.
- It involves assessing potential risks, data protection measures, encryption, access controls, and compliance with regulatory requirements.

**4. Economic Perspective**

- It evaluates the cost-benefit analysis of adopting cloud services compared to traditional on-premises solutions.
- It considers factors like total cost of ownership (TCO) and return on investment (ROI).

**5. User Perspective**

The end-users' experience is crucial, including factors like ease of use, accessibility, performance, and reliability of cloud services.

**6. Legal and Compliance Perspective**

- Cloud services may involve data storage and processing across different jurisdictions.
- Understanding legal implications, data residency requirements, and compliance with data protection laws is essential.

**7. Scalability and Elasticity Perspective**

- Cloud services offer scalability and elasticity to accommodate changing demands.
- It allows businesses to optimize resource allocation and manage fluctuating workloads efficiently.

**8. Interoperability Perspective**

- Cloud services often involve integrating multiple platforms and services.
- Ensuring interoperability enables seamless data exchange and application communication.

**9. Environmental Perspective**

- Cloud services can have environmental impacts due to data centers' energy consumption.



- Evaluating energy efficiency and sustainable practices is relevant from this perspective.

### **10. Future Perspective**

- considering the ongoing advancements and innovations in cloud technology, assessing the future trends and potential developments is crucial to stay ahead in the evolving cloud landscape.

**Key Factors:** The following key factors are used to avoid the challenges or to reduce the challenges for adoption of cloud computing in service perspective.

1. Developing authentication models in the Cloud
2. High Availability of Cloud Services
3. Using Cloud Multi-Tenant Infrastructure Model
4. Better Cloud Compatibility and Scalability for Cloud Services
5. Need to Virtualization Technology in Cloud Computing Environments
6. Implement Automated Tools and Develop Application Portability
7. Review service-level agreements
8. Flexibility Access to Data on Cloud Storage
9. Create, Deploy, Develop, and Implement Policies and Procedures for the Cloud
10. Challenge Cloud Infrastructure Need to Trust Computing and Cryptography
11. Data Protection and Integrity for the Cloud
12. Enhancing Cyber Challenge Systems
13. Change Management and Incident Response Procedures (Plan)
14. Hypervisor Complexity
15. Cloud Reduce Denial of Service (DoS) Attack
16. Understand the Fundamental Technologies
17. Services are Fully Managed and Delivered by a Third Party in Cloud Computing
18. Reducing Cost and Carbon Footprint for Cloud Services
19. Controls Need to Composite Cloud Services
20. Speed of Cloud Deployment and Ease Integration
21. Decreased effort in management technology in Cloud Computing

- 22. Managing Cloud Data Confidentiality and Increasing Auditability
- 23. Implement Application Level for Data Caching
- 24. Usability and Biometric System for Cloud Computing Environment
- 25. Cryptography and Steganography

**6. What are the types of cloud models? Explain in detail. (April/May 2024)**

➤ **Types of cloud model**

- 1. Deployment model
- 2. Service model

➤ **Cloud cube model**

**Two set of Models:**

- 1. **Deployment Model**– Location and management of cloud infrastructure
- 2. **Service Models** – Accessing the particular type of services on cloud computing platform

**NIST Model:** (National Institute of Standard and technology as shown in **Fig 1.7**)

- US government is a major consumer of cloud computing network
- It defines separate deployment and service models
- **Concept:**  
Initial version: Doesn't require a cloud to use virtualization to pool resources

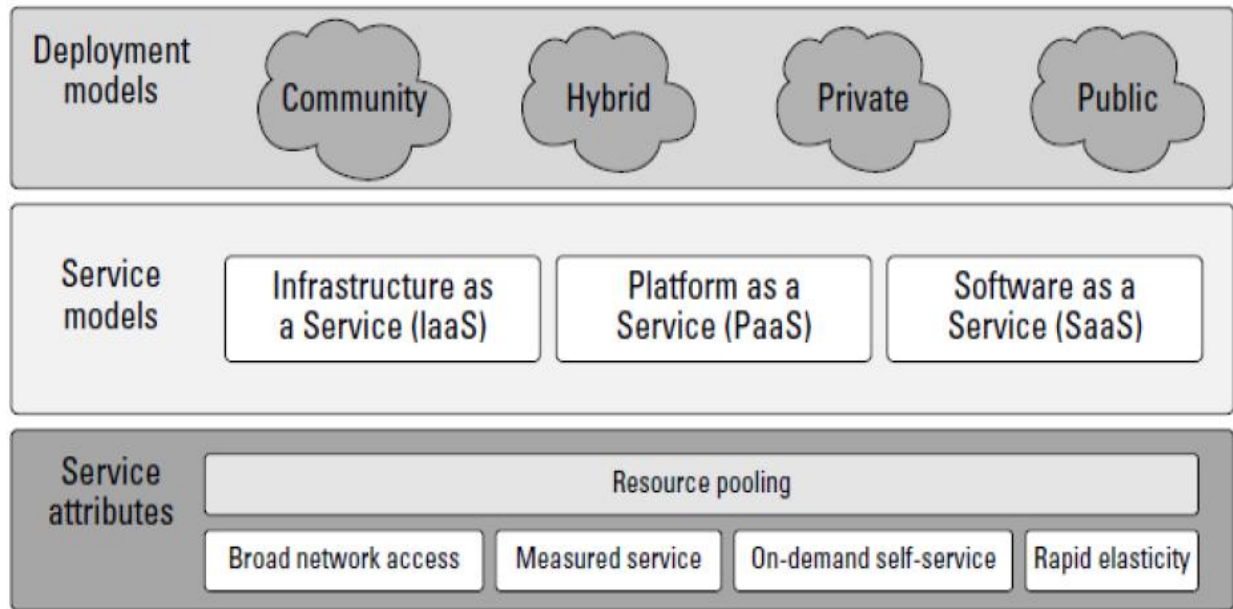
**Latest Version:** It supports

- 1. Virtualization
- 2. Multi – tenancy

Follows modular interacting components - SOA

**Drawback:**

- 1. Not addressing the intermediary services
  - a. Transaction or service brokers
  - b. Provisioning
  - c. Integration
  - d. Interoperability services



**Fig 1.7NIST Cloud Architecture**

#### **Cloud Cube Model:**

**Goal:** Protection of cloud networks

**Four Dimension:** (Refer **Fig 1.8**)

1. Physical location of the data (Internal – I, External – E based on organization boundaries)
2. Ownership (Proprietary – P, Open – O)
  - Technology ownership
  - Interoperability
  - Ease of data transfer
  - Degree of vendor-application lock-in
3. Security Boundary (Perimeterized – per, De-Perimeterized – (D-p))
 

Operation is inside or outside security boundary or network firewall
4. Sourcing
 

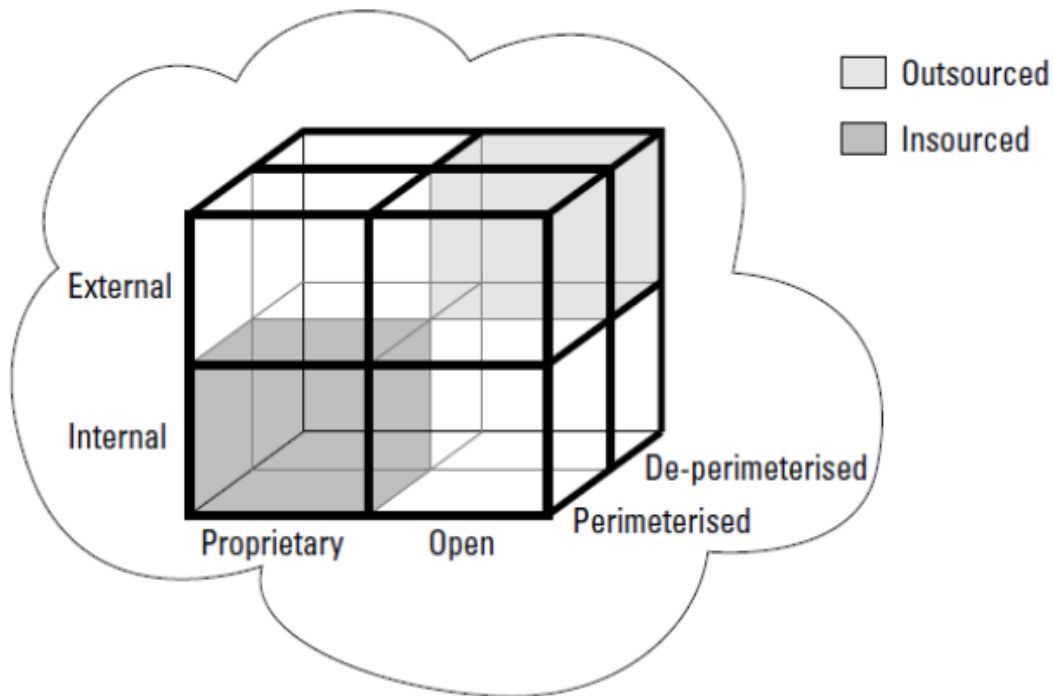
Service provided by either customer or service provider (delivery of the service)

Two Different States:

1. Per (IP, IO, EP, EO)
2. D-P (IP, IO, EP, EO)

---

### The Jericho Forum's Cloud Cube Model



**Fig 1.8 Cloud Cube Model**

**7.Explain in detail about cloud deployment Models.(april/ may 2024)**

#### **Deployment Models**

1. Public cloud
2. Private cloud
3. Hybrid cloud
4. Community cloud
5. Multi cloud

## 6. Gaia-X

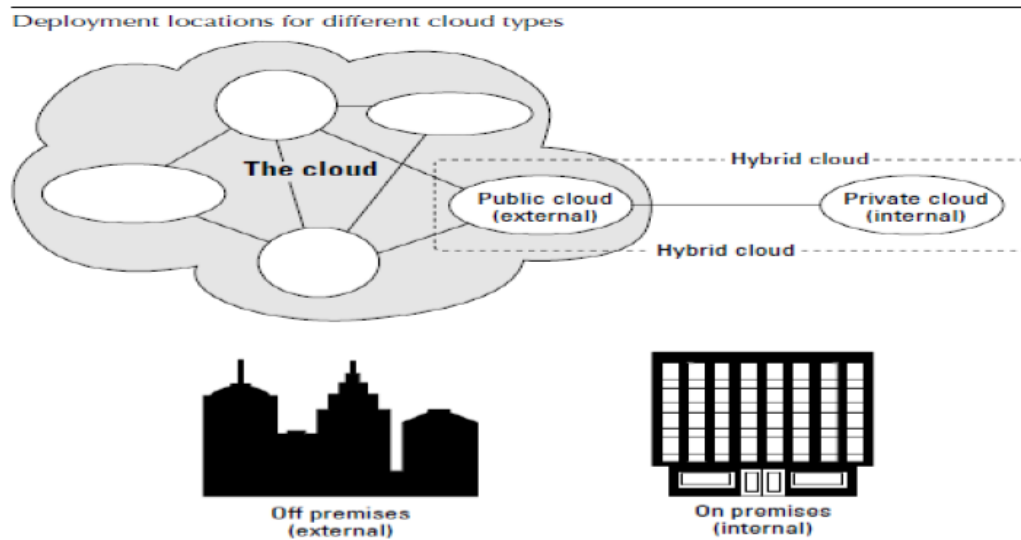


Fig 1.9 Deployment location for different cloud types

## Four Models based on NIST Definition: (Refer Fig 1.9)

## 1. Public cloud

- It is available for public use
- It is owned by an organization selling cloud services
- It provides a **shared platform** that is accessible to the **general public** through an Internet connection.
- **Legal Agreement:** The cloud infrastructure builds and provisioned for any organization or individuals wants to use it and agree to the terms and conditions of use.
- **Services Offered:** Cloud service provider provides all the possible services and hardware based on the needs of the consumer.

- **pay-as-per-use model:** free or sold on-demand, allowing customers to pay only per usage for the CPU cycles, storage, or bandwidth they consume.
- **Hosting:** Service provider location
- **Connectivity:** Must connected to the public network
- **Resources are shared with other users**
- **Management of cloud:** Cloud Service Provider
- **Technology Used in Public Cloud:**
  - a. Virtualization
  - b. Service Oriented Architecture (SOA)
  - c. Grid Computing
  - d. Utility Computing
- **Example:** YouTube, iCloud, Dropbox, Microsoft OneDrive, Google Drive, Gmail, Microsoft Azure, AWS, NetFlix, IBM Blue Cloud, Sun Cloud etc..
  
- **Advantages:**
  - a. High Scalability and reliability (Distributed)
  - b. Low cost
  
  - c. Location independent (services offered through internet)
  - d. Easy set up
- **Disadvantages:**
  - a. Security depends on the service provider
  - b. Performance is medium (depends on network bandwidth)
  - c. Less customization
  - d. Limited controls (infrastructure and services)
  - e. Compliance requirements are challenging

## 2. Private Cloud (Internal Cloud or Corporate Cloud)

Operated for exclusive use of an organization as shown in **Fig 1.10**.  
Managed by the organization or third party.

**Services offered:** Specific services and hardware as per the need of the enterprise are available in a private cloud.

**Responsibility:** End-user organization is responsible for the operation of a private cloud.

**Sharing of resources is removed.**

**Management of Cloud:** Organization or private.

**Hosting of Private Cloud:** On or off premises (places) - On-premise datacenters are built on the organization's premises, whereas private clouds are hosted on remote infrastructure.

**Isolation:** Resources are isolated and in the control of one organization.

**Connectivity:** Connected to the private network.

**Dedicated Platform:** It is a dedicated platform in a public cloud environment.

**Technology Used in Private Cloud:**

1. Virtualization
2. Management software
3. Automation

**Expensive:** It is more expensive to purchase than public cloud.



**Fig 1.10 Private Cloud**

**Types of Private Cloud:**

- Virtual private cloud (stored in public cloud but the resources are Private)
- Hosted (servers are not shared with others)
- Managed (hosted + provider management)

**Example:** Microsoft KVM, HP, Red Hat & VMWare, AWS S3, etc...

**Benefits:**

- Better security & privacy
- Better control
- Predictable cost (high compare to public)
- Legal compliance can be resolved easily
- Improved Flexibility
- Quick service delivery
- Easy resource customization

**Limitations:**

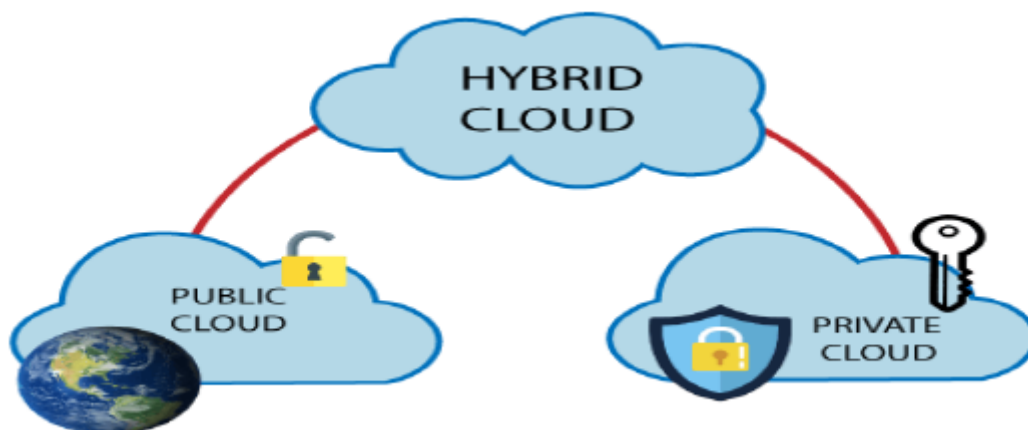
- Limited Scalability
- Need huge initial investment
- Limited Access
- Skilled people are required to operate

**Preference of private cloud over Public cloud:**

- ✓ Private cloud is an easier way (or the only way) to meet their regulatory compliance requirements.
- ✓ Easy to deal with confidential documents.

**3. Hybrid Cloud**

- Combination of multiple clouds (combination of public and private cloud) as shown in **Fig 1.11**.

**Fig 1.11 Hybrid Cloud**



**Goal:**

create a unified, automated, and well-managed computing environment.

**Functionalities:**

Non-critical activities are performed by the public cloud and critical activities are performed by the private cloud.

It allows the data and applications to move between the two environments.

**Example:**

Amazon, Microsoft, Google, Cisco, NetApp, etc...

**Types of Hybrid cloud platforms**

- Customer managed
- Vendor managed
- Partner managed
- Cloud provider managed

**Advantages**

- Greater flexibility
- Improved deployment, security and compliance
- Better control
- Effective risk management

**Disadvantages**

- Complex network design
- Infrastructure compatibility issues
- Reliability is depends on cloud service providers

**4. Community Cloud** (one or several organization) – Government Cloud

- It is organized to serve to a common function or purpose as shown in **Fig 1.12**.



**Fig 1.12 Community Cloud**

Managed by organization or third party.

**Group of organization:** It allows systems and services to be accessible by a group of several organizations to share the information.

- It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.
- It allows to share missions, policy, security, regulatory compliance needs.

**Advantages:**

- Cost effective
- Flexible and scalable
- Security
- Sharing of infrastructure

**Disadvantages:**

- Not suitable for single organization
- Slow adoption of data
- Fixed amount of data storage and bandwidth is shared among group of members
- It is costlier than public cloud
- Sharing of resources is difficult

4. **Multi Cloud** : Use the resources from several providers to get the best benefits from each unique service.

5. **Gaia-X**:(Global Architecture for Interoperable Analytics and Applications)

It is a modern data infrastructure developed by Germany's government which is fast, reliable, secure and competitive cloud model.

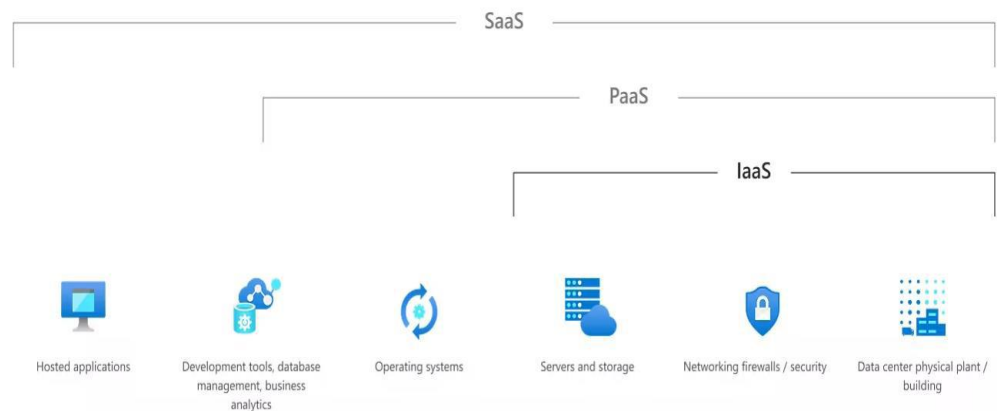
### 8.Explain in detail about cloud service models?

#### SERVICE MODELS

##### Types of service models

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)
4. Storage as a Service (StaaS)
5. Identity as a Service (IdaaS)
6. Compliance as a Service (CaaS)
7. Anything as a Service (XaaS)

**Different Types of Cloud computing Service Models** (SPI models) as shown in **Fig 1.13**.

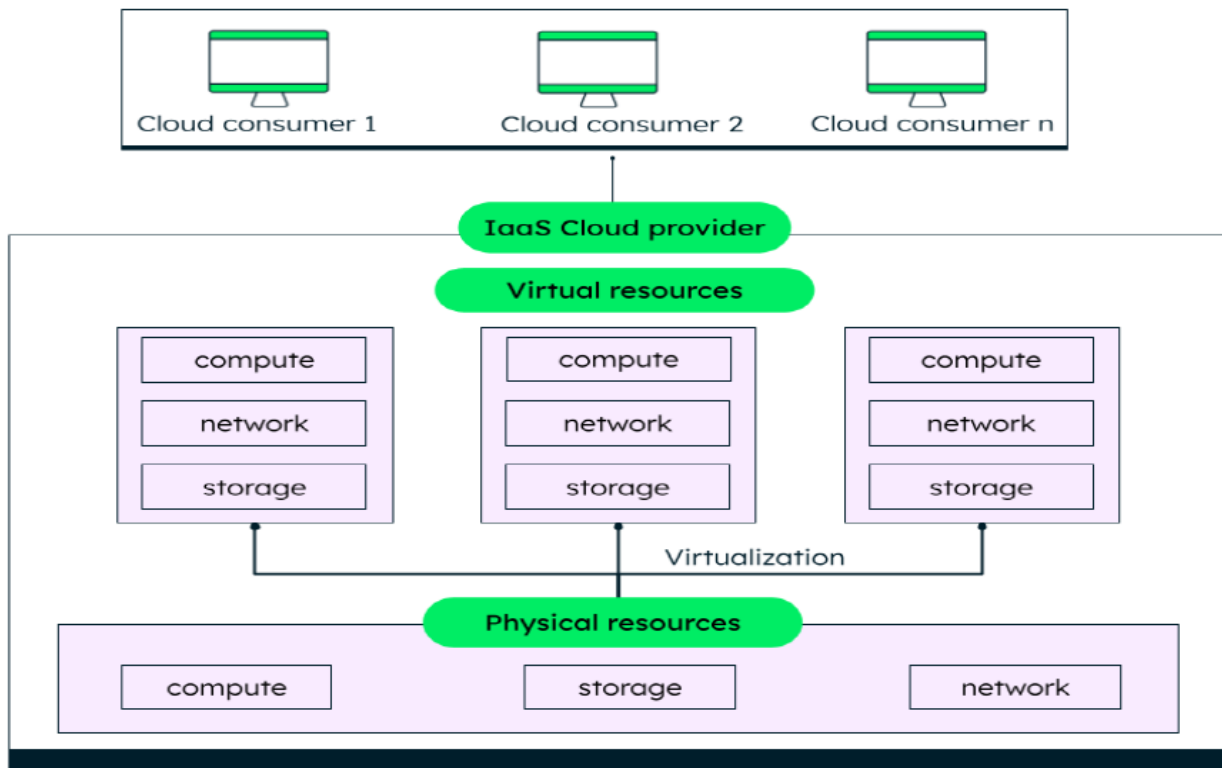


**Fig 1.13 Service Model Architecture**

#### 1. Infrastructure as a Service (IaaS) (Hardware as a Service – HaaS)

- The infrastructure is managed over the internet as shown in the **Fig 1.14**.
- **Goal:** It helps users to avoid the cost and complexity of purchasing and managing the physical servers.

- **Resources:** It is a collection of physical and virtualized resources that provide consumers with the basic building blocks needed to run applications and workloads in the cloud.
- **Role of IaaS CSP:** Managing and Maintaining the infrastructure.
- It provides the resources like (on-demand request),
  - a. Virtual Machines
  - b. Virtual Infrastructure
  - c. Virtual Storage
  - d. Servers
  - e. Networking
  - f. Other Hardware assets
  - g. Load balancers



**Fig 1.14 IaaS Architecture**

- Least level of integrated functionality and lowest level of integration.
- **Role of Cloud Consumers:** The cloud consumer is responsible for installing, configuring, and managing software and keeping the data secure.

- **Additional Services:**

- a. Detailed billing management
- b. Logging
- c. Monitoring
- d. Storage resiliency
- e. Security

- **Example:** Amazon Elastic Compute Cloud (EC2), Eucalyptus, Gogrid, Flexi Scale, Linode, Rack Soace Cloud, Terremark.

- **Benefits:**

- Speed
- Performance
- Reliability
- Back u p and recovery
- Competitive pricing
- Shared infrastructure
- It allows to access the resources through web
- It follows Pay – as – per - use model
- It supports on-demand scalability

**Disadvantages:**

- Security
- Maintenance and upgrade (no 100% upgradation for all software)
- Interoperability issues

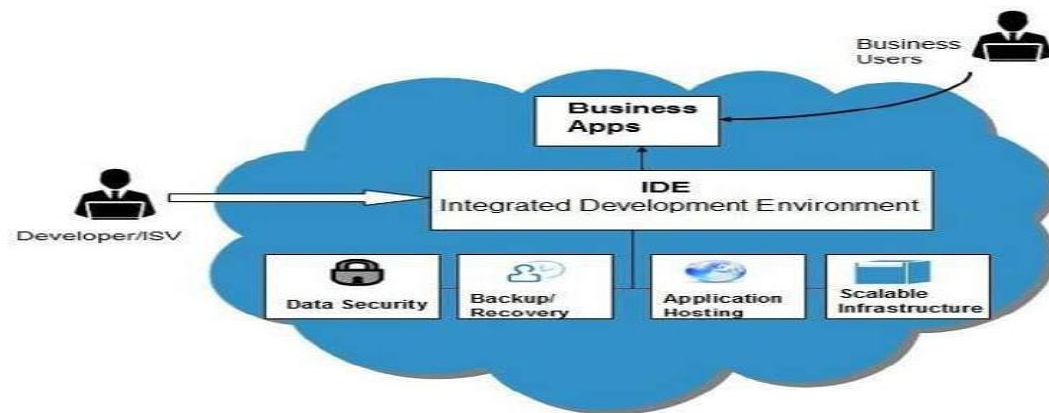
**Suitable Applications Area:** use cases

- High performance computing
- Website Hosting
- Big data analytics
- App development

## 2. Platform as a Service (PaaS)

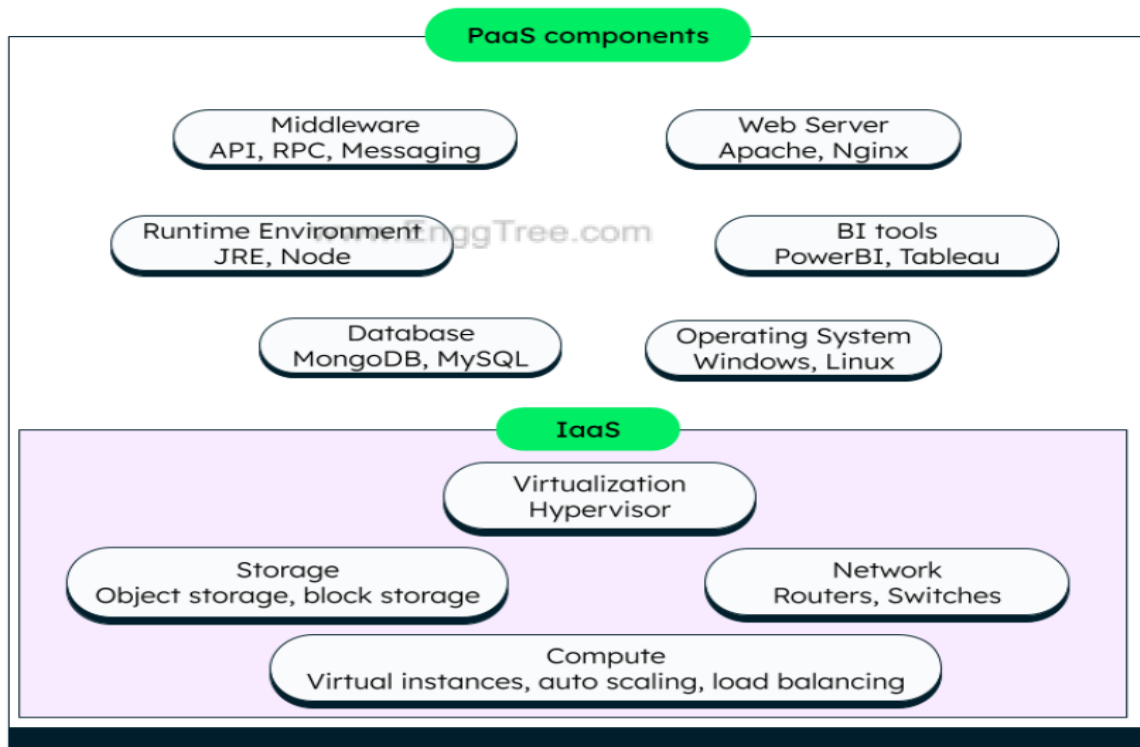
- **Goal:** It provides complete cloud environment that includes everything developers need to build, run, and manage applications. (complete development and deployment environment) in the below **Fig 1.15**.

- It provides run time environment support.
- Programmer: It allows the programmer easily to create, test, run and deploy the applications.
- It provides the services like IaaS as shown in **Fig 1.16**.
  - a. Operating Systems
  - b. Application Services
  - c. Development frameworks
  - d. Transactions
  - e. Control Structure
- Client deploy the application or use the application using tools by using PaaS providers.



**Fig 1.15 PaaS Architecture**

- Service provider manages client infrastructure, OS and enabling software.
- Client is responsible for installing and managing the deployed application.



**Fig 1.16 PaaS services like IaaS**

- PaaS Services Examples: Force.com, GoGrid Cloud Center, Google AppEngine, Windows Azure platform.
- Service Providers : Google Apps, Oracle on Demand, Salesforce.com, SQLAzure.

**Advantages:**

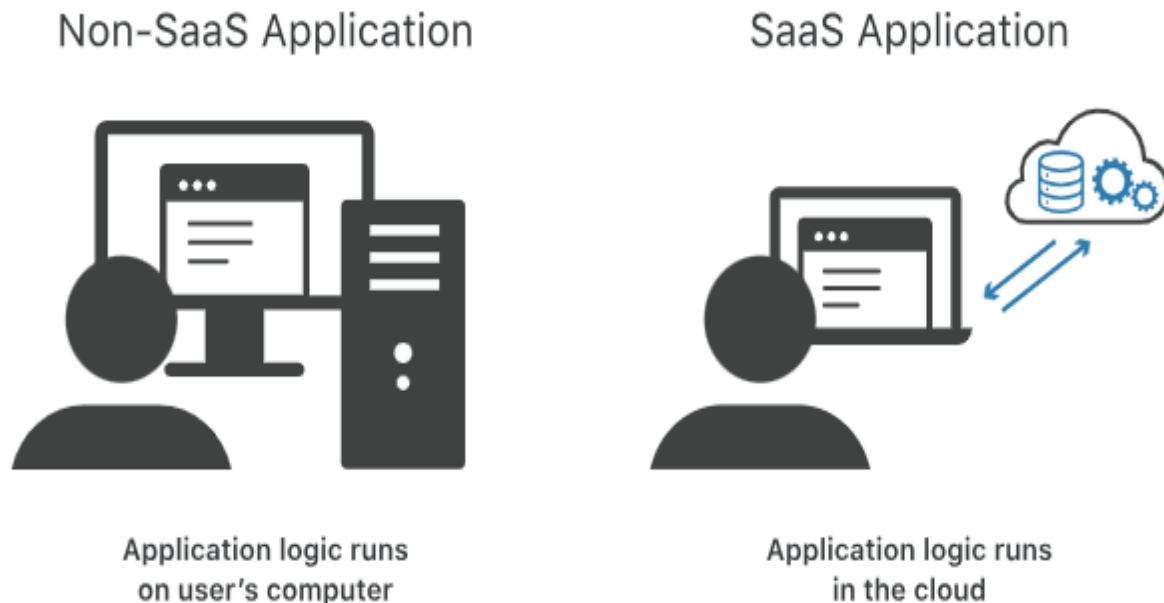
- Simplified development
- Pre-build business functionality
- Scalability
- Support geographically distributed development teams
- Efficiently manage the application lifecycle
- Cut coding time
- Develop for multiple platforms—including mobile—more easily
- Increase productivity
- Maintain security measures
- Use existing skills and investments

**Disadvantages:**

- Vendor lock – in (migration of platform)
- Data privacy depends on the service providers
- Integration with local machine is difficult

**3. Software as a Service (SaaS)**(On-Demand Software, Web-based software, or hosted software)

- It provides the complete operating environment with applications, management and the user interface. (access from anywhere, any device) as shown in **Fig 1.17**.
- Thin Client interface between application and user through browser.
- **Services:** The services host by the CSP and its available to the end users over the internet.

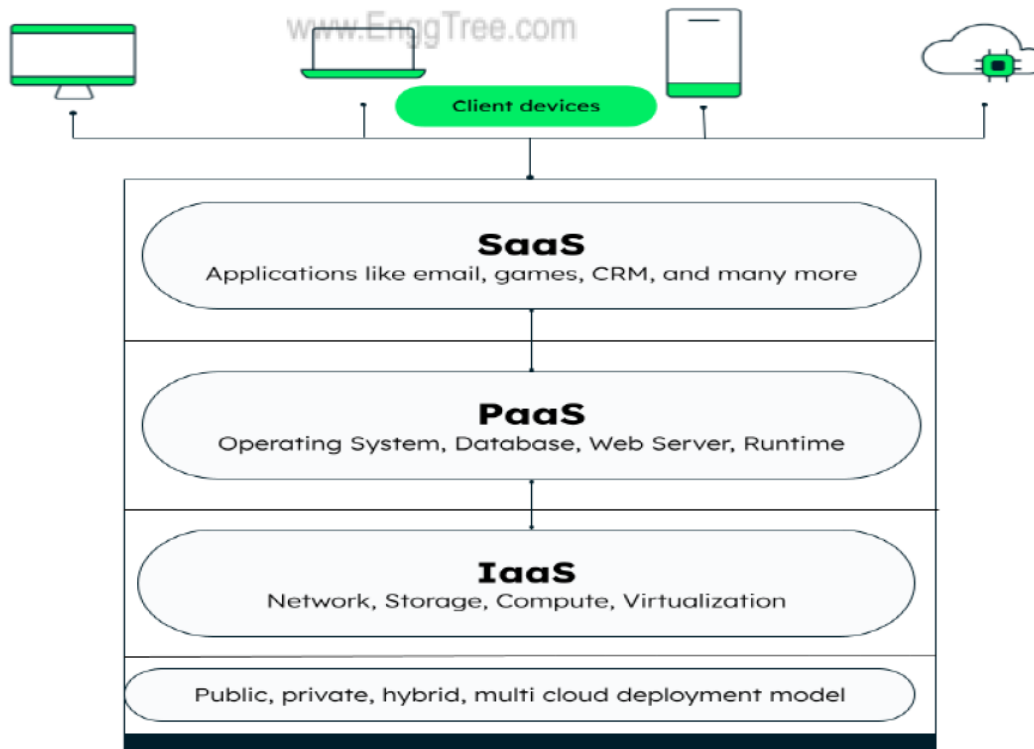


**Fig 1.17 SaaS and Non SaaS Service**

- **No Installation:** The end-users no need to install any software on their devices to access these services.
- **API:** It provides Application Programming Interface (API), which allows the developer to develop a customized application.
- **Accessing the services from client environment:** Software as a Service is commonly accessed through a web browser, with users logging into the system using a username and password as shown in **Fig 1.19**.
- **Services Offered by SaaS:**(Refer **Fig 1.18**)



1. Business Services (start-up services) - Enterprise Resource Planning(ERP), Customer Relationship Management (CRM), billing and sales.
2. Electronic Document management services (Ex: Slack, Samepage, Box, and Zoho Forms).
  - Social Networks.
  - Mail Services - handle the unpredictable number of users and load on email services.



**Fig 1.18 Services Offered by SaaS**

**Example:** Zoom, Slack, DocSign, Spotify, Adobe Creative Cloud, Salesforce.com, Oracle CRM, Constant Contact, Google Apps, Net Suite, GoTo Meeting, Dropbox, etc...

**Advantages:**

- It supports efficient data management
- It supports robust cloud infrastructure
- Automatic updation of software versions
- Scalable usage
- Better customization support
- One to many model (single instance shared by multiple users)

- Less hardware required
- Low maintenance cost
- No installation of software required



**Fig 1.19 SaaS Application**

#### **Disadvantage security depends on CSP**

- a. Latency issue (Speed of delivery)
- b. Entire services are depends on the internet
- c. Switching between different vendors are difficult (Portability)
- d. Customer lose control over version
- e. Browser based issues

#### **Cloud Reference Model**

- The diagrammatic representation of Cloud reference model as shown in **Fig 1.20**

The Cloud Reference Model

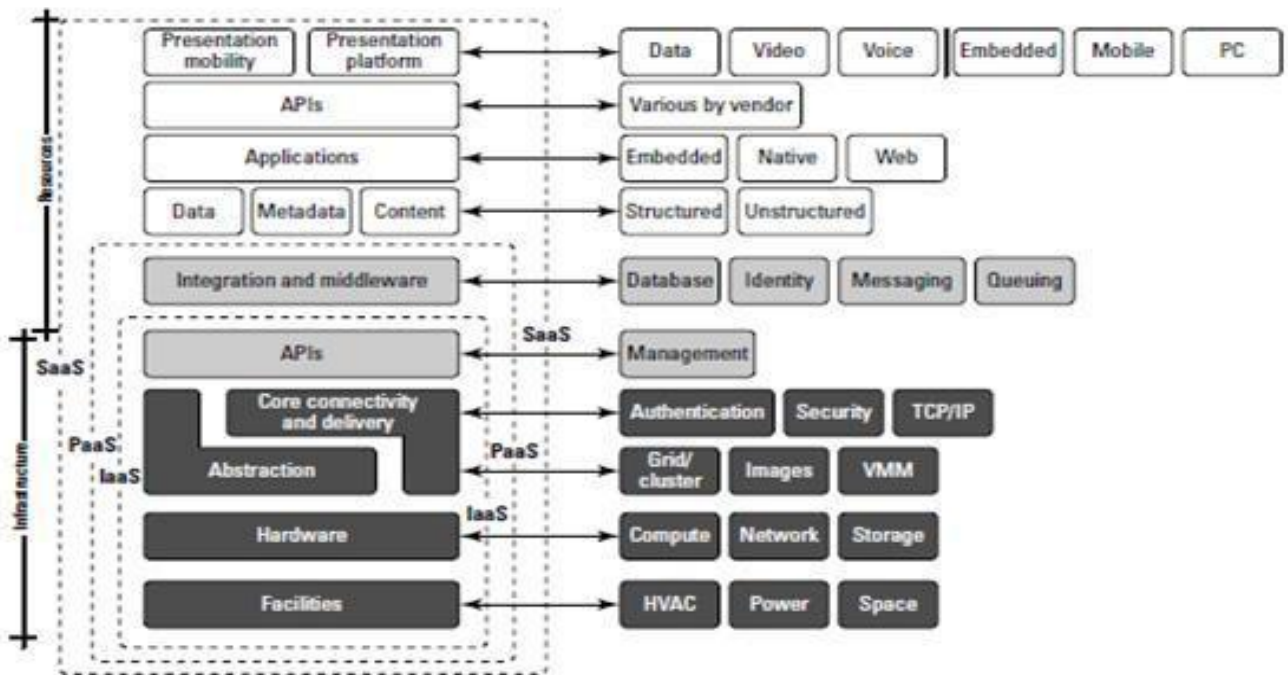


Fig 1.20 Cloud Reference Model

### Anything as a Service

It is also known as everything as a Service. Most of the cloud service providers nowadays offer anything as a service that is a compilation of all of the above services including some additional services.

### Advantages of XaaS:

1. **Scalability:** XaaS solutions can be easily scaled up or down to meet the changing needs of an organization.
2. **Flexibility:** XaaS solutions can be used to provide a wide range of services, such as storage, databases, networking, and software, which can be customized to meet the specific needs of an organization.
3. **Cost-effectiveness:** XaaS solutions can be more cost-effective than traditional on-premises solutions, as organizations only

pay for the services.

**Disadvantages of XaaS:**

1. **Dependence on the provider:** Users are dependent on the XaaS provider for the availability, scalability, and reliability of the service, which can be a risk if the provider experiences outages or other issues.
2. **Limited flexibility:** XaaS solutions may not be able to accommodate certain types of workloads or applications, which can limit the value of the solution for certain organizations.
3. **Limited integration:** XaaS solutions may not be able to integrate with existing systems and data sources, which can limit the value of the solution for certain organizations.

**9. Discuss the purpose and importance of adopting cloud service (Nov/Dec-2024)**

Cloud services have become an essential part of modern IT infrastructure, helping businesses and individuals **store, process, and manage data efficiently** over the internet. Here's why organizations adopt cloud computing:

**1. Purpose of Cloud Services**

**a. On-Demand Computing Resources**

- Provides scalable computing power, storage, and applications without needing physical infrastructure.
- Reduces the burden of maintaining on-premises servers.

**b. Cost Efficiency**

- Eliminates upfront capital expenses (CapEx) for hardware.

- Operates on a pay-as-you-go or subscription basis, optimizing operational costs (OpEx).

**c. Scalability and Flexibility**

- Enables businesses to scale resources up or down based on demand.
- Supports business growth without requiring major IT investments.

**d. Accessibility & Remote Work**

- Users can access applications and data from anywhere with an internet connection.
- Supports remote teams and global collaboration.
- Cloud providers invest heavily in cybersecurity, offering **encryption, identity management, and compliance certifications** (e.g., GDPR, HIPAA).
- Reduces security risks associated with on-premises systems.

**e. Innovation & Speed to Market**

- Provides a platform for rapid application development and deployment.
- Enables businesses to experiment with AI, Big Data, and IoT without large investments.

**f. Competitive Advantage**

- Startups and enterprises can focus on core business activities instead of IT management.
- Enables organizations to leverage advanced technologies without the need for specialized expertise.

## Recommended Cloud Models for a Trendy Shopping Portal

Launching a **trendy shopping portal** in multiple locations requires a **scalable, cost- effective, and highly available** cloud solution. Below are the best **service and deployment models** for this use case.

### 1. Recommended Cloud Service Model

#### Service Model

#### Why It's Suitable for a Shopping Portal?

**Software as a Service (SaaS)** If using an existing e-commerce platform (e.g., Shopify, BigCommerce).

**Platform as a Service (PaaS)** If developing a custom web app with high customization and integrations.

**Infrastructure as a Service (IaaS)** If requiring full control over hosting, scalability, and security.

#### Choice: PaaS + IaaS Hybrid

- **PaaS** (e.g., AWS Elastic Beanstalk, Google App Engine) helps develop and deploy the shopping portal without managing infrastructure.
- **IaaS** (e.g., AWS EC2, Azure VM) provides **full control** over hosting and storage, enabling high performance and security.

### 2. Recommended Cloud Deployment Model

#### Deployment Model

#### Why It's Suitable for a Shopping Portal?

<b>Public Cloud</b>	Cost-effective, scalable, and widely available. Best for general online stores.
<b>Hybrid Cloud</b>	Combines public cloud for scalability and private cloud for secure transactions.
<b>Multi-Cloud</b>	Uses multiple cloud providers to ensure redundancy and global reach.

### **Best Choice: Multi-Cloud or Hybrid Cloud**

- **Multi-Cloud** (AWS, Azure, GCP) ensures high availability across regions, reducing downtime.
- **Hybrid Cloud** allows **secure payment processing** on a private cloud while hosting web content on a public cloud.
- **Final Recommendation for a Shopping Portal**

✓ **Service Model: PaaS + IaaS** (for development, hosting, and scaling).

✓ **Deployment Model: Multi-Cloud or Hybrid Cloud** (for global reach, security, and performance).

**10..Mr. Anis is an intruder forged the identity of an authentic bank customer Mr. George and entered inside the bank. He bypassed security measures card-based identification and signature matching and took certain bank's confidential information. In order to trace Mr. Anis, bank officials require to match the signature of intruder with 5 lakh people in the criminal records. Is it possible to deploy a secure cloud model to trace such kind of vulnerabilities or bypassing security measures happening at each bank location? Discuss the identified cloud deployment model with neat sketch and elaborate its benefits by relating it to the given scenario.**

To address the security breach where Mr. Anis impersonated Mr. George and accessed confidential bank information, implementing a cloud-based biometric signature verification system can enhance security measures across all bank

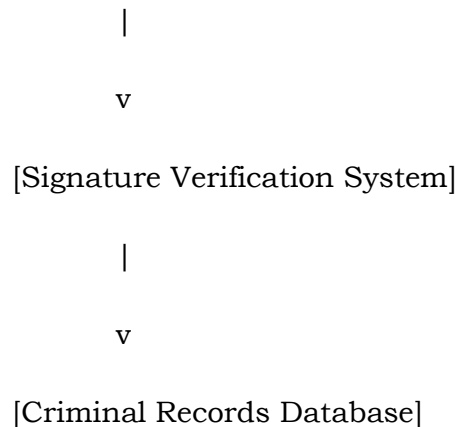
locations. This system would enable the bank to match the intruder's signature against a database of 500,000 criminal records efficiently.

### **Proposed Cloud Deployment Model: Hybrid Cloud**

A hybrid cloud model combines the strengths of both private and public clouds, allowing banks to manage sensitive data securely while leveraging the scalability and cost-effectiveness of public cloud services. In this model, sensitive information, such as customer signatures and confidential data, is stored within the bank's private cloud infrastructure, ensuring enhanced control and security. Less sensitive operations and computational tasks, like large-scale signature matching against criminal records, can be handled by the public cloud.

#### **Architecture Diagram:**

[Bank Branches] --(Data Collection)--> [Private Cloud Storage] --(Secure Data Transfer)--> [Public Cloud Processing]



#### **Benefits in the Given Scenario:**



1. **Enhanced Security:** Storing sensitive customer data in a private cloud ensures that confidential information remains under the bank's direct control, reducing the risk of unauthorized access.
2. **Scalability:** The public cloud component allows the bank to efficiently process and match the intruder's signature against a vast database of criminal records without overloading internal resources.
3. **Cost Efficiency:** By utilizing public cloud resources for intensive computational tasks, the bank can minimize the need for expensive on-premises hardware investments.
4. **Flexibility:** A hybrid cloud model enables seamless integration of existing on-premises systems with cloud-based applications, facilitating a smoother transition and better resource utilization.
5. **Improved Incident Response:** With centralized data storage and processing, the bank can quickly analyze security breaches and implement corrective measures across all locations.

Implementing a hybrid cloud-based biometric signature verification system can significantly enhance the bank's ability to detect and prevent security breaches like the one involving Mr. Anis, ensuring robust protection of confidential information across all branches.

**UNIT II****CLOUD SERVICES STRATEGY**

Cloud Strategy Fundamentals - Cloud Strategy Management Framework -Cloud Policy - Key Driver for Adoption - Risk Management - IT Capacity and Utilization- Demand and Capacity matching - Demand Queueing - Change Management – Cloud Service Architecture.

**PART - A****1. What is Cloud Strategy and its Goal?**

**Cloud strategy:** It is the plan an organization follows to host its IT infrastructure in a cloud environment.

**Goal:**

- Optimize the business outcomes (speed, resilience [elasticity] and agility) (or) Ensure Effective performance of the infrastructure.
- Enable distributed based cloud architecture for different services.
- Growing the public to improve the skills internally.
- Minimize the risks and challenges.

**2. What are the principles of Cloud Strategy principles?**

- Trust
- Enablement
- Enterprise Risk
- Capability
- Cost-benefit
- Accountability

**3. Define Data Management and Governance.**

- Define how data will be managed, stored, and accessed in the cloud.
- Establish data governance policies to ensure data quality, privacy, and compliance.

**4. Define Strategy Life Cycle in Deployment Phase.**

1. Planning for utilizing cloud technology
2. Capabilities of an enterprise

3. Target architecture require
4. Transition planning & gap analysis
5. Planning to implement cloud
6. Governance & significance of SOA (Service-Oriented Architecture)

**5. Define planning Phase and its steps.****Planning Phase**

Perform the problem analysis & risk analysis for switching to cloud technology.

**Steps:**

- a) Development of Business Architecture
- b) Development of IT Architecture
- c) QOS development requirement
- d) Development of Transformation plan

**6. Define Cloud Strategy Management.**

- It is a structured approach that guides organizations through the process of developing, implementing, and managing their cloud strategies.
- It provides a systematic way to align business objectives, technology decisions, and operational considerations when adopting and utilizing cloud services.
- It is essential for providing a structured, consistent, and effective approach to managing cloud services.
- It helps organizations mitigate risks, optimize resources, ensure security and compliance, and align cloud strategies with business objectives in a rapidly evolving technological landscape.

**7. List out the Components of cloud Strategy Management Framework.**

- Assessment and Analysis - Workload assessment (identify current IT landscape, business needs).
- Business Objectives and Alignment (vision and objectives).
- Selection of suitable Deployment Models.
- Selection of suitable Service Models to align with the business goals.
- Governance and policies (security, compliance, data management and budgeting).

- Data Management and Governance – Define how data will be managed, stored, and accessed in the cloud. Establish data governance policies to ensure data quality, privacy, and compliance.
- Cost Management.
- Migration Plan.
- Vendor Selection - Evaluate and choose a cloud service provider based on factors such as service offerings, pricing, geographic availability, reliability, and support.
- Performance and Scalability.
- Resilience and Disaster Recovery.
- Training and Skill Development.
- Change Management and Training.
- Performance Monitoring and Management.
- Continuous Improvement.
- Communication and Reporting.

**8. Define Migration Strategy.****Migration Strategy:**

If migrating existing applications and data to the cloud, develop a migration strategy that includes risk assessment, testing, and a phased approach to minimize disruptions.

**9. Define Business Alignment.**

- Ensure that your cloud strategy aligns with your organization's overall business goals and objectives.
- Understand how cloud technology can support and drive your business forward.

**10. What is Cost Management?**

- Cloud services can become costly if not properly managed. Create a cost management plan that includes budgeting, cost tracking, and optimization strategies to control expenses effectively.

- This may involve using cloud cost management tools and practices to avoid unexpected bills.

**11. Define Cloud Service Selection.**

Determine which cloud service models (IaaS, PaaS, SaaS) and providers (e.g., AWS, Azure, Google Cloud) are the best fit for the organization's needs. Consider factors like cost, performance, and the specific services offered by each provider.

**12. Define Cloud Policy.**

- Cloud policy" typically refers to a set of rules, guidelines, and regulations that govern the use of cloud computing services within an organization or by individuals.
- These policies are put in place to ensure the secure, efficient, and compliant use of cloud resources, as well as to protect data and meet specific business or regulatory requirements.

**13. What are the Key aspects of Cloud Policy?**

- Data Security and Privacy: - Access control and authentication
- Access and Identity Management – user access controls
- Resource Provisioning and Management
- Cost Management
- Vendor Management – selection of CSP
- Disaster Recovery and Business Continuity
- Change Management
- Cloud Service Adoption
- Monitoring and Incident Response
- Training and Awareness

**14. Define Data Retention.**

Policies may dictate how long data can be stored in the cloud and under what circumstances data should be deleted.

**15. What is Service Level Agreements (SLAs)?**

**Service Level Agreements (SLAs):**

Ensure that cloud providers meet their SLAs in terms of uptime, performance, and support. Policies may require regular reviews of SLAs.

**16. Define Vendor Management.**

If multiple cloud service providers are used, the policy may outline how vendor relationships are managed.

**17. Define Cloud service Adoption.**

- It is the strategically move taken by an organization in order to bring the services at one common platform pertaining to the responsibilities of an organization, with the motive to clear the cost, access the cloud storage, mitigates the risk factors and deliver scalable services.
- It plays a pivotal role in shaping the strategy, benefits, and outcomes of adopting cloud services.

**18. List out the Key factors in adoption of cloud service Management.**

- Security
- Cost Saving or cost Efficiency
- Efficiency
- Flexibility and Scalability
- Rapid Recovery
- Increased Convenience – easy accessing
- Speed and Productivity
- Strategic Value [ competitive edge to businesses - business agility and customer satisfaction]
- Multi-tenancy (multiple customer share the underlying models)
- Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)
- Standards
- Sustainability
- Rapid deployment – Cloud services enables fast provisioning of resources and deployment of applications. (reduce time for the product enter into market)

- Access to advanced technologies
- Reduced IT Management Burden
- Competitive advantage

**19. What is Risk management?**

Risk management in cloud services management involves identifying, assessing, mitigating, and monitoring potential risks associated with using cloud computing resources and services.

**20. What are the types of Risk in cloud computing?****Types of Risk in cloud computing**

- **Data breach** - unauthorized access to the confidential data of an organization.
- **Cloud vendor security risk** – CSP cloud security and risk mitigation affects organization growth.
- **Availability** - Any internet connection loss disrupts the cloud provider's services, making the services inoperative.
- **Compliance** - The service provider might not follow the external audit process, exposing the end user to security risks.

**21. List out the Steps involved in Risk Management.**

- Risk Identification – identify the potential risk.
- Risk Assessment.
- Risk Mitigation Strategies - Develop strategies to mitigate or reduce identified risks.
- Data security (encryption techniques).
- Compliance and governance – policy.
- Vendor risk management - evaluate the security practices and certifications of CSP.
- Data Loss Prevention.
- Service availability.
- Change Management – It ensures that updates, changes, and configurations are carefully planned and tested to avoid disruptions.
- Business continuity.

- Incident Response.
- Cost management.
- Continuous Monitoring.
- Audit and reporting.
- Employee training and awareness.
- Establish Service Level Agreements (SLA).

**22. What are the Advantages in Risk Management?**

- Forecast probable issues (identify the risks – helps to implementing appropriate control strategies)
- Increase the scope of growth
- Business process improvement
- Better budgeting

**23. What are the different processes in Risk Management?**

- Identify the risk
- Analyze the risk
- Evaluate the risk (ranked based on the severity)
- Solve the risk
- Monitor or review the risk

**24. Define Capacity management.**

Capacity management involves planning, monitoring, and optimizing IT resources to ensure that they meet current and future demands while **avoiding underutilization or over provisioning**.

**25. What is the Role of Cloud Capacity Management?**

- a. It reduces the excess capacity occupied by the services.
- b. It helps to increase the business growth.
- c. It reduces the cost of the service.

**26. What are the benefits of Effective capacity and Utility management?**

- Cost efficiency
- Performance optimization
- Scalability



- Flexibility - Easy to align with business needs
- Resource allocation based on priority
- Proactive Problem Detection
- Data driven decision (effective resource allocation)

**7. What is Resource Provisioning and Resource monitoring?**

**Resource Provisioning**– Over provisioning (allocating more resources than necessary) and under provisioning (allocating fewer resources than needed) can both have negative impacts on cost and performance.

**Resource monitoring:** Tracking metrics such as CPU usage, memory consumption, storage usage, and network bandwidth.

**28. What is the Need for Demand and capacity utilization?**

- Efficient allocation of resources
- Optimizing cost (cost management)
- Maintain better performance
- Improve customer satisfaction
- Inventory management

**29. Define Demand Forecasting.**

**Demand Forecasting** is the process of estimating the future demand for a service or product on historical data, market trends, customer behavior, and other factors.

**30. List out the different forecasting models.**

1. Based on varying detail (business needs)
2. Time
3. Type of data storage

**31. Define the relationship between demand and capacity matching.**

1. Balancing demand and supply
2. Efficient resource utilization
3. Customer satisfaction
4. Revenue generation
5. Cost control

- 6. Risk management
- 7. Technology and innovation - Automation, data analytics, and AI-driven forecasting can enhance decision-making.

**32. Define Resource Utilization.**

- Optimize the utilization of resources to minimize costs and environmental impact.
- Monitor resource usage and performance continuously to identify underutilized or over utilized resources.
- Implement workload management and orchestration to make the most efficient use of resources.

**33. Define Reserved Instances/Reserved Capacity.**

- Many cloud providers offer the option to reserve instances or capacity in advance, which can lead to cost savings.
- However, this requires a good understanding of your long-term resource needs.

**34. Define Auto-scaling Policies.**

- Set up auto-scaling policies that trigger resource provisioning or deprovisioning based on predefined thresholds.
- For example, scale up when CPU utilization exceeds 80% and scale down when it falls below 30%.

**35. What is Caching and Content Delivery Networks (CDNs)?**

Implement caching mechanisms and CDNs to offload some of the traffic from your primary infrastructure, reducing the need for additional resources to handle the same demand.

**36. Define Demand Queuing.**

- It refers to the practice of organizing and prioritizing incoming requests for cloud resources or services in a systematic manner when the available resources are currently insufficient to fulfill all requests immediately.
- Excessive queuing can lead to long waiting times and user dissatisfaction.

**37. What are the Challenges faced if queue mechanism is not implemented?**

1. Service rejection
2. Unpredictable access
3. User dissatisfaction
4. Missed business opportunities
5. Inefficient resource utilization
6. Lack of prioritization
7. Unpredictable performance
8. Loss of business opportunities
9. Negative impact in revenue
10. Reduced customer loyalty

**38. List out the Services associated with Queuing.**

- Monitoring and metrics
- Notification and feedback
- Load balancing
- Prioritization

**39. What are the Advantages in Demand Queuing?**

- Resource optimization
- Fairness (FIFO order)
- Performance stability
- Reduced service failure (minimize the rejection of services)

**40. Define Stakeholder Engagement.**

- Identify all stakeholders, both internal and external, who will be affected by the cloud migration.
- Ensure that they are involved in the decision-making process and are informed about the changes.

**41. What is the Need of change management?**

- Maintain control
- Maintain Stability
- Maintain security

- Maintain compliance

**42. What are the Advantages of Change Management?**

1. Continuous improvement
2. Adopt to new technology and innovation
3. Improve vendor relationship
4. Adopt to new infrastructure
5. Helps to improve the security
6. Minimize user impact
7. Helps to reduce the risks

**43. What are the Different components in Cloud Service Architecture?**

1. Service Consumption
2. Service usage and Billing
3. Service Security
4. Service monitoring and Control
5. Self-Service
6. Service support
7. Service Function
8. Service Economics
9. Service chain Entity

**44. Define Monolithic.**

This is a traditional architecture where all components of the application are tightly integrated into a single codebase. It may be less flexible and scalable but is simpler to manage in some cases.

**45. Define Cloud service architecture.**

- Cloud service architecture refers to the design and structure of software applications and services that are hosted and delivered over the internet through cloud computing platforms.
- These architectures are designed to leverage the scalability, flexibility, and cost-efficiency of cloud infrastructure and services.

**46. Define the term change in cloud.**

The addition, modification, or removal of anything that could have direct or indirect effect on services.

**47. Define Change Management.**

Change Management is the methodology and processes used by organizations to plan and manage these changes (or) the process responsible for controlling the lifecycle of all changes, enabling beneficial changes to be made with minimum disruption to IT services (or) deliver critical updates to products while simultaneously minimizing disruption to user workflow (or) it is a structured process of planning, implementing, and tracking changes to cloud-based systems, applications, and services while minimizing disruption to business operations and ensuring the integrity and security of the environment.

**48. List the issues in the transition to cloud services?(April/May 2024)**

There are several issues that can arise when transitioning to cloud services, including

- Security and compliance
- Cost management
- Data Loss
- Performance
- Vendor lock-in
- Skill gap
- Service disruption
- Bandwidth and performance

**49. How will you manage demand and capacity matching in cloud service?(April/may 2024)**

To manage demand and capacity matching in cloud services, you can use strategies like demand forecasting, capacity assessment, and monitoring.

**Demand forecasting**

- Analyze historical data, market trends, customer preferences, and external factors to improve forecast accuracy.
- This helps you plan capacity proactively.

**Capacity assessment**

- Calculate your current resource capacity using historical time data.
- This helps you identify underutilized resources.

**Monitoring**

- Regularly monitor usage and performance to identify when adjustments are needed.
- Use monitoring and log management tool to collect data.

**50.compare Demand and Capacity matching. (Nov/Dec-24)**

**Demand Matching:** Focuses on understanding and predicting the user or application demand for resources (e.g., CPU, memory) to ensure that the required resources are available when needed. This is often dynamic and varies based on usage patterns.

**Capacity Matching:** Involves ensuring that the available resources (e.g., infrastructure, hardware) meet or exceed the demand. This is about having enough capacity to handle peak demand without over- provisioning

**51.Is it necessary to adopt change management in cloud environment? (Nov/Dec-24)**

Yes, adopting change management in a cloud environment is necessary to ensure smooth transitions, minimize risks, and maintain service availability. It helps in managing updates, ensuring compliance, and preventing disruptions by providing a structured approach to implementing changes.

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**PART B****1. Explain in detail about cloud strategy fundamentals.**

- **Cloud Strategy Fundamentals**
- **Cloud Strategy principles**
- **Fundamental Aspects for strategy formulation**
- **Main Phases**
  - 1. Strategy Phase**
  - 2. Planning Phase**
  - 3. Deployment Phase**
    - **Strategy Life Cycle**

**CLOUD STRATEGY FUNDAMENTALS**

**Strategy:** It involves setting goals and priorities, determining actions to achieve the goals, and mobilizing resources to execute the actions.

**Cloud strategy:** It is the plan an organization follows to host its IT infrastructure in a cloud environment.

**Goal:**

1. Optimize the business outcomes (speed, resilience [elasticity] and agility)  
(or) Ensure Effective performance of the infrastructure
2. Enable distributed based cloud architecture for different services
3. Growing the public to improve the skills internally
4. Minimize the risks and challenges
5. It refers to the core principles and considerations that organizations should take into account when adopting and implementing cloud technologies.
6. Cloud Strategy must support (cloud management),
  - ✓ Cost
  - ✓ Service level
  - ✓ Functionalities

**Cloud Strategy principles:**

- Trust
- Enablement
- Enterprise Risk
- Capability
- Cost-benefit
- Accountability

**Fundamental Aspects for strategy formulation**

1. Business Objectives and Alignment - align the cloud strategy with the overall business strategy to ensure that technology decisions are in line with the company's direction.
2. Workload Assessment - Evaluate existing applications and workloads to determine which ones are suitable for migration to the cloud.
3. Selection of suitable Deployment Models.
4. Selection of suitable Service Models to align with the business goals.
5. Security and Compliance - Security strategy that addresses data protection, access control, encryption, and compliance requirements specific to your industry and jurisdiction.
6. Data Management and Governance – Define how data will be managed, stored, and accessed in the cloud. Establish data governance policies to ensure data quality, privacy, and compliance.
7. Cost or financial Management.
8. Migration Plan.
9. Vendor Selection - Evaluate and choose a cloud service provider based on factors such as service offerings, pricing, geographic availability, reliability, and support.
10. Performance and Scalability.
11. Resilience and Disaster Recovery.
12. Training and Skill Development.
13. Change Management and Training.
14. Performance Monitoring and Management.
15. Continuous Improvement.
16. Communication and Reporting.



**Main Phases:****1. Strategy Phase**

- It is the initial and foundational part of strategy steps.
- It sets the foundation for successful cloud adoption by aligning technology decisions with business goals and considering the organization's unique needs and challenges.

**2. Planning Phase**

Perform the problem analysis & risk analysis for switching to cloud technology.

**Steps:**

- a) Development of Business Architecture
- b) Development of IT Architecture
- c) QOS development requirement
- d) Development of Transformation plan

**3. Deployment Phase****Strategy Life Cycle:**

- a) Planning for utilizing cloud technology
- b) Capabilities of an enterprise
- c) Target architecture require
- d) Transition planning & gap analysis
- e) Planning to implement cloud
- f) Governance & significance of SOA (Service-Oriented Architecture)

**2. Explain briefly about Cloud Strategy Management Framework. (April/May 2024)****CLOUD STRATEGY MANAGEMENT FRAMEWORK****Definition:**

- It is a structured approach that guides organizations through the process of developing, implementing, and managing their cloud strategies.
- It provides a systematic way to align business objectives, technology decisions, and operational considerations when adopting and utilizing cloud services.
- It is essential for providing a structured, consistent, and effective approach to managing cloud services.

- It helps organizations mitigate risks, optimize resources, ensure security and compliance, and align cloud strategies with business objectives in a rapidly evolving technological landscape as shown in **Fig 2.1**.

**Need for Cloud Service Framework:**

1. Need common standard ad practices (wide range of services, technologies and providers)
2. Complexity management (hybrid or multi-cloud setups)
3. Efficiency
4. Scalability
5. Security and compliance
6. Training and on boarding (easy)
7. Change management (adopt with new technologies in cloud)
8. Resource management

**Components of cloud Strategy management Framework:**

1. Assessment and Analysis - Workload assessment (identify current IT landscape, business needs).
2. Business Objectives and Alignment (vision and objectives).
3. Selection of suitable Deployment Models.
4. Selection of suitable Service Models to align with the business goals.
5. Governance and policies (security, compliance, data management and budgeting).
6. Data Management and Governance – Define how data will be managed, stored and accessed in the cloud. Establish data governance policies to ensure data quality, privacy, and compliance.
7. Cost Management.
8. Migration Plan.
9. Vendor Selection - Evaluate and choose a cloud service provider based on factors such as service offerings, pricing, geographic availability, reliability, and support.
10. Performance and Scalability.
11. Resilience and Disaster Recovery.
12. Training and Skill Development.
13. Change Management and Training.

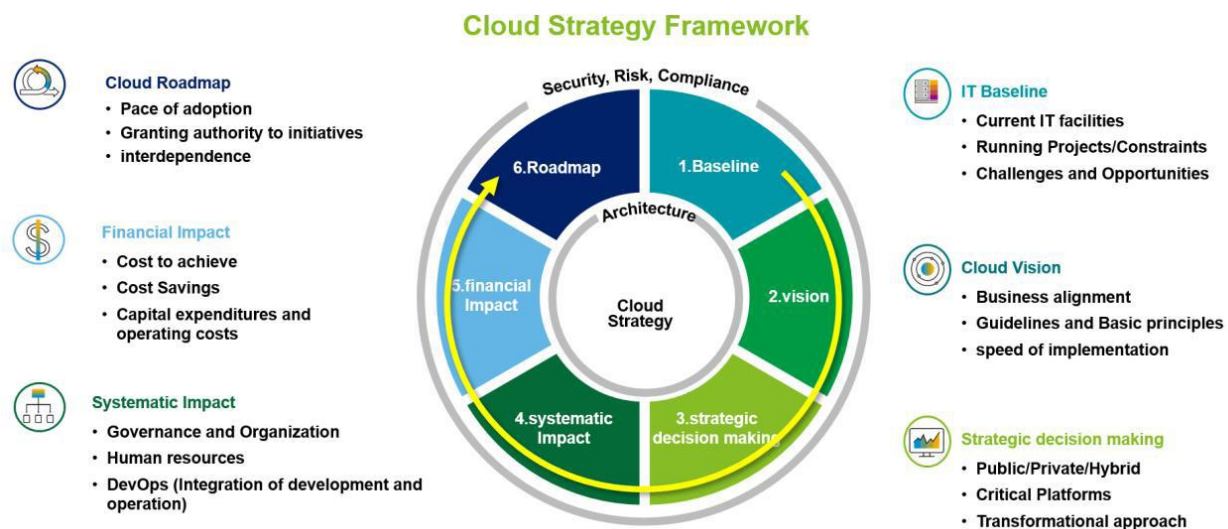
14. Performance Monitoring and Management.

15. Continuous Improvement.

16. Communication and Reporting.

### Framework Architecture:

Cloud strategy framework can help to develop a viable cloud strategy from multiple perspectives



**Fig 2.1 Cloud Strategy Framework**

### 3. Explain in detail Cloud Policy? (Nov/Dec 2024)

#### CLOUD POLICY

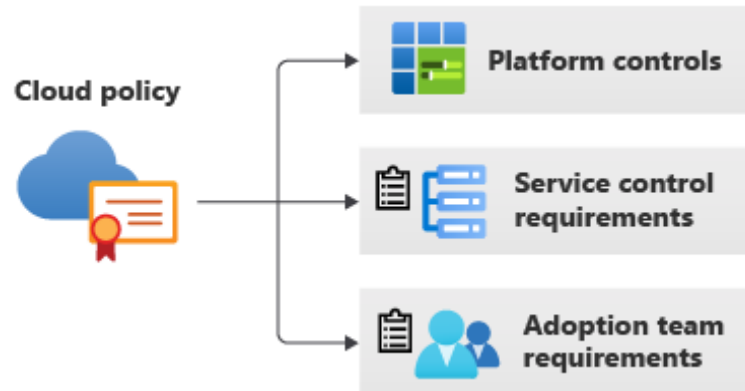
##### Cloud security policy:

- It is formal guidelines companies adhere to that help ensure safe and secure operations in the cloud. (or) set of rules, guidelines, and principles that an organization establishes to govern the use, management, and security of cloud computing resources and services.
- It is an essential part of your cloud security strategy and helps your organization properly store and protect your critical data assets.
- Cloud policies are designed to ensure that organization's business goals as shown in **Fig 2.2**.

**Entire Life cycle:** A cloud policy is applicable throughout the entire lifecycle of cloud adoption.

**Guidance:** It serves as a guiding document that outlines the rules, guidelines, and best practices for using, securing, and managing cloud resources effectively.

**Not adopting cloud policy:** If not adopting a cloud policy can result in a lack of consistency, security vulnerabilities, compliance risks, inefficiencies, and missed opportunities.



**Fig 2.2 Cloud Policy**

#### **Policy ensures**

- a) Confidentiality
- b) Integrity
- c) Availability of data stored
- d) Accessing of data
- e) Manipulation of data

#### **Key aspects:**

- Data Security and Privacy: - Access control and authentication
- Access and Identity Management – user access controls
- Resource Provisioning and Management
- Cost Management
- Vendor Management – selection of CSP
- Disaster Recovery and Business Continuity
- Change Management
- Cloud Service Adoption

- Monitoring and Incident Response
- Training and Awareness

#### **4.Discuss about Key Driver for Adoption. (Nov/Dec 2024)**

##### **KEY DRIVER FOR ADOPTION**

- It is the strategically move taken by an organization in order to bring the services at one common platform pertaining to the responsibilities of an organization, with the motive to clear the cost, access the cloud storage, mitigates the risk factors and deliver scalable services.
- It plays a pivotal role in shaping the strategy, benefits, and outcomes of adopting cloud services.

##### **Business Drivers:**

- **Capacity Planning** - Estimates the production capacity (storage, infrastructure, hardware, software, availability of resources) needed for its products to cope with the ever-changing demands in the market. It depends on,
  - ✓ Level of demand
  - ✓ Cost of production
  - ✓ Availability of funds
- Cost Reduction.
- Organizational Agility - the process by which an organization will adapt and evolve to sudden changes caused by internal and external factors.

##### **Drivers to cloud adoption:**

- Security
- Cost Saving or cost Efficiency
- Efficiency
- Flexibility and Scalability
- Rapid Recovery
- Increased Convenience – easy accessing
- Speed and Productivity
- Strategic Value [ competitive edge to businesses - business agility and customer satisfaction]

- Multi-tenancy (multiple customer share the underlying models)
- Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)
- Standards
- Sustainability
- Rapid deployment – Cloud services enables fast provisioning of resources and deployment of applications. (reduce time for the product enter into market)
- Access to advanced technologies
- Reduced IT Management Burden
- Competitive advantage

key drivers for cloud service adoption are not defined clearly, an organization may face various challenges and uncertainties when transitioning to the cloud.

**Consequences of not well-defined key drivers:**

1. Lack of strategic alignment
2. Unpredictable outcome
3. Inefficient resource utilization
4. Inconsistent decision making
5. Missed opportunities
6. Security and compliance risk
7. Limited adoption to advanced technologies
8. Difficult in vendor selection

**5.Explain in detail about Risk Management. (Nov/Dec 2024)**

**RISK MANAGEMENT**

**Risk management:** Risk management in cloud services management involves identifying, assessing, mitigating, and monitoring potential risks associated with using cloud computing resources and services.

**Effective Risk Management:** Proactive risk control.

**Life Cycle:** It needs to be applied throughout the entire lifecycle of cloud services management, from the initial planning and assessment phases to ongoing operations and monitoring.

**Continuous process:** Risk management is a continuous and integral part of cloud services management.

**Risk management life cycle:** It is a structured process that organizations follow to identify, assess, mitigate, monitor, and respond to risks.

**Different risk management Process:**

1. Identify the risk
2. Analyze the risk
3. Evaluate the risk (ranked based on the severity)
4. Solve the risk
5. Monitor or review the risk

**Types of Risk in cloud computing:**

1. **Data breach** - unauthorized access to the confidential data of an organization.
2. **Cloud vendor security risk** - CSP cloud security and risk mitigation affects organization growth.
3. **Availability** - Any internet connection loss disrupts the cloud provider's services, making the services inoperative.
4. **Compliance** - The service provider might not follow the external audit process, exposing the end user to security risks.

**Steps involved in Risk Management:**

- Risk Identification – identify the potential risk.
- Risk Assessment.
- Risk Mitigation Strategies - Develop strategies to mitigate or reduce identified risks.
- Data security (encryption techniques).
- Compliance and governance – policy.
- Vendor risk management - evaluate the security practices and certifications of CSP.
- Data Loss Prevention.
- Service availability.
- Change Management – It ensures that updates, changes, and configurations are carefully planned and tested to avoid disruptions.

- Business continuity - ensure that critical applications and data can be restored in the event of a disaster.
- Incident Response.
- Cost management.
- Continuous Monitoring.
- Audit and reporting.
- Employee training and awareness.
- Establish Service Level Agreements (SLA) with CSP.

**Benefits of Risk Management:**

- Forecast probable issues (identify the risks – helps to implementing appropriate control strategies)
- Increase the scope of growth
- Business process improvement
- Better budgeting

**Best practices for Risk Management:**

- Better selection of CSP
- Deploy Technical safeguards to monitor the activities of the consumers
- Establish effective control strategies
- Optimize cloud service model

**6.Explain in detail about IT Capacity and Utilization.****IT Capacity and Utilization**

**Capacity of cloud:** It defines the amount of resources, such as CPU, memory, disk space, network bandwidth, and concurrent users that the cloud provider can allocate to for the applications and services.

**IT Capacity plan:** IT defines the resources necessary to meet the organization's service requirements.

**Issues of no proper capacity planning:** It leads to performance problems, unnecessary hardware expenditures, and user dissatisfaction.

**Factors for measuring capacity plan:** capacity plan is derived from the current and future utilization for holding, storing and accommodating the software services.



**Survey report:** servers' average utilization in the traditional data center is between 5% and 20%.

**Capacity management:** It involves planning, monitoring, and optimizing IT resources to ensure that they meet current and future demands while avoiding underutilization or over provisioning.

**Utilization:** It defines the percentage of time that a component is actually occupied, as compared with the total time that the component is available for use.

**Example:** Assume for an instance if a CPU processes transactions for a total of 40 seconds during a single minute then what is the utilization factor?

$$\text{Utilization factor in percentage} = 40/60 \times 100 = 2/3 = 67\%$$

**Role of Cloud Capacity Management:**

1. It reduces the excess capacity occupied by the services
2. It helps to increase the business growth
3. It reduces the cost of the service

**IT capacity**

1. Planning for Capacity - It helps ensure that the organization has the right amount of resources to handle demand.
2. Resource Provisioning – Over provisioning (allocating more resources than necessary) and under provisioning (allocating fewer resources than needed) can both have negative impacts on cost and performance.

**IT utilization**

Utilization rates indicate how much of the available capacity is being actively used.

**Resource monitoring:** Tracking metrics such as CPU usage, memory consumption, storage usage, and network bandwidth.

**Optimization:** Reallocating resources to achieve better efficiency and performance.

**Benefits of Effective capacity and Utility management:**

- Cost efficiency
- Performance optimization
- Scalability
- Flexibility - Easy to align with business needs

- Resource allocation based on priority
- Proactive Problem Detection
- Data driven decision (effective resource allocation)

**7.Explain in detail about Demand and Capacity Matching.****DEMAND AND CAPACITY MATCHING****Goal:**

- Ensure the available resources are efficiently utilized to meet customer demand without causing supply shortages or excessive resource wastage.
- It is a fundamental concepts in cloud computing.

**Demand:**

The amount of computing resources that users require at any given time.

**Need for Demand and capacity utilization:**

- a. Efficient allocation of resources
- b. Optimizing cost (cost management)
- c. Maintain better performance
- d. Improve customer satisfaction
- e. Inventory management

**Parameters for deciding the demands:**

- a. User activity
- b. Application usage
- c. Business operations

**General Methods:**

- a.Adjusting capacity to match demands
- b.Alterng demands to match available capacity

**Strategies for demand and capacity matching:**

- a. Capacity expansion / reduction
- b. Flexible operations (adjust output more easily to match changing demand)
- c. Demand Forecasting
- d. Lead Time management – quickly responds to demands
- e. Buffer stocks – Maintain buffer stocks to manage temporary demands
- f. Collaboration – supply chain management

- g. Pricing strategies - Dynamic pricing strategies can be used to influence demand during peak periods or to stimulate demand during low-capacity periods

**Demand Forecasting:** It is the process of estimating the future demand for a service or product on historical data, market trends, customer behavior, and other factors.

**Different forecasting models:**

1. Based on varying detail (business needs)
2. Time
3. Type of data storage

**Capacity management:** It is the process of planning, allocating, and adjusting there sources of a business to match the demand for its products or services.

**Key aspects define the relationship between demand and capacity matching:**

1. Balancing demand and supply
2. Efficient resource utilization
3. Customer satisfaction
4. Revenue generation
5. Cost control
6. Risk management
7. Technology and innovation - Automation, data analytics, and AI-driven forecasting can enhance decision-making.

**Challenges:**

1. Uncertainty in demand prediction
2. Investment costs for expanding capacity requires investment
3. **Lead Time:** Rapidly adjusting capacity might not be feasible due to lead times for equipment, hiring, or training.
4. Seasonality (fluctuations in demands - maintain consistency throughout is not feasible)

**8.Explain in detail about Demand Queueing.**

**Exemplify in detail about demand queuing strategy with relevant example. (April / May -2024)**

**DEMAND QUEUEING****Demand Queuing:**

- It refers to the practice of organizing and prioritizing incoming requests for cloud resources or services in a systematic manner when the available resources are currently insufficient to fulfill all requests immediately.
- Excessive queuing can lead to long waiting times and user dissatisfaction.

**Need for effective queue strategies:**

It is need to fine-tune their queuing strategies and ensure that resource capacity is adjusted to meet the overall demand over time.

**Balance:**

Need to create a balance between demand queuing and providing timely access to resources for effective management.

**Essential tool:**

It ensures fair and organized access to resources during times of high demand, promoting a balanced and efficient service environment.

**Need for Queuing Strategies:**

It helps to manage the situations when the demand for resources temporarily exceeds the available capacity.

**Size of the Queue:**

It defines the balance between demand and capacity Size of the queue is measured by counting the number of requests or tasks that are currently waiting in line to be processed or fulfilled by the cloud service provider.

**Situation suitable for implement queuing strategies:**

- a) Incoming request for accessing resources
- b) Limited capacity of the resources available
- c) The number of requests exceed the available resources capacity
- d) Prioritization of request
- e) Resource allocation based on criteria
- f) Monitoring and metrics

**Services associated with Queuing:**

- a) Monitoring and metrics
- b) Notification and feedback
- c) Load balancing

- d) Prioritization

**Advantages:**

- a) Resource optimization
- b) Fairness (FIFO order)
- c) Performance stability
- d) Reduced service failure (minimize the rejection of services)

**Challenges faced if queue mechanism is not implemented:**

- a) Service rejection
- b) Unpredictable access
- c) User dissatisfaction
- d) Missed business opportunities
- e) Inefficient resource utilization
- f) Lack of prioritization
- g) Unpredictable performance
- h) Loss of business opportunities
- i) Negative impact in revenue
- j) Reduced customer loyalty

**9.Explain in detail about Change Management.****CHANGE MANAGEMENT****Definition of change:**

The addition, modification, or removal of anything that could have a direct or indirect effect on services.

**Definition:**

It is the methodology and processes used by organizations to plan and manage these changes (or) the process responsible for controlling the lifecycle of all changes, enabling beneficial changes to be made with minimum disruption to IT services (or) deliver critical updates to products while simultaneously minimizing disruption to user workflow (or) it is a structured process of planning, implementing and tracking changes to cloud-based systems, applications, and services while minimizing

disruption to business operations and ensuring the integrity and security of the environment.

**Condition for consistent change management:** The changes must be beneficial and the minimum disruption to IT services.

**Managed activities:** It refers to a set of policies and actions that ensure change is properly managed throughout every stage of the process.

**Survey report:** Effective change management strategy allows 93% of organizations to successfully achieve predefined objectives.

**Complexity of implementing the changes:** Complex due to the dynamic and interconnected nature of cloud services.

**Need for change management:**

- a. Maintain control
- b. Maintain Stability
- c. Maintain security
- d. Maintain compliance

**Stable and Reliable:** It is crucial for maintaining a stable and reliable cloud environment, ensuring data security and compliance, and facilitating the seamless evolution of cloud-based solutions as business needs evolve.

**Duration of change management:** It depends on,

- a. Complexity of the change
- b. Scope of the cloud environment
- c. Organization's processes
- d. Level of coordination required.

**Need for Rollback:** Yes required if any risks happen due to the changes

**Basic types of change management:**

- a. Routine updates and patches
- b. Configuration change
- c. Upgradation in resource scaling
- d. Migration and deployment
- e. New feature implementation (new functionality)
- f. Service decommissioning (removing feature)
- g. Data management
- h. Security enhancement

- i. Vendor changes
- j. Disaster recovery and business continuity
- k. Process and work flow changes

**Outline or steps involved in change management:**

1. Change identification and request (new feature / existing, configuration change or security)
2. Change evaluation – assess the potential impact [Evaluate technical feasibility, risk analysis, benefits, costs and alignment with business goals]
3. Change planning – develop a plan for implementing the change (it involves defining the scope, setting priorities, allocating resources and creating timeline)
4. Testing and validation
5. Communication and stakeholder management - Keep all relevant stakeholders informed about the upcoming change
6. Change deployment – implement the changes in the production based on plan (requires careful execution to minimize disruptions to ongoing operations)
7. Monitoring and feedback – identify or detect any anomalies, performance degradation or security issues introduced due to the changes if any
8. Issue Resolution – Address the issue (rollback needed in necessary)
9. Documentation and knowledge management
10. Post- change review

**Advantages of Change Management:**

- a. Continuous improvement
- b. Adopt to new technology and innovation
- c. Improve vendor relationship
- d. Adopt to new infrastructure
- e. Helps to improve the security
- f. Minimize user impact
- g. Helps to reduce the risks

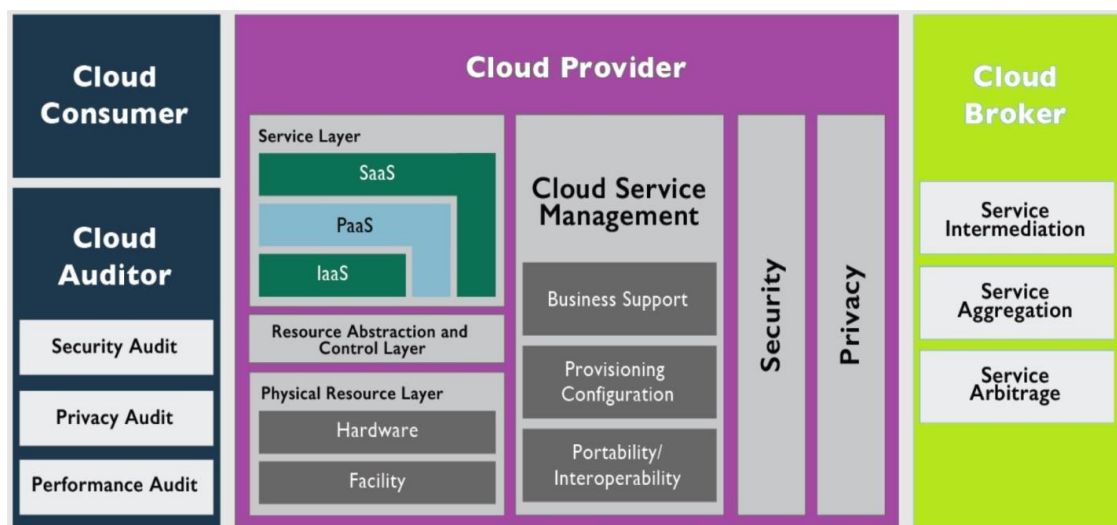
**10.Explain in detail about Cloud Service Architecture.?**

Describe about cloud service architecture with neat diagram. (April / May -2024)

**CLOUD SERVICE ARCHITECTURE**

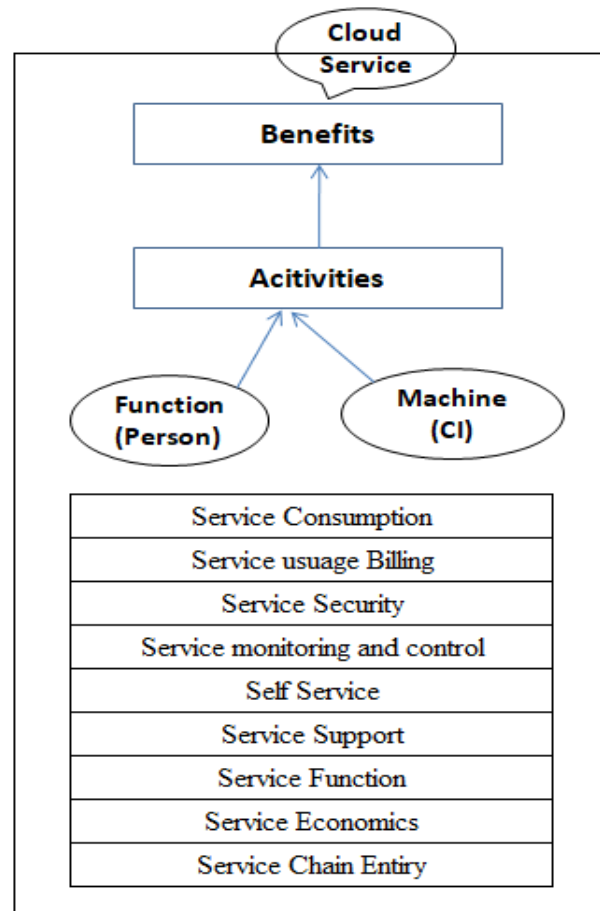
**Cloud service:** It refers to various internet based information technology resources as shown in **Fig 2.3**.

**Cloud Service architecture:**



**Fig 2.3 Cloud Service architecture**





**Fig 2.4 Different Components Cloud Service architecture**

**Different components of Cloud Service Architecture :(Refer Fig 2.4)**

1. Service Consumption
2. Service usage and Billing
3. Service Security
4. Service monitoring and Control
5. Self-Service
6. Service support
7. Service Function
8. Service Economics
9. Service chain Entity

**1.Service Consumption:** (how much bandwidth data is consumed)- Service consumption is based on the usage of cloud resources based on entitlement or subscription.

**Parameters:** It includes

- a. Offering (type of service models used)
- b. Consumption component (the way the resources are used – Pay-as-you-Go, reserved instances, spot instances, subscription, free tier, etc..)
- c. Consumption method – Effective organization of resources (optimization)
- d. Consumption pre-requisite (well structured, efficient goals)

## **2. Service Usage and Billing**

- It is used to generating bills for the resources used based on predefined policies.
- **Functionalities involved:**
  - a. Metering – measuring and tracking of resource usage.
  - b. Billing – Generating invoice.
  - c. Unit of Measurement – Specific metrics used to measure the resource consumption.
  - d. Instrumentation - process of adding monitoring, tracking, and measurement capabilities to various components and services.

## **3. Service Security**

- It offers security of cloud-based services, resources, and data.
- It includes,
  - a. Consumer access.
  - b. Authentication and authorization.
  - c. Entitlement / usage permission.

## **4. Service monitoring and Control**

- It includes
  - a. Monitoring boundary
  - b. Instrumentation
  - c. Map – Graph representation about utilization of resources status, health and performance.

## **5. Self-Service**

- It enables auto-fix scripts / automation, access to knowledge nuggets.

## **6. Service support**

- It covers SLA commitments, resolver groups and product owners.

## **7. Service Function**

- -It includes
  - a. Service name
  - b. Function
  - c. Description
  - d. Status
  - e. Utility
  - f. Warranty

**8. Service Economics**

- It deals with the principles, costs and benefits of cloud computing.
- It includes
  - a. Cost management
  - b. Cost model
  - c. Charge back / show back

**9. Service chain Entity**

- It defines a sequence or combination of interconnected cloud services or resources that work together to deliver a specific functionality or application.
- It includes
  - a. Creator
  - b. Provider
  - c. Supporter
  - d. Integrator
  - e. Orchestrator
  - f. Aggregator
  - g. Consumer
  - h. Payer

**11.Decode the scalability of Disney + Hotstar App, cloud architecture, concurrency control meet the increasing demands for content delivery, security, cost- effectiveness and workflow with neat diagram. (April/May-2024)**

### **Disney+Hotstar: An introduction**

The journey started with the launch of the Hotstar app, in 2015, which was developed by Star India. The 2015 Cricket World Cup was about to start, along with the 2015 IPL tournament, and Star network wanted to fully capitalize on the insane viewership.

While Hotstar generated massive 345 million views for World Cup, 200 million views were generated for the IPL Tournament.

This was before the Jio launch, which happened in 2016. And watching TV series and matches on the mobile was still at a nascent stage. The foundation was set.

The introduction of Reliance Jio's telecom network changed Internet usage in India, and this changed everything for Hotstar.

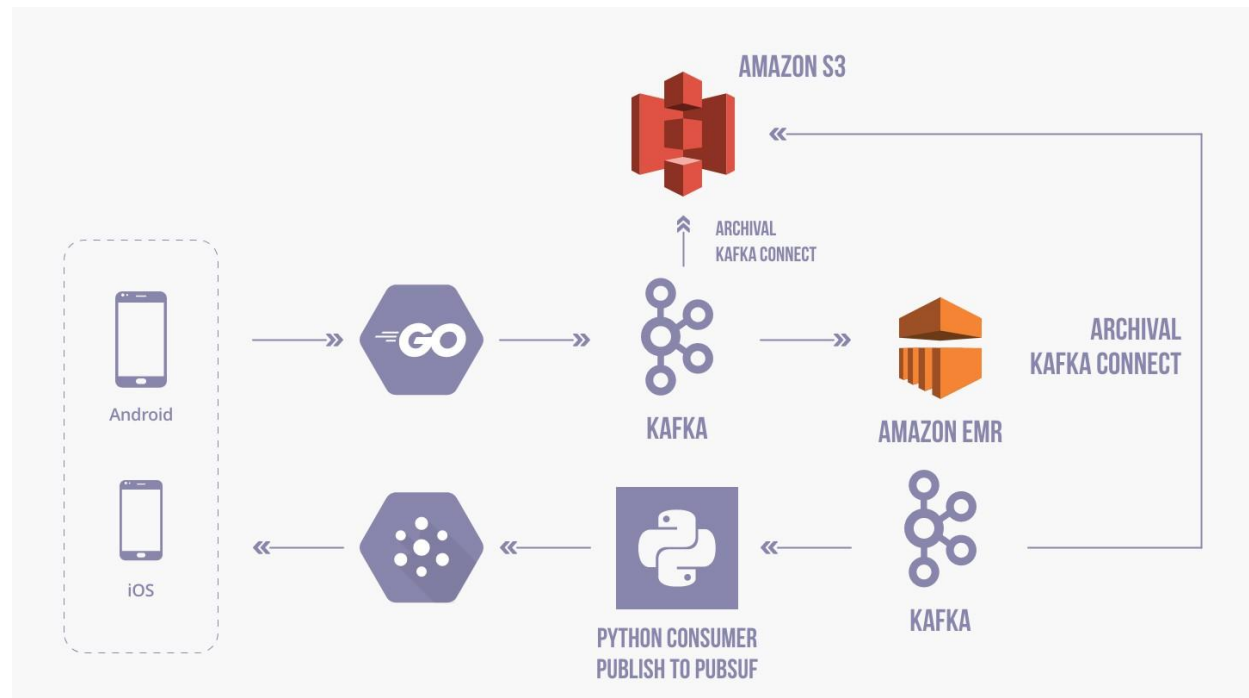
### **Decoding the scalability of Disney+Hotstar app: powerful data structure**

We will observe the architecture of the Disney+Hotstar app, and decode how they are able to ensure such powerful scalability, on a consistent basis.

### **Backend of Disney+Hotstar**

The team behind Disney+Hotstar has ensured a powerful backend by choosing Amazon Web Services or AWS for their hosting, while their CDN partner is Akamai.

Almost 100% of their traffic is supported by EC2 instances & S3 Object store is deployed for the data store



At the same time, they use a mixture of on-demand & spot instances to ensure that the costs are controlled. For spot instances, they use machine learning & data analytics algorithms which drastically reduces their overall expenses of managing the backend.

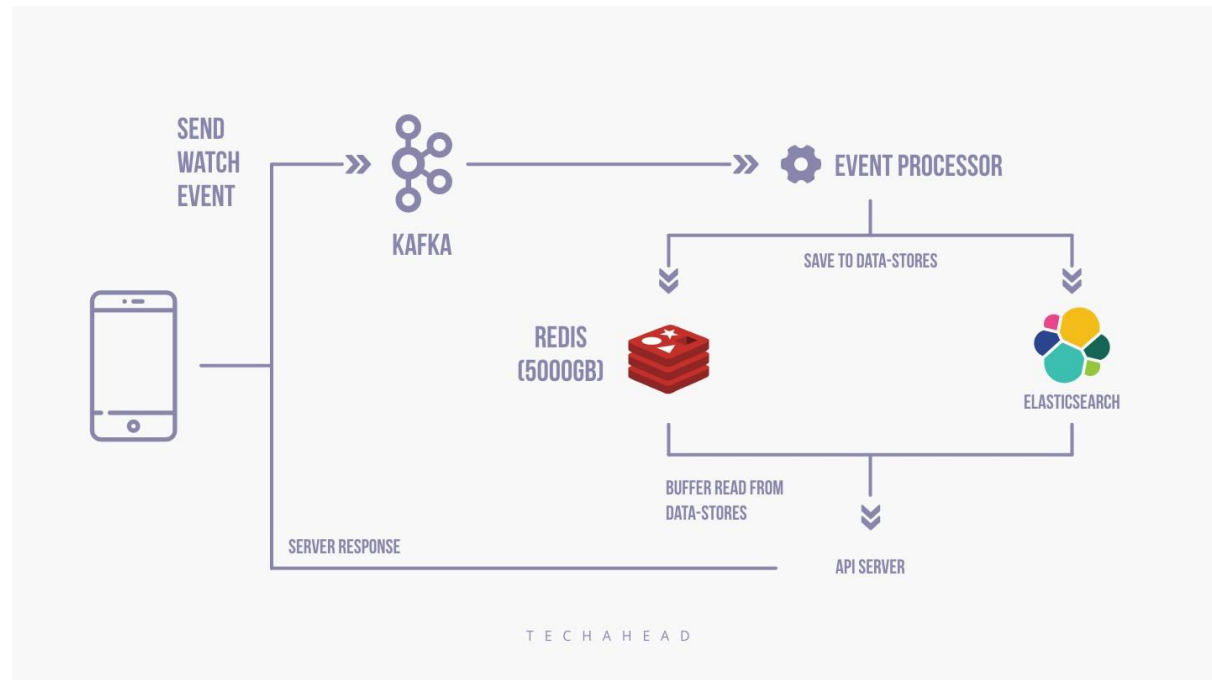
AWS EMR Clusters is the service they use to process terabytes of data (in double-digit) on a daily basis. Note here, that AWS EMR is a managed Hadoop framework for processing massive data across all EC2 instances.

In some cases, they also use Apache Spark, Presto, HBase frameworks in-sync with AWS EMR.

### **The core of scalability: infrastructure setup**

Here are some interesting details about their infrastructure setup for load testing, just before an important event such as IPL matches.

They have 500+ AWS CPU instances, which are C4.4X Large or C4.8X Large running at 75% utilization.

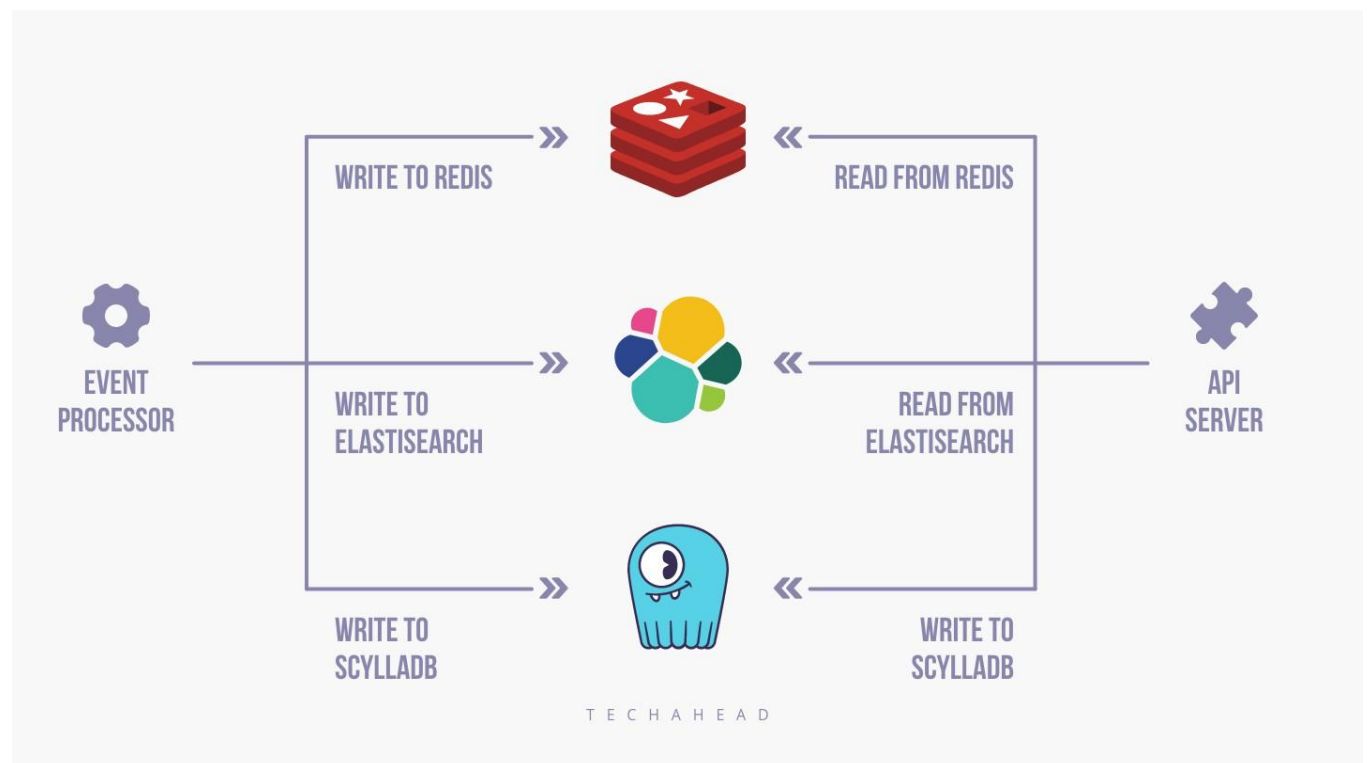


The entire setup of Disney+Hotstar infrastructure has 16 TBs of RAM, 8000 CPU core, with a peak speed of 32Gbps for data transfer. This is the scale of their operations, which ensures that millions of users are able to concurrently access live streaming on their app.

Note here, that C4X instances are really high CPU-intensive operations, ensuring a low price-per-compute ratio. With C4X instances, the app has high networking performance and optimal storage performance at no additional cost.

Disney+Hotstar uses these Android components for having a powerful infrastructure (and to keep the design loosely coupled for more flexibility):

- ViewModel: For communicating with the network layer and filling the final result in LiveData.
- Room
- LifecycleObserver
- RxJava 2
- Dagger 2 and Dagger Android
- AutoValue
- Glide 4
- Gson
- Retrofit 2 + okhttp 3
- Chuck Interceptor: For ensuring swift and easy debugging of all network requests, when the devices are not connected with the network.



## How Disney+Hotstar ensures seamless scalability?

There exist basically two models to ensure seamless scalability: Traffic based and Ladder based.

In traffic-based scaling, the tech team simply adds new servers and infrastructure to the pool, as the number of requests being processed by the system keeps on adding.

Ladder-based scaling is opted in those cases, wherein the details and the nature of the new processes are not clear. In such cases, the tech team of Disney+Hotstar has pre- defined ladders per million concurrent users.

As more requests are processed by the system adds on, new infrastructure in terms of ladders is added.





As of now, the Disney+Hotstar app has a concurrency buffer of 2 million concurrent users, which are, as we know, optimally utilized during the peak events such as World Cup matches or IPL tournaments.

In case the number of users goes beyond this concurrency level, then it takes 90 seconds to add new infrastructure to the pool, and the container and the application take 74 seconds to start.

In order to handle this time lag, the team has a pre-provisioned buffer, which is the opposite of auto-scaling and has proven to be a better option.

The team also has an in-built dashboard called Infradashboard, which helps the team to make smart decisions, based on the concurrency levels, and prediction models of new users, during an important event.

By using Fragments, the team behind Disney+Hotstar has ensured modularity to the next level.

Here are some of the features that a typical page holds:

- Player
- Vertically and horizontally scrolling lists, which display other contents. Now, the type of data being displayed and the UI of these lists varies based on what type of content it is.
- Watch and Play, Emojis.
- Heatmap and Key Moments.
- Different type player controllers. — Live, Ads, VoD (Episodes, Movies etc.)
- Different type of Ad formats
- Nudge to ask user to login.
- Nudge to ask user to pay for All Live Sports
- Chromecast
- Content Description
- Error View and more

**Deploying intelligent client for seamless performance**

- On occasions when latency in response is increased for the application client and the backend is overwhelmed with new requests, then there are established protocols, which absorb this sudden surge.
- For instance, in such cases, the intelligent client deliberately increases the time interval between subsequent requests, and the backend is able to get some respite.
- For the end-users, there exists caching & intelligent protocols, which ensures that they are not able to differentiate this intentional time-lag, and the user experience is not hampered.
- Besides, the Infradashboard continuously observes and reports every single severe error and fatal exception happening on millions of devices, and either they are rectified in real- time, or deploy a retry mechanism for ensuring seamless performance.
- This was just the tip of the iceberg!
- If you wish to know more about how Disney+Hotstar operates, its system architecture, database architecture, network protocols, and more and wish to launch an app similar to Disney+Hotstar, then you can connect with our team, and explore the possibilities.

**UNIT-III****CLOUD SERVICE MANAGEMENT**

Cloud Service Reference Model, Cloud Service Life Cycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Market place, Cloud Service Operations Management.

**PART -A****1. What is Cloud Service Management?**

- Cloud management is the organized management of cloud computing products and services that operate in the cloud.
- It refers to the processes, strategies, policies, and technology used to help control and maintain public and private cloud, hybrid cloud, or multi cloud environments.

**2. What is Cloud service Reference Model?**

- The Cloud Reference Model is a framework used by customers and vendors to define best practices for cloud computing.
- The reference model defines five main actors: the cloud consumer, cloud provider, cloud auditor, cloud broker, and cloud carrier.

**3. What is the type of cloud service reference model?**

- There are three type of cloud computing refrence model which are ,
  - Infrastructure as a Service (IaaS)
  - Platform as a Service (PaaS)
  - Software as a Services (SaaS)

**4. Define Infrastructure as a Service (IaaS) with suitable example.**

- IaaS is also known as Hardware as a Service (HaaS). It is a computing infrastructure managed over the internet.
- The main advantage of using IaaS is that it helps users to avoid the cost and complexity of purchasing and managing the physical servers.

**Example:**

- ✓ Digital Ocean, Linode, Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), Rackspace, and Cisco Meta cloud.

**5. What are the Characteristics of IaaS?**

- Resources are available as a service
- Services are highly scalable
- Dynamic and flexible
- GUI and API-based access
- Automated administrative tasks

**6. Define Platform as a Service (PaaS) with suitable example.**

- PaaS cloud computing platform is created for the programmer to develop, test, run, and manage the applications.

**Example:**

- AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, Magento Commerce Cloud, and OpenShift.

**7. What are the Characteristics of PaaS?**

- Accessible to various users via the same development application
- Integrates with web services and databases

- Builds on virtualization technology, so resources can easily be scaled up or down as per the organization's need
- Support multiple languages and frameworks
- Provides an ability to "Auto-scale"

#### 8. Define Software as a Service (SaaS) with suitable example.

- SaaS is also known as "on-demand software". It is software in which the applications are hosted by a cloud service provider.
- Users can access these applications with the help of internet connection and web browser.

##### Example:

- BigCommerce, Google Apps, Salesforce, Dropbox, ZenDesk, Cisco WebEx, ZenDesk, Slack, and GoToMeeting

#### 9. What are the Characteristics of SaaS with suitable example?

- Managed from a central location
- Hosted on a remote server
- Accessible over the internet
- Users are not responsible for hardware and software updates. Updates are applied automatically
- The services are purchased on the pay-as-per-use basis

#### 10. Differentiate between IaaS, PaaS, and SaaS .

Parameter	IaaS	PaaS	SaaS
Definition	It provides virtualized computing resources (server, storage, and	It gives developers a platform to create and deploy apps without having to	It gives users online access to software applications that are hosted and

	networking) over the internet.	manage the underlying infrastructure.	controlled by a different supplier.
<b>Stand for</b>	Infrastructure as a Service	Platform as a Service	Software as a Service
<b>Used By</b>	Network Architect	Developers	End Users.
<b>Pros</b>	Affordable, flexible, accessible, reliable	Cost-effective, increased productivity, easy scalability, easy accessibility	Scalable and accessible, affordable, easy to upgrade, easy deployment
<b>Cons</b>	Lack of control, Data security issue	Compatibility issue, vendor changes	Insufficient data security, less control
<b>Example Services</b>	Amazon Web Service (AWS), Microsoft Azure, Google Cloud Platform	Heroku, OpenShift, Beanstalk, Apache Stratos	Google Workspace, Salesforce, Dropbox

### 11. Define and draw the Life Cycle of Cloud Service Management.

- Cloud Computing is the booming industry of the present time and will continue to grow by many folds in the near future.
- Nowadays, it's really hard to find a safe, secure, and yet cost-effective place to store your data and business-critical ideas.
- But, with the rise of cloud computing, this problem is vanishing exponentially.
- Cloud provides us with a place where your data can not only be stored but can also be accessed easily over the internet. Using Cloud Computing you can also host and manage your applications.

**12. Why we need Cloud Computing Solution?**

- Improved software and hardware performance
- Flexibility and affordability
- Increased uptime and availability
- Better collaboration with real-time sharing

**13. What is the advantage and disadvantage of cloud service Life cycle?****Advantages:**

- Cost Saving
- High Speed
- Backup and restore of data
- Reliability

**Disadvantages:**

- Performance can vary
- Downtime.

**14. Define Cloud service design.**

- Service design is aimed at designing what to offer users through a service catalog.
- At its most basic, a service catalog is a listing of services from which user can choose, thus initiating the cloud service provisioning process.

**15. What is the address to needs of cloud service design?**

- Design internal and external cloud services
- Define service tiers and service levels
- Create a "bill of materials" for each service

**16. How do you handle legacy systems?**

In this article, you will learn how to effectively manage legacy systems and technical debt in IT operations by following these steps:

- Assess the current state
- Define the target state
- Plan the transition
- Execute the transition
- Validate the results
- Continuously improve
- Here's what else to consider

**17. What is a Legacy System?**

- A legacy system is outdated computing software and/or hardware that is still in use. The system still meets the needs it was originally designed for, but doesn't allow for growth.
- What a legacy system does now for the company is all it will ever do. A legacy system's older technology won't allow it to interact with newer systems.

**18. Write the uses of legacy system.**

- Investment
- Fear
- Difficulty

**19. What is benchmarking in cloud computing?(april/may 2024)**

- Benchmarks are often used to measure performance of computing resources and have previously been applied to cloud resources.
- Benchmarking is usually performed independently of an application and does not take into account any bespoke requirements an application might have.



**Example:**

Benchmarks could be used to compare processes in one retail store with those in another store in the same chain.

**20. What are the various types of benchmarking?**

- Performance benchmarking
- Practice benchmarking
- Internal benchmarking
- External benchmarking

**21. Define Cloud Service Capacity Planning.**

- Cloud capacity planning is an essential piece of any effective IT strategy. When you leverage cloud capacity planning effectively, it can improve service performance, increase agility, and reduce costs.
- Cloud capacity planning aims to match demand with available resources.

**22. What is the cloud capacity planning process?**

- Cloud capacity planning: Strategies and best practices
- Regularly review and adjust plans
- Embrace automation and auto-scaling
- Invest in monitoring and analytics tools
- Train and up skill your team
- Test different scenarios
- Study workload patterns
- Plan for data transfer costs
- Collaborate across departments

**23. What are the benefits of cloud capacity planning?**

- When you leverage cloud capacity planning effectively, it can improve service performance, increase agility, and reduce costs.
- Cloud capacity planning aims to match demand with available resources.

**24. What is cloud service deployment?**

- Cloud deployment is the process of deploying an application through one or more hosting models—software as a service (SaaS), platform as a service (PaaS) and/or infrastructure as a service (IaaS)—that leverage the cloud.
- This includes architecting, planning, implementing and operating workloads on cloud.

**Examples:**

- ✓ OpenStack, Microsoft Azure Stack., VMWare vCloud Suite, Amazon AWS Outposts.

**25. What are the 4 types of deployment cloud services?**

There are four main types of cloud computing deployment models in wide adoption

- Private / On-premises cloud.
- Public Cloud
- Hybrid Cloud
- Multicloud

**26. What is a deployment diagram?**

- A deployment diagram shows components and artifacts in relation to where they are used in the deployed system.
- A component diagram defines the composition of components and artifacts

in the system. Note: Deployment diagrams are distinct from deployment topologies, a different type of model.

## 27.What is a cloud service migration?

### Cloud migration:

Cloud migration is the process of moving applications and data from one location, often a company's private, on-site ("on-premises") servers to a public cloud provider's servers, but also between different clouds.

### Example:

Great migrations include the Indo-European migrations to Europe, the Middle East.

## 28. What are the types of cloud migration strategies?

- Replatforming
- Repurchasing
- Refactoring
- Retiring
- Retaining

## 29.What is cloud marketplace?(april/may 2024)

- A cloud marketplace is a type of application marketplace. It is synonymous with SaaS marketplace.
- At a cloud marketplace, customers can go to an online storefront to find, purchase, and manage cloud-based applications.

**Examples :** AWS Marketplace, Microsoft Azure Marketplace, and Google Cloud Marketplace.

## 30.What is cloud operations management?

- Cloud Operations (CloudOps) is the practice of managing delivery, tuning, optimization, and performance of workloads and IT services that run in a cloud

environment including multi, hybrid, in the data center and at the edge.

**31. Why Consider Cloud Operations Management?**

- Security Operations
- Scalability and Automation
- Growing Complexity
- Remote Cloud Platforms

**32. What are the advantages of cloud migration?**

**Write the benefits of migrating a cloud service on-demand. (Nov/Dec-24)**

- Extremely Scalable
- Better Storage
- Automated Tasks
- Operational Flexibility

**33.What are the Conditions of cloud service life cycle?**

- Alignment with Business Needs
- Continuous Monitoring and Improvement

**34. Write the advantages of cloud service design.****Advantages:**

- Security
- Cost Saving or cost Efficiency
- Efficiency
- Flexibility and Scalability
- Rapid Recovery
- Increased Convenience – easy accessing
- Speed and Productivity

**35.Define Scaling of resources.**

- ✓ Scaling of resources: Users can scale resources up or down as needed, enabling flexibility, scalability, and cost efficiency in managing their applications and services.

**36.What are the important parameters to be considered in cloud environment?  
(Nov/Dec-24)**

The important parameters to consider in a cloud environment are:

1. **Scalability:** The ability to dynamically adjust resources (compute, storage, etc.) based on demand, ensuring the system can grow or shrink as needed without disruption.

**Security:** Protecting data and applications through encryption, access control, and compliance with industry standards to prevent unauthorized access and data breaches

**PART B**

**1.Explain briefly about Cloud Service Reference Model (CSRM). Describe in detail about the cloud service reference model and design parameters.**

**(April / May -2024)**

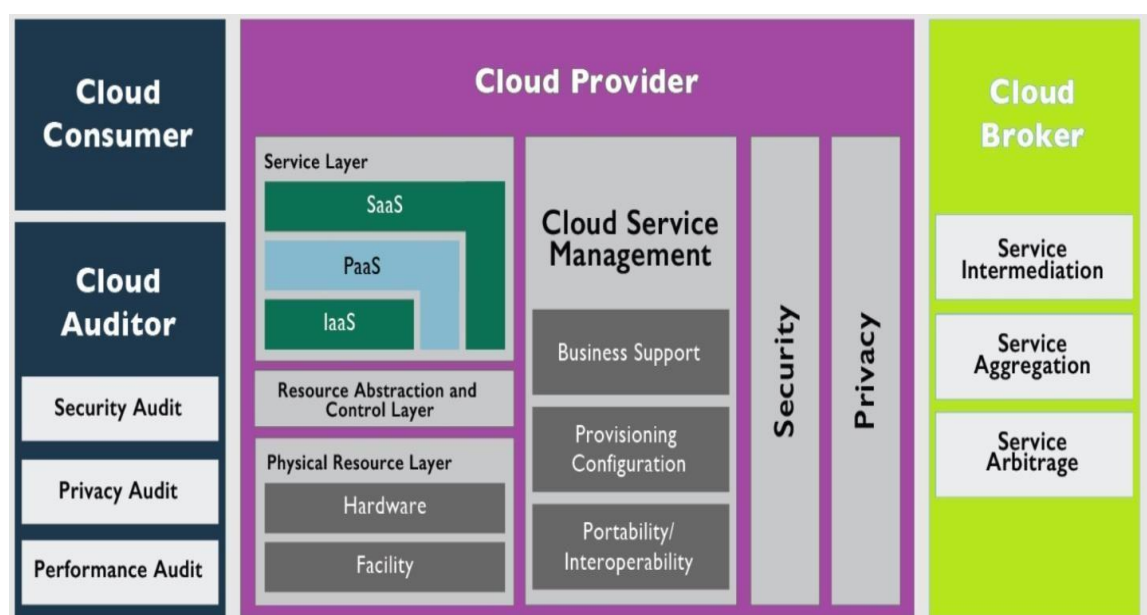
**CLOUD SERVICE REFERENCE MODEL (CSRM)**

**Definition:** It is a conceptual framework which provides a structured approach to understanding and categorizing various components and aspects of cloud services and their management as shown in **Fig 3.1**.

- ❖ It aims to standardize the terminology and concepts related to cloud computing.
- ❖ It helps organizations navigate the complexities of cloud services and effectively manage them.
- ❖ **Goal:** It is used for understanding the relationships and interactions between different components in cloud services and their management.
- ❖ It helps organizations effectively plan, design, deploy, and manage cloud services while ensuring a clear understanding of roles, responsibilities, and expectations for all parties involved.
- ❖ **Basic Service management Concepts:** (Key components) - Terminologies
  - Service Management – The special capabilities of business needs
  - Organization (A person or group of persons who have their own function, with their own responsibilities, authorities, and relationships)
  - Service Consumers
  - Service Providers
  - Product – Offers a value for a consumer
  - Resources – It is used to configure the products
  - Value – the perceived benefits, usefulness and importance of something
  - Service Relationship – Define the relationship between service providers and service consumers
  - Service Offering – Services satisfy a specific customer.
  - Service Relationship management.

- Service Provision – Activities performed by service providers to provide services.
- Service Consumption.
- Service Contract - The service contract outlines the terms and conditions under which the service is provided (pricing, usage policies, performance metrics).
- Service Level Agreements (SLAs) – It specifies the agreed-upon levels of service performance and availability that the provider commits to delivering to the consumer.
- Service Quality Metrics - the measurements used to assess the quality and performance of the cloud service.
- Service Administration – It encompasses tasks related to managing the configuration, security, and compliance of the service.
- Service Deployment and Orchestration – It involves the process of deploying, configuring, and managing cloud services to ensure they run efficiently and effectively (Automation).
- Service Data - The data associated with the cloud service, including user data, application data, configurations, and any other information required for the service to function properly.
- Service Catalog.

#### Cloud Service Reference Model:



**Fig 3.1 Cloud Service Reference Model**

**2.Explain in detail about Cloud Service Life Cycle.**

**With neat diagram, illustrate the cloud service lifecycle with functionalities. (April / May -2024) (april/may 2024)**

**CLOUD SERVICE LIFE CYCLE****Definition:**

- It refers to the stages and processes that a cloud service goes through from its initial planning and design to its eventual retirement.
- It encompasses all the activities and considerations involved in the creation, deployment, management, optimization, and eventual removal of cloud services within an organization's cloud environment.

**Goal:**

1. Efficient Service Delivery - It aims to ensure that cloud services are delivered efficiently, meeting users' needs and expectations while aligning with business objectives.
2. Scalability and Adaptability.
3. Optimization - Continuously optimizing services to improve performance, resource utilization, and cost efficiency.
4. Security and Compliance - Ensuring that services meet security standards and regulatory compliance throughout their lifecycle.
5. Innovation - Encouraging innovation by facilitating the introduction of new features, technologies, and improvements to the services.
6. Cost Management - Managing costs effectively by optimizing resource usage, monitoring expenditures, and eliminating unnecessary services.

**Different Roles:**

**Service Owner** - The individual or team responsible for the overall strategy, design, and management of the cloud service throughout its lifecycle.

**Service Provider** - The entity that delivers the cloud service, which can be an internal IT team or a third-party provider.

**Service Users** - The individuals, departments, or external customers who consume and interact with the cloud service.

**Conditions:**

- Alignment with Business Needs



- Continuous Monitoring and Improvement

#### Different Phases of Cloud service Life Cycle:

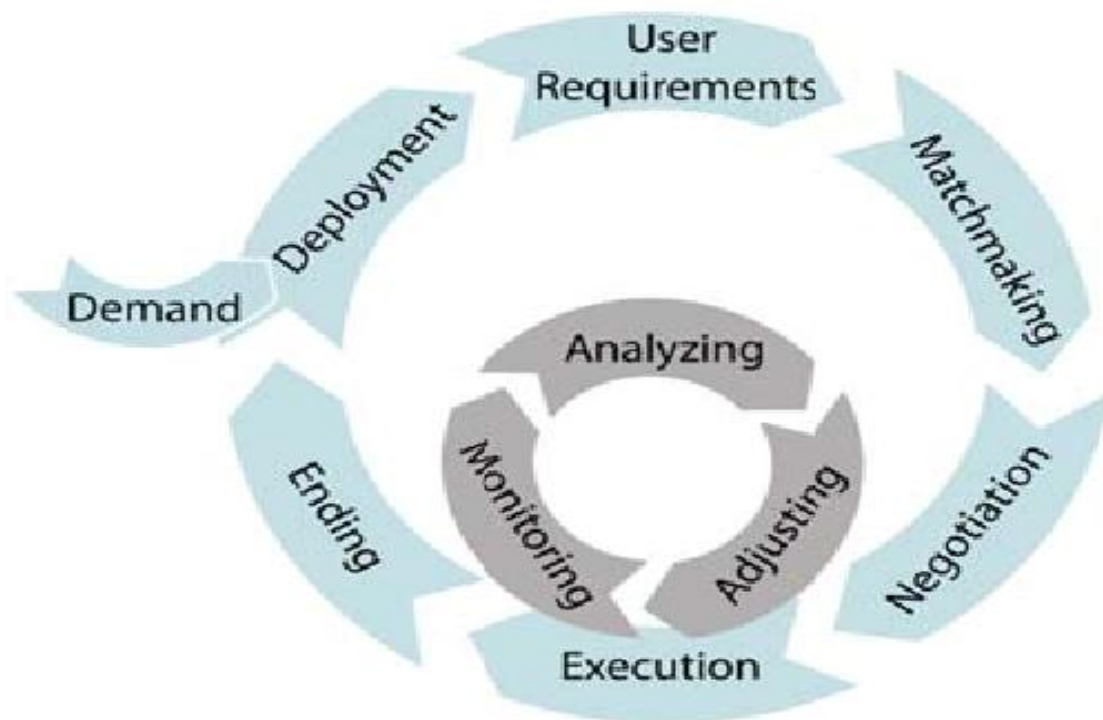


Figure 1: Cloud Service Lifecycle

Fig:3.2Cloud service lifecycle

- **Planning and Design**
  - ✓ It defines the service's purpose, requirements, architecture and design.
  - ✓ The initial plan includes objectives, scope, resources, and a high-level roadmap.
- **Deployment and Provisioning**
  - ✓ The service is deployed based on the design, utilizing infrastructure resources such as virtual machines, containers, and networking components.
  - ✓ Provisioning involves setting up users, access controls, and configurations.
- **Management and Operations** - It involves day-to-day management, monitoring, scaling, performance optimization, security enforcement, and

compliance maintenance

- **Scaling and Optimization** - As usage patterns change, the service may need to be scaled up or down to ensure optimal performance and cost-effectiveness. Optimization efforts focus on resource utilization and efficiency.
- **Updates and Upgrades** - Regular updates, patching, and upgrades are performed to enhance functionality, security, and compatibility. This includes testing and validation to prevent disruptions.
- **Monitoring and Analytics** - Ongoing monitoring of the service's performance, usage, and security helps identify issues and trends. Analytics provide insights for making informed decisions.
- **End-of-Life and Decommissioning** - When a service is no longer needed or becomes obsolete, it is retired in a controlled manner. Data may be migrated, and resources are released.
- **Configuration and Customization** - Once deployed, the resource may require configuration adjustments and customization to align with specific business needs and user requirements.
- Data Management and Backup.
- Cloud Cleanup.

### 3.Explain in detail about Basics of cloud service Design.

#### BASICS OF CLOUD SERVICE DESIGN

##### Goal:

To create an efficient, reliable, and scalable solutions that leverage the capabilities of cloud computing to meet the specific needs of an organization or application. It supports the users through a service catalog.

##### Primary objectives:

1. Scalability and flexibility
2. Reliability and availability
3. Optimized resource optimization
4. Security
5. Better User experience
6. Effective performance
7. Interoperability

8. Innovation and Agility
9. Disaster recovery and business continuity
10. Elasticity

**Steps involved in cloud service design (refer in Fig 3.2):**

1. Assessment and Analysis - Workload assessment (identify current IT landscape, business needs).
2. Business Objectives and Alignment (vision and objectives).
3. Selection of suitable Deployment Models.
4. Selection of suitable Service Models to align with the business goals.
5. Governance and policies (security, compliance, data management and budgeting).
6. Data Management and Governance – Define how data will be managed, stored and accessed in the cloud. Establish data governance policies to ensure data quality, privacy, and compliance.
7. Cost Management.
8. Migration Plan.
9. Vendor Selection - Evaluate and choose a cloud service provider based on factors such as service offerings, pricing, geographic availability, reliability and support.
10. Performance and Scalability.
11. Resilience and Disaster Recovery.
12. Training and Skill Development.
13. Change Management and Training.
14. Performance Monitoring and Management.
15. Continuous Improvement.
16. Communication and Reporting.

**A service catalog:**

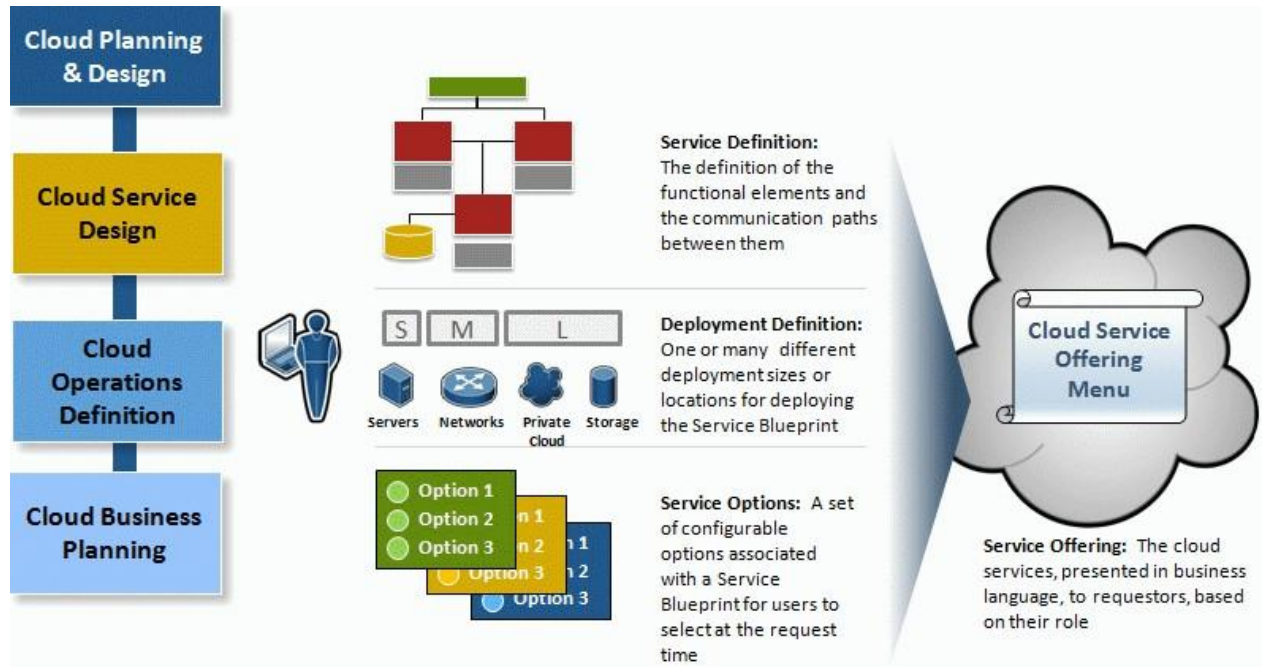
It is a listing of services from which a user can choose, thus initiating the cloud service provisioning process.

**Different types of users considered for service catalog:**

1. Development team

2. R&D groups

3. The application team in charge of building and maintaining internal applications



**Fig 3.3 Cloud Service Design**

- ❖ It helps the balance between customize offering to the users along with tight controls on the services in the cloud environment.

**Attributes of service catalog:**

- Operating systems
- Middleware stacks
- Applications offered
- Networking options – for both simple network configuration and multi-tenancy support
- Compliance packages
- Monitoring tools
- Service levels
- Prices associated with each component, if desired

**Advantages:**

- Security
- Cost Saving or cost Efficiency

- Efficiency
- Flexibility and Scalability
- Rapid Recovery
- Increased Convenience – easy accessing
- Speed and Productivity
- Strategic Value [ competitive edge to businesses - business agility and customer satisfaction]
- Multi-tenancy (multiple customer share the underlying models)
- Service and innovation(use many API and use flexible cloud tools and environments to build new and innovative applications and process)
- Standards
- Sustainability
- Rapid deployment
- Access to advanced technologies
- Reduced IT Management Burden
- Competitive advantage

#### **4.Explain in detail about dealing with legacy system and services?**

### **DEALING WITH LEGACY SYSTEMS AND SERVICES**

#### **Legacy systems:**

It is any outdated computing system, hardware or software that is still in use. Ex.: Microsoft windows 7 (no longer supported after 2020).

**Example for Legacy Systems:** COBOL, SAP, Lotus Notes.

#### **Primary challenge in legacy Systems:**

- ✓ It often built on outdated technologies and software, which may not be compatible with modern cloud platforms.

#### **Condition for migration of legacy systems into cloud:**

- ✓ Data need to be restructured or reformatted or re-architected before it can be successfully migrated into the cloud.

#### **Criteria to migrate from legacy systems to cloud:**

- Compatibility assessment (restructure, refactoring, reengineering)

- Business impact
- Cost benefit analysis
- Risk analysis
- Security and compliance
- Data migration strategy
- Performance and scalability
- Integration strategy
- User experience
- Training and knowledge transfer

**Steps involved to manage legacy systems in cloud:**

- Assessment and Inventory
- Prioritization (based on goals, technical feasibility, potential impact)
  - Analyze for the suitable for migration
- Refactoring or replatform
- Integration strategy (API, middleware tools)
- Data Migration
- Hybrid approach (local and cloud services in the legacy systems)
- Security and compliance
- Testing and validation
- Monitoring and management (track the performance)
- Training and support
- Retirement strategy (migrate from legacy systems to cloud)
- Documentation
- Continuous improvement
- Communication (maintain communication with stakeholders about the progress, benefits, challenges of the transition)

**5.Explain in detail about Benchmarking of Cloud Services.**

**BENCHMARKING OF CLOUD SERVICES**

**Goal of Benchmarking in cloud services:**

It is the process of evaluating and comparing the performance, capabilities, and characteristics of various cloud service providers or offerings against specific criteria or standards.

**Primary Purpose:** It helps the organizations make informed decisions when selecting a cloud service provider, determining resource allocation, assessing service quality and optimizing their cloud infrastructure.

**Need for Benchmarking:**

The following functionalities need to be achieved

- Security
- Cost Saving or cost Efficiency
- Efficiency
- Flexibility and Scalability
- Rapid Recovery
- Increased Convenience – easy accessing
- Speed and Productivity
- Strategic Value [ competitive edge to businesses - business agility and customer satisfaction]
- Multi-tenancy (multiple customer share the underlying models)
- Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)
- Standards
- Sustainability
- Rapid deployment
- Access to advanced technologies
- Reduced IT Management Burden
- Competitive advantage

**Solution:** Need to identify the best service provider.

**Cloud Strategy:** It helps organizations align their cloud strategy with their performance, cost, security, and scalability needs, ensuring that they make the best choices for their unique circumstances.

**Basic Requirements:**

1. Careful planning
2. Accurate measurement techniques
3. Deep understanding of the organization's requirements

**Different ways of implement benchmarking techniques:**

1. Performance Evaluation (factors - speed, memory usage, storage performance, network latency, and data transfer rates)
2. Comparative analysis
3. Standardized metrics
4. Workload simulation (access the cloud services under various conditions)
5. Resource scaling (based on demand)
6. Cost – effective analysis
7. Service level agreements
8. Security and compliance
9. Continuous improvement

**Different Benchmarking Techniques:**

1. Workload benchmarking
2. Application benchmarking
3. Standardized benchmarking
4. Cloud storage benchmarking
5. Network benchmarking
6. Cost Benchmarking
7. Scaling Benchmarking
8. Cloud Provider Comparison
9. Real-Time Monitoring and Analysis
10. User Experience Benchmarking

**Example of Benchmarking Tools:**

1. iperf - measure network throughput
2. ipref3 – measure network bandwidth and throughput
3. wrk – Measure HTTP applications
4. YCSB (Yahoo Cloud Serving Benchmark) – measure NoSQL databases
5. UnixBench – system performance
6. Geekbench – CPU and memory performance
7. SPEC CPU Benchmark – system performance



8. TPC Benchmarks (Transaction Processing Performance Council)

**6.Explain in detail about Cloud Service Capacity Planning.(april/may 2024)**

**Discuss in detail about cloud service capacity planning strategies and best practices. (April / May -2024)**

### **CLOUD SERVICE CAPACITY PLANNING**

**Definition of cloud service planning:** It refers to the process of determining the optimal amount of computing resources, required to meet the demands of an organization's applications and workloads hosted in a cloud environment as shown in **Fig 3.3**.

#### **Different types of Resources:**

1. Virtual Machine – instance of OS and associated software run in physical server
2. Storage
3. Networking
4. Database
5. Containers and orchestration (configuration of multiple tasks)
6. AI and machine learning services
7. Analytics and Big data analytics
8. Monitoring and management tools

**Scaling of resources:** Users can scale resources up or down as needed, enabling flexibility, scalability, and cost efficiency in managing their applications and services.

#### **Accessing the services or resources:**

- ✓ These resources are hosted in data centers and are made available to users over the internet.
- ✓ It aims to match demand with available resources.

#### **Situation suitable to implement capacity Planning:**

- ✓ It is implemented as an ongoing and proactive process throughout the lifecycle of your cloud-based applications and services.
- ✓ It is a continuous and Iterative process.

#### **Need for Capacity planning:**

- ✓ Resource optimization

- ✓ Cost management
- ✓ Performance and user experience
- ✓ Scalability
- ✓ Availability and Redundancy
- ✓ Data Management
- ✓ Infrastructure agility
- ✓ Security and compliance
- ✓ Environmental sustainability

**Goal of efficient capacity****planning:**

- ✓ Forecasting future resource needs
- ✓ Preventing any performance bottlenecks or service disruptions due to insufficient capacity.
- ✓ Maintain balance between providing a responsive and reliable service to users (avoid under-provisioning and over-provisioning).

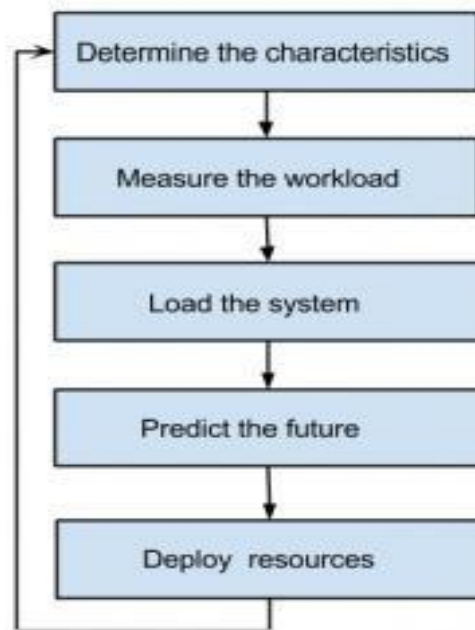
**Key factors considered for efficient capacity planning:**

- ✓ Performance monitoring
- ✓ Forecasting
- ✓ Resource Sizing
- ✓ Elasticity and Scalability
- ✓ Application Analysis
- ✓ Cost optimization – Select the most effective resource configuration
- ✓ Testing and simulation (before implementing changes validate the capacity planning decisions)
- ✓ Regular review (planning is ongoing process)
- ✓ Cloud provider services (managed services and tools)

**Strategic steps for effective capacity planning:**

- ✓ Define business goals and objectives
- ✓ Data Analysis
- ✓ Forecast future demand
- ✓ Resource sizing and selection
- ✓ Implement scalability strategies

- ✓ Redundancy and High availability
- ✓ Testing and simulation
- ✓ Cost analysis and optimization
- ✓ Monitoring and Real-time Insights
- ✓ Regular review and Iteration
- ✓ Collaboration and communication



**Fig 3.3 Cloud service Capacity planning**

**Factors for updation in the capacity planning:**

1. Changing business needs
2. User behaviors
3. Technological advancements

**Advantages of Capacity Planning:**

1. Optimal Resource Utilization
2. Cost efficiency
3. Performance optimization
4. Scalability and flexibility
5. Improve reliability
6. Predictable performance
7. Effective disaster recovery

8. Improved decision making
9. Efficient practices
10. Enhanced security
11. Regulatory compliance

**7.Explain in detail about Cloud Service Deployment and Migration. Explain about cloud migration strategies, deployment methods and its solutions. (April / May -2024).**

### **CLOUD SERVICE DEPLOYMENT AND MIGRATION**

**Concept:** Cloud service deployment and migration refer to the processes of moving applications, services, or workloads from on-premises environments or one cloud platform to another.

**Goal:** Successful transition (deployment and migration) while minimizing disruptions.

**Requirement for successful deployment and migration:**

1. Clear strategy
2. Effective planning
3. Validation
4. Effective communications with IT teams

**Basic Condition for the selection of deployment and migration:**

1. Business Alignment or goals
2. Application suitability
3. Resource planning
4. Network connectivity
5. Cost Analysis
6. Security and compliance
7. Backup and recovery
8. Staff training
9. Change management

**Cloud Service Deployment:**

It involves the process of setting up and launching applications or services on a cloud platform.

**Advantages:** Improve Scalability, reliability and flexibility

**Steps involved for successful deployment:** (pre-requisite)

1. Environment preparation – set up a necessary infrastructure (VM, storage, networking and security groups in cloud environment).
2. Application packaging – packaging it with all its dependencies, configurations and data.
3. Deployment Strategy - Select a suitable deployment strategy based on application architecture and requirements. (Docker or serverless computing –AWS Lambda).
4. Orchestration – Container application (complex applications) – (Ex: Kubernetes).
5. Configuration and Scaling – Setup auto scaling rules to adjust the resources based on demand for optimal performance and scalability.
6. Security and access control – Implement necessary security measures (firewall, encryption, access controls, authentication mechanisms).
7. Testing and quality assurance.
8. Monitor and Management.
9. Testing User interfaces (seamless experience for end users).
10. Rollout and validation - Gradually roll out the deployment to a subset of users for validation before making it available to the wider audience.

**Cloud Service Migration:**

**Moving:** It involves moving existing applications, data, or workloads from on-premises environments or one cloud platform to another.

**Advantages:** cost savings, scalability, improved performance, the need to leverage specific cloud services.

**Migration time:** It can vary widely depending on the application complexity and scope.

**Stages in cloud migration:**

1. Planning
2. Preparation
3. Execution
4. Validation

5. Post-migration activities

**Steps involved for successful migration:** (pre-requisite)

1. Assessment and planning
2. Choosing migration approach
3. Lift and shift migration (moving application as –is)
4. Re-platforming (making minor modifications for compatibility)
5. Re-architecting (modifying or redesigning for cloud-native features)
6. Replacing applications
7. Data Migration (ensure data consistency, integrity and minimum down time)
8. Application Migration
9. Networking and connectivity (setup networking and connectivity for seamless communication)
10. Security and compliance – Implement effective security measures
11. Testing and Validation
12. User training
13. Change management
14. Monitoring and optimization

**8.Explain in detail about Cloud Marketplace.**

### **CLOUD MARKETPLACE**

**Role:**

- It acts as an intermediary platform that connects cloud service providers, software vendors, and end-users (or) It is an online platform provided by cloud service providers that offers a wide range of pre-configured software applications, services and resources for organizations to discover, purchase, deploy, and manage within their cloud environments.
- It facilitates the discovery, procurement, deployment, and management of various software applications, services, and resources within a cloud environment.

**Centralized Hub:** It acts as a centralized hub where users can explore and procure solutions to meet their specific needs, often with the added benefit of simplified deployment and integration.

**Goals:** It offers

1. Simplified procurement - simply the procurement process.
2. Efficient deployment – streamlined deployment of applications.
3. Integration –It enables seamless integration between the solutions offered in the marketplace and existing cloud resources, allowing for smooth interoperability and reduced compatibility issues.
4. Cost Management: It contributes to cost management by offering clear pricing models, pay-as-you-go options, and visibility into usage, helping organizations optimize their spending.
5. Innovations: It encourages innovation by providing a platform for users to discover and experiment with new technologies, tools, and services that can enhance their cloud environments.

**Requirements for effective cloud marketing:**

1. Vendor collaboration
2. User adoption
3. Security and compliance

**Basic Components:**

1. Product Listing
2. Application variety
3. Licensing Models
4. User reviews and ratings
5. Integration APIs
6. Vendor Management
7. Resource Monitoring
8. Governance and Compliance Tools
9. Support and Documentation (setup and troubleshoot)
10. Update and Maintenance
11. Multi – cloud computability
12. Discovery and Exploration of new technologies
13. Customization

**9.Explain in detail about Cloud Service Operations Management.**

## CLOUD SERVICE OPERATIONS MANAGEMENT

**Goal:** The operation management process is to monitor and control the IT services and IT infrastructure as shown in **Fig 3.4**.

**Day to day routine tasks:** It monitors the day to day routine tasks related to the operations of infrastructure components and applications.

### Five Principles:

The operation team must follow the five principles.

- 1) Operations – Management of operations.
  - Workload placement based on resource requirements
  - Rollouts and rollbacks
  - Service discovery
  - Load balancing
  - Horizontal scaling
  - Recovery
- 2) Monitoring – Detect an issue if any (Four golden metrics: Latency, traffic, error rate and saturation).
- 3) Eventing and Alerting – Alert the primary responder in terms of Email or SMS if any issues detected.
- 4) Collaboration – Identify the location of the issue.
- 5) Root Cause Analysis – It is used to prevent the same incident from reappear (investigation)

### Operation Tasks:

**Orchestration helps for an automation process as shown in Table 3.1**

S.No.	Tasks	Role of Orchestration
1.	Patching	If the portal allows the consumer to upload specific patches and apply them, Orchestration will coordinate the automated deployment and installation of the patches.
2.	Backup and Restore	Backup is scheduled to occur regularly (initial creation, modification, deletion of backup job should be automated and coordinated by the orchestration system.



3.	Antivirus management	Handle scanning, detection, remediation of virus and worms will be handle by the antivirus applications.
4.	Compliance and checking	Compliance applications will typically handles the scanning, detection and reporting of compliance.
5.	Monitoring	Monitor the type of data should be exported based on policy.

**Table 3.1 Orchestration automation process**

**DevOps:** The combination of cultural philosophies, practices, and tools that increases an organization's ability to deliver applications and services at high velocity.

### **Cloud Service Capabilities:**

#### **1. Provisioning management**

It refers to the process of planning, deploying, configuring, and managing there sources and services within a cloud computing environment to meet the needs of users and applications.

##### **Key aspects:**

- Resource allocation and scaling
- Automation
- Orchestration (coordination)
- Configuration management
- Monitoring and optimization
- Cost Management
- Security and self control
- Service Level Agreements(SLAs)
- Compliance and control

#### **2. Subscription Management**

- Maintenance of the configuration of subscription (configuration / maintenance of PaaS and SaaS services).
- It refers to the process of handling and overseeing the various subscriptions and licensing agreements associated with using cloud services.

- It involves managing the acquisition, utilization, renewal, and monitoring of subscriptions to cloud-based resources, applications, and services.

### **3. Patch Management**

- It refers to the process of planning, implementing, and monitoring software patches and updates across the various components and services within a cloud computing environment.
- **Goal:** To ensure that the cloud infrastructure, applications, and services remain up to date with the latest security fixes, bug patches, and feature enhancements.
- It is used to maintain the security, stability and performance of the cloud environment.

### **4. Financial Management**

- It refers to the process of planning, tracking, optimizing, and controlling the costs associated with using cloud resources, services, and infrastructure.
- It involves managing expenses, optimizing resource utilization, and ensuring that cloud expenditures align with the organization's budget and financial goals.
- It involves continuous monitoring, analysis, and optimization to ensure that organizations are making the most of their cloud investments while staying within budget.

### **5. License Management**

It refers to the process of tracking, managing, and optimizing software

- licenses and subscriptions for cloud-based applications, services, and resources.
- It involves ensuring compliance with licensing agreements, managing license costs, and efficiently allocating licenses to users and instances within a cloud environment.

### **6. Security Management**

- It refers to the comprehensive process of planning, implementing, and maintaining security measures to protect the confidentiality, integrity, and availability of data, applications, and resources within a cloud computing environment.

- It is a critical aspect of maintaining a secure and reliable cloud environment.
- It involves a combination of technical measures, processes, and education to protect cloud resources from threats and vulnerabilities while ensuring compliance with security regulations and industry standards.

### **7. Identity and Access Management**

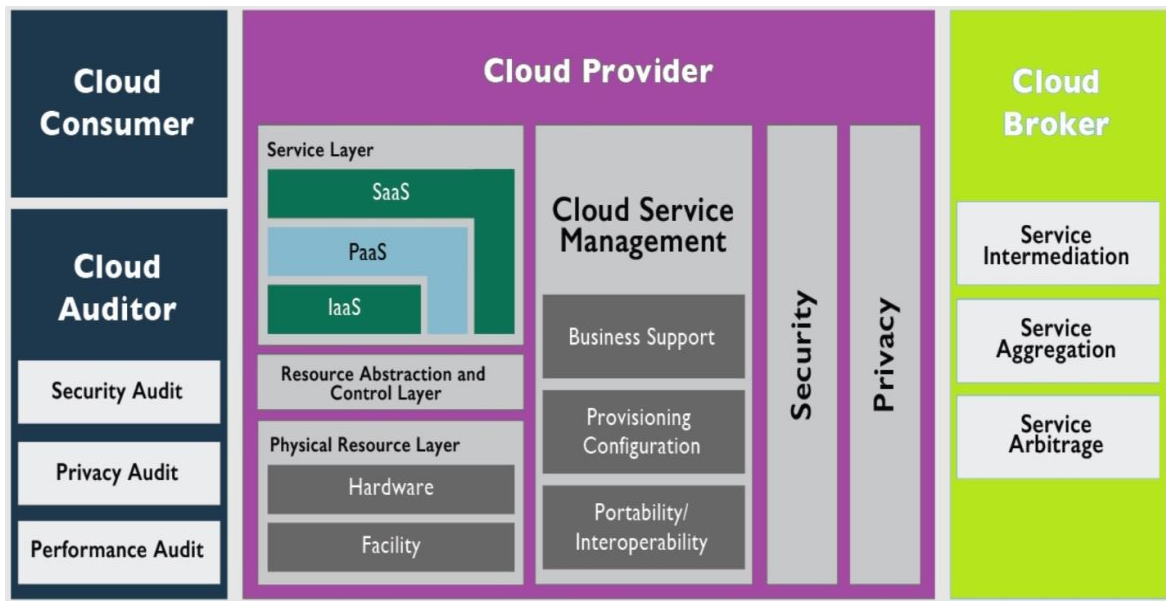
- Managing user identities, roles, and permissions to control who has access to cloud resources.
- Implementing multi-factor authentication (MFA) and role-based access control (RBAC) to prevent unauthorized access.

### **8. Optimization Management**

- It refers to the continuous process of enhancing the efficiency, performance, and cost-effectiveness of cloud resources, services, and infrastructure.
- It involves analyzing, adjusting, and fine-tuning various aspects of the cloud environment to ensure optimal utilization of resources, improved user experience, and cost savings.
- It includes load balancing, Auto scaling, resource utilization, performance monitoring, database optimization etc.,

### **10. Describe each component involved in the cloud service Reference Model with proper explanation of each component. (Nov/Dec-24)**

The **Cloud Service Reference Model** (CSRM) consists of several key components that define how cloud computing services are structured and delivered



**Fig 3.4 Cloud Service Reference Model**

These components enable a standardized approach to understanding and categorizing the different layers and services within the cloud ecosystem. Here's a breakdown of the main components of the Cloud Reference Model:

### 1. Cloud Consumer

- **Description:** The cloud consumer is the entity (individual, organization, or system) that uses the cloud services. Consumers may directly interact with cloud services, like SaaS applications, or indirectly via higher-level services.
- **Responsibilities:**
  - Select and consume cloud services based on needs (e.g., SaaS, PaaS, IaaS).
  - Manage and monitor service usage.
- **Example:** A business using Microsoft 365 (SaaS) or a developer using AWS EC2 (IaaS).

### 2. Cloud Provider

- **Description:** The cloud provider offers cloud services to consumers, managing the cloud infrastructure and delivering the service layers (IaaS,

PaaS, SaaS). The provider ensures resource management, service provisioning, and operational support.

- **Responsibilities:**
  - Provision and maintain cloud infrastructure and services.
  - Ensure service availability, security, and performance.
- **Example:** AWS, Microsoft Azure, Google Cloud.

### 3. Cloud Service

- **Description:** This refers to the actual service or functionality provided by the cloud. It can be categorized into different service models: IaaS, PaaS, SaaS, and sometimes FaaS (Function as a Service) and STaaS (Storage as a Service).
- **Responsibilities:**
  - Deliver specific functionality like storage, computation, or application hosting.
  - Operate on-demand based on user requests and service agreements.
- **Examples:**
  - **SaaS:** Google Workspace, Salesforce.
  - **PaaS:** AWS Elastic Beanstalk, Google App Engine.
  - **IaaS:** AWS EC2, Microsoft Azure VMs.

### 4. Cloud Service Models

- **Description:** Cloud service models define the level of abstraction and management provided in a cloud environment. These models help clarify what responsibilities the consumer and provider have in terms of service delivery.
  - **IaaS (Infrastructure as a Service):** Provides virtualized computing resources (e.g., virtual machines, storage, and networks).
  - **PaaS (Platform as a Service):** Offers a platform for building, testing, and deploying applications without managing underlying infrastructure.
  - **SaaS (Software as a Service):** Delivers software applications over the internet, eliminating the need for installation or maintenance.

- **FaaS (Function as a Service):** A serverless model that enables developers to run code in response to events without managing servers.
- **STaaS (Storage as a Service):** Provides cloud-based storage options for businesses and consumers.

## 5. Cloud Service Interfaces

- **Description:** Cloud service interfaces provide communication mechanisms through which consumers interact with cloud services. These include:
  - **APIs:** Application Programming Interfaces allow consumers to interact programmatically with cloud services.
  - **Web Portals:** Graphical user interfaces that provide access to cloud services.
- **Responsibilities:**
  - Enable consumers to access, manage, and configure cloud resources and services.
  - Provide monitoring and billing interfaces for service usage.

## 6. Cloud Infrastructure

- **Description:** The underlying physical or virtual resources that support cloud services, such as computing power, storage, and networking. The infrastructure is abstracted from consumers, allowing them to focus on using services rather than managing hardware.
- **Responsibilities:**
  - Provide the hardware resources (servers, networks, storage) necessary to run cloud services.
  - Ensure scalability, redundancy, and high availability.
- **Example:** AWS EC2 instances, Azure Virtual Machines.

## 7. Cloud Management and Orchestration

- **Description:** This refers to the systems and tools used by cloud providers and consumers to manage, monitor, and automate cloud services. It ensures resources are allocated and optimized as per the demand.
- **Responsibilities:**

- Automate resource provisioning, scaling, and maintenance.
- Provide visibility into service performance, usage, and billing.
- **Examples:** AWS CloudFormation, Kubernetes (for container orchestration), Azure Resource Manager.

## 8. Cloud Governance and Compliance

- **Description:** This component involves managing policies, regulatory compliance, and security within the cloud environment. It ensures that cloud resources are used in a secure and compliant manner.
- **Responsibilities:**
  - Implement security measures such as encryption, identity management, and access control.
  - Ensure compliance with industry regulations (e.g., GDPR, HIPAA).
- **Examples:** IAM (Identity and Access Management) tools, encryption at rest and in transit.

## 9. Cloud Security

- **Description:** Cloud security covers all aspects of protecting data, applications, and resources in a cloud environment from potential threats. It is a shared responsibility between the cloud provider and consumer.
- **Responsibilities:**
  - Protect data with encryption, firewalls, and intrusion detection.
  - Ensure secure data access and authentication mechanisms are in place.
- **Examples:** Security groups in AWS, Azure Security Center.

## 10. Cloud Service Catalog

- **Description:** A cloud service catalog is a collection of available cloud services and resources that can be selected and consumed by cloud users. It may include predefined configurations, templates, and service offerings.
- **Responsibilities:**

- Allow users to browse, select, and provision cloud services based on their needs.
- Provide information on pricing, usage limits, and service options.
- **Examples:** AWS Marketplace, Microsoft Azure Marketplace.



**UNIT – IV****UNIT – IV - CLOUD SERVICE ECONOMICS**

Pricing models for Cloud Services – Freemium - Pay Per Reservation - Pay per User – Subscription based Charging - Procurement of Cloud-based Services - Capex vs OpexShift - Cloud service Charging - Cloud Cost Models.

**PART A****1. What is Cloud Service Economics?**

- ✓ Cloud economics is the study of the cost, resource usage, and business impact of a cloud IT platform for an organization.
- ✓ A cloud economics analysis examines whether the benefits of a cloud platform outweigh the cost and hassle of migration, in both the short and long term.

**2. What are the benefits of cloud Economics?**

- Cost Savings
- Increased Efficiency
- Flexibility

**3. What is Economic background of cloud computing?**

- It is charged on a pay as you use model.
- Scalable and user friendly.

**4. Define model pricing.**

- ✓ Pricing modeling refers to the methods you can use to determine the right price for your products.
- ✓ Price models take into consideration factors such as cost of producing an item, the customer's perception of its value and type of product—for example, retail goods compared to services.

**5. What are the various types of model pricing?**

- Cost-plus pricing model
- Value-based pricing model
- Hourly pricing model
- Fixed pricing model
- Equity pricing model

**6. Write the advantages of pricing models.**

- These models give customers flexibility and control over their spending by allowing them to pay only for what they use.
- Such models also enable customers to try a service knowing that a long-term commitment is not required.

**7. What is freemium in cloud computing?**

- ✓ Freemium users can use the basic free version for free, forever. The freemium model allows users to experience and get hooked to products by removing initial barriers to adoption.
- ✓ As users realize incremental value over time, they are willing to pay for premium features and capabilities.

**Example of a freemium model**

- ✓ Dropbox. Dropbox, the pioneering cloud storage provider, rose to prominence on its freemium pricing model.

**8. Write the pros and cons of freemium cloud service.****Pros:**

- Companies can easily acquire potential users and collect their user information and data.
- They can make revenue on ads and boost their own business numbers to enhance the application.
- For startups, it provides a large amount of brand awareness without requiring a lot of customer support.

**Cons:**

- Free users never convert to paid users.
- Too many features on the free version may prevent users from upgrading to a premium version.
- Users may get tired of a free version that doesn't offer additional bells and whistles.

**9. What are the factors of pricing landscape in cloud services?**

- Type of services
- Cloud service providers
- Geographical regions
- Evolving industry trends

**10. Write the categories of pricing models.**

- Freemium
- Pay – per reservation
- Per- User / Per – Seat Pricing - for SaaS
- Pay-as-You-Go (PAYG) / On-demand Pricing

**11. Write the advantages of pricing model.****Advantages:**

- Cost predictability
- Resource optimization
- Flexible scaling
- Efficient budgeting

**12. What are the features of freemium model?**

- Basic essential features
- Limited amount of resources
- Limited amount of storage
- Limited amount of usage

**13. What are the Characteristics of Freemimum Pricing models?****Characteristics of Freemimum Pricing models:**

- Basic free tier – It offers the base version of the service for free.
- Limited functionality.
- Upgrade to premium version when additional features required
- Scalable usage .
- Low entry barrier (no financial commitment).

**14. What are the advantage and disadvantage of using freemium model?****Advantage:**

- Low barrier to entry.
- User acquisition.
- Product exploration – make the user to understand about the products.
- Customer conversion – upgrading if the product is valuable.
- Feedback and improvement.

**Disadvantage:**

- It offers limited resources.
- Usage restrictions.
- Upgrade Complexity.

**15. Define concept of pay per reservation pricing model.****Concept:**

- ✓ Customers pay a fee for reserving a specific set of cloud resources for a defined period.
- ✓ It provides the customers with dedicated resources that are reserved exclusively for their use, regardless of whether those resources are actively utilized during the reservation period.

**16. What are the applications of pay per reservation pricing model?**

- Predictable workloads
- Cost optimization
- Budget constraints

**17. What are the Characteristics of per reservation pricing model?**

- Reserved resources
- Exclusive Access
- Fixed Price
- Flexibility

**18. What are the advantage and disadvantage of per reservation pricing model?****Advantages:**

- Resource assurance
- No resource contention
- Predictable cost
- Stability

**Disadvantages:**

- Underutilization
- Rigidity - Adjust the plan if needs changed
- Complexity increased during decision making process

**19. Define pay per user pricing model.**

- ✓ It is a billing approach where customers are charged based on the number of users who access and use a particular cloud service.
- ✓ It is often used in SaaS applications (the service is accessed by multiple users within an organization).

**20. Write the Characteristics pay per user pricing model.****Characteristics:**

- User Count (user based cost)
- Easy scalability
- Customization – different tiers or level based features Predictable cost

**21. What are the advantage and disadvantage of pay per user pricing model?****Advantages:**

- Cost Control
- Scalability
- Fair pricing
- Easy adoption

**Disadvantages:**

- User management
- User inactivity
- User roles
- Pricing changes

**22. What is subscription-based charging? Define subscription-based charging in cloud.( Nov/Dec-2024)**

- ✓ It is commonly used for cloud computing. Cloud customers pay upfront, prior to receiving access to cloud services.
- ✓ Customers are charged based on the resources and services they consume over a specific period (monthly or yearly basis). ∞ Prices are often based on the subscription's length.

**23. Write basic Criteria of subscription based charging.**

- Well defined plans
- Service variety
- Billing Infrastructure
- Billing Cycle

**24. What are the Characteristics of Subscription based Charging?**

- Recurring Payments
- Predictable Costs
- Resource Allocation
- Tiered Plans

**25. What are the advantage and disadvantage of subscription based charging?****Advantages:**

- Predictability
- Cost Savings
- Flexibility

**Disadvantages:**

- Underutilization
- Vendor Lock-In
- Limited Scalability

**26. Define procurement of cloud-based services.**

- ✓ It is a systematic process of identifying, evaluating, selecting, acquiring, and managing various cloud services from providers to meet an organization's computing and IT needs.

**27. List out the steps involved for procurement of Cloud Services.**

- Assessment of Business Goals
- Requirements Definition
- Vendor Research
- Vendor Evaluation
- Request for Proposal (RFP)
- Proposal Evaluation

**28. Write Characteristics of procurement of Cloud Services.**

- Pay-as-You-Go Model
- Flexibility
- OpEx Allocation
- Resource Ownership

**29. Write the Advantages of procurement of Cloud Services.**

- Cost Efficiency
- Resource Flexibility
- Focus on Core Business
- Reduced Risk

**28. Define cloud service charging.**

- ✓ The process of determining and applying costs to cloud services consumed by users or organizations.

**29. What is the formula of cloud services charging?****Formula for calculation of cloud services charging:**

$$✓ \text{Cost} = (\text{Usage Measurement}) \times (\text{Rate}) \text{ (or) } \text{Resource Usage} * \text{Rate}$$

**30. What are the Requirements for effective charging?**

- Resource monitoring tools
- Service Catalog
- Rate Structure
- User Identification

**31. What is the purpose of cloud cost model?**

- ✓ It is used to optimize and manage the costs associated with utilizing cloud services efficiently.



**It is used to controls,**

- Spending Costs
- Allocated Costs
- Make informed decisions about resource provisioning

**32. List the various types of cloud cost model.**

- Pay-as-You-Go (PAYG) / On-demand Pricing
- Reserved Instances (RIs) Model
- Spot instances (bid)
- Dedicated instances / Hosts
- Data Transfer Pricing
- Storage Pricing

**33. What are the types of storage services?**

- Object Storage
- Block Storage
- File storage
- Database Storage

**34. Define API calls pricing.**

- ✓ API calls pricing o It refers to the pricing model used by cloud service providers for the use of their application programming interfaces (APIs).
- ✓ It enables the developers to access and interact with various cloud services, data, and functionalities provided by the cloud provider.

**35. What is the formula for Data Processing Cost Calculation?**

**Formula for Data Processing Cost Calculation:**

- ✓  $\text{Data Processing Cost} = \text{Volume of Data Processed} \times \text{Price per GB (or TB)} \times \text{Resource Utilization Factor}$

**36. What is the shift from CapEx to OpEx?**

- ✓ This shift from CAPEX to OPEX is becoming increasingly common in the IT industry as businesses move towards more flexible and scalable solutions.

**37. What is the CapEx to operating ratio?**

- ✓ The CAPEX to Operating Cash Ratio assesses how much of a company's cash flow from operations is being devoted to capital expenditure.

**38. What are the Factors influencing of CapEx?**

- Long-term costs
- Vendor lock-in
- security

**39. Define Operational Expenditures (OpEx).**

- ✓ It defines an ongoing operational expenses incurred by organizations to maintain and operate their business activities.
- ✓ The expenses are incurred regularly and include costs such as rent, utilities, employee salaries, and services.

**40. What are the Characteristics of Operational Expenditures?**

- OpEx costs are more flexible.
- IT can be adjusted more easily based on changing needs.
- It is as operating expenses on the income statement.

**42. Compare between pay per user and pay per reservation with an example. (April/May-2024)**

In cloud computing, **Pay Per User** and **Pay Per Reservation** are two different pricing models. Let's compare them with an example:

Feature	Pay Per User	Pay Per Reservation
<b>Definition</b>	Charges based on the number of users accessing the service.	Charges based on the number of reservations or bookings made.

<b>Best For</b>	Businesses with a fixed or predictable number of users.	Businesses where usage depends on customer demand or transactions.
<b>Cost Structure</b>	Flat or tiered pricing per user per month/year.	Variable pricing based on the number of transactions or bookings.
<b>Flexibility</b>	Predictable costs, good for stable usage.	More cost-effective for businesses with fluctuating demand.
<b>Scalability</b>	Increases linearly with users.	Scales dynamically with demand.

**43.List the various pricing models for cloud services.(April/May-2024)**

1. Pay-As-You-Go (PAYG)
2. Subscription-Based Cloud Pricing Model
3. Reserved Instance Cloud Pricing Model
4. Spot Pricing Model
5. AWS Savings Plan

**44.How pricing model in cloud platform ease the task of cloud users?  
(Nov/Dec-2024)**

Cloud pricing models ease the task of cloud users in several ways. They are:

- 1.Budget Control** – Users can choose the best model for their needs.
- 2.Scalability** – Cloud services adjust to demand without manual intervention.
- 3.Cost Optimization** – Different models help minimize unnecessary expenses.
- 4. Ease of Management** – Automated billing and monitoring reduce admin overhead.

**PART B****1. Explain in detail about Pricing Models for Cloud Services.****PRICING MODELS FOR CLOUD SERVICES**

- ❖ **Goal:** It provides customers with a flexible, transparent, and cost-effective way to access and utilize computing resources, software, and other services offered by cloud service providers.
- ❖ **Key parameters used for selection of pricing models in cloud:** (Goals)
  1. Cost efficiency
  2. Flexibility and scalability
  3. Innovation and experimentation – Allow the clients to work in new technologies
  2. without any technological risks
  3. Resource optimization
  4. Customization
  5. Competitive advantages
  6. Customer Satisfaction
  7. Selection of resources and services based on their requirements (Business goals)
  8. Simplicity and transparency (pricing models are easy to understand)
- ❖ **Win-Win Situation:** It provides a win-win situation for both customers and cloud providers.
- ❖ **Pricing Structure:** each cloud provider might have its own unique pricing structure and terminology for these models.
- ❖ **A service catalog:** It is a listing of services from which a user can choose, thus initiating the cloud service provisioning process.
- ❖ **Different types of users considered for service catalog:**
  - a. Development team
  - b. R&D groups

- c. The application team in charge of building and maintaining internal applications

❖ **Attributes of service catalog:**

1. Operating systems
2. Middleware stacks
3. Applications offered
4. Networking options – for both simple network configuration and multi-tenancy support
5. Compliance packages
6. Monitoring tools
7. Service levels
8. Prices associated with each component, if desired

❖ **Pricing landscape in cloud services:**

- ✓ It defines the
  1. overall layout, structure
  2. characteristics of pricing options, models,
  3. strategies within a particular industry
  4. market, or context
- ✓ It is dynamic and can vary significantly based on different parameters

**Factors:**

Factors that influence the price of cloud resources

Some factors that influence the price of cloud resources are as follows:

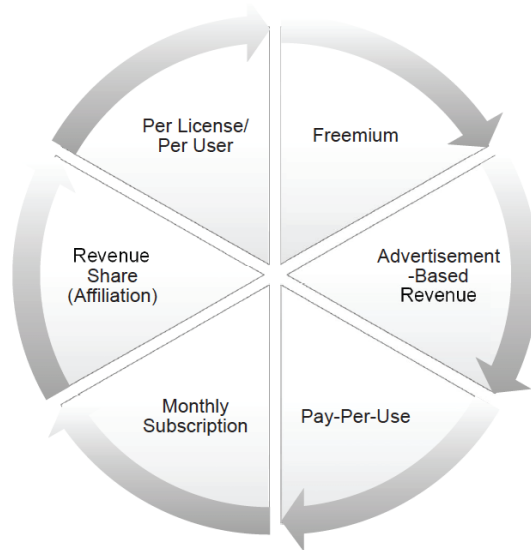
1. Social category of customers, all clients should be offered a fair price, however, should be viewed social aspect of clients or social classifications. Classification should be done depending on client's location.

2. Cost of data center, the price should be calculated for data centers, as cost of real estate, backup power, maintenance, cooling resources, network connectivity, security features etc.
3. User reputation, the reputation of the users has a special importance in cloud services considering various attacks, sniffing programs, Trojans etc.
4. Provider reputation, cloud provider's reputation is also necessary to create a trust from the community when it is known that may have sensitive data. The reputation is the component of trust and it also measures reliability. Using cloud infrastructure for critical business computation necessitate that the reputation of the cloud provider is well established.
5. Public review, public reviews on issues such as downtime, phishing and data loss and password weakness can be valuable in pricing of cloud services.
6. SLA (Service Level Agreement) is a negotiated agreement for services between cloud providers and cloud customers. Most often SLAs are dictated by the cloud providers.
7. Co-cloud users, the nature of multi-tenancy in a cloud could enable competitive companies to use the same cloud platform. Information about co-tenants in the cloud can be used to influence service price.

❖ **Different Pricing models:**

1. Freemium
2. Pay – per reservation
3. Per- User / Per – Seat Pricing - for SaaS
4. Pay-as-You-Go (PAYG) / On-demand Pricing
5. Subscription based Charging

6. Reserved Instances
7. Spot instances (bid)
8. Dedicated instances / Hosts
9. Data Transfer Pricing
- 10.Storage Pricing
- 11.Function Execution (Serverless) Pricing
- 12.API calls pricing
- 13.Data Processing Pricing



Cost Pricing Model

❖ **Advantages:**

1. Cost predictability
2. Resource optimization
3. Flexible scaling
4. Efficient budgeting
5. Value based decision making
6. Competitive advantages for providers
7. Promotion of Innovation
8. Vendor – Selection criteria
9. Scalability support
- 10.Resource allocation visibility

The three main categories of costs typically associated with setting up and maintaining premises infrastructure:

- a. Capital costs server software, licensing and hardware, as well a infrastructure, storage environments and backup systems.
- b. Operational costs including support for server and network infrastructure, as well as storage warranty, data center facilities, existing system administration labor costs, and IT staff training and turnover.
- c. Indirect business costs including unplanned and planned downtime.

## **2.Explain in detail about Freemium Models.**

### **FREEMIUM MODELS**

- ❖ It is a basic version of a product or service is offered for free to users, with the option to upgrade to a premium or paid version that offers additional features, functionality or resources.
- ❖ It is widely used in the software and cloud services industry.
- ❖ High lifetime value: It tends to work well for internet-based businesses with small customer acquisition costs, but high lifetime value.
- ❖ **Basic features:** It allows users to utilize basic features of a software, game, or service for free, then charges for "upgrades" to the basic package.
- ❖ **Accessible features:** IT offers
  1. Basic essential features
  2. Limited amount of resources
  3. Limited amount of storage
  4. Limited amount of usage
- ❖ **Characteristics of Freemimum Pricing models:**
  1. Basic free tier – It offers the base version of the service for free.
  2. Limited functionality.
  3. Upgrade to premium version when additional features required.
  4. Scalable usage.
  5. Low entry barrier (no financial commitment).
  6. User encouragement (make the user to familiarize the services).



7. Customer segmentation.
8. Marketing and user Acquisition (attracting potential customers).
9. Trial Period.
10. Monetization strategy – providers generate revenue from users who require additional features or resources.

❖ **Examples:**

1. Google Workspace
2. Drop box (storage free upto 2GB)
3. Github (provides free code repositories and collaboration tools for open-source projects, while paid plans offer private repositories, advanced collaboration features, and security controls)
4. Wordpress.com (free blogging and website creation – limited customization)
5. Zoom – Video conferencing (limited duration – 45mins)
6. Canva – free graphic design
7. Grammarly
8. Jira Software - small teams to track and manage projects
9. Zoho CRM - basic sales and contact management
10. Mind Meister - mind mapping tool with limited features

❖ **Advantages:**

1. Low barrier to entry
2. User acquisition
3. Product exploration – make the user to understand about the products
4. Customer conversion – upgrading if the product is valuable
5. Feedback and improvement
6. Brand recognition
7. Community building

❖ **Disadvantages:**

1. It offers limited resources
2. Usage restrictions.
3. Upgrade Complexity - Transitioning from the free tier to a premium plan might involve data migration, configuration changes, and adjustment to new features.

4. Lock-in concerns - find it difficult to switch to another provider or service due to data lock-in.
5. Inconsistent experience – different level of access in premium and freemium users.
6. Overlook features - freemium users might not be aware of the full range of features offered by the premium version, leading to underutilization of the service's potential.

### **3.Explain in detail about Pay Per Reservation Pricing Models.**

#### **PAY PER RESERVATION PRICING MODELS**

- ❖ **Concept:** Customers pay a fee for reserving a specific set of cloud resources for a defined period.
- ❖ **Private cloud:** It allows the customers use the resources like private cloud.
- ❖ **Dedicated resources:** It provides the customers with dedicated resources that are reserved exclusively for their use, regardless of whether those resources are actively utilized during the reservation period.
- ❖ **Change of demands:** It is may not be as flexible for adapting to changing demands.
- ❖ **Peak usage time:** It ensures guaranteed availability even during peak usage times.
- ❖ **Suitable situation:** Critical applications or services that require dedicated resources.
  1. Predictable workloads
  2. Cost optimization
  3. Budget constraints
  4. Long term projects
  5. Consistent performance
  6. Predictable billing
  7. Consistency in resource availability
- ❖ **Characteristics:**

1. Reserved resources (Customization) - reserve a predetermined amount of computing resources, such as CPU, memory, and storage, for a specified duration.
2. Exclusive Access - During the reservation period, the reserved resources would be exclusively allocated to the customer who made the reservation.
3. Fixed Price - charged a fixed fee for the reservation, regardless of whether they fully utilize the reserved resources or not.
4. Flexibility - It offers customers the flexibility to choose the type and configuration of resources they want to reserve based on their specific requirements.
5. Predictability - it easier for budgeting and financial planning.
6. Guaranteed availability.

❖ **Advantages:**

1. Resource assurance
2. No resource contention (not shared. So performance degradation)
3. Predictable cost
4. Stability
5. Simplified processing time
6. Customized reservations
7. Mitigation of Resource Scarcity (customers with reservations would not be affected by resource shortages)

❖ **Disadvantages:**

1. Underutilization
2. Rigidity - Adjust the plan if needs changed
3. Complexity increased during decision making process

**4.Explain in detail about Pay per user Pricing Models.**

**PAY PER USER PRICING MODELS**

- ❖ **Concept:** It is a billing approach where customers are charged based on the number of users who access and use a particular cloud service.
- ❖ It is often used in SaaS applications (the service is accessed by multiple users within an organization).

- ❖ **User count:** The cost is directly tied to the user count.
- ❖ **Overall pricing:** Each user who has access to the cloud service contributes to the overall pricing.
- ❖ **Cost and number of users** are directly proportional to each other.
- ❖ **Customization of services based on user roles:** It offers different tiers or levels based on the features and capabilities required by different user roles, with higher tiers offering more advanced functionality.
- ❖ **Active user:** The cost is determined by the number of active users within a given period (monthly or annually).
- ❖ **Total Cost:** Total cost is determined by the total number of users who have access to and use the cloud services.
- ❖ **Suitable situation:** It is suitable for organizations seeking a straightforward way to scale cloud service usage based on their user base (workloads with fluctuating demands, where resource requirements vary over time).
- ❖ **Change of demands:** It is more flexible for adapting to changing demands.
- ❖ **Characteristics:**
  1. User Count (user based cost)
  2. Easy scalability
  3. Customization – different tiers or level based features
  4. Predictable cost
- ❖ **Advantages:**
  1. Cost Control
  2. Scalability
  3. Fair pricing
  4. Easy adoption
  5. Predictable budgeting
- ❖ **Disadvantages:** (Need to be eliminated for effective)
  1. User management - accurate user management and tracking are essential to ensure accurate billing. Organizations need systems in place to add and remove users as needed.
  2. User inactivity – It ensures not paying for inactive or redundant users who are not actively using the service.
  3. User roles.

4. Pricing changes - potential changes in user count and the associated costs as the organization evolves.
  4. User Adoption - Organizations should monitor user adoption rates to ensure
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**5. Explain in detail about Subscription Based charging.**

**Illustrate in detail about subscription-based cost charging model, its merits and demerits, implications and implementation issues with an example application. (April / May -2024)**

**SUBSCRIPTION BASED CHARGING**

- ❖ It is commonly used for cloud computing.
- ❖ **Payment:** Cloud customers pay upfront, prior to receiving access to cloud services.
- ❖ Customers are charged based on the resources and services they consume over a specific period (monthly or yearly basis).
- ❖ Prices are often based on the subscription's length.
- ❖ **Lower cost:** A longer subscription often translates to a lower cost.
- ❖ It offers a balance between predictability and flexibility for customers, enabling them to access cloud resources and services according to their needs and budgets over predefined periods.
- ❖ **Careful evaluation:** customers should carefully evaluate their resource needs and the terms of the subscription before committing to a specific plan.
- ❖ **Criteria for define subscription based model:** (Provider side)
  1. Well defined plans - providers must develop and offer distinct subscription plans with varying features and resources.
  2. Service variety – providers offers a range of subscription plans to cater to different user requirements.
  3. Billing Infrastructure - A robust billing system is essential for accurately tracking and charging customers based on their chosen plans.
  4. Billing Cycle - Providers need to define the billing cycle (e.g., monthly, annually) and associated payment methods.

5. Upgrade/Downgrade Mechanism - A mechanism for customers to easily switch between subscription plans is necessary.
6. Cancellation Policy - Clear guidelines on how customers can cancel subscriptions, including any associated penalties or fees.
7. Resource Monitoring - Tools to track resource consumption and usage patterns are necessary to allocate resources fairly.
8. Resource allocation - Subscription plans should specify the allocation of resources included in each plan.

❖ **Characteristics of Subscription based Charging:**

1. Recurring Payments - Customers make regular payments for the subscription plan they have chosen, regardless of actual resource usage during the billing cycle.
2. Predictable Costs - Customers have a clear understanding of their costs over the subscription period, aiding budgeting and financial planning.
3. Resource Allocation - Subscribers receive a set allocation of resources based on their chosen subscription plan.
4. Tiered Plans - Providers offer different plans with varying resource allocations, features and support levels to cater to diverse customer needs.
5. Flexibility - Subscribers can often upgrade or downgrade plans to match changing resource requirements.
6. Long-Term Commitment - Subscribers commit to using the service for a predefined period, which can lead to cost savings through discounts.
7. Value-Added Services - Higher-tier plans might include access to additional services, priority support, or specialized features.
8. Renewal and Cancellation - Subscriptions auto-renew unless canceled, and cancellation terms vary among providers.
9. Usage Monitoring - Customers often have tools to track their usage and assess whether their chosen plan aligns with their needs.
10. Discounts - Service providers sometimes offer discounts for customers who commit to longer subscription periods. This can incentivize customers to opt for annual subscriptions rather than monthly ones.

11. Vendor Lock-In Considerations - While subscription-based models offer predictability, they might also create vendor lock-in situations where it becomes challenging to migrate to a different provider due to contractual commitments.

❖ **Scenario suitable:**

1. Stable workloads - consistent workloads and resource requirements
2. Strict budget planning
3. Predictable demand – demand predictable over time
4. Long term projects - defined timelines can subscribe to resources for the duration of the project
5. Discounted pricing –reduce overall costs
6. Resource guarantees - resource availability
7. Service bundles – Different subscription plans

❖ **Advantages:**

1. Predictability - Customers can anticipate costs and budget more effectively.
2. Cost Savings - Longer commitments may come with discounts or reduced rates.
3. Flexibility - Plans can often be adjusted as needs change.
4. Access to Features - Higher-tier plans offer access to additional features and services.
5. Resource Allocation - Guaranteed resource availability even during peak times.

❖ **Disadvantages:**

1. Underutilization - Customers might end up paying for resources they don't fully use.
2. Vendor Lock-In - Long-term commitments might make it challenging to switch providers.
3. Limited Scalability - Sudden resource spikes can lead to issues if not accommodated in the chosen plan.
4. Complexity - Managing different subscription plans and their changes can be complex for both customers and providers.

**6.Explain in detail about Procurement of Cloud-Based Services.****PROCUREMENT OF CLOUD-BASED SERVICES**

- ❖ **Concept:** It is a systematic process of identifying, evaluating, selecting, acquiring, and managing various cloud services from providers to meet an organization's computing and IT needs.
- ❖ **Business Requirements:** It encompasses the entire lifecycle of selecting, acquiring, deploying, and overseeing cloud services to meet business requirements.
- ❖ **Structured process:** It is a structured process of selecting and managing cloud services.
- ❖ The procurement must align with organization's strategic objectives and operational requirements.
- ❖ **Criteria for procurement of cloud services:**
  1. Business needs.
  2. Service Quality - Selected services should meet the performance, availability, reliability standards specified in SLA.
  3. Security.
  4. Scalability.
  5. Cost Effectiveness.
  6. Integration - services should seamlessly integrate with existing IT infrastructure and applications.
  7. Vendor reputation - cloud service provider's reputation, track record, and customer reviews should be considered to assess their reliability.
  8. Data Governance - how the cloud provider handles data, including data ownership, privacy, and data portability.
- ❖ **Characteristics:**
  1. Strategy alignment – Align with business needs and strategy.
  2. Continuous process (continuous evaluation and optimization).
  3. Flexibility - Cloud services can be procured on-demand, providing flexibility in resource allocation.
  4. Resource management - The organization can adjust resources as needed, ensuring cost-efficiency



**❖ Steps involved for procurement of Cloud Services:**

1. Assessment of Business Goals - Identify the organization's IT needs, objectives and requirements for cloud services.
2. Requirements Definition - Clearly define the technical, functional, and operational requirements for the desired cloud services.
3. Vendor Research.
4. Vendor Evaluation
5. Request for Proposal (RFP).
6. Proposal Evaluation.
7. Contract Negotiation - Negotiate contract terms, pricing, SLAs, security measures and other important details.
8. Service Deployment - Implement and configure the selected cloud services according to your organization's needs.
9. Monitoring and Management - Implement monitoring tools to track performance, availability and usage. Manage the services based on SLAs.
10. Cost Management - Continuously monitor costs and optimize resource usage to align with budgetary goals.
11. Security and Compliance - Implement security measures and ensures compliance with relevant regulations.
12. Performance Optimization - Continuously monitor and optimize the performance of cloud services based on usage patterns and needs.
13. Scalability - Scale resources up or down based on demand and changing requirements.
14. Review and Feedback - Regularly review the performance, value, and alignment of cloud services with organizational goals. Gather feedback from users.
15. Contract Renewal/Modification - Determine whether to renew, modify, or terminate contracts based on performance and evolving needs.

**❖ Advantages:**

1. Aligns with Business Goals
2. Enables Cost Control
3. Flexibility in Resource Allocation
4. Access to Expertise

5. Improved Scalability
6. Reduced IT Infrastructure Complexity

**7.Explain in detail about Capex vs Opex Shift.**

**Compare and contrast between Capex and Opex Shift in cloud economy. (6)**  
**(April / May -2024)**

**Capex vs Opex Shift**

❖ **Capital Expenditures (CapEx):**

- ✓ CapEx refers to upfront investments made by organizations to purchase physical assets (hardware, equipment, and infrastructure).
- ✓ The assets are typically used for the long term and are considered as part of the organization's fixed assets.
- ✓ **Characteristics:**
  - It is substantial and involves significant planning and budgeting.
  - These investments are capitalized on the balance sheet and depreciated over time.
- ✓ Traditional IT infrastructure often involves large CapEx investments in purchasing and setting up servers, storage, networking equipment, and datacenters.

❖ **Operational Expenditures (OpEx):**

- ✓ It defines an ongoing operational expenses incurred by organizations to maintain and operate their business activities.
- ✓ The expenses are incurred regularly and include costs such as rent, utilities, employee salaries, and services.
- ✓ **Characteristics:**
  - OpEx costs are more flexible.
  - IT can be adjusted more easily based on changing needs.
  - It is as operating expenses on the income statement.

❖ **Shift from CapEx to opEx:**

- ✓ It involves changing the way organizations invest in and budget for their IT infrastructure and services.
- ✓ The shift involves changing the financial model from upfront investments in hardware and facilities to paying for resources and services on an ongoing, consumption-based basis.
- ✓ **Factors influencing the transition or shift:**
  - a. Long-term costs
  - b. Vendor lock-in
  - c. security
- ✓ **Criteria:** The following criteria to be considered while evaluating CapEx to OpEx shift.
  - 1. Cost predictability involves more predictable.
  - 2. Resource Scalability -CapEx investments might to over provisioning or under provisioning.
  - 3. Financial Flexibility - OpEx eliminates the need for large initial investments, freeing up capital for other strategic initiatives.
  - 4. Risk Management - OpEx reduces the financial risk associated with technology obsolescence and asset depreciation.
  - 5. Budget Management - OpEx aligns expenses with actual usage and provides better budget control.
  - 6. Innovation Focus - OpEx allows organizations to focus on innovation and core business activities rather than infrastructure management.

❖ **Characteristics:**

- 1. Pay-as-You-Go Model - OpEx involves paying for resources as consumed, promoting cost efficiency.
- 2. Flexibility - Cloud services offer the flexibility to adjust resources based on demand, avoiding resource wastage.
- 3. OpEx Allocation - Cloud services are treated as operational expenses on the income statement rather than being capitalized on the balance sheet.
- 4. Resource Ownership - In the CapEx model, the organization owns physical assets, while in the OpEx model, the cloud provider owns and maintains the infrastructure.

❖ **Steps involved for procurement of Cloud Services (OpEx):**

1. Assessment of Business Goals - Identify the organization's IT needs, objectives and requirements for cloud services.
2. Requirements Definition - Clearly define the technical, functional and operational requirements for the desired cloud services.
3. Vendor Research.
4. Vendor Evaluation.
5. Request for Proposal (RFP)
6. Proposal Evaluation.
7. Contract Negotiation - Negotiate contract terms, pricing, SLAs, security measures, and other important details.
8. Service Deployment - Implement and configure the selected cloud services according to your organization's needs.
9. Monitoring and Management - Implement monitoring tools to track performance, availability, and usage. Manage the services based on SLAs.
10. Cost Management - Continuously monitor costs and optimize resource usage to align with budgetary goals.
11. Security and Compliance - Implement security measures and ensures compliance with relevant regulations.
12. Performance Optimization - Continuously monitor and optimize the performance of cloud services based on usage patterns and needs.
13. Scalability - Scale resources up or down based on demand and changing requirements.
14. Review and Feedback - Regularly review the performance, value, and alignment of cloud services with organizational goals. Gather feedback from users.
15. Contract Renewal/Modification - Determine whether to renew, modify, or terminate contracts based on performance and evolving needs.

❖ **Advantages:**

1. Cost Efficiency - it helps to avoid large upfront investments.
2. Resource Flexibility - It allows easy scalability to match changing demand.
3. Focus on Core Business - OpEx frees up resources to focus on innovation and strategic projects.
4. Reduced Risk - OpEx reduces the risk of technology obsolescence and underutilization.

5. Budget Predictability - OpEx aligns expenses with usage, enabling better budget management.
6. Rapid Deployment - Cloud services enable quicker deployment of resources compared to traditional CapEx models.

### 8. Explain in detail about Cloud Service Charging. ?

#### CLOUD SERVICE CHARGING

- ❖ **Concept:** The process of determining and applying costs to cloud services consumed by users or organizations.
- ❖ **Factors:** The charges are assigned based on the following factors.
  1. Type of resources used
  2. Amount of resources consumed
  3. The level of services are accessed
  4. Subscription plans
  5. Additional services
- ❖ **Goal:** It aims to ensure transparency, cost efficiency, and alignment between resource consumption and financial expenditure.
- ❖ **Transparent Billing:** It creates an accurate and transparent billing based on the actual resources used by customers within the cloud environment.
- ❖ **Cloud service Providers:** It enables cloud service providers to recover their operational costs and generate revenue.
- ❖ **Customers:** It allows the customer to pay for the resources and services they use promoting cost transparency and effective resource management.
- ❖ **Formula for calculation of cloud services charging:**
- ❖  $\text{Cost} = (\text{Usage Measurement}) \times (\text{Rate})$  (or)  $\text{Resource Usage} * \text{Rate}$
- ❖ **Characteristics of Cloud Service Charging:**
  1. Usage-Based - Charges are often based on the actual consumption of resources.
  2. Variability - Costs can vary based on usage patterns, time of use, and the specific services utilized.
  3. Subscription Models - Some services offer fixed subscription plans that provide access to specific resources and features for a set fee.

4. Resource Allocation - Higher usage or more advanced features typically lead to higher charges.
5. Add-On Services - Additional services like data backup, security features, and premium support may result in extra charges.
6. Billing Cycles - Charges are usually billed on a regular basis (e.g., monthly) or at the end of a usage period.
7. Cost Transparency - Cloud service providers offer usage dashboards and reports to help users understand and manage their expenses.

❖ **Requirements for effective charging:**

1. Resource monitoring tools.
2. Service Catalog.
3. Rate Structure.
4. User Identification - Identifying and associating users with their resource consumption for proper allocation of charges.
5. Billing System
6. Transparency - detailed usage reports and invoices, promoting transparency in charging.

❖ It supports,

1. Financial planning
2. Encouragement in effective resource usage
3. Ensures fairness in distributing costs

❖ **Steps involved for calculation of charges:**

1. Resource Usage Monitoring - Track resource consumption.
2. Usage Measurement - Cloud providers measure resource usage in terms of hours, storage capacity, data volume, etc...
3. Rate Determination - Assign rates or prices to different resource units or services.
4. Cost Calculation - Multiply the usage measurements by the assigned rates to calculate the cost for each resource or service.
5. Aggregation - Sum up the costs of all resources and services used during a billing period.
6. Invoicing and Billing - Generate invoices or statements detailing the services used and their associated costs.

7. Payment - Users or organizations pay the billed amount through various payment methods.

❖ **Factors affecting cloud services charging:**

1. Resource Consumption - The amount of resources used directly impacts the cost.
2. Service Type - Different services (e.g., compute, storage, database) have varying costs.
3. Usage Duration - Longer usage periods result in higher charges.
4. Service Features - Advanced features or performance options might incur additional costs.
5. Data Transfer - Charges can apply to data transferred in and out of the cloud environment.
6. Geographical Region - Pricing may vary based on the physical location of datacenters and services.
7. Service Level - Higher service levels (e.g., availability, performance) often come with higher costs.

**9. Explain in detail about Cloud Cost Models.**

**Exemplify in detail about various cloud cost models and its applications.(7)**  
**(April / May -2024)**

**CLOUD COST MODELS**

- ❖ **Purpose:** It is used to optimize and manage the costs associated with utilizing cloud services efficiently.
- ❖ It is used to controls,
1. Spending Costs
  2. Allocated Costs
  3. Make informed decisions about resource provisioning
- ❖ **Factors:** The following factors are used to select the best cost models.
1. Cost visibility – It provides clear visibility into cloud expenses.
  2. Cost Allocation - It allows for accurate allocation of costs to projects, departments, or teams.

3. Cost Prediction: It helps in forecasting future costs based on historical data.
4. Resource Optimization: It enables the resource optimization to minimize unnecessary expenses.
5. Scalability: IT should be adaptable to different cloud providers and environments.

❖ **Inputs:**

1. Usage data.
2. Price information.
3. Resource tagging (Metadata – associated resources with projects, departments or cost centers).
4. Historical Data - Past usage and cost data to analyze trends.

❖ **Outputs:**

1. Cost Reports - Detailed breakdowns of cloud spending by resource, project, or department.
2. Cost Allocation Reports - Allocation of costs to specific entities.
3. Cost Projections - Forecasts of future cloud costs based on historical data and trends.
4. Optimization Recommendations - Suggestions for cost-saving measures, such as resizing instances or using reserved instances.

❖ **Different Cloud Cost models:**

**1. Pay-as-You-Go (PAYG) / On-demand Pricing:**

- ✓ It is the default pricing model where the user pays for actual resource usage.
- ✓ It offers flexibility, scalability, and cost transparency to organizations by billing them based on actual resource usage.
- ✓ **Characteristics of PAYG:**
  1. Usage based billing
  2. No need to pay any upfront payments (No initial payments)
  3. Granular billing (charged for exact number of hours use a resource)
  4. Flexibility (Resource scale up or scale down based on demands)
  5. Cost Transparency – Detailed reports



6. **Pay-Per-Use Services** – It extends beyond compute and storage resources; it includes pay-per-use services like databases, server less computing, content delivery networks (CDNs) etc.,

- ✓ **Suitable Application:** It is particularly beneficial for businesses with variable workloads and resource requirements.
- ✓ **Formula:** Total Cost = Usage (in units) \* Unit Price
- ✓ **Cloud Service Providers:** Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP) follow this model.
- ✓ Example: if the user runs a virtual machine for 100 hours at a rate of \$0.05 per hour, then what is the total cost?

$$\text{Total Cost} = 100 * 0.05 = \$5$$

## 2. Reserved Instances (RIs) Model:

- ✓ It involves reserving resources for a specified term at a lower cost.
- ✓ **Characteristics:**
  1. Resource Reservation – The users commit to reserving a specific amount of cloud resources for a fixed duration.
  2. Upfront Payment - To secure the cost savings of RIs, users typically make an upfront payment covering a portion of the total cost for the reserved resources.
  3. Reduced hourly rate.
  4. Available in peak times.
  5. Term length.
- ✓ **Cloud Service Providers:** Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP) follow this model.
- ✓ **Suitable Application:** It beneficial for organizations with predictable workloads and a desire to save on their cloud expenses.
- ✓ **Inputs:**
  1. Upfront Cost (U) - The upfront payment made when purchasing the RI.
  2. Hourly Rate with RI (RI) - The reduced hourly rate for the reserved resource.
  3. Hourly Rate without RI (PAYG) - The standard PAYG hourly rate for the same resource.

4. Usage Hours (T) - The number of hours you intend to use the reserved resource during the reservation term.

✓ **Formula:** Total Cost = Upfront Payment + (Usage (in units) \* Reduced UnitPrice)

✓ The formula for calculating the cost savings with RIs compared to PAYG is:

$$\text{Total Cost} = (\text{PAYG} - \text{RI}) * T - U$$

### 3. Spot instances (bid):

✓ It allows you to use spare capacity at lower prices, but they can be terminated with short notice.

✓ **Characteristics:**

1. Dynamic pricing.

2. Short term usage.

3. Interruptible – The cloud providers can terminate them with short notice if the capacity is needed elsewhere. Users are typically given a two-minute warning before termination.

4. Bidding Process - Users can set a maximum price (bid) in which we are willing to pay for a spot instance. If the spot price remains below the bid price, the instance runs. If it exceeds the bid price, the instance is terminated. This bidding system helps users control costs.

✓ Formula: Total Cost = Usage (in units) \* Spot Price

### 4. Dedicated instances / Hosts:

✓ The customers lease dedicated physical servers or instances from the cloud provider.

✓ **Not shared:** The servers are not shared with other customers, ensuring that the customer has full control over the hardware and can maintain higher levels of isolation and security.

✓ **Characteristics:**

1. Isolation - Dedicated instances or hosts provide a high level of isolation, reducing the risk of resource contention with other customers.

2. Security.

3. Performance - Dedicated resources often offer consistent and predictable performance.

- 4. Cost – More expensive than other models.
- 5. Customization – Select suitable resources and configurations.
- ✓ **Suitable Application:** It is used when strict compliance, security, or performance requirements need to be met.
- ✓ **Inputs:**
  - 1. Resource Requirements    2. Duration
- ✓ **Output:**
  - 1. Dedicated Resources        3. Isolated Environment
- ✓ Formula for Cost Calculation in Dedicated Instances / Hosts Model:

Total Cost = (Price per Dedicated Instance or Host) x (Number of Dedicated Instances or Hosts) x (Duration in Hours or Months)

### 5. Data Transfer Pricing:

- ✓ It refers to the pricing structure and cost associated with transferring data in and out of a cloud service provider's network.
- ✓ It can vary significantly between cloud providers and often depends on factors such as the volume of data transferred, the geographic regions involved, and the type of network (e.g., internet or inter-region) used for the data transfer.
- ✓ Ingress: Data flowing into the cloud provider's network (customer on-premises).
- ✓ Egress: Data flowing out of the cloud provider's network sent to end-users or other services outside the cloud provider's infrastructure.
- ✓ **Characteristics:**
  - 1. Variable costs – cost based on data transfer.
  - 2. Tiered Pricing - The cost per unit of data decreases as the volume of data transferred increases.
  - 3. Geographic Considerations - Data transfer costs can vary based on the geographic locations involved in the transfer.
  - 4. Data Transfer Methods - The pricing model may differentiate between data transferred over the public internet.
- ✓ **Inputs:**
  - 1. Volume of data transferred
  - 2. Geographic Location

3. Data Transfer Method (private network connections, internet, inter-region transfers)

✓ **Formula for Data Transfer Cost Calculation:**

Data Transfer Cost = Data Transfer Volume (in GB or TB) x Price per GB (or TB) of Data Transfers

**6. Storage Pricing:**

- ✓ It refers to the pricing structure and cost associated with storing data in a cloud service provider's storage infrastructure.
- ✓ Cloud service providers charge customers for the storage space they consume in the cloud.
- ✓ **Dynamic Pricing:** (based on) 1. Volume 2. Type of Storage 3. Duration of the Storage.
- ✓ **Types of storage Services:** Object Storage, Block Storage, File storage, Database Storage
- ✓ **Characteristics:**
  - 1. Cost is based on capacity used in cloud space
  - 2. Tiered Pricing - The cost per unit of data decreases as the volume of data transferred increases
  - 3. Type of storage (standard, premium, archival)
  - 4. Data retention period – cost will vary depends on the duration of data storage
  - 5. Data transfer cost – data transfer rate may be different
- ✓ **Formula for Storage Cost Calculation:**

Storage Cost = Storage Capacity (in GB or TB) x Price per GB (or TB) x Duration (in months or years)

**7. Function Execution (Serverless) Pricing:**

- ✓ The developers write and deploy individual functions that are executed in response to events or triggers, such as HTTP requests, database changes, or file uploads.
- ✓ **Characteristics:**
  - 1. Granular Billing - Serverless pricing is highly granular, with charges based on the actual execution time and resource usage of individual functions.

2. Event-Driven - Functions are triggered by specific events or requests, and users are billed only when functions are executed in response to these events.
  3. Resource Flexibility - The cloud provider dynamically allocates resources (CPU, memory) based on the function's requirements, and users are charged accordingly.
  4. Scalability - Serverless functions can automatically scale to handle varying workloads, and users pay only for the resources consumed during execution.
- ✓ Formula for Function Execution (Serverless) Cost Calculation:

$$\text{Execution Cost} = \text{Execution Time (in seconds)} \times \text{Memory Allocated (in GB)} \times \text{Price per GB-second of Execution Time}$$

### **8. API calls pricing:**

- ✓ It refers to the pricing model used by cloud service providers for the use of their application programming interfaces (APIs).
- ✓ It enables the developers to access and interact with various cloud services, data and functionalities provided by the cloud provider.

✓ **Characteristics:**

1. Request – based billing – number of API requests handled
2. Tiered pricing
3. Rates depends on the different API types
4. Geographical considerations

✓ **Formula for API Call Cost Calculation:**

$$\text{API Call Cost} = \text{Number of API Calls} \times \text{Price per API Call}$$

### **9. Data Processing Pricing:**

- ✓ The cloud service providers to charge customers for the computation and processing of data within their cloud environments.

- ✓ **Data Processing Activities:** Data Analysis, transformation, querying, machine learning etc.
- ✓ **Characteristics:**
  1. Computation based on billing
  2. Type of data processing
  3. Resource allocation (user can specify the amount of CPU, memory, resource allocated)
- ✓ **Inputs:**
  1. Volume of data processed
  2. Type of data processing
  3. Resource allocation
- ✓ **Formula for Data Processing Cost Calculation:**

Data Processing Cost = Volume of Data Processed x Price per GB (or TB) x Resource Utilization Factor

**10. Formulate pseudocode for each pricing model in cloud service platform by considering the number of users, service charges/hour, number of components used, CPU utilization. Defend your answers. (13)**  
**(Nov/Dec-2024)**

Here's pseudocode for different cloud service pricing models, considering the number of users, service charges per hour, number of components used, and CPU utilization.

**1. Pay-As-You-Go Model**

Users are charged based on actual usage per hour.

FUNCTION

    calculate\_pay\_as\_you\_go(users, service\_charge\_per\_hour, usage\_hours)

    total\_cost = users \* service\_charge\_per\_hour \* usage\_hours

    RETURN total\_cost

END FUNCTION

## 2. Subscription-Based Model

Users pay a fixed amount for a period (e.g., monthly or yearly).

FUNCTION

```
calculate_subscription_cost(users, subscription_fee_per_user)
```

```
total_cost = users * subscription_fee_per_user
```

```
RETURN total_cost
```

END FUNCTION

## 3. Resource-Based Model

Charges depend on the number of components used (e.g., storage, virtual machines, databases).

FUNCTION

```
calculate_resource_based_cost(components, cost_per_component,  
usage_hours)
```

```
total_cost = components * cost_per_component * usage_hours
```

```
RETURN total_cost
```

END FUNCTION

## 4. CPU Utilization-Based Model

Users are charged based on CPU usage percentage.

FUNCTION calculate\_cpu\_based\_cost(cpu\_utilization, cost\_per\_cpu\_unit,  
usage\_hours)

```
total_cost = cpu_utilization * cost_per_cpu_unit * usage_hours
```

```
RETURN total_cost
```

END FUNCTION

## 5. Hybrid Model

Combines fixed subscription and usage-based pricing.

```
FUNCTION
  calculate_hybrid_cost(users, subscription_fee, components,
    cost_per_component, usage_hours)
  subscription_cost = users * subscription_fee
  usage_cost = components * cost_per_component * usage_hours
  total_cost = subscription_cost + usage_cost
  RETURN total_cost
END FUNCTION
```

## 6. Tiered Pricing Model

Different price levels based on usage.

```
FUNCTION
  calculate_tiered_pricing(users, usage_hours, base_rate, tier1_limit, tier1_rate,
    tier2_rate)
  total_cost = 0

  IF usage_hours <= tier1_limit THEN
    total_cost = users * usage_hours * tier1_rate
  ELSE
    total_cost = (users * tier1_limit * tier1_rate) + (users * (usage_hours -
    tier1_limit) * tier2_rate)
  END IF

  RETURN total_cost
END FUNCTION
```

**11.How cloud cost models could help in minimizing the burden of cloud users in choosing the right service appropriate for their requirement and budget?(Nov/Dec-2024)**



- As cloud computing becomes integral to modern business operations, 82% of enterprises report cost savings from their transition to the cloud.
- While cloud computing offers cost savings, managing these costs can be difficult. Traditional IT systems often waste money due to having too many overused or underused resources. Cloud cost models are built to tackle these issues, ensuring businesses only pay for what they need.
- The shift from traditional IT to cloud-based models introduces several financial challenges:
  - First, it transforms fixed IT costs into variable ones, complicating budget forecasts.
  - Second, without effective cloud pricing models, organizations risk paying for resources they don't use, draining financial resources.
  - Third, while beneficial, the cloud's scalability feature can lead to cost unpredictability if not adequately managed.
- Cloud cost models are crucial. They ensure organizations pay only for what they use, promoting significant cost efficiency.
- Understanding and strategically implementing these cost models is essential for maximizing the financial benefits of cloud computing, enhancing budget management, and improving operational efficiency.

### **Understanding Cloud Cost Models**

Cloud cost models explain how cloud service providers (CSPs) charge for their services. These models are vital in helping businesses plan their budgets and decide how much to spend on cloud resources, affecting their overall cloud strategy and efficiency.

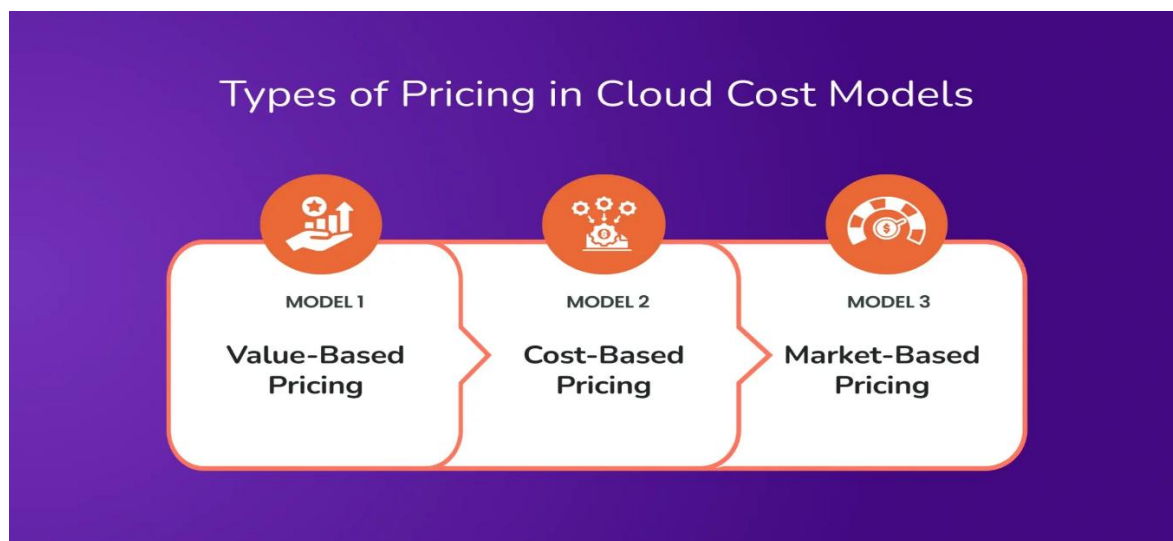
Cost modeling involves examining the type of resources, how long they are used, and where data centers are located. This analysis helps companies manage their cloud spending more effectively, improving resource allocation and cost-efficiency.

### **The Importance of Cloud Cost Models in Cloud Computing**

Cloud cost models are integral to the strategic deployment of cloud services.

1. They help organizations understand and predict expenses, enabling better financial planning and resource allocation. Given the dynamic nature of cloud computing, this understanding is crucial, where factors like demand, supply, and competitive pricing influence costs.
2. For instance, using reserved cases can lead to savings of about 72% compared to on-demand pricing. This alignment between cost and consumption prevents financial waste and allows for better budget planning and resource allocation, optimizing cloud services' financial and operational aspects.

### Types of Pricing in Cloud Cost Models



### Types of Pricing in Cloud Cost Models

**Understanding different pricing helps businesses choose the most suitable model based on their specific needs:**

- **Value-Based Pricing:** Prices are set based on the perceived value of the service to the customer, driven primarily by demand.

- **Cost-Based Pricing:** This approach is influenced by the service's cost, with prices often reflecting the underlying expenses involved in providing the cloud resources.
- **Market-Based Pricing:** Competitive forces and the balance of supply and demand dictate this pricing model, making it essential for businesses to stay informed about market trends.

### Factors for determined the Cloud usage Cost:

When using cloud computing services, your costs are primarily determined by compute power, network usage, and storage needs. Here's a simple breakdown of each:

1. **Compute Power:** Cloud service providers offer various compute instances, basically different memory and processing power packages. Some instances also include specialized features like enhanced networking or graphics acceleration. The cost depends on how many instances you use, their type, and how long you use them.
2. **Network Usage:** Costs in this category are based on how much data you send to and from the cloud. Most providers charge for data transfer, and you might also pay extra for network services like dedicated IP addresses, network gateways, or load balancers.
3. **Storage:** Providers typically offer different storage services you can choose based on your needs. For example, with elastic storage services, you pay for each gigabyte of storage you use per month.

Cloud cost models help minimize the burden of cloud users in choosing the right service by providing structured pricing options tailored to different needs. Here's how they assist in decision-making:

### 1. Offering Flexible Pricing Options

- Users can choose from **pay-as-you-go, subscription, or hybrid models** based on their usage pattern.
- **Example:** A startup with unpredictable traffic can opt for **pay-as-you-go**, while an enterprise with stable needs may prefer a **subscription model**.

## 2. Enabling Cost Transparency

- Cloud platforms provide **cost calculators** and **billing dashboards** to estimate and monitor expenses.
- Helps users **compare pricing models** and select the most cost-effective one.

## 3. Scalability Without Financial Risk

- Users can **start small and scale up** without upfront investments.
- **Example:** A business launching a new application can start with **low-cost resources** and expand based on demand.

## 4. Cost Optimization with Tiered & Reserved Pricing

- **Tiered pricing** offers discounts as usage increases, benefiting high-volume users.
- **Reserved instances** allow cost savings for long-term commitments.

## 5. Performance vs. Cost Trade-off Simplification

- Cloud pricing models **align costs with resource consumption**, allowing users to balance performance and budget.
- **Example:** A data-intensive AI application can use a **CPU utilization-based model** to pay only for processing power used.

## 6. Auto-Scaling & Budget Alerts

- Cloud services **automate scaling** to ensure users don't overpay for idle resources.
- **Budget alerts** notify users before exceeding cost limits.

## 7. Industry-Specific Pricing Models

Cloud providers offer **custom pricing models** for industries like healthcare, education, and finance, helping users **avoid unnecessary costs**

**12.Exemplify in detail about Amazon Web Services (AWS) cloud model in the following aspects with relevant applications. (15 Marks) (April/May-2024)**

- (i) **pay-as-you-go pricing model.**
- (ii) **security and compliance**
- (iii) **freemium**
- (iv)**pay per user/registration**
- (v) **diverse service**

### **Amazon Web Services (AWS) Cloud Model –**

AWS provides a highly scalable and flexible cloud computing platform with a variety of pricing models, security measures, and services that cater to businesses of all sizes. Below is an in-depth look at AWS in the following aspects:

#### **(i) Pay-As-You-Go Pricing Model**

The **Pay-As-You-Go (PAYG)** model in AWS allows users to pay only for the resources they consume, without upfront costs or long-term contracts. This is beneficial for businesses that need dynamic scalability.

#### **Key Features:**

- Charges are based on actual usage (e.g., per second, per hour, per request).
- No upfront investment; costs scale with demand.
- Supports auto-scaling to optimize cost-efficiency.

#### **Examples of AWS Services Using PAYG:**

1. **Amazon EC2 (Elastic Compute Cloud)** – Charges per second or hour for virtual machines (instances).
2. **AWS Lambda** – Charged based on the number of function executions and execution time.

3. **Amazon S3 (Simple Storage Service)** – Pay per GB stored and per API request.
4. **Amazon RDS (Relational Database Service)** – Charged per running database instance.

**Real-World Application:**

- **E-commerce Platforms:** A company like Shopify uses AWS to handle spikes in traffic during events like Black Friday. They only pay for the extra computing power needed during peak times.

**(ii) Security and Compliance**

AWS provides a robust security infrastructure with built-in compliance features to protect data, applications, and workloads.

**Key Security Features:**

- **Identity and Access Management (IAM)** – Allows fine-grained access control.
- **AWS Shield** – DDoS protection service.
- **Amazon GuardDuty** – AI-driven threat detection.
- **AWS Key Management Service (KMS)** – Encryption key management.
- **Virtual Private Cloud (VPC)** – Isolated cloud network for security.
- **Compliance Certifications** – AWS complies with ISO 27001, HIPAA, GDPR, SOC 2, etc.

**Examples of Secure Applications:**

1. **Financial Institutions (e.g., JPMorgan Chase)** – AWS security ensures compliance with banking regulations.
2. **Healthcare (e.g., Philips Healthcare)** – Uses AWS to store patient data securely under HIPAA compliance.

**Real-World Application:**

- **Government Agencies:** The **CIA** uses AWS GovCloud for highly secure workloads that require top-tier encryption and access control.

**(iii) Freemium Model**

AWS offers a **Free Tier** that allows users to test its services before committing to paid plans.

**Key Features:**

- **Always Free Services** – Limited free usage (e.g., AWS Lambda 1M free requests per month).
- **12-Month Free Tier** – Includes free EC2, S3, RDS, etc., up to a limit.
- **Trials for Paid Services** – Some services offer time-limited free trials (e.g., Amazon Redshift).

**Examples of AWS Services in the Freemium Model:**

1. **AWS Lambda** – 1M free requests/month.
2. **Amazon EC2** – 750 hours of t2.micro instance/month (for 12 months).
3. **Amazon S3** – 5GB of free storage.
4. **Amazon RDS** – Free-tier database instance usage for a limited time.

**Real-World Application:**

- **Startups and Developers:** Small startups use the **AWS Free Tier** to build prototypes before scaling.

**(iv) Pay-Per-User / Registration Model**

AWS supports a **pay-per-user** pricing model for certain services, especially in the SaaS (Software as a Service) domain.

**Key Features:**

- Charges are based on the number of users accessing a service.
- Often used for cloud-based identity management and enterprise collaboration tools.

**Examples of AWS Services Using Pay-Per-User Model:**

1. **Amazon WorkSpaces** – Virtual desktop service; users pay per registered workspace.
2. **AWS IAM Identity Center (formerly AWS SSO)** – Pay per user for authentication services.
3. **Amazon Chime** – Video conferencing service; pay per host/user.
4. **Amazon QuickSight** – BI (Business Intelligence) tool charged per active user.

**Real-World Application:**

- **Corporate Remote Work Solutions:** Companies use **Amazon WorkSpaces** to provide employees with virtual desktops that are paid for based on usage.

**(v) Diverse Services**

AWS provides a **broad range of services** across computing, storage, AI, machine learning, IoT, and more.

**Key AWS Service Categories and Examples:**

1. **Compute** – Amazon EC2, AWS Lambda, AWS Fargate.
2. **Storage** – Amazon S3, Amazon EBS, AWS Backup.
3. **Database** – Amazon RDS, DynamoDB, Amazon Aurora.
4. **Machine Learning & AI** – Amazon SageMaker, AWS DeepLens, Amazon Rekognition.
5. **Networking & CDN** – Amazon VPC, AWS CloudFront, AWS Route 53.
6. **IoT Services** – AWS IoT Core, AWS Greengrass.



7. **Security & Compliance** – AWS Shield, AWS WAF, AWS IAM.
8. **Analytics** – AWS Glue, Amazon Redshift, Amazon Kinesis.
9. **Application Integration** – Amazon SNS, Amazon SQS, AWS Step Functions.

**Real-World Application:**

- **Netflix** uses AWS for video streaming, data storage (S3), and AI-based content recommendations (SageMaker).
- **NASA** uses AWS for big data analytics and machine learning applications.

Finally, AWS provides flexible pricing models, top-tier security, and diverse services catering to various industries. Businesses can leverage:

- Pay-as-you-go for scalability
- Freemium for cost-efficient development
- Security for compliance
- Pay-per-user for SaaS-based solutions
- Diverse services for innovation

**13.To address the task of rearranging library books on a shelf using a technique that compares distant books rather than adjacent ones, the Shell Sort algorithm is a suitable choice. Shell Sort is an in-place comparison-based sorting algorithm that generalizes insertion sort by allowing the exchange of items that are far apart. The algorithm starts by sorting elements far apart from each other and progressively reduces the gap between elements to be compared, effectively employing an increment sequence and diminishing increment strategy. ( Nov/Dec-2024)**

**Estimating the Cost of Deploying a Real-Time Shell Sort Application Using Cloud Services:**

Deploying a real-time application for sorting tasks like Shell Sort on the cloud involves several considerations that influence cost:

**1. Compute Resources:**

- **Virtual Machines (VMs) or Containers:** The choice between VMs and containers affects cost. Containers are generally more lightweight and can be more cost-effective for certain workloads.
- **Instance Types:** Selecting instances with appropriate CPU and memory configurations is crucial. For compute-intensive tasks, instances with higher CPU performance may be necessary.

**2. Storage:**

- **Data Storage:** Depending on the volume of data (e.g., the number of books to be sorted), storage requirements can vary. Cloud providers offer various storage solutions, such as object storage or block storage, each with different pricing.

**3. Data Transfer:**

- **Ingress and Egress:** Data transfer into the cloud (ingress) is typically free, but transferring data out of the cloud (egress) can incur costs. It's important to estimate the amount of data that will be moved in and out of the cloud environment.

**4. Pricing Models:**

- **On-Demand Pricing:** This model allows you to pay for compute capacity by the hour or second with no long-term commitments. It's flexible but can be more expensive for sustained workloads.
- **Reserved Instances:** By committing to use cloud resources for a one- or three-year term, you can receive a significant discount compared to on-demand pricing. This is cost-effective for predictable, steady-state usage.
- **Spot Instances:** These are spare compute capacities offered at discounted rates. They are cost-effective but come with the risk of termination if the capacity is needed elsewhere.

**Justification:**

Estimating the exact cost requires detailed information about the application's specific requirements, such as the size of the dataset, the frequency of sorting operations, and performance expectations. However, by analyzing these parameters and selecting appropriate cloud services and pricing models, it's possible to deploy a cost-effective

solution. For instance, if the sorting operations are periodic and predictable, reserved instances might offer cost savings. Conversely, for intermittent or unpredictable workloads, on-demand or spot instances could be more economical.

In conclusion, deploying a real-time Shell Sort application on the cloud is feasible, and with careful planning and consideration of the factors mentioned above, you can estimate and manage the associated costs effectively.

**UNIT - 5****CLOUD SERVICE GOVERNANCE & VALUE**

IT Governance Definition - Cloud Governance Definition - Cloud Governance Framework - Cloud Governance Structure - Cloud Governance Considerations – Cloud Service Model Risk Matrix - Understanding Value of Cloud Services - Measuring the value of Cloud Services - Balanced Scorecard - Total Cost of Ownership.

**PART A****1. What is the meaning of IT governance?**

- ✓ IT governance (ITG) is the process of managing and controlling key IT capability decisions to improve IT management, ensure compliance, and increase value from IT technology investments.
- ✓ IT governance centers around making sure the organization knows what impact IT decisions have on business value.

**Examples of IT Governance:**

Real-Life Example: In a financial institution, a governance board oversees IT projects to ensure they align with organizational goals and compliance standards.

**2. What are the 3 pillars of IT governance?**

- ✓ Therefore, it is important to have a robust IT governance framework that is based on three pillars: reports, compliance, and security.
- ✓ Reports are the means by which IT governance demonstrates the value and performance of IT to the organization and its stakeholders.

**3. What is the role of IT in governance?**

- ✓ ICT promotes transparency in governance by facilitating public access to government operations and data.
- ✓ Government websites, open data initiatives, and online portals provide channels for citizens to retrieve official documents, including reports and budgets.

**4. What are the risks of IT governance?**

- ✓ Implementing IT governance without considering risk factors exposes the company to various potential risks, including: Vulnerability of the computer system. Constraints arising from a lack of system availability. Customer rejection due to issues and failures.

**5. What are the three major types of IT risks?**

- ✓ These are applied to three dimensions, i.e., fundamental categories of information security risk: Security Governance, Vulnerability Management, and Threat Exposure.

**6. Define Cloud governance.**

- ✓ Cloud governance is a set of rules and policies adopted by companies that run services in the cloud. The goal of cloud governance is to enhance data security, manage risk, and enable the smooth operation of cloud systems.

**7. What are the key pillars of cloud governance model?**

- ✓ The three main components of a cloud governance policy are financial management, automation and orchestration, and continuous compliance.
- ✓ Financial management aligns with multiple principles of cloud governance and helps your business manage costs.

**8. What is the need in cloud governance?**

- Security and privacy risks
- Vendor lock-in
- Cloud Sprawl
- Shadow IT and unwarranted usage of cloud resources
- Lack of data portability and interoperability

**9. What are the principles of cloud governance?**

- financial management
- operations management
- security and compliance management
- data management
- performance management
- asset and configuration management

**10. What are the Challenges of cloud governance?**

- Performance Management
- Governance/Control
- Cost Management
- Security Issues.

**11. Differentiate between the IT Governance and Cloud Governance.**

IT Governance	Cloud Governance
IT encompasses the overall management and decision making processes related to all aspects of information technology within an organization.	IT specifically focuses on the policies, processes, and controls related to the adoption, management, and utilization of cloud computing services within an organization.
It addresses a broad spectrum of technology related activities.	It is centered on managing cloud services, providers, and resources.
It covers a range of technologies, both on premises and cloud-based, and focuses on their holistic management and alignment with business objectives.	It is limited to the management of cloud services and resources provided by third-party cloud service providers.

**12. Define cloud governance framework.**

- ✓ It is a structured set of guidelines, processes, policies, and practices that
- ✓ organizations implement to ensure effective and secure management of their cloud
- ✓ Computing resources and services.

**13. What is the Role of a cloud governance framework?**

- ✓ It ensures the effective and secure.
- ✓ Management of cloud computing resources and services within an organization.

**14. Write the Requirements for effective cloud governance.**

- Compliance
- Security
- Cost Optimization
- Resource Management
- Vendor Management
- Data Governance

**15. What are the Steps involved for Developing and implementing a cloud governance framework?**

- ✓ Assessment
- ✓ Strategy Formulation
- ✓ Policy Development
- ✓ Role Definition
- ✓ Process Establishment
- ✓ Monitoring and Improvement
- ✓ Education and Training

**16. Write the advantages of cloud governance framework.**

- Risk Mitigation
- Cost Savings
- Alignment
- Compliance

**17. Define cloud governance structure.**

- ✓ It refers to a structured framework of policies, processes, roles, and responsibilities that guide the planning, implementation, operation, and management of cloud services within an organization.

**18. What are the five main domains of cloud infrastructure security?**

- ✓ Identity and Access Management
- ✓ Securing Data in the Cloud
- ✓ Securing the Operating System
- ✓ Protecting the Network Layer
- ✓ Managing Security Monitoring, Alerting, Audit Trail, and Incident Response

**19. What is the Role of a cloud governance framework?**

- ✓ It establishes a structured and standardized approach to managing cloud resources, services, and data while minimizing risks and maximizing the benefits of cloud technology.
  - Aligning cloud adoption with business goals and strategies
  - Ensuring data security, privacy, and compliance with regulations
  - Optimizing cloud costs and resource utilization
  - Managing risks associated with cloud technology

**20. Write the Format procedure of Cloud Governance Structure.**

- Governance Policies
- Roles and Responsibilities Matrix
- Cloud Resource Allocation Guidelines
- Security and Compliance Guidelines
- Cloud Performance Metrics and Monitoring Processes

**21. What are the advantages of Cloud Governance Structure?**

- Risk Mitigation
- Cost Savings
- Alignment
- Compliance

**22. What is cloud governance consideration?**

- ✓ It refers to the set of important factors, principles, and practices that organizations must take into account when designing and implementing a governance framework for managing their cloud services.

**23. What are the governance factors to consider when using cloud computing? The**

**Cloud Governance policy must include the following:**

- ✓ Standards for the design of infrastructure
- ✓ Monitoring of infrastructure and application
- ✓ Security Policy
- ✓ Programming standards
- ✓ Backup recovery services

**24. What are the benefits of cloud governance consideration?**

- Aligning cloud adoption with business goals and strategies
- Ensuring data security, privacy, and compliance with regulations
- Optimizing cloud costs and resource utilization
- Managing risks associated with cloud technology
- Establishing clear roles and responsibilities for cloud management.

**25. Define cloud service model Risk Matrix.**

- ✓ It is a tool used to assess and prioritize risks associated with different cloud service models (IaaS, SaaS, PaaS).

**26. What is the purpose of cloud service model Risk Matrix?**

- ✓ It helps the organizations understand and manage the unique risks inherent in each service model and assists in making informed decisions about cloud adoption and risk mitigation strategies.

**27. Why to Need for Risk Matrix?**

- ✓ Balanced approach to cloud adoption
- ✓ Effectively allocate resources for risk mitigation
- ✓ Align cloud strategies with business goals



**28. Write the formula for risk matrix.****Formula:**

- ✓ The calculation of composite matrix is calculated by, Risk

$$\text{Score} = \text{Severity Level} \times \text{Likelihood Level}$$

**29. What is the purpose of understanding value of cloud service?**

- ✓ A value curve can analyze and compare the unique benefits and advantages of different cloud service providers (or) It is used to measure.
- ✓ Cloud service management to ensure that organizations are achieving their intended goals, optimizing resources, and making informed decisions.
- ✓ It helps the organizations to demonstrate the tangible benefits of cloud services, optimize resource usage, and make informed decisions about cloud strategies.

**30. Write the Attributes for evaluation of cloud service providers.**

- Performance
- Scalability
- Reliability
- Security
- Cost
- Ease of use

**31. What is Aspects in the impact of cloud computing in IT operations and business Strategies?**

- ✓ **Strategic Decision-Making** - A clear grasp of the value of cloud services enables informed decision-making about whether and how to adopt cloud solutions in alignment with business goals.
- ✓ **Resource Optimization** - Understanding the benefits of cloud services helps optimize resource allocation, leading to cost-efficient and agile IT operations.

**32. Define Competitive Edge.****Competitive Edge:**

- ✓ Organizations that comprehend the value of cloud services can leverage them to gain a competitive edge through improved efficiency, scalability, and faster time-to-market.

**33. Define measuring the value of cloud services. How the value of cloud services measured?**  
**NOV/DEC 2024**

- ✓ It is used to measure cloud service management to ensure that organizations are achieving their intended goals, optimizing resources, and making informed decisions.
- ✓ It helps the organizations to demonstrate the tangible benefits of cloud services, optimize resource usage, and make informed decisions about cloud strategies.

**34. Write the performance of measuring cloud service.**

- Scalability
- Reliability
- Security
- Cost
- Ease of use
- Support
- Latency

**35. Write the condition of measuring cloud service.**

- Accurate Data
- Timeframe
- Resource Variability
- Business Context
- Scope

Commented [s1]:

**36. Define Total Cost of Ownership (TCO).**

- ✓ It compares the total costs of using cloud services with the costs of traditional on-premises solutions. It includes direct costs.

**Example:**

- ✓ subscription fees, hardware, personnel

**37. Define Return on Investment (ROI).**

- ✓ It calculates the return gained from cloud investments compared to the costs incurred.
- ✓ It considers both the financial benefits (revenue growth, cost savings) and the costs of adopting and maintaining cloud services.
- ✓ ROI is often expressed as a percentage of the initial investment.

**38.What is the concept of balanced scorecard?**

- ✓ It is a strategic management system maps an organization's strategy into clear objectives, measures, targets, and initiatives.

**39.Define balanced scorecard.**

- ✓ It provides a structured approach to measuring cloud value by considering a balanced set of metrics that encompass various aspects of the organization's performance and strategic goals.

**40.Write the Characteristics of Balanced Scoreboard.**

- Balanced Approach
- Alignment
- Cause-and-Effect Relationship
- Measurement Variety
- Long-Term Focus

**41.Define total cost ownership.**

- ✓ It refers to calculating all the direct and indirect costs of implementing, operating and maintaining a cloud environment (or) the complete estimation of all direct and indirect costs associated with adopting, implementing, and managing cloud services over their entire lifecycle.

**42.Write the Parameters of total cost ownership.**

- ✓ Time Horizon -The period over which the TCO is calculated.
- ✓ Discount Rate - The rate used to adjust future costs to their present value.
- ✓ Growth Rate - If applicable, the projected growth of cloud usage.

**43.What is the formula of total cost ownership?****Formula:**

- ✓  $TCO = \text{Initial Costs} + \text{Ongoing Costs} + \text{Maintenance Costs} + \text{Downtime Costs} + \text{Upgrade Costs} + \text{Expansion Costs}.$

**44.Write some examples of Total Cost Ownership.****Example:**

Consider a small business looking to migrate its IT infrastructure to the cloud.

**The TCO analysis involves**

- Calculating the costs associated with initial setup
- Monthly subscription fees
- IT staff salaries
- Data transfer Cost
- Potential downtime

**45. Write the advantages of total cost ownership.**

**Advantages:**

- It helps the organization to take better informed decisions
- It helps for accurate budget planning
- It helps to reduce the potential hidden costs (Risk assessment)
- It provides better communication and alignment with vendor selection

**46. Differentiate between cloud governance and cloud management. APRIL/MAY 2024**

- **Cloud Governance:**

A policy stating that all sensitive data must be encrypted when stored in the cloud.

- **Cloud Management:**

Implementing encryption protocols on specific cloud storage buckets to comply with the data encryption policy.

**47. What do you mean by cloud service model risk matrix? APRIL/MAY 2024, Nov/Dec 24**

A **Cloud Service Model Risk Matrix** is a tool used to assess and visualize the risks associated with different cloud service models (e.g., IaaS, PaaS, SaaS). It helps organizations evaluate the level of risk across various factors, such as **security**, **compliance**, **control**, and **responsibility**, depending on the specific cloud model they are using.

- **Risk Assessment**
- **Responsibility Mapping**

**1. Explain in detail about IT Governance Definition.**

**IT GOVERNANCE DEFINITION**

- ❖ **Definition:** It refers to the framework of processes, policies, procedures, and structures that guide and oversee the strategic planning, management, and use of information technology (IT) resources within an organization.
- ❖ **Structured Approach:** It provides a structured approach for organizations to make well-informed decisions, manage risks, and maximize the value derived from their IT resources.
- ❖ IT governance is essential for organizations to ensure that their IT activities are aligned with business goals, well-managed, and compliant.
- ❖ **Objectives:** To ensure that IT activities,
  - 1) Aligned with the organization's business goals
  - 2) Risks are managed effectively
  - 3) IT investments deliver value
  - 4) Support overall business success
- ❖ **Critical Challenges:**
  - a. Alignment with business goals
  - b. Risk management.
  - c. Resource optimization.
  - d. Regulatory compliance - strict regulations and compliance requirements related to data privacy, security, and reporting.
  - e. Decision- making – need a structured framework for making informed and strategic decisions about technology investments, projects, and operations.
  - f. Transparency - trust among stakeholders by providing visibility into IT activities and decisions.
- ❖ **Requirements for Effective It Governance:**
  1. Clear Business Strategy
  2. Leadership support
  3. Cross-functional support (informed decisions – team supports)
  4. Risk management awareness
  5. Defined roles and responsibilities
- ❖ **Key Components of IT Governance:** (Measure the effectiveness of IT Governance)
  1. Strategic Alignment - IT initiatives and investments are closely aligned with the organization's business strategy and objective (clear understanding of how technology contributes to achieving business goals).
  2. Decision Making – It establishes the clear lines of authority for approving IT projects, resource allocation, and technology adoption.
  3. Risk Management - Identifying and managing IT-related risks [cyber security threats, data breaches, operational disruptions, and compliance issues].
  4. Resource management – Effectively manages the IT resources [hardware, software, human capital and financial investments (including resource optimization)].

5. Performance Measurement - Establishing metrics and key performance indicators (KPIs) to evaluate the effectiveness of IT initiatives and to monitor the performance of IT systems and services.
6. Compliance - Ensuring that IT activities adhere to relevant laws, regulations, industry standards, and internal policies. Compliance is crucial for maintaining trust, security, and ethical conduct.
7. Communication and Collaboration - Facilitating effective communication and collaboration between IT teams, business units, and stakeholders. It ensures that IT decisions are well-informed and that technology initiatives address the needs of the organization.
8. Accountability - Defining roles and responsibilities for IT governance, ensuring that individuals and teams are accountable for their actions and decisions related to IT.
9. Transparency - Providing clear and understandable information about IT projects, strategies, and outcomes to stakeholders, fostering trust and effective decision-making.
10. Continuous Improvement - Regularly evaluating and improving IT governance practices to adapt to changing technologies, business needs, and industry trends. This helps ensure that the organization remains agile and responsive.
11. Ethics and Culture - Promoting a culture of ethical behavior, data privacy, and responsible technology use throughout the organization.
12. IT Investment Management - Making informed decisions about IT investments, including the evaluation of costs, benefits, and risks associated with adopting new technologies.
13. IT Service Delivery - Overseeing the delivery of IT services to ensure they meet the needs of the organization and its users, focusing on quality, reliability, and efficiency.

**2. Explain in detail about Cloud Governance Definition.****CLOUD GOVERNANCE DEFINITION**

- ❖ **Definition:** It refers to the set of policies, processes, and controls that organizations establish and implement to ensure that their cloud computing resources and services are effectively and efficiently managed, aligned with business goals, and compliant with relevant regulations and standards.
- ❖ **Objectives:** To ensure that cloud computing services,
  1. Aligned with the organization's business goals
  2. Risks are managed effectively
  3. Support overall business success
  4. Complies with regulation
- ❖ **Need for cloud Governance:** (importance)
  1. Cost management
  2. Security and compliance
  3. Resource management
  4. Vendor Management
  5. Data Management
  6. Performance and availability
- ❖ **Requirements for Cloud Governance:**
  1. Cloud Strategy
  2. Cloud expertise
  3. Clear roles and responsibilities
  4. Leadership buy-in - Support from senior leadership is essential for allocating resources and driving cultural change
  5. Risk Assessment
- ❖ **Key Components of cloud Governance:** (Measure the effectiveness)
  1. Strategic Alignment - It aligned with the cloud strategy and objective (clear understanding of how technology contribute to achieving business goals).
  2. Security and Governance - It measures the guarantee that data and applications are secured and that regulatory requirements are met.
  3. Resource Optimization - Governance practices should lead to optimal cloud resource utilization and cost-effectiveness.
  4. Vendor Management - Effective governance facilitates the selection, negotiation, and ongoing management of cloud service providers.
  5. Data Management - Cloud governance ensures proper data handling, storage, and privacy measures.
  6. Performance and Availability - Governance should result in consistent performance and availability of cloud services.
  7. Change Management - Governance should accommodate changes in cloud technology, services, and organizational needs.
  8. Risk Management - Governance strategies should identify and mitigate risks associated with cloud adoption. [cyber security threats, data breaches, operational disruptions, and compliance issues].

9. Monitoring and Reporting - Effective governance includes mechanisms for monitoring cloud usage, performance, and compliance, with clear reporting mechanisms.

10. Continuous Improvement - Governance practices should be adaptable and evolve with changes in technology and business requirements.

❖ **Difference between IT Governance and Cloud Governance:(Refer Table 5.1)**

S.No.	Charact- eristics	IT Governance	Cloud Governance
	Scope	IT encompasses the overall management and decision making processes related to all aspects of information technology within an organization.	IT specifically focuses on the policies, processes, and controls related to the adoption, management, and utilization of cloud computing services within an organization.
2.	Focus	It addresses a broad Spectrum of technology related Activities.	It is centered on managing cloud services, providers, and resources.
3.	Technology Environment	It covers a range of Technologies, both on premises and cloud-based, and focuses on their holistic management and alignment with business objectives.	It is limited to the Management of cloud services and resources provided by third-party cloud service providers.
4.	Challenges Addressed	It addresses challenges related to IT service delivery, legacy systems, technology planning, and risk management across various technology domains, and ensuring that IT supports the business effectively.	It addresses challenges specific to cloud computing, such as data security in shared environments, vendor lock-in, multi-cloud management, and cost control in the cloud.
5.	Decision-Making	It involves decision-making across a wide range of technology domains and focuses on ensuring alignment with business objectives.	The decisions primarily revolve around selecting appropriate cloud services, managing vendor relationships, ensuring compliance within the cloud, and optimizing cloud costs.

**Table 5.1 IT Governance and Cloud Governance Difference**



**3. Explain in detail about Cloud Governance Framework.****CLOUD GOVERNANCE FRAMEWORK****❖ Framework**

It is a structured set of guidelines, principles, practices, and tools that provide a systematic approach to solving complex problems, making decisions, or achieving specific goals within a particular context.

**❖ Definition**

It is a structured set of guidelines, processes, policies, and practices that organizations implement to ensure effective and secure management of their cloud computing resources and services

**❖ Foundation**

It offers a foundation for organizing, planning, and implementing various activities in a consistent and effective manner.

**❖ Role of a cloud governance framework**

It ensures the effective and secure management of cloud computing resources and services within an organization.

**❖ Negative impact or consequences**

If the organization fails to adopt the cloud governance framework, the organization may face negative impacts on organization's efficiency, security, vulnerability, compliance and overall success.

**❖ Systematic Approach**

It provides a systematic approach to align cloud strategies with

1. Business goals (effective informed decision making)
2. Manage risks
3. Maintain security and ensure compliance
4. Optimize costs
5. Drive overall value from cloud adoption (Realizing the full capacity of cloud technology)

**❖ Goal**

It establishes a structured and standardized approach to managing cloud resources, services, and data while minimizing risks and maximizing the benefits of cloud technology.

1. Aligning cloud adoption with business goals and strategies
2. Ensuring data security, privacy, and compliance with regulations
3. Optimizing cloud costs and resource utilization
4. Managing risks associated with cloud technology

5. Establishing clear roles and responsibilities for cloud management
6. Enabling efficient decision-making related to cloud services
7. Ensuring transparent communication and reporting on cloud activities

❖ **Requirements for effective cloud governance**

1. Compliance - Ensuring that cloud activities adhere to industry regulations, legal requirements, and organizational policies.
2. Security - Implementing robust security measures to protect data, applications, and infrastructure in the cloud.
3. Cost Optimization - Monitoring and managing cloud costs through resource optimization, budget control, and cost-effective service selection.
4. Resource Management - Efficiently managing cloud resources, including instances, storage, and networking, to prevent underutilization or overprovisioning.
5. Vendor Management - Defining processes for selecting, onboarding, and managing relationships with cloud service providers.
6. Data Governance - Establishing data ownership, access controls, data classification, and data lifecycle management in the cloud.
7. Risk Management - Identifying, assessing, and mitigating risks associated with cloud adoption, such as data breaches and service disruptions.

❖ **Steps involved for Developing and implementing a cloud governance framework:**

1. Assessment - Assess the organization's current cloud landscape, identify gaps and risks, and determine the need for a governance framework.
2. Strategy Formulation - Define the objectives, goals, and guiding principles of the cloud governance framework.
3. Policy Development - Create policies and guidelines that cover various aspects of cloud usage, including security, compliance, data management, and cost control.
4. Role Definition - Clearly define roles and responsibilities for individuals and teams involved in cloud management.
5. Process Establishment - Establish processes for cloud service provisioning, monitoring, security, incident response, and more.
6. Education and Training - Provide training and education to staff members to ensure they understand and adhere to the governance framework.
7. Implementation - Roll out the governance framework across the organization, aligning cloud activities with the established policies and processes.
8. Monitoring and Improvement - Continuously monitor cloud activities, collect feedback, and make necessary adjustments to improve the framework's effectiveness.

❖ **Advantages:** The advantages of implementing cloud governance framework are:-

1. Risk Mitigation - Minimizes security vulnerabilities and reduces the risk of data breaches and other cloud-related risks.
2. Cost Savings - Optimizes cloud costs by preventing wastage and ensuring efficient resource utilization.
3. Alignment - Aligns cloud strategies with overall business objectives, ensuring technology investments deliver value.
4. Compliance - Helps maintain compliance with regulations, industry standards, and internal policies.
5. Efficiency - Streamlines cloud management processes, leading to improved operational efficiency.
6. Transparency -Provides transparency into cloud activities, decision-making processes, and resource utilization.
7. Data Protection - Ensures data security, privacy, and proper data handling practices in the cloud.
8. Adaptability - Allows organizations to adapt to changing cloud technologies and requirements effectively.

**4. Explain in detail about Cloud Governance Structure. Explain about cloud governance structure and its importance for an organization value . APRIL/MAY 2024**

**CLOUD GOVERNANCE STRUCTURE**

**Definition**

It refers to a structured framework of policies, processes, roles, and responsibilities that guide the planning, implementation, operation, and management of cloud services within an organization

**Requirements for Cloud Governance**

1. Cloud Strategy
2. Cloud expertise
3. Clear roles and responsibilities
4. Leadership buy-in - Support from senior leadership is essential for allocating resources and driving cultural change
5. Risk Assessment

**Goal**

It establishes a structured and standardized approach to managing cloud resources, services, and data while minimizing risks and maximizing the benefits of cloud technology.

1. Aligning cloud adoption with business goals and strategies
2. Ensuring data security, privacy, and compliance with regulations
3. Optimizing cloud costs and resource utilization
4. Managing risks associated with cloud technology
6. Establishing clear roles and responsibilities for cloud management
7. Enabling efficient decision-making related to cloud services
8. Ensuring transparent communication and reporting on cloud activities

**Steps to Establish cloud governance structure**

1. Strategic Alignment - It aligned with the cloud strategy and objective (clear understanding of how technology contribute to achieving business goals).
2. Security and Governance - It measures the guarantee that data and applications are secured and that regulatory requirements are met.
3. Resource Optimization - Governance practices should lead to optimal cloud resource utilization and cost-effectiveness.
4. Vendor Management - Effective governance facilitates the selection, negotiation, and ongoing management of cloud service providers.
5. Data Management - Cloud governance ensures proper data handling, storage, and privacy measures.
6. Performance and Availability - Governance should result in consistent performance and availability of cloud services.

7. Change Management - Governance should accommodate changes in cloud technology, services, and organizational needs.
9. Risk Management - Governance strategies should identify and mitigate risks associated with cloud adoption [cyber security threats, data breaches, operational disruptions, and compliance issues].
10. Monitoring and Reporting - Effective governance includes mechanisms for monitoring cloud usage, performance, and compliance, with clear reporting mechanisms.
11. Continuous Improvement - Governance practices should be adaptable and evolve with changes in technology and business requirements.

**Format of Cloud Governance Structure:**

1. Governance Policies
2. Roles and Responsibilities Matrix
3. Cloud Resource Allocation Guidelines
4. Security and Compliance Guidelines
5. Cloud Performance Metrics and Monitoring Processes

**Advantages:** The advantages of implementing cloud governance framework

1. Risk Mitigation - Minimizes security vulnerabilities and reduces the risk of data breaches and other cloud-related risks.
2. Cost Savings - Optimizes cloud costs by preventing wastage and ensuring efficient resource utilization.
3. Alignment - Aligns cloud strategies with overall business objectives, ensuring technology investments deliver value.
4. Compliance - Helps maintain compliance with regulations, industry standards, and internal policies.
5. Efficiency - Streamlines cloud management processes, leading to improved operational efficiency.
6. Transparency - Provides transparency into cloud activities, decision-making processes, and resource utilization.
7. Data Protection - Ensures data security, privacy, and proper data handling practices in the cloud.
8. Adaptability - Allows organizations to adapt to changing cloud technologies and requirements effectively.

**Importance of Cloud Governance Structure for Organizational Value:**☐ **Enhanced Security and Risk Mitigation:**

- A well-structured cloud governance framework ensures that security best practices are followed and risks related to data breaches, unauthorized access, and non-compliance are minimized. By actively managing and controlling security, organizations can protect sensitive data and maintain customer trust.

☐ **Cost Control and Optimization:**

- Without governance, cloud resources can be underutilized or over-provisioned, leading to unnecessary costs. A cloud governance structure ensures that cloud usage is monitored and optimized, which directly impacts cost savings.

☐ **Regulatory Compliance:**

- Cloud governance ensures that the organization complies with industry-specific regulations and laws. Failure to comply can result in penalties, loss of customer trust, and reputational damage.

☐ **Operational Efficiency:**

- Clear governance policies and roles ensure that the cloud environment operates smoothly. By managing access rights, security protocols, and resource utilization, organizations can prevent operational bottlenecks and ensure that cloud services are delivering maximum value.

☐ **Flexibility and Scalability:**

- Cloud governance helps organizations take full advantage of the scalability of the cloud while preventing overuse or underuse of resources. It supports the agile deployment of new services or features.

☐ **Better Decision-Making:**

- Cloud governance provides transparency through reporting and monitoring tools. This data allows organizations to make informed decisions about cloud usage, investments, and optimization strategies.

☐ **Alignment with Business Goals:**

- The governance framework ensures that cloud adoption aligns with the organization's broader business objectives. It helps prioritize cloud initiatives that have the most value to the business, ensuring that cloud investments contribute to growth, innovation, and competitive advantage.

**5. Explain in detail about Cloud Governance Considerations****CLOUD GOVERNANCE CONSIDERATIONS****Definition**

It refers to the set of important factors, principles, and practices that organizations must take into account when designing and implementing a governance framework for managing their cloud services.

**Requirements for Cloud Governance:**

1. Cloud Strategy
2. Cloud expertise
3. Clear roles and responsibilities
4. Leadership buy-in - Support from senior leadership is essential for allocating resources and driving cultural change
5. Risk Assessment

**Goal**

It establishes a structured and standardized approach to managing cloud resources, services, and data while minimizing risks and maximizing the benefits of cloud technology.

1. Aligning cloud adoption with business goals and strategies
2. Ensuring data security, privacy, and compliance with regulations
3. Optimizing cloud costs and resource utilization
4. Managing risks associated with cloud technology
5. Establishing clear roles and responsibilities for cloud management
6. Enabling efficient decision-making related to cloud services
7. Ensuring transparent communication and reporting on cloud activities

**Steps for Cloud Governance Considerations:**

1. Strategic Alignment - It aligned with the cloud strategy and objective (clear understanding of how technology contribute to achieving business goals).
2. Security and Governance - It measures the guarantee that data and applications are secured and that regulatory requirements are met.
3. Resource Optimization - Governance practices should lead to optimal cloud resource utilization and cost-effectiveness.
4. Vendor Management - Effective governance facilitates the selection, negotiation, and ongoing management of cloud service providers.
5. Data Management - Cloud governance ensures proper data handling, storage, and privacy measures.
6. Performance and Availability - Governance should result in consistent performance and availability of cloud services.

7. Change Management - Governance should accommodate changes in cloud technology, services, and organizational needs.
  8. Risk Management - Governance strategies should identify and mitigate risks associated with cloud adoption [cyber security threats, data breaches, operational disruptions, and compliance issues].
  9. Monitoring and Reporting - Effective governance includes mechanisms for monitoring cloud usage, performance, and compliance, with clear reporting mechanisms.
  10. Continuous Improvement - Governance practices should be adaptable and evolve with changes in technology and business requirements.
- 

## **6. Explain in detail about Cloud Service Model Risk Matrix.**

### **CLOUD SERVICE MODEL RISK MATRIX**

#### **Definition**

It is a tool used to assess and prioritize risks associated with different cloud service models (IaaS, SaaS, PaaS).

#### **Purpose**

It helps the organizations understand and manage the unique risks inherent in each service model and assists in making informed decisions about cloud adoption and risk mitigation strategies.

#### **Category of Risks**

It categorizes risks based on their severity and likelihood, allowing organizations to allocate resources and prioritize risk mitigation efforts accordingly.

**Need for Risk Matrix:** Organizations must understand and manage the risks to ensure

1. Balanced approach to cloud adoption,
2. Effectively allocate resources for risk mitigation
3. Align cloud strategies with business goals.

#### **Inputs:**

1. List of cloud service models (IaaS, PaaS, SaaS).
2. Identified risks associated with each service model.
3. Assigned severity and likelihood levels for each risk and service model.

**Risk Severity Levels:** Low, Moderate, High, Critical

**Likelihood Levels:** Low, Medium, High

**Formula:** The calculation of composite matrix is calculated by, Risk

Score = Severity Level × Likelihood Level



**Example of Cloud Service Risk Matrix: (Refer Table 5.2)**

Service Model	IaaS	PaaS	SaaS
Data Security	High (Critical)	Moderate (High)	Low (Moderate)
Availability	Moderate (High)	Low (Moderate)	Low (Moderate)
Vendor Lock-in	Moderate (High)	Low (Moderate)	Low (Moderate)
Configuration	High (Critical)	Moderate (High)	Low (Moderate)
Customization	Moderate (High)	High (Critical)	Low (Moderate)
Compliance	High (Critical)	Moderate (High)	Low (Moderate)
Integration	Moderate (High)	High (Critical)	Low (Moderate)
Data Privacy	High (Critical)	Moderate (High)	Low (Moderate)
Performance	Moderate (High)	High (Critical)	Low (Moderate)
Scalability	Moderate (High)	High (Critical)	Low (Moderate)

**Table 5.2 Risk Matrix Example Steps****involved to construct the Risk Matrix:**

1. Assessment - Identify potential risks associated with each service model, considering factors like data security, availability, vendor lock-in, etc...
2. Severity and Likelihood - Assign a severity level and a likelihood level to each risk for each service model.
3. Matrix Population - Fill out the matrix with the assigned severity and likelihood levels for each risk and service model.
4. Prioritization - Based on the populated matrix, prioritize risks by focusing on those with the highest combined severity and likelihood ratings.
5. Mitigation - Develop risk mitigation strategies for each high-priority risk, considering specific actions to reduce the risk's severity or likelihood.
6. Decision-Making - Use the matrix to guide decisions about cloud service models.

**Advantages**

1. Provides a structured approach to understanding and comparing risks across different cloud service models.
2. Assists in making informed decisions about adopting specific cloud service models based on risk tolerance and business needs.
3. Facilitates resource allocation for risk mitigation efforts by identifying high priority risks.

**Limitations**

1. Subjectivity - Assessing severity and likelihood can be subjective and influenced by individual interpretation.
2. Complexity - Calculating composite risk scores might oversimplify the complexity of some risks.

3. Incomplete Picture - The matrix might not capture all possible risks, particularly if new risks emerge over time.
4. Static Nature - The matrix might not reflect changes in risk profiles as technologies evolve and cloud landscapes shift.

## **7. Explain in detail about Understanding Value of Cloud Services.**

### **UNDERSTANDING VALUE OF CLOUD SERVICES**

#### **Purpose of value estimation**

A value curve can analyze and compare the unique benefits and advantages of different cloud service providers (or) It is used to measure cloud service management to ensure that organizations are achieving their intended goals, optimizing resources, and making informed decisions.

It helps the organizations to demonstrate the tangible benefits of cloud services, optimize resource usage, and make informed decisions about cloud strategies.

#### **Need for measuring a value:**

- ✓ The rapid changes in evolving landscape of technology and business requirement form the customers.
- ✓ Organizations are increasingly adopting cloud computing to stay competitive, streamline operations, and deliver better services to their customers.

#### **Goal of Measuring the value of Cloud services:**

1. Align with business objectives
2. Assess the effectiveness of utilizing cloud resources and services (performance)
3. Optimized costs
4. Impact of cloud resources and services in business
5. Return on investment (ROI) of utilizing cloud resources and services within an organization (drives overall value – Maximized benefits)

#### **Attributes for evaluation of cloud service providers**

1. Performance
2. Scalability
3. Reliability
4. Security
5. Cost
6. Ease of use
7. Support
8. Latency

- 9. Uptime
- 10. Downtime
- 11. Throughput
- 12. Error rate

❖ **Aspects in the impact of cloud computing in IT operations and business strategies:**

1. Strategic Decision-Making - A clear grasp of the value of cloud services enables informed decision-making about whether and how to adopt cloud solutions in alignment with business goals.
2. Resource Optimization - Understanding the benefits of cloud services helps optimize resource allocation, leading to cost-efficient and agile IT operations.
3. Innovation - Cloud services can foster innovation by providing access to advanced technologies without significant upfront investment, allowing businesses to experiment and explore new avenues.
4. Competitive Edge - Organizations that comprehend the value of cloud services can leverage them to gain a competitive edge through improved efficiency, scalability, and faster time-to-market.

**8. Explain in detail about Measuring the value of Cloud Services. APRIL/MAY 2024****MEASURING THE VALUE OF CLOUD SERVICES**

- ❖ **Purpose:** It is used to measure cloud service management to ensure that organizations are achieving their intended goals, optimizing resources, and making informed decisions.
- ❖ It helps the organizations to demonstrate the tangible benefits of cloud services, optimize resource usage, and make informed decisions about cloud strategies.

- ❖ **Goal of Measuring the value of Cloud services:**

1. Align with business objectives
2. Assess the effectiveness of utilizing cloud resources and services (performance)
3. Optimized costs
4. Impact of cloud resources and services in business
5. Return on investment (ROI) of utilizing cloud resources and services within an organization (drives overall value – Maximized benefits)

- ❖ **Measuring of cloud performance:** The following parameters are used to measure the performance of cloud services.

- |                |                |
|----------------|----------------|
| 1. Performance | 7. Support     |
| 2. Scalability | 8. Latency     |
| 3. Reliability | 9. Uptime      |
| 4. Security    | 10. Downtime   |
| 5. Cost        | 11. Throughput |
| 6. Ease of use | 12. Error rate |

- ❖ **Requirements**

1. Clear Objectives - Define specific goals and outcomes that the organization expects to achieve through cloud services.
2. Data Collection - Gather accurate and relevant data about resource utilization, performance metrics, costs, and business outcomes.
3. Metrics Selection - Choose appropriate metrics that align with the organization's goals and provide meaningful insights into value creation.
4. Baseline Comparison - Establish a baseline for comparison, which can be the performance and costs before adopting cloud services.
5. Consistency - Use consistent methodologies and measurement criteria to ensure accurate comparisons over time.
6. Stakeholder Involvement - Involve stakeholders from different departments to gather diverse perspectives and requirements.

**Conditions:** the following conditions can impact the measurement of cloud service value,

1. **Accurate Data** - Reliable and up-to-date data is essential for accurate measurement. Inaccurate data can lead to misleading results.
2. **Timeframe** - Consider the time period over which value will be measured. Short term and long-term impacts can differ.
3. **Resource Variability** - Cloud resources may vary in terms of usage patterns, performance, and costs, which can affect measurement outcomes.
4. **Business Context** - The industry, organization size, and business model influence how cloud value is measured.
5. **Scope** - The scope of cloud services being measured should be clearly defined. Different services might have different impacts.

**Purpose of Measuring the value:**

1. **Decision-Making** - Provide data-driven insights to make informed decisions about resource allocation, service selection, and cloud strategies.
2. **Optimization** - Identify opportunities to optimize resource usage, reduce costs, and enhance performance.
3. **Demonstration of ROI** - Quantify the return on investment to demonstrate the value of cloud services to stakeholders and justify cloud-related expenses.
4. **Business Alignment** - Ensure that cloud services align with business goals and contribute to the organization's success.
5. **Continuous Improvement** - Identify areas for improvement and adjustments in cloud service management practices.

**Methodologies used to measure the value of cloud services**

1. **Total Cost of Ownership (TCO)** - It compares the total costs of using cloud services with the costs of traditional on-premises solutions. It includes direct costs (e.g., subscription fees, hardware, personnel) and indirect costs (e.g., maintenance, training, and downtime).
  - ✓ This analysis helps organizations understand cost savings and make informed decisions.
2. **Return on Investment (ROI)** - It calculates the return gained from cloud investments compared to the costs incurred.
  - ✓ It considers both the financial benefits (revenue growth, cost savings) and the costs of adopting and maintaining cloud services.
  - ✓ ROI is often expressed as a percentage of the initial investment.
3. **Cost-Benefit Analysis** - It weighs the monetary benefits gained from cloud services against the associated costs.

- ✓ It helps organizations assess whether the benefits outweigh the costs and whether investing in cloud services is justified.
- 4. Performance Metrics** - It assesses the impact of cloud services on factors like application response times, service availability, and user experience.
  - ✓ Monitoring tools provide data on metrics such as latency, uptime, and transaction speed to evaluate the service quality.
- 5. Key Performance Indicators (KPIs)** - It's a specific, quantifiable metrics that align with the organization's goals.
  - ✓ Cloud-related KPIs might include metrics like time-to-market for new services, cost per transaction, and application performance benchmarks.
- 6. Business Outcome Metrics** - It involves assessing how cloud services impact key business metrics such as revenue growth, customer retention, market share, and operational efficiency.
- 7. Customer Satisfaction and User Experience** - Surveys, feedback mechanisms, and user experience metrics provide insights into how cloud services impact customer satisfaction and overall user experience.
- 8. Risk Assessment and Mitigation** - Assessing risks associated with cloud services and measuring the effectiveness of risk mitigation strategies is another methodology.
  - ✓ It involves identifying potential risks, calculating their potential impact, and determining the cost of avoiding or mitigating these risks.
- 9. Time-to-Market Analysis** – It evaluates how quickly new services or features can be deployed in the cloud compared to traditional approaches. It helps assess the agility and flexibility gained from cloud adoption.
- 10. Benchmarking** - It involves comparing an organization's performance against industry standards or competitors.
  - ✓ Cloud benchmarking can help assess whether the organization is achieving similar or better outcomes with cloud services.
- 11. Surveys and Feedback** - Gathering feedback from stakeholders, users, and teams using cloud services can provide qualitative insights into their perceived value and impact.
- 12. Case Studies and Success Stories** - Reviewing case studies and success stories from similar organizations can provide qualitative evidence of the value realized from cloud services.

**13. Balanced Scorecard** - It measures value from multiple perspectives, including financial, customer, internal processes, and innovation and learning.

**Limitations:** There are some limitations to consider when measuring the values of cloud services.

1. **Complexity** - Cloud services' impacts can be multifaceted, making it challenging to capture all aspects accurately.
2. **Subjectivity** - Some value aspects, such as improved customer satisfaction, can be subjective and harder to quantify.
3. **External Factors** - External factors, such as market changes or regulatory shifts, can influence measurement outcomes.
4. **Data Availability** - Access to comprehensive and accurate data might be limited, affecting the accuracy of measurements.
5. **Time Lag** - The full impact of cloud services might take time to materialize, leading to delayed measurement results.
6. **Interdependencies** - The value of cloud services might be influenced by other organizational initiatives or external factors.

## 9. Explain in detail about Balanced Scorecard.

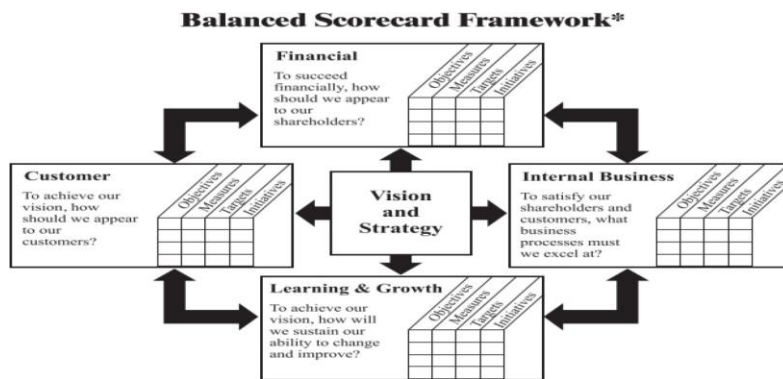
### **BALANCED SCORECARD**

- **Concept:** It is a strategic management system maps an organization's strategy into clear objectives, measures, targets, and initiatives.
- **Definition:** It provides a structured approach to measuring cloud value by considering a balanced set of metrics that encompass various aspects of the organization's performance and strategic goals.
- **Comprehensive view:** It provides a comprehensive view of how cloud services contribute to the overall business objectives **as shown in Fig 5.1.**
- **Tool:** It is a tool for monitoring the strategic decisions taken by the company based on indicators previously established
- **Translator:** It acts as a translator of strategy and a performance communicator.

### **Key Performance Indicators (KPI) (or) Four Perspectives in Balanced Scorecard Framework:**

Divide the strategic management into 4 perspectives.

1. Financial Perspective
2. Customer
3. Internal Business Processes
4. Learning and Growth



**Fig 5.1 Balanced Scoreboard Frame work**

### ➤ **Characteristics of Balanced Scoreboard:**

1. **Balanced Approach** - The framework balances financial and non-financial KPIs, providing a holistic view of performance.
2. **Alignment** -The KPIs align with the organization's strategic goals and objectives.
3. **Cause-and-Effect Relationship** - The KPIs are interconnected, showing how improvements in one area can positively impact others.



4. Measurement Variety - The framework includes both quantitative and qualitative measures.
  5. Long-Term Focus - It considers both short-term and long-term objectives for sustainable success.
  6. Continuous Improvement – It helps to tracking KPIs in multiple dimensions, it encourages continuous improvement in all areas of the organization.
  7. Adaptability - The KPIs can be adjusted based on changing business needs and goals.
- **Example1:** Balanced Scorecard to cloud value measurement in a software-as- service (SaaS) company (**Refer Table 5.3**)

KPI(s)	Goal	Calculation
<b>Financial Perspective</b>	<b>Financial Perspective</b>	(Previous IT Costs) - (Current Cloud Costs)
<b>Customer Perspective</b>	Customer Satisfaction with Service Availability	(Number of Uptime Hours) / (Total Hours) * 100
<b>Internal Process Perspective</b>	Time-to-Market for New Features	Time taken to Develop and Deploy New Feature
<b>Learning and Growth Perspective</b>	Employee Training and Skill Development	Number of Employees Who Completed Training

**Table 5.3 Balanced Scoreboard measurement**

**Example 2:** Strategic map for an E-Commerce Business(Refer Table 5.4)

	Objectives	Goals	Indicators	Initiatives
<b>Financial Perspective</b>	<i>To increase sales and reduce costs</i>	<i>15% increase in net sales and 10% decrease in operating costs</i>	<i>Financial statements</i>	<i>Negotiate with suppliers</i>
<b>Customer Perspective</b>	<i>To be a reference for a variety of products</i>	<i>Increase in launching new products every quarter by 15%</i>	<i>Number of new products launched per quarter</i>	<i>Create an innovation and development committee</i>
<b>Internal Process Perspective</b>	<i>To be able to develop new products constantly</i>	<i>Start at least five new product development projects every month</i>	<i>Project innovation reports</i>	<i>Acquire specific software for managing product development</i>
<b>Learning and Growth Perspective</b>	<i>To have extremely knowledgeable staff in product development</i>	<i>Have at least 2 professionals with masters degrees in product development</i>	<i>Number of product development professionals with masters degrees</i>	<i>Select an employee to receive masters training and hire another with a masters degree</i>

**Table 5.4 E-Commerce Business Strategic****Advantages:**

1. Comprehensive View - The Balanced Scorecard provides a holistic perspective
2. Alignment with Goals - It ensures that cloud value measurement aligns with the organization's strategic objectives and goals.
2. Multiple Metrics - By using a variety of metrics, it offers a well-rounded evaluation of cloud services' impact.
3. Cause-and-Effect Relationship - The framework establishes a cause-and-effect relationship between different performance indicators, allowing organizations to understand how improvements in one area affect others.
4. Strategic Focus - It assists in focusing on long-term goals.
5. Communication and Alignment - The Balanced Scorecard facilitates communication and understanding across different teams and stakeholders about how cloud services contribute to the overall success of the organization.

**Limitations:**

1. Complex Implementation.
  2. Subjectivity – KPIs associated weights are related to the scenario.
  3. Dynamic in nature (metrics and benchmarks may adopt to changing business conditions).
  4. Data availability is less.
- 

**10. Explain briefly about Total Cost of Ownership(TCO).****TOTAL COST OF OWNERSHIP (TCO)****➤ Definition**

It refers to calculating all the direct and indirect costs of implementing, operating and maintaining a cloud environment (or) the complete estimation of all direct and indirect costs associated with adopting, implementing, and managing cloud services over their entire lifecycle.

**➤ Direct costs:** It includes compute, storage and network resources costs.**➤ Indirect costs:** It includes personnel, training and maintenance costs.**➤ Inputs for calculation of TCO:**

1. Initial investment costs (hardware, software, migration)
2. Subscription fees for cloud services
3. Personnel cost (salaries, training, support)
4. Maintenance and support costs
5. Downtime costs
6. Upgrade and expansion costs
7. Data transfer and bandwidth costs

**Characteristics of TCO:**

1. Comprehensiveness - It accounts for all relevant cost factors, providing a holistic view of cloud expenditure.
2. Long-Term Perspective - It considers the full lifecycle of cloud services, including costs over time.
3. Data-Driven - It requires accurate data on various costs, making it more reliable for decision-making.
4. Risk Mitigation - By identifying potential hidden costs, it helps in better risk assessment.
5. Comparative Analysis - It enables comparisons between different cloud service options or between cloud and on-premises solutions.

**Other Parameters:**

1. Time Horizon -The period over which the TCO is calculated.
2. Discount Rate - The rate used to adjust future costs to their present value.
3. Growth Rate - If applicable, the projected growth of cloud usage.

**Formula:**

$$\text{TCO} = \text{Initial Costs} + \text{Ongoing Costs} + \text{Maintenance Costs} + \text{Downtime Costs} + \text{Upgrade Costs} + \text{Expansion Costs}$$

**Example:** Consider a small business looking to migrate its IT infrastructure to the cloud. The TCO analysis involves,

1. Calculating the costs associated with initial setup
2. Monthly subscription fees
3. IT staff salaries
4. Data transfer Cost
5. Potential downtime

**Advantages:**

1. It helps the organization to take better informed decisions
2. It helps for accurate budget planning
3. It helps to reduce the potential hidden costs (Risk assessment)
4. It provides better communication and alignment with vendor selection

**Limitations:**

1. Difficult to collect accurate data.
2. Dynamic Nature - Cloud costs and technology change over time, making long term TCO predictions less accurate.
3. Complexity - The calculations involve various parameters, leading to potential complexity in analysis.

**11.Elaborate the cloud Governance framework with neat Sketch and explain with an Example of banking sector. NOV/DEC 2024**

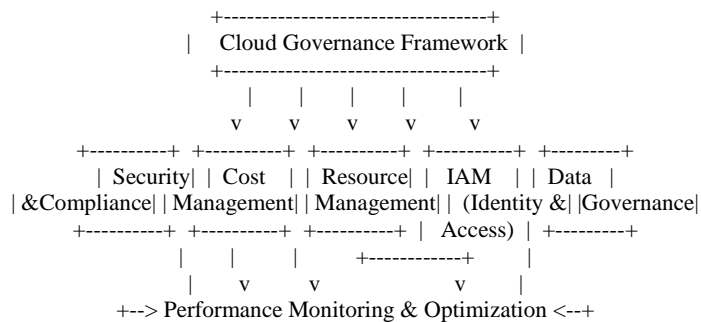
**Discuss in detail about cloud governance framework and Structure. APRIL/MAY 2024**

**Cloud Governance Framework**

A **Cloud Governance Framework** is a set of policies, controls, and guidelines designed to ensure that cloud resources and services are effectively and securely managed within an organization. It ensures compliance with regulatory standards, security protocols, and cost management, while also optimizing cloud service utilization.

The main components of the **Cloud Governance Framework** are:

1. **Security and Compliance:** Ensures that the cloud resources meet legal, regulatory, and organizational security requirements.
2. **Cost Management:** Manages cloud spending, budgeting, and forecasting to avoid overspending and optimize resource utilization.
3. **Resource Management:** Ensures efficient management of cloud resources, including computing, storage, and network components.
4. **Identity and Access Management (IAM):** Controls who has access to what resources in the cloud environment, ensuring only authorized users can access sensitive data or critical services.
5. **Performance Monitoring and Optimization:** Monitors the cloud environment to ensure optimal performance, availability, and scalability.
6. **Data Governance and Privacy:** Manages how data is stored, accessed, and protected in the cloud, ensuring compliance with privacy laws (e.g., GDPR).

**Cloud Governance Framework Sketch:****Explanation of Cloud Governance Components with Banking Sector Example:****1. Security and Compliance:**

- **Objective:** To ensure that the bank's cloud services comply with regulations like **GDPR**, **PCI DSS** (Payment Card Industry Data Security Standard), and other financial regulations.
- **Example in Banking:** The bank may use **encryption** for sensitive data, implement **multi-factor authentication** (MFA) for customer access to online banking, and ensure **auditing and logging** are in place to track any access to financial data. Cloud providers will also be required to meet specific certifications (e.g., ISO 27001) to ensure security standards are maintained.

**2. Cost Management:**

- **Objective:** To keep track of cloud expenses and ensure optimal use of resources without overspending.
- **Example in Banking:** The bank could use cloud services for data storage, transaction processing, and analytics. By leveraging cloud cost management tools, they can track and allocate costs based on departments (e.g., retail banking vs. corporate banking) and optimize for cost-efficiency, adjusting resource usage during peak periods like the holiday season, where transaction volumes are higher.

**3. Resource Management:**

- **Objective:** To manage and optimize the allocation of cloud resources such as compute power, storage, and network resources.
- **Example in Banking:** A bank may allocate specific cloud resources for high-transaction services (like online payments or real-time fraud detection), ensuring resources are scaled according to

demand. Cloud automation can be used to scale resources dynamically based on peak usage, such as scaling down resources after business hours.

#### 4. Identity and Access Management (IAM):

- **Objective:** To manage who has access to cloud resources and ensure only authorized individuals can access sensitive data or systems.
- **Example in Banking: Role-based access control (RBAC)** could be implemented in the cloud to grant different levels of access to employees (e.g., branch managers, customer service agents, executives). For example, an executive might have access to financial reports, while a teller at a branch only has access to customer account data for transactions. This ensures security and prevents unauthorized access to critical banking systems.

#### 5. Performance Monitoring and Optimization:

- **Objective:** To ensure that cloud systems perform efficiently, provide high availability, and can scale up or down based on demand.
- **Example in Banking:** A banking application must be highly available, especially during critical times like financial market opening hours. By using **cloud monitoring tools**, the bank can continuously monitor system performance and respond to issues proactively, ensuring that services like online banking or mobile apps are available 24/7. Cloud optimization tools can automatically scale resources during times of heavy traffic, such as when a customer launches an online loan application process.

#### 6. Data Governance and Privacy:

- **Objective:** To ensure that data is stored and processed in compliance with privacy laws and industry standards.
- **Example in Banking:** Banks handle sensitive financial data and need to comply with laws like **GDPR** in Europe. For example, customers' personal and financial data needs to be encrypted, and the bank must ensure that data is stored in regions that comply with jurisdictional data storage regulations. Data retention policies should also be in place to delete data after a certain period, in compliance with regulatory requirements.

### 12. Illustrate the parameters of Balanced Scorecard and measuring the value of Cloud services. NOV/DEC 2024

#### Balanced Scorecard (BSC) and Measuring the Value of Cloud Services

The **Balanced Scorecard (BSC)** is a strategic management tool used to measure and track the performance of an organization across multiple perspectives, ensuring a balanced view of its operations. It was developed by **Robert Kaplan** and **David Norton** and includes four key parameters (perspectives):

1. **Financial Perspective:** Focuses on measuring the financial performance of the organization, including profitability, revenue growth, and cost management.
2. **Customer Perspective:** Examines customer satisfaction and how the company's offerings align with customer needs.

3. **Internal Processes Perspective:** Measures the efficiency and effectiveness of internal business processes.
4. **Learning and Growth Perspective:** Focuses on employee training, development, and organizational growth, emphasizing innovation and continuous improvement.

### Applying the Balanced Scorecard to Measure the Value of Cloud Services

When evaluating the value of cloud services using the Balanced Scorecard, organizations need to adapt each of the four perspectives to measure how cloud computing contributes to achieving their overall goals. Here's how each parameter can be applied:

#### 1. Financial Perspective

The financial perspective evaluates how cloud services impact the bottom line. This includes cost savings, ROI (Return on Investment), and revenue generation due to cloud adoption.

- **Metrics to Measure:**
  - **Cost Reduction:** Savings from reduced infrastructure, hardware, and maintenance costs by migrating to the cloud.
  - **ROI:** Calculation of the return on investment from cloud adoption (e.g., comparing initial setup costs with the long-term cost savings).
  - **Total Cost of Ownership (TCO):** Comparing the TCO of traditional IT infrastructure versus cloud infrastructure.
  - **Revenue Growth:** Increased revenue from more agile business operations or new services enabled by the cloud.

**Example:** A bank migrates its core banking systems to the cloud, leading to reduced server maintenance costs and the ability to scale quickly during peak periods (e.g., holiday season). This could reduce costs by 30% and allow for more efficient operations, thus contributing to financial growth.

#### 2. Customer Perspective

The customer perspective focuses on how cloud services improve customer satisfaction, engagement, and overall experience.

- **Metrics to Measure:**
  - **Customer Satisfaction (CSAT):** How cloud-based services (e.g., online banking, mobile apps) enhance user experience and meet customer expectations.
  - **Customer Retention:** Impact of cloud capabilities on retaining customers, such as faster response times or more personalized services.
  - **Service Availability:** Ensuring high uptime and availability of cloud-based services.
  - **Customer Engagement:** Increased usage and interaction with services enabled by the cloud, such as mobile banking or online account management.

**Example:** A cloud-based mobile banking app increases customer satisfaction by providing a seamless, fast, and always-available service, leading to higher retention rates among customers.

### 3. Internal Processes Perspective

This perspective evaluates the impact of cloud services on internal processes, operations, and productivity.

- **Metrics to Measure:**
  - **Operational Efficiency:** How cloud-based tools improve the efficiency of internal operations, such as faster data processing, simplified workflows, or reduced manual interventions.
  - **Process Innovation:** The ability of cloud solutions to support innovation by providing flexibility and the tools for process automation (e.g., AI and machine learning).
  - **Time-to-Market:** Faster delivery of new products or services by leveraging cloud infrastructure, reducing development cycles.
  - **Business Continuity:** Improved disaster recovery, business continuity, and backup processes in the cloud.

**Example:** A financial institution uses a cloud-based data analytics platform to process transactions more quickly, allowing them to identify fraud in real time. This improves operational efficiency and ensures customer trust in the system.

### 4. Learning and Growth Perspective

This perspective focuses on the long-term capability of the organization to adapt, innovate, and grow through the use of cloud technologies.

- **Metrics to Measure:**
  - **Employee Training:** The degree to which employees are trained to work with new cloud technologies and tools.
  - **Innovation and Product Development:** How cloud services foster innovation and enable the rapid creation of new products or services (e.g., launching new customer-facing apps).
  - **Collaboration:** Improvement in teamwork and collaboration due to cloud-based collaboration tools (e.g., shared document storage, video conferencing).
  - **Employee Engagement:** The effect of cloud adoption on employee morale and productivity.

**Example:** A bank implements cloud-based collaboration tools (e.g., Microsoft 365 or Slack) that improve internal communication and teamwork among employees across different branches. This results in quicker decision-making, better customer service, and enhanced employee satisfaction.

#### Measuring the Value of Cloud Services with the Balanced Scorecard:

To evaluate the full value of cloud services using the **Balanced Scorecard**, you would typically track specific **Key Performance Indicators (KPIs)** under each perspective.

#### **Example of KPIs for Each Perspective:**

- **Financial Perspective:**
  - ROI from cloud adoption.
  - Percentage reduction in IT infrastructure costs.
  - TCO comparison between traditional IT vs. cloud.



- **Customer Perspective:**
  - Customer satisfaction score (CSAT).
  - Average service downtime or availability.
  - Customer retention rate after adopting cloud-based solutions.
- **Internal Processes Perspective:**
  - Average time for deploying new applications or features.
  - Efficiency improvements in internal workflows.
  - Percentage of business processes automated via cloud solutions.
- **Learning and Growth Perspective:**
  - Number of employees trained on cloud technologies.
  - Number of new services/products developed using cloud.
  - Employee engagement or satisfaction with cloud tools.

### 13. Write in detail about measuring the value of cloud services with an example. APRIL/MAY 2024

#### Measuring the Value of Cloud Services

Measuring the value of cloud services is crucial for understanding how well the adoption of cloud technologies is contributing to an organization's business goals. The **value** of cloud services isn't just about cost savings but also about the strategic benefits such as scalability, flexibility, innovation, and enhanced performance. There are several key factors and metrics organizations can use to measure this value.

Here's a detailed breakdown of how to measure the value of cloud services:

#### 1. Financial Metrics

These metrics help assess the direct economic impact of adopting cloud services.

- **Total Cost of Ownership (TCO):** TCO compares the total costs of owning and maintaining traditional IT infrastructure versus the cloud. Cloud services often reduce upfront capital expenses and shift them to operational expenses (OPEX).
- **Return on Investment (ROI):** ROI measures the financial return relative to the cost of adopting cloud services.
- **Cost Reduction:** Cloud services often help reduce costs in areas such as hardware, software licensing, maintenance, and operational overhead.
- **Cost per Transaction/Service:** For transaction-based cloud services (like cloud hosting for e-commerce platforms), measuring the cost per transaction or per user access helps in understanding efficiency.

#### 2. Performance and Scalability Metrics

These focus on how cloud services improve the operational capacity and performance of a business.

- **Uptime and Availability:** One of the primary reasons businesses migrate to the cloud is for improved service availability and uptime. Cloud service providers often guarantee higher uptime percentages than on-premise infrastructure.

- **Scalability:** Cloud services enable businesses to scale resources up or down based on demand. Measuring how quickly and easily you can scale is a key metric for value.
- **Latency:** For businesses that depend on real-time data processing (e.g., financial transactions or online gaming), cloud services with low latency are essential. Lower latency translates into better user experience and operational efficiency.

### **3. Customer Satisfaction and Experience**

The cloud can significantly improve customer experience through better service delivery, responsiveness, and innovation.

- **Customer Retention:** Cloud-based solutions can enhance services like customer support, mobile apps, and online portals. Measuring customer retention rates after implementing cloud services can demonstrate the service's value.
- **Customer Engagement:** Cloud tools often provide enhanced customer engagement through personalized experiences, AI-driven recommendations, and real-time services.

### **4. Operational Efficiency and Innovation**

Cloud services often result in more efficient operations and the ability to innovate faster.

- **Time to Market:** Cloud computing enables faster development cycles, which helps organizations bring new products and services to market quicker. Measuring the reduction in time to launch a product can highlight the value of cloud services.
- **Automation:** Cloud services often include automation tools for managing resources, deployments, and processes, which reduces manual intervention and improves productivity.
- **Innovation and New Capabilities:** Cloud computing enables companies to access advanced technologies like AI, machine learning, big data analytics, and block chain. Measuring the creation of new services or capabilities can indicate the value added by the cloud.

### **5. Security and Compliance**

These metrics focus on how cloud services contribute to enhancing security and meeting compliance standards.

- **Security Incidents:** By monitoring the number of security incidents (e.g., breaches, attacks, etc.) before and after cloud adoption, organizations can evaluate how cloud services improve security.
- **Compliance and Regulatory Adherence:** Cloud service providers often adhere to industry-specific regulations (e.g., GDPR, HIPAA, PCI-DSS). Tracking how well cloud adoption helps an organization meet regulatory requirements adds value.

### **Example of Measuring the Value of Cloud Services: A Retail Business**

**Scenario:** A retail company decides to migrate its e-commerce platform to the cloud to improve performance, scale, and customer experience.

- **Financial Metrics:** By using the cloud, the company reduces server maintenance and hardware costs, saving 25% annually on infrastructure.
- **Performance Metrics:** The cloud platform's auto-scaling feature helps the website handle 50% more traffic during the holiday season without downtime.
- **Customer Metrics:** The cloud-based e-commerce platform delivers faster load times, resulting in improved customer satisfaction and a 10% increase in sales during peak periods.
- **Operational Efficiency:** The company's inventory management system, now cloud-based, is able to update stock levels in real-time, reducing errors by 15%.
- **Security:** The cloud provider offers enhanced DDoS protection and regular security patches, reducing the risk of cyber attacks by 40%.

In this case, the company sees not just direct financial savings but also improved customer satisfaction, increased scalability, and a competitive edge through innovation—all of which contribute to the overall value of adopting cloud services.