PIE Tech

POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Approved by **AICTE** and Affiliated to **Anna University**)

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Department of Computer Science and Engineering

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III Year – VI Semester

CCS336- Cloud Service Management

UNIT -1

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

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

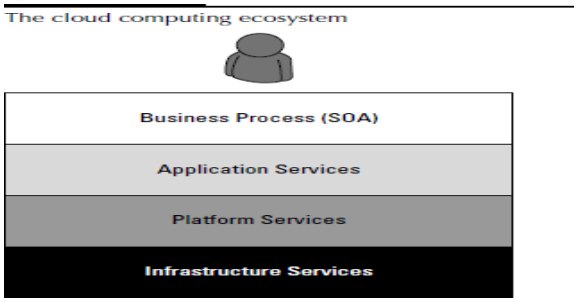
1. Characteristics
2. Service Models
3. Deployment Models

CLOUD COMPUTING ECO SYSTEM

- 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

- **Diagrammatic Representation**:



- **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.

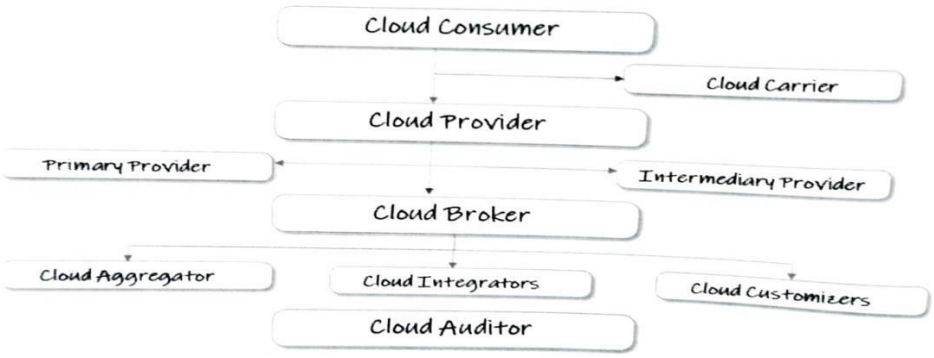
- **Functionalities**: CIO must arrange

    a. On-boarding
    b. Managing
    c. Delivering IT and business services

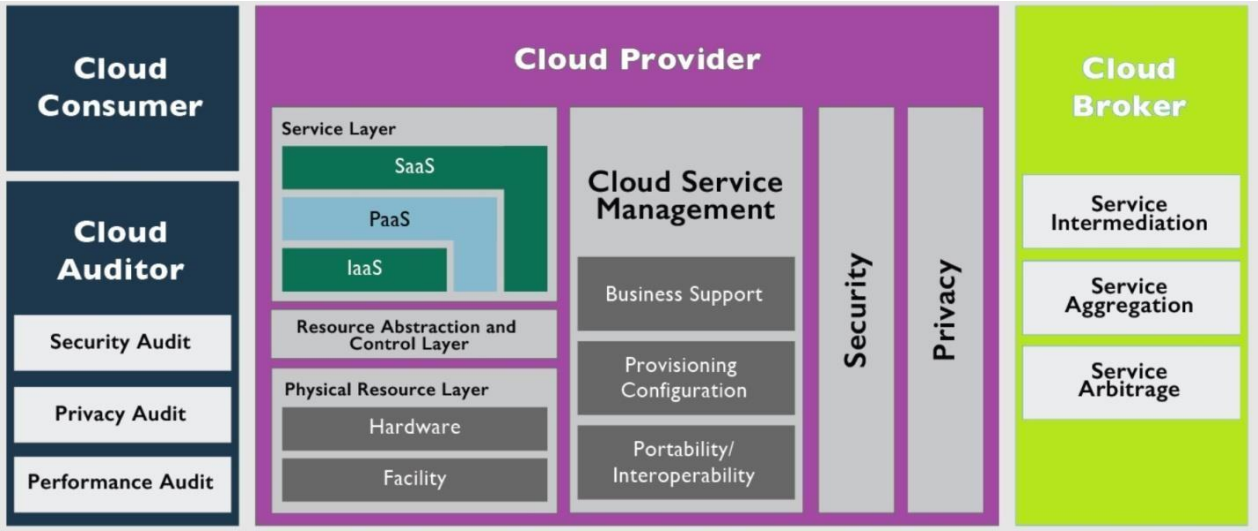
Performance Parameters:

a. Consistent Performance
b. Security
c. Control

- **Different Roles within the Cloud Eco System:**



❖ **Cloud Reference Architecture:** With respect to cloud eco-system



❖ **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**:
    a. Browse the list of services (catalogue of available resources) offered by cloud service providers or cloud broker's
    b. Request the desired services
    c. 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**:
    a. Acquire and maintain necessary computing infrastructure
    b. Supports various services (run different software applications) –SaaS and PaaS
    c. 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:**
  i. **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…
  ii. **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.

❖ **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 Legal 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.

❖ **Cloud 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:**
  - Aggregation
  - Arbitrage
  - 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:**
    a. Security
    b. Privacy
    c. Performance
- Compliance with g*uidelines can be confirmed by audits by examining observable evidence*. (verify the compliance with the standard)

Essential Characteristics (unique features)

❖ **Core attributes** (5 Attributes)

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

a. On-demand:

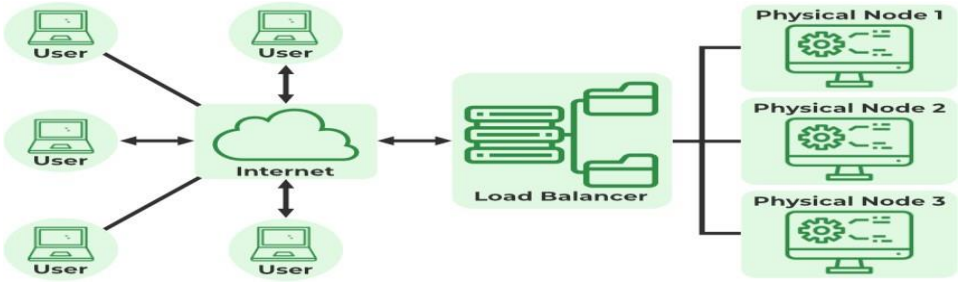
- It is an *important and valuable features* of cloud computing.
- It is enterprise-level delivery model that *allows users to easily provision and* deprovision cloud resources when needed or "on-demand.
- **Self-service mode**: Consume storage and server time as required without intervening with the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

b. 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)

c. 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.
- **Resource Pooling**: Serving the several consumers with a shared set of material assets. (service to the consumers simultaneously)
- **Data security** should not compromised while sharing the resources (multi-tenancy -> 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 efficient resource usage.



d. 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:**
    a. High availability and reliability
    b. Growth supporting
    c. Automation capability
    d. Cost effective
- **Disadvantages:**
    a. Learning Curve (learning new programming tools)
    b. Security (authentication, incident response, root cause analysis)
    c. Cloud lock-in (vendors lock the resources into the service)

e. 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**:
    a. Increase in revenue margin
    b. Improve quality of user experience
    c. Improve elastic scaling cost
    d. Improve level of automation
    e. Improve transaction latency and throughput
    f. Increase open source adoption

BASICS OF INFORMATION TECHNOLOGY SERVICE MANAGEMENT AND CLOUD SERVICE MANAGEMENT

Information Technology Service Management (ITSM)

- **Service management**: It includes the operational aspects of the applications and services.
- **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
- **Different Services**: It includes all the processes and activities to design, create, deliver, and support IT services.
- **Practices involved in entire life cycle**:
  a. Designing b. Developing c. Managing d. Optimizing
- **IT services incorporates**
  a. Best Practices b. Technology c. People d. Processes
- **Requirements needed for ISTM software and Tools:**
  a. Easy to use and setup
  b. Enable collaboration (Provides a platform for developers and cross-functional teams to work together for faster issue resolution.)
  c. Adapts to your needs
- **Situation Enables ITSM:** Need streamlining to maximize the business value
  a. Service Management
  b. Asset Management
  c. Service Lifecycle
  d. Incident Management
  e. Change Management
  f. Problem Management
  g. Service Level Management - Defining and maintaining service level agreements (SLAs) to ensure service quality.

- **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

- 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

SERVICE PERSPECTIVES

❖ **Common Perspective related to cloud services**:

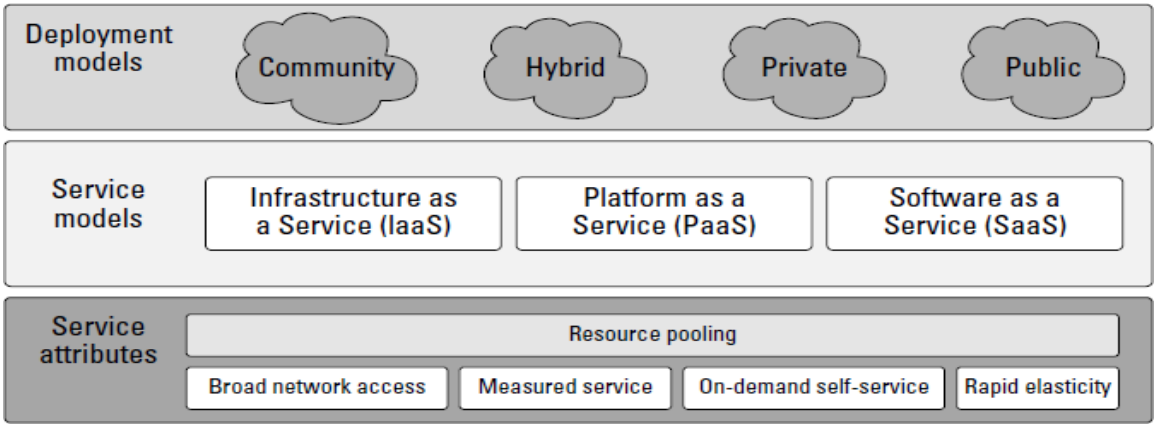
1. **Business perspective**
   - Cloud services offer cost-effective solutions by eliminating the need for physical infrastructure and maintenance.
   - Scale resources as needed, enhance flexibility, and focus on core business activities.
2. **Technical Perspective**
   - Cloud services involve virtualization, 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

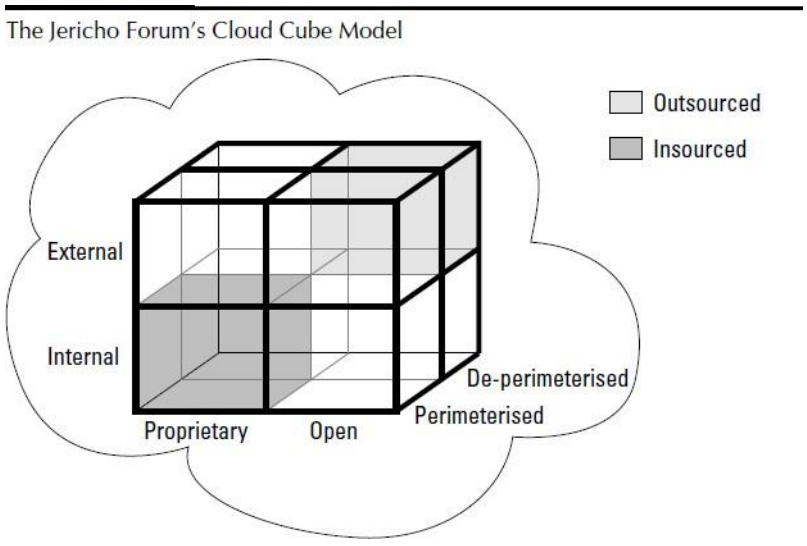
Cloud Types

- **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)
  - 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
  - *NIST cloud Computing Architecture*

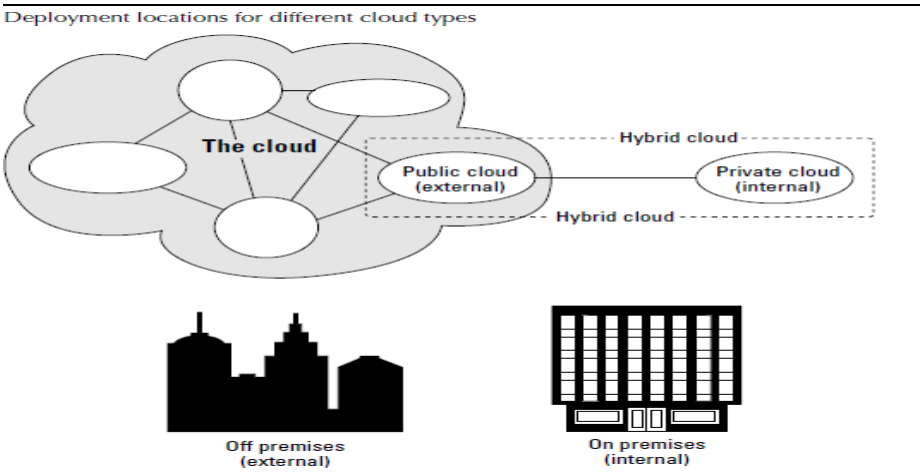


❖ **Cloud Cube Model:**

- **Goal**: Protection of cloud networks
- **Four Dimension**:
  1. Physical location of the data (Internal – I, External € 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 (deliver of the service)
- *Two Different States*:
  1. Per (IP, IO, EP, EO)
  2. D-P (IP, IO, EP, EO)
- *Diagrammatic Representation:*



❖ Deployment Models:



- ***Four Models based on NIST Definition*:**

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

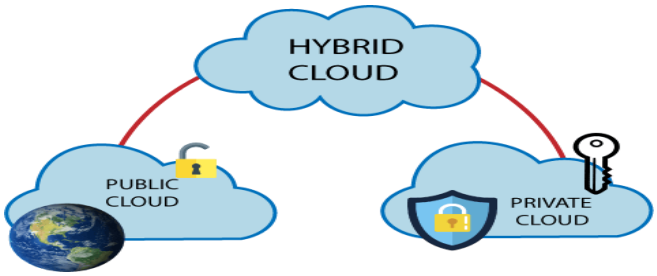
2. **Private Cloud** (Internal Cloud or Corporate Cloud)
   - Operated for exclusive use of an organization
   - Managed by the organization or third party
   - **Services offered**: *Specific services and hardware* as per the need of the enterprise are available in a private cloud.
   - **Responsibility**: 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 data centers 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:**
    a. Virtualization
    b. Management software
    c. Automation
- **Expensive**: It is more expensive to purchase than public cloud

- **Types of Private Cloud:**
    a. Virtual private cloud (stored in public cloud but the resources are private)
    b. Hosted (servers are not shared with others)
    c. Managed (hosted + provider management)
- **Example**: Microsoft KVM, HP, Red Hat & VMWare, AWS S3, etc.,
- **Benefits**:
    a. Better security & privacy
    b. Better control
    c. Predictable cost (high compare to public)
    d. Legal compliance can be resolved easily
    e. Improved Flexibility
    f. Quick service delivery
    g. Easy resource customization
- **Limitations**:
    a. Limited Scalability
    b. Need huge initial investment
    a. Limited Access
    b. 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)



- **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**
    a. Customer managed
    b. Vendor managed
    c. Partner managed
    d. Cloud provider managed
- **Advantages**
    a. Greater flexibility
    b. Improved deployment, security and compliance
    c. Better control
    d. Effective risk management
- **Disadvantages**
    a. Complex network design
    b. Infrastructure compatibility issues
    c. 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

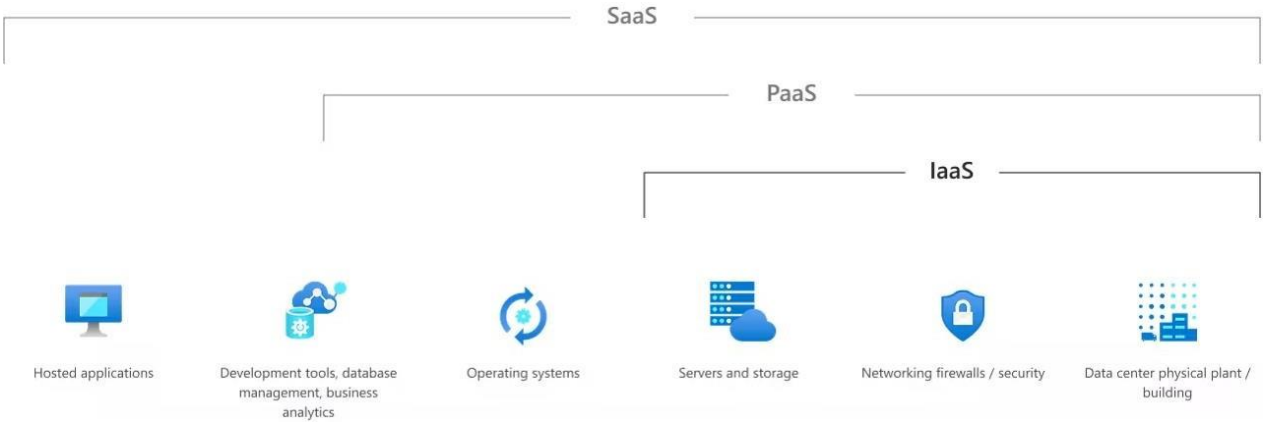
- Managed by organization or third party
- **Group of organization**: It allows systems and services to be accessible by a group of several organizations to share the information.
- It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.
- It allows to share missions, policy, security, regulatory compliance needs
- **Advantages**
  a. Cost effective
  b. Flexible and scalable
  c. Security
  d. Sharing of infrastructure
- **Disadvantages**
  a. Not suitable for single organization
  b. Slow adoption of data
  c. Fixed amount of data storage and bandwidth is shared among group of members
  d. It is costlier than public cloud
  e. Sharing of resources is difficult

5. **Multi Cloud** : Use the resources from several providers to get the *best benefits from each unique service*
6. **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

▪ SERVICE MODELS

❖ **Different Types of Cloud computing Service Models** (SPI models)

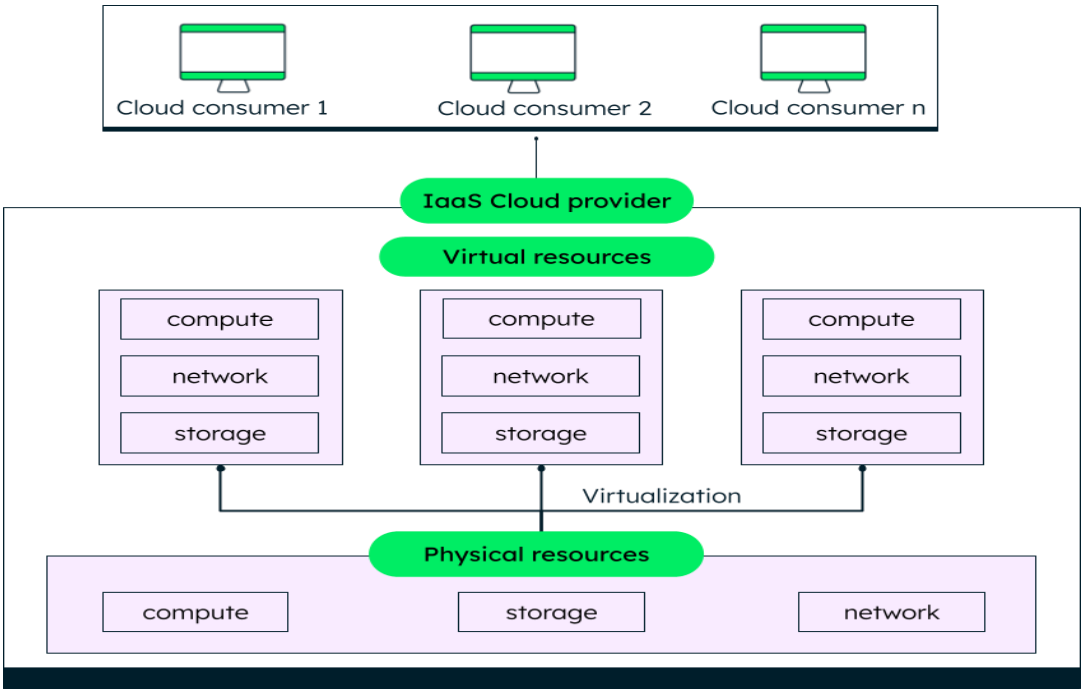
a. Infrastructure as a Service (IaaS)
b. Platform as a Service (PaaS)
c. Software as a Service (SaaS)
d. Storage as a Service (StaaS)
e. Identity as a Service (IdaaS)
f. Compliance as a Service (CmaaS)
g. Anything as a Service (XaaS)



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

- The infrastructure is managed over the internet
- **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



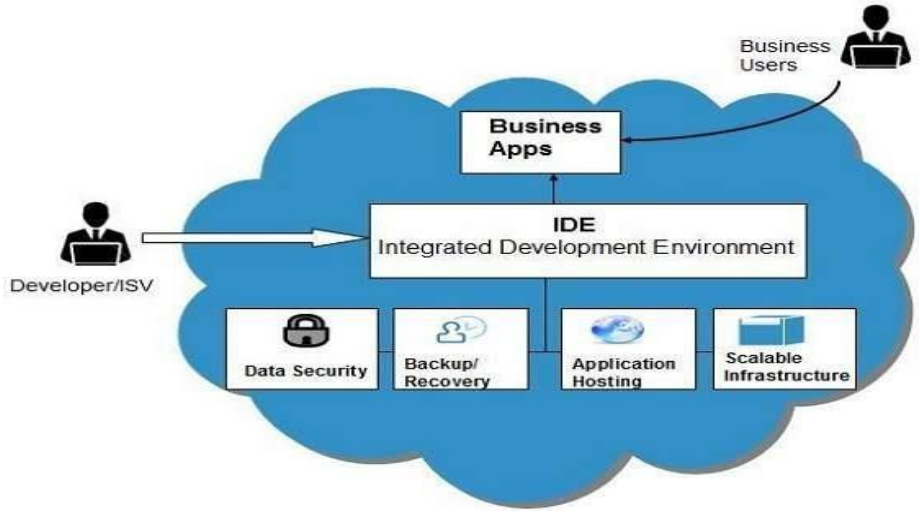
- Least level of integrated functionality and lowest level of integration
- **Role of Cloud Consumers**: The cloud consumer is responsible for installing, configuring, and managing software and keeping the data secure.
- **Additional Services**:
    a. Detailed billing management
    b. Logging
    c. Monitoring
    d. Storage resiliency
    e. Security
- **Example**: Amazon Elastic Compute Cloud (EC2), Eucalyptus, Gogrid, FlexiScale, Linode, RackSoace Cloud, Terremark
- **Benefits**:
    a. Speed
    b. Performance
    c. Reliability

d. Back u p and recovery
e. Competitive pricing
f. Shared infrastructure
g. It allows to access the resources through web
h. It follows Pay – as – per - use model
i. It supports on-demand scalability

- **Disadvantages:**
  a. Security
  b. Maintenance and upgrade (no 100% upgradation for all software)
  c. Interoperability issues
- **Suitable Applications Area:** use cases
  a. High performance computing
  b. Website Hosting
  c. Big data analytics
  d. App development

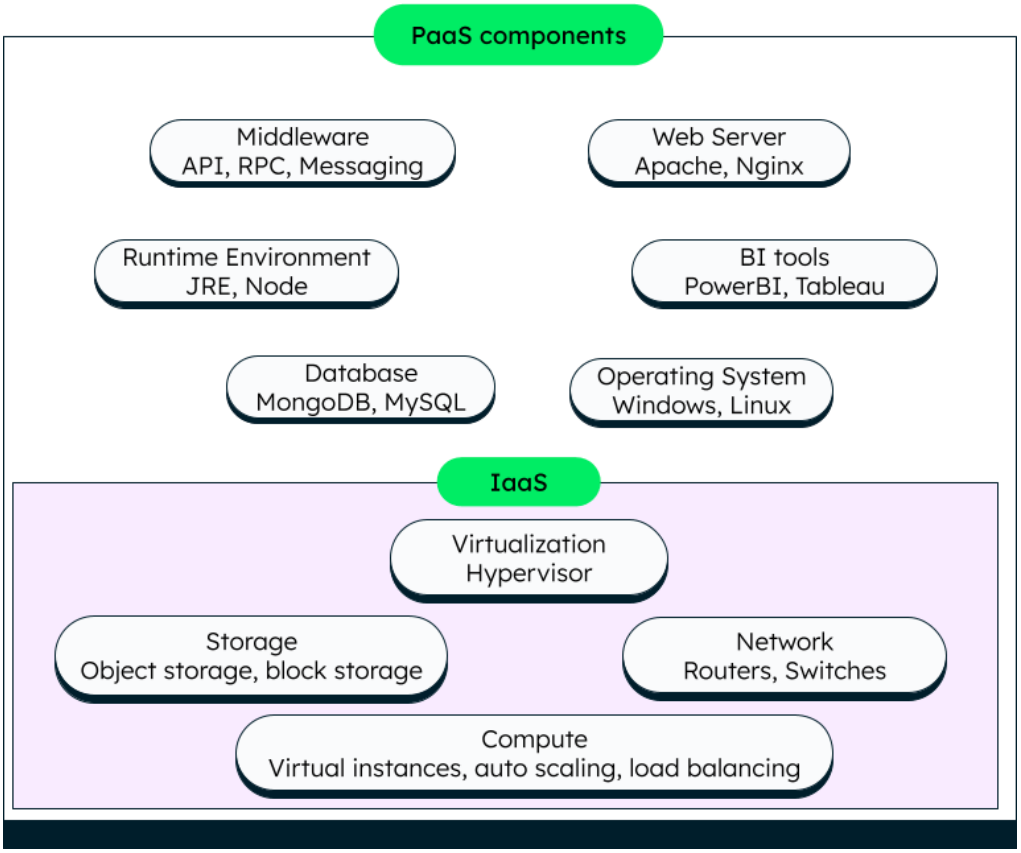
2. Platform as a Service (PaaS)

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



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

  - *PaaS Services Examples*: Force.com, GoGrid Cloud Center, Google App Engine, Windows Azure platform
  - *Service Providers* : Google Apps, Oracle on Demand, SalesForce.com, SQL Azure

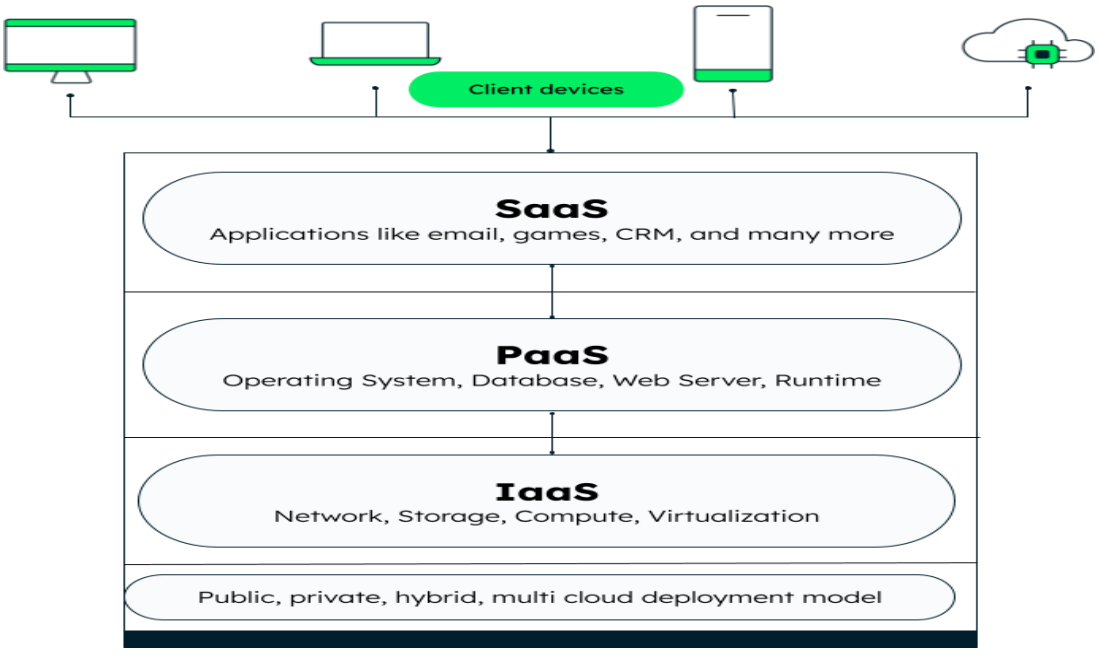


- ***Advantages*:**
    a. Simplified development
    b. Pre-build business functionality
    c. Scalability
    d. Support geographically distributed development teams
    e. Efficiently manage the application lifecycle.
    f. Cut coding time.
    g. Develop for multiple platforms—including mobile—more easily.
    h. Increase productivity
    i. Maintain security measures
    j. Use existing skills and investments.
- ***Disadvantages:***
    a. Vendor lock – in (migration of platform)
    b. Data privacy depends on the service providers
    c. 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)
- 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

- **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
- **Services Offered by SaaS:**
    a. Business Services (start-up services) - Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), billing and sales
    b. Electronic Document management services (Ex: Slack, Samepage, Box, and Zoho Forms)
    c. Social Networks
    d. Mail Services - handle the unpredictable number of users and load on e-mail services



- **Example**: Zoom, Slack, DocSign, Spotify, Adope Creative Cloud, Slaesforce.com, Oracle CRM, Constant Contact, Google Apps, NetSuite, GoTo Meeting, Dropbox, etc..

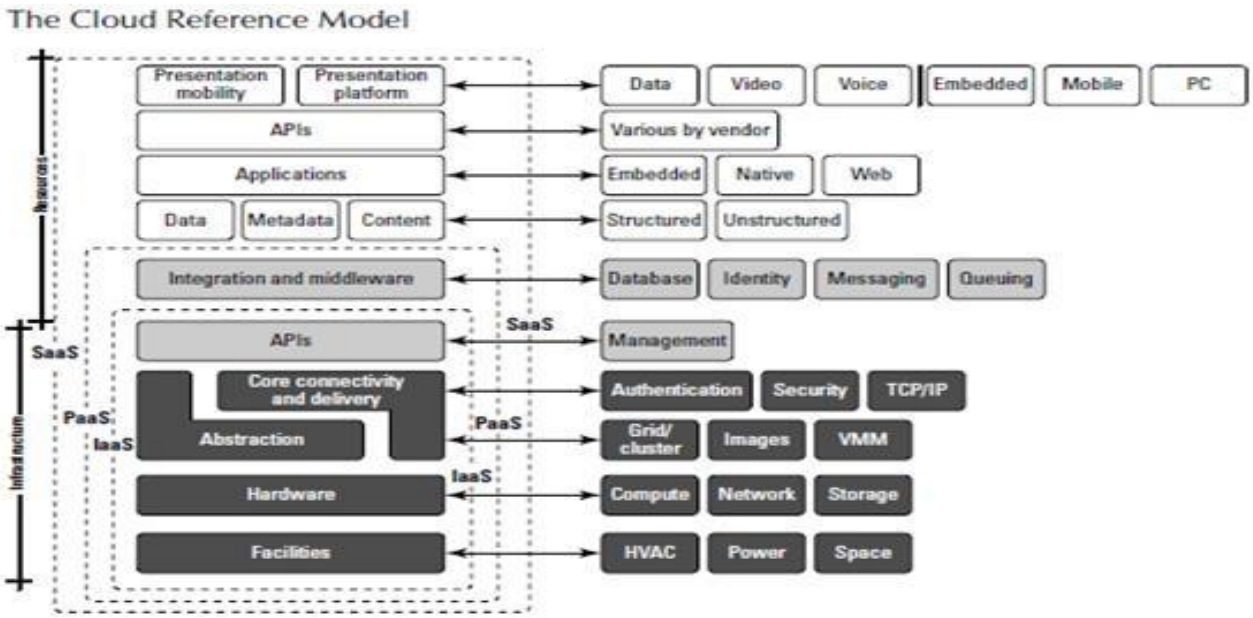
Advantages:

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

Users can access SaaS applications on any device

- **<u>Disadvantages</u>**:
  a. Security depends on CSP
  b. Latency issue (Speed of delivery)
  c. Entire services are depends on the internet
  d. Switching between different vendors are difficult (Portability)
  e. Customer lose control over version
  f. Browser based issues

❖ **<u>Cloud Reference Model</u>**



UNIT -2
CLOUD SERVICE STRATEGY

Syllabus: 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

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
- It refers to the *core principles and considerations* that organizations should take into account when *adopting and implementing cloud technologies*.
- *Cloud Strategy* must supports (cloud management)
    a. Cost
    b. Service level
    c. Functionalities
- **Cloud Strategy principles:**
    a. Trust
    b. Enablement
    c. Enterprise Risk
    d. Capability
    e. Cost-benefit
    f. 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 :**

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)

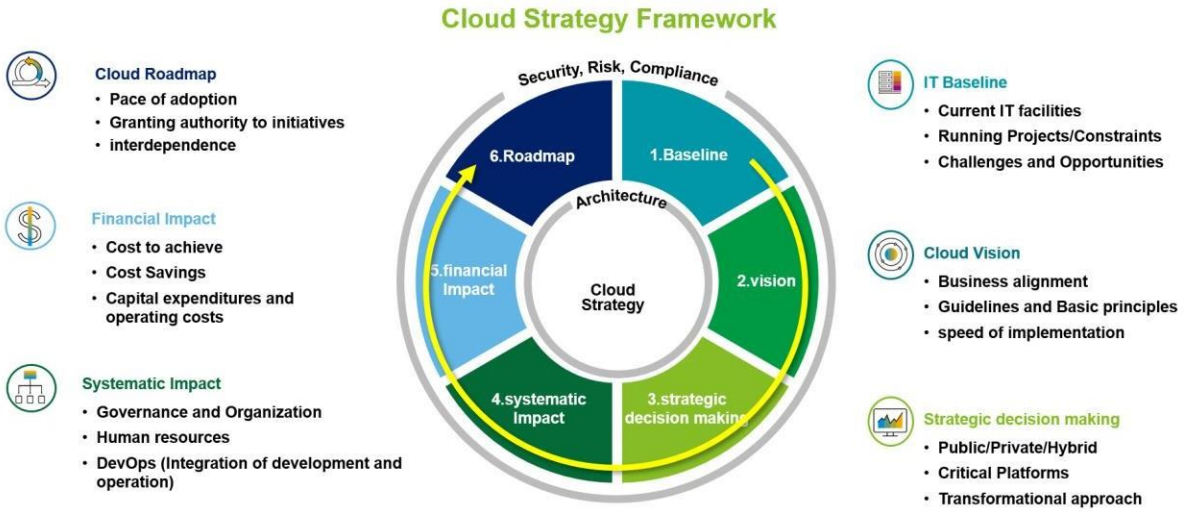
CLOUD STRATEGY MANAGEMENT FRAMEWORK

- **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.
- **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 onboarding (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



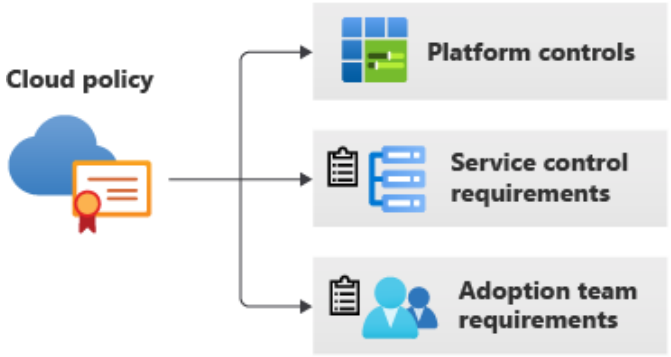
CLOUD POLICY

❖ **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.*

- **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.
- **Policy ensures**
    a. Confidentiality
    b. Integrity
    c. Availability of data stored
    d. Accessing of data
    e. Manipulation of data
- **Key aspects:**
    a. Data Security and Privacy: - Access control and authentication
    b. Access and Identity Management – user access controls
    c. Resource Provisioning and Management
    d. Cost Management
    e. Vendor Management – selection of CSP
    f. Disaster Recovery and Business Continuity
    g. Change Management
    h. Cloud Service Adoption
    i. Monitoring and Incident Response
    j. Training and Awareness

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:**
    a. **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
    b. Cost Reduction
    c. 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:**
    1. Security
    2. Cost Saving or cost Efficiency
    3. Efficiency
    4. Flexibility and Scalability
    5. Rapid Recovery
    6. Increased Convenience – easy accessing
    7. Speed and Productivity
    8. Strategic Value [competitive edge to businesses - business agility and customer satisfaction]
    9. Multi-tenancy (multiple customer share the underlying models)
    10. Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)

11. Standards
12. Sustainability
13. Rapid deployment – Cloud services enables fast provisioning of resources and deployment of applications. (reduce time for the product enter into market)
14. Access to advanced technologies
15. Reduced IT Management Burden
16. 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**:
    a. Lack of strategic alignment
    b. Unpredictable outcome
    c. Inefficient resource utilization
    d. Inconsistent decision making
    e. Missed opportunities
    f. Security and compliance risk
    g. Limited adoption to advanced technologies
    h. Difficult in vendor selection

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:**
    a. Identify the risk
    b. Analyze the risk
    c. Evaluate the risk (ranked based on the sevierity)
    d. Solve the risk
    e. Monitor or review the risk
- **Types of Risk in cloud computing**:
    a. Data breach - unauthorized access to the confidential data of an organization
    b. Cloud vendor security risk – CSP cloud security and risk mitigation affects organization growth
    c. Availability - Any internet connection loss disrupts the cloud provider's services, making the services inoperative
    d. Compliance - The service provider might not follow the external audit process, exposing the end user to security risks
- **Steps involved in Risk Management**:
    1. Risk Identification – identify the potential risk
    2. Risk Assessment
    3. Risk Mitigation Strategies - Develop strategies to mitigate or reduce identified risks
    4. Data security (encryption techniques)
    5. Compliance and governance - policy
    6. Vendor risk management - evaluate the security practices and certifications of CSP
    7. Data Loss Prevention
    8. Service availability
    9. Change Management – It ensures that updates, changes, and configurations are carefully planned and tested to avoid disruptions.
    10. Business continuity - ensure that critical applications and data can be restored in the event of a disaster.
    11. Incident Response

12. Cost management
13. Continuous Monitoring
14. Audit and reporting
15. Employee training and awareness
16. Establish Service Level Agreements (SLA) with CSP

- **Benefits of Risk Management:**
    a. Forecast probable issues (identify the risks – helps to implementing appropriate control strategies)
    b. Increase the scope of growth
    c. Business process improvement
    d. Better budgeting
- **Best practices for Risk Management:**
    a. Better selection of CSP
    b. Deploy Technical safeguards to monitor the activities of the consumers
    c. Establish effective control strategies
    d. Optimize cloud service model

IT Capacity and Utilization

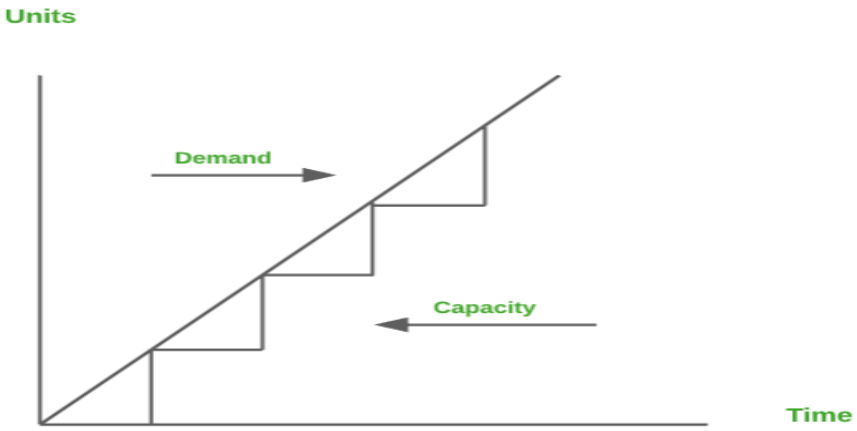
- **Capacity of cloud:** It defines the amount of resources, such as CPU, memory, disk space, network bandwidth, and concurrent users that the cloud provider can allocate to for the applications and services.
- **IT Capacity plan**: IT defines the resources necessary to meet the organization's service 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?
    Utilization factor in percentage = 40/60*100 = 2/3 = 67%
- **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
- **IT capacity**
  a. *Planning for Capacity* - It helps ensure that the organization has the right amount of resources to handle demand.
  b. *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**:
  a. Cost efficiency
  b. Performance optimization
  c. Scalability
  d. Flexibility - Easy to align with business needs

e. Resource allocation based on priority
f. Proactive Problem Detection
g. Data driven decision (effective resource allocation)

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.



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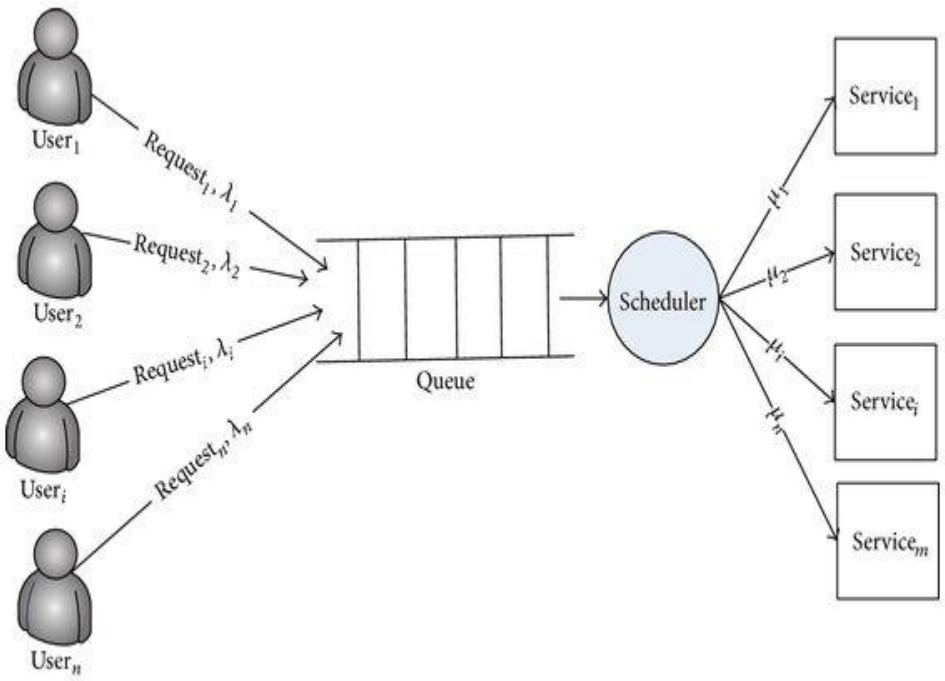
- **Need for Demand and capacity utilization:**
    a. Efficient allocation of resources
    b. Optimizing cost (cost management)
    c. Maintain better performance
    d. Improve customer satisfaction
    e. Inventory management
- **Parameters for deciding the demands:**
    a. User activity
    b. Application usage
    c. Business operations
- **General Methods:**
    a. Adjusting capacity to match demands
    b. Altering 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:**
    a. Based on varying detail (business needs)
    b. Time
    c. Type of data storage
- **Capacity management**: It is the process of planning, allocating, and adjusting the resources of a business to match the demand for its products or services
- **Key aspects define the relationship between demand and capacity matching:**
    a. Balancing demand and supply
    b. Efficient resource utilization
    c. Customer satisfaction
    d. Revenue generation
    e. Cost control
    f. Risk management
    g. Technology and innovation - Automation, data analytics, and AI-driven forecasting can enhance decision-making.

❖ **Challenges:**

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



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

CHANGE MANAGEMENT

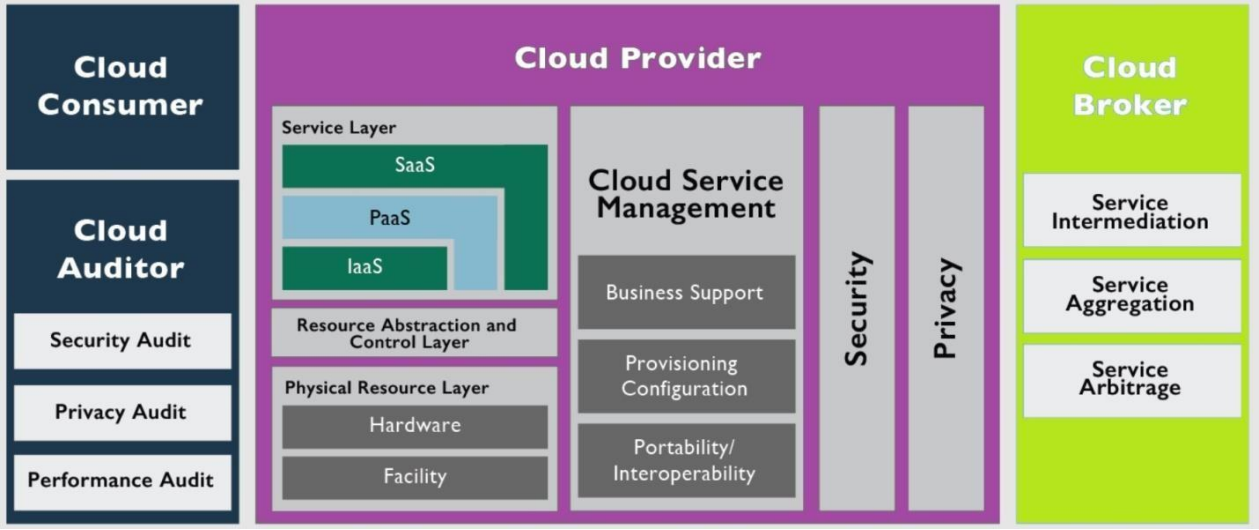
- **Definition of change**: The addition, modification, or removal of anything that could have a direct or indirect effect on services.
- **Definition**: It is the methodology and processes used by organizations to plan and manage these changes (or) the process responsible for *controlling the lifecycle 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

- **<u>Outline or steps involved in change management</u>**:
    a. Change identification and request (new feature / existing, configuration change or security)
    b. Change evaluation – assess the potential impact [Evaluate technical feasibility, risk analysis, benefits, costs and alignment with business goals]
    c. Change planning – develop a plan for implementing the change (it involves defining the scope, setting priorities, allocating resources and creating timeline)
    d. Testing and validation
    e. Communication and stakeholder management - Keep all relevant stakeholders informed about the upcoming change
    f. Change deployment – implement the changes in the production based on plan (requires careful execution to minimize disruptions to ongoing operations)
    g. Monitoring and feedback – identify or detect any anomalies, performance degradation or security issues introduced due to the changes if any
    h. Issue Resolution – Address the issue (rollback needed in necessary)
    i. Documentation and knowledge management
    j. Post- change review
- **<u>Advantages of Change Management:</u>**
    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

CLOUD SERVICE ARCHITECTURE

- **Cloud service**: It refers to various internet based information technology resources.
- **Cloud Service architecture:**



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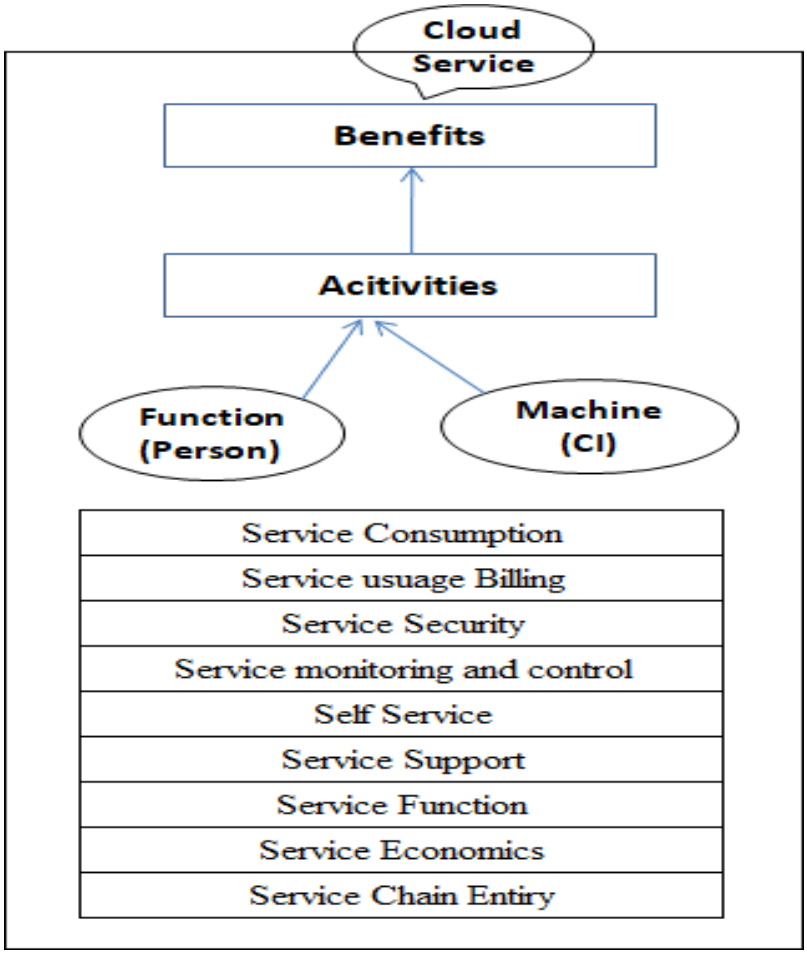


❖ **Different components of Cloud Service Architecture:**

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

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

UNIT - 3

CLOUD SERVICE MANAGEMENT

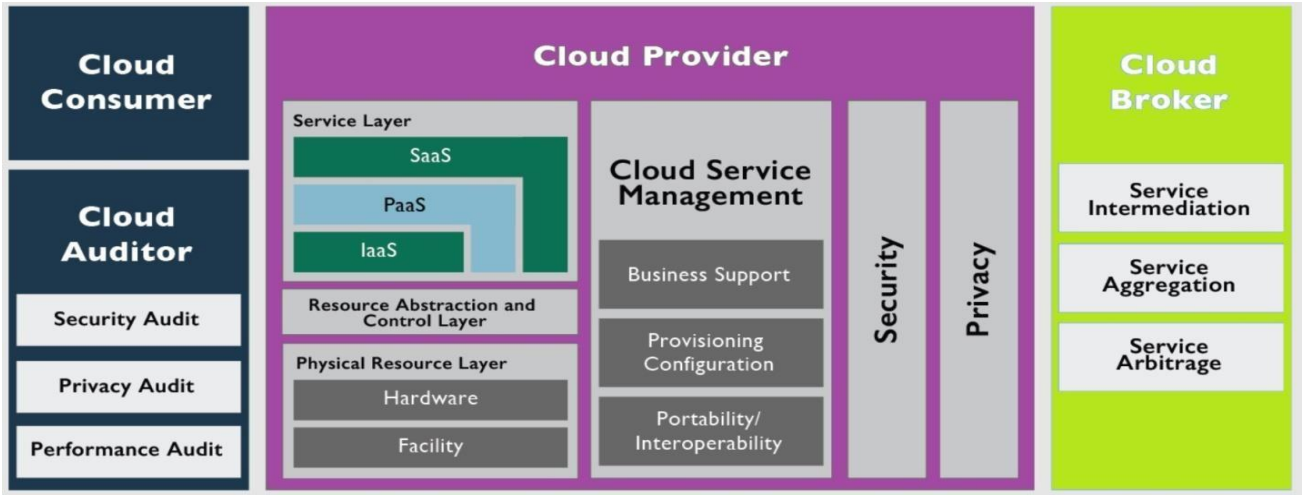
Cloud Service Reference Model, Cloud Service Life Cycle, Basics of Cloud Service Design, Dealing with Legacy Systems and Services, Benchmarking of Cloud Services, Cloud Service Capacity Planning, Cloud Service Deployment and Migration, Cloud Marketplace, Cloud Service Operations Management.

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.
- 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
    1. Service Management – The special capabilities of business needs
    2. Organization (A person or group of persons who have their own function, with their own responsibilities, authorities, and relationships)
    3. Service Consumers
    4. Service Providers
    5. Product – Offers a value for a consumer
    6. Resources – It is sued to configure the products
    7. Value – the perceived benefits, usefulness and importance of something
    8. Service Relationship – Define the relationship between service providers and service consumers

9. Service Offering – Services satisfy a specific customer
10. Service Relationship management
11. Service Provision – Activities performed by service providers to provide services.
12. Service Consumption
13. *Service Contract* - The service contract outlines the terms and conditions under which the service is provided. (pricing, usage policies, performance metrics)
14. *Service Level Agreements (SLAs)* – It *specifies the agreed-upon levels of service performance and availability* that the provider commits to delivering to the consumer.
15. *Service Quality Metrics* - the measurements used to assess the quality and performance of the cloud service
16. *Service Administration* – It encompasses tasks related to managing the configuration, security, and compliance of the service.
17. *Service Deployment and Orchestration* – It involves the process of deploying, configuring, and managing cloud services to ensure they run efficiently and effectively (Automation).
18. *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.
19. *Service Catalog*

❖ **Cloud Service Reference Model:**



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:**
  1. **Service Owner** - The individual or team responsible for the overall strategy, design, and management of the cloud service throughout its lifecycle.
  2. **Service Provider -** The entity that delivers the cloud service, which can be an internal IT team or a third-party provider.
  3. **Service Users -** The individuals, departments, or external customers who consume and interact with the cloud service.
- **Conditions:**
  1. Alignment with Business Needs
  2. Continuous Monitoring and Improvement

❖ **Different Phases of Cloud service Life Cycle:**

1. *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.
2. *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.
3. *Management and Operations* - It involves day-to-day management, monitoring, scaling, performance optimization, security enforcement, and compliance maintenance.
4. *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.
5. *Updates and Upgrades* - Regular updates, patching, and upgrades are performed to enhance functionality, security, and compatibility. This includes testing and validation to prevent disruptions.
6. *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.
7. *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.
8. *Configuration and Customization* - Once deployed, the resource may require configuration adjustments and customization to align with specific business needs and user requirements.
9. *Data Management and Backup*
10. *Cloud Cleanup*

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**:
    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

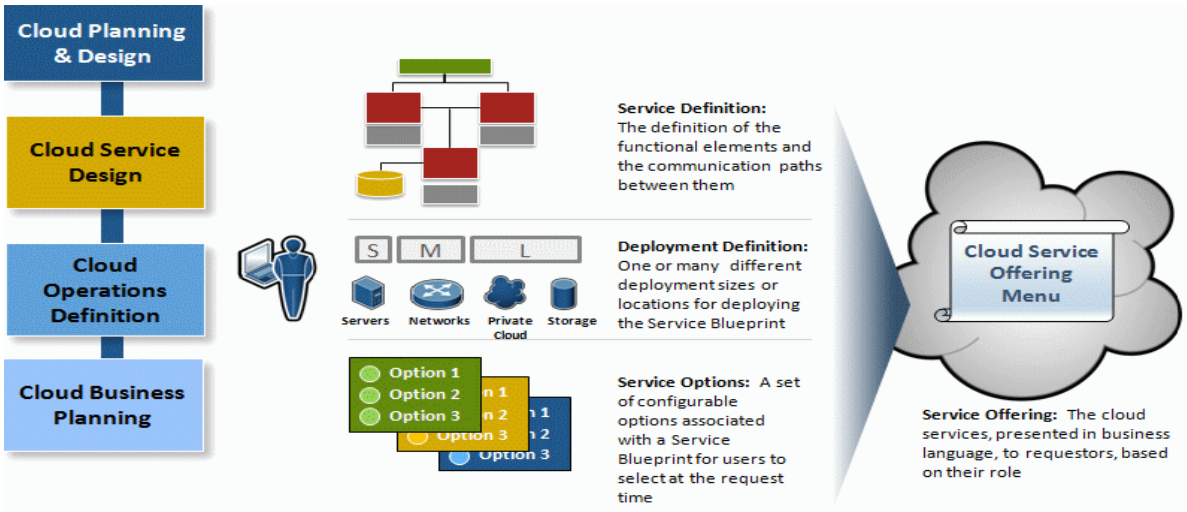
9. Vendor Selection - Evaluate and choose a cloud service provider based on factors such as service offerings, pricing, geographic availability, reliability, and support.
10. Performance and Scalability
11. Resilience and Disaster Recovery
12. Training and Skill Development
13. Change Management and 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:**

a. Development team
b. R&D groups
c. The application team in charge of building and maintaining internal applications

❖ **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:**

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

❖ **<u>Advantages</u>**:

1. Security
2. Cost Saving or cost Efficiency
3. Efficiency
4. Flexibility and Scalability
5. Rapid Recovery
6. Increased Convenience – easy accessing
7. Speed and Productivity
8. Strategic Value [competitive edge to businesses - business agility and customer satisfaction]
9. Multi-tenancy (multiple customer share the underlying models)
10. Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)
11. Standards
12. Sustainability
13. Rapid deployment
14. Access to advanced technologies
15. Reduced IT Management Burden
16. Competitive advantage

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**:
    1. Compatibility assessment (restructure, refactoring, reengineering)
    2. Business impact
    3. Cost benefit analysis
    4. Risk analysis
    5. Security and compliance
    6. Data migration strategy
    7. Performance and scalability
    8. Integration strategy
    9. User experience
    10. Training and knowledge transfer
- **Steps involved to manage legacy systems in cloud**:
    1. Assessment and Inventory
    2. Prioritization (based on goals, technical feasibility, potential impact) – Analyze for the suitable for migration
    3. Refactoring or replatform
    4. Integration strategy (API, middleware tools)
    5. Data Migration
    6. Hybrid approach (local and cloud services in the legacy systems)
    7. Security and compliance
    8. Testing and validation
    9. Monitoring and management (track the performance)

10. Training and support
11. Retirement strategy (migrate from legacy systems to cloud)
12. Documentation
13. Continuous improvement
14. Communication (maintain communication with stakeholders about the progress, benefits, challenges of the transition)

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
    1. Security
    2. Cost Saving or cost Efficiency
    3. Efficiency
    4. Flexibility and Scalability
    5. Rapid Recovery
    6. Increased Convenience – easy accessing
    7. Speed and Productivity
    8. Strategic Value [competitive edge to businesses - business agility and customer satisfaction]
    9. Multi-tenancy (multiple customer share the underlying models)
    10. Service and innovation (use many API and use flexible cloud tools and environments to build new and innovative applications and process)
    11. Standards
    12. Sustainability
    13. Rapid deployment

14. Access to advanced technologies
15. Reduced IT Management Burden
16. 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**:
    a. Careful planning
    b. Accurate measurement techniques
    c. 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**:
    a. iperf - measure network throughput
    b. ipref3 – measure network bandwidth and throughput
    c. wrk – Measure HTTP applications
    d. YCSB (Yahoo Cloud Serving Benchmark) – measure NoSQL databases
    e. UnixBench – system performance
    f. Geekbench – CPU and memory performance
    g. SPEC CPU Benchmark – system performance
    h. TPC Benchmarks (Transaction Processing Performance Council)

CLOUD SERVICE CAPACITY PLANNING

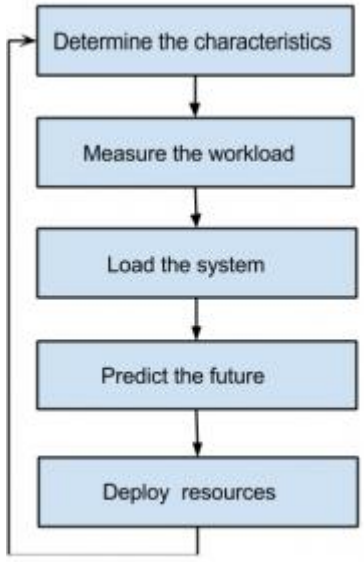
- **Definition of cloud service planning**: It refers to the *process of determining the optimal amount of computing resources*, required to *meet the demands of an organization's applications and workloads hosted* in a cloud environment.
- **Different types of Resources**:
    a. Virtual Machine – instance of OS and associated software run in physical server
    b. Storage
    c. Networking
    d. Database
    e. Containers and orchestration (configuration of multiple tasks)
    f. AI and machine learning services
    g. Analytics and Big data analytics
    h. 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**:
    a. Resource optimization
    b. Cost management
    c. Performance and user experience
    d. Scalability
    e. Availability and Redundancy
    f. Data Management
    g. Infrastructure agility
    h. Security and compliance
    i. Environmental sustainability
- **Goal of efficient capacity planning:**
    a. Forecasting future resource needs
    b. Ensuring that the cloud resources are efficiently utilized
    c. Preventing any performance bottlenecks or service disruptions due to insufficient capacity.
    d. Maintain balance between providing a responsive and reliable service to users (avoid under-provisioning and over-provisioning)
- **Key factors considered for efficient capacity planning**:
    a. Application Analysis
    b. Performance monitoring
    c. Forecasting
    d. Resource Sizing
    e. Elasticity and Scalability
    f. Cost optimization – Select the most effective resource configuration

g. Testing and simulation (before implementing changes → validate the capacity planning decisions)
h. Regular review (planning is ongoing process)
i. Cloud provider services (managed services and tools)

❖ **Strategic steps for effective capacity planning:**

a. Define business goals and objectives
b. Data Analysis
c. Forecast future demand
d. Resource sizing and selection
e. Implement scalability strategies
f. Redundancy and High availability
g. Testing and simulation
h. Cost analysis and optimization
i. Monitoring and Real-time Insights
j. Regular review and Iteration
k. Collaboration and communication



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

a. Changing business needs
b. User behaviors
c. Technological advancements

- **Advantages of Capacity Planning:**
    a. Optimal Resource Utilization
    b. Cost efficiency
    c. Performance optimization
    d. Scalability and flexibility
    e. Improve reliability
    f. Predictable performance
    g. Effective disaster recovery
    h. Improved decision making
    i. Efficient practices
    j. Enhanced security
    k. Regulatory compliance

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 it dependencies, configurations and data
3. *Deployment Strategy* - Select a suitable deployment strategy based on application architecture and requirements. (Dockers or serverless computing – AWS Lamda)
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
        i. Lift and shift migration (moving application as –is)
        ii. Re-platforming (making minor modifications for compatibility)
        iii. Re-architecting (modifying or redesigning for cloud-native features)
        iv. Replacing applications
    3. Data Migration (ensure data consistency, integrity and minimum downtime)
    4. Application Migration
    5. Networking and connectivity (setup networking and connectivity for seamless communication)
    6. Security and compliance – Implement effective security measures
    7. Testing and Validation
    8. User training
    9. Change management
    10. Monitoring and optimization

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 need*s, 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

CLOUD SERVICE OPERATIONS MANAGEMENT

- **Goal**: The operation management process is to *monitor and control the IT services and IT infrastructure.*
- **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, traqffic, 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.

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.

❖ **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:**

14. Provisioning management

- It refers to the *process of planning, deploying, configuring, and managing the resources and services* within a cloud computing environment to meet the needs of users and applications.
- **Key aspects**:

a. Resource allocation and scaling
b. Automation
c. Orchestration (coordination)
d. Configuration management
e. Monitoring and optimization
f. Cost Management
g. Security and self control
h. Service Level Agreements (SLAs)
i. 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..

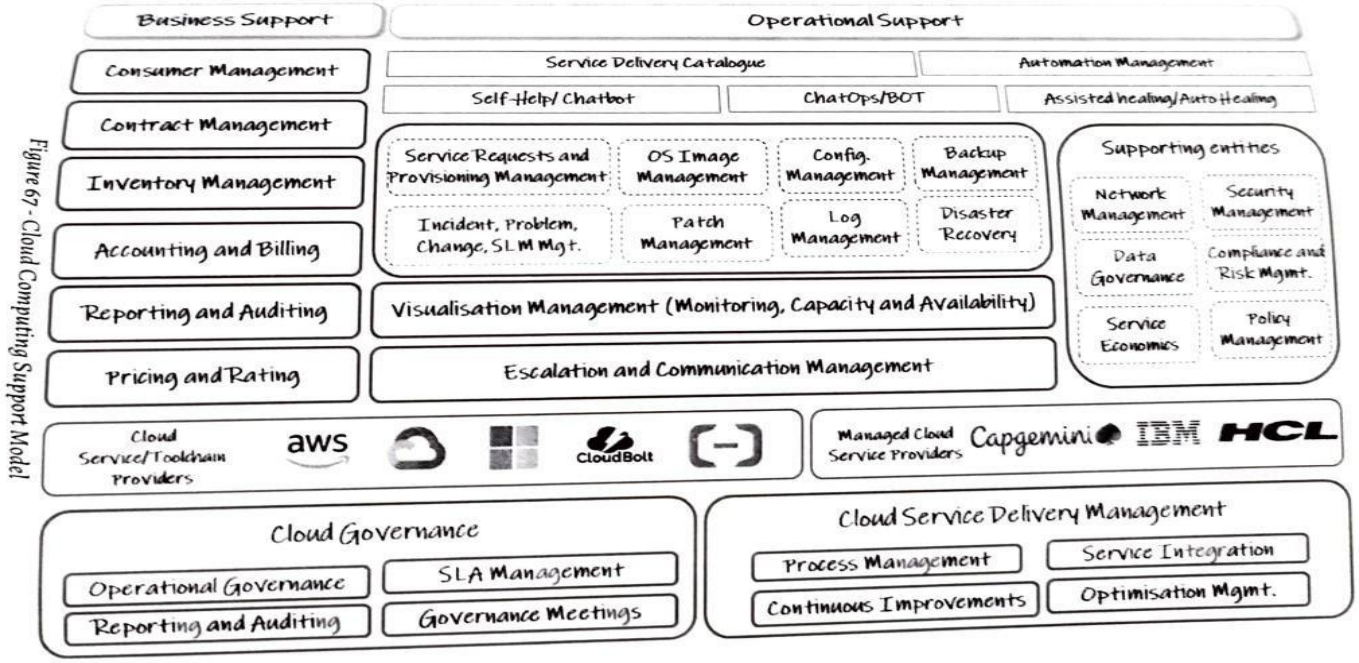


Figure 67 - Cloud Computing Support Model

UNIT - 4

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 Opex Shift - Cloud service Charging - Cloud Cost Models

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 without any technological risks
  4. Resource optimization
  5. Customization
  6. Competitive advantages
  7. Customer Satisfaction
  8. Selection of resources and services based on their requirements (Business goals)
  9. 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**:
  1. Type of services
  2. Cloud service providers
  3. Geographical regions
  4. Evolving industry trends

❖ **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

- **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

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. MindMeister - 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.

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. Limited flexibility

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 ties 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.
  5. *User Adoption* - Organizations should monitor user adoption rates to ensure that the cloud service is being used effectively across the organization.

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)
  a. *Well defined plans* - providers must develop and offer distinct subscription plans with varying features and resources.
  b. *Service variety* – providers offers a range of subscription plans to cater to different user requirements.

c. *Billing Infrastructure* - A robust billing system is essential for accurately tracking and charging customers based on their chosen plans.

d. *Billing Cycle* - Providers need to define the billing cycle (e.g., monthly, annually) and associated payment methods.

e. *Upgrade/Downgrade Mechanism* - A mechanism for customers to easily switch between subscription plans is necessary.

f. *Cancellation Policy* - Clear guidelines on how *customers can cancel subscriptions, including any associated penalties or fees*.

g. *Resource Monitoring* - Tools to track resource consumption and usage patterns are necessary to allocate resources fairly.

h. *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.

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:**
    11. Strategy alignment – Align with business needs and strategy
    12. Continuous process (continuous evaluation and optimization)

13. Flexibility - Cloud services can be procured on-demand, providing flexibility in resource allocation.
14. 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 ensure 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

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 data centers.

❖ **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 shit
  5. *Cost predictability* involves more predictable
  6. *Resource Scalability* -CapEx investments might to over provisioning or under provisioning
  7. *Financial Flexibility* - OpEx eliminates the need for large initial investments, freeing up capital for other strategic initiatives.
  8. *Risk Management* - OpEx reduces the financial risk associated with technology obsolescence and asset depreciation.
  9. *Budget Management* - OpEx aligns expenses with actual usage and provides better budget control.
  10. *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 ensure 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:**

11. *Cost Efficiency* - it helps to avoid large upfront investments.
12. *Resource Flexibility* - It allows easy scalability to match changing demand.
13. *Focus on Core Business* - OpEx frees up resources to focus on innovation and strategic projects.
14. *Reduced Risk* - OpEx reduces the risk of technology obsolescence and underutilization.
15. *Budget Predictability* - OpEx aligns expenses with usage, enabling better budget management.
16. *Rapid Deployment* - Cloud services enable quicker deployment of resources compared to traditional CapEx models.

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:**

Cost = (Usage Measurement) × (Rate) (or) Resource Usage * 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 data centers and services.
7. *Service Level* - Higher service levels (e.g., availability, performance) often come with higher costs.

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) follows 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?

     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) follows 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 Unit Price)
- The formula for *calculating the cost savings with RIs compared to PAYG is*:

  Total Cost = (PAYG – 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
     2. 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:

  Execution Cost = Execution Time (in seconds) x Memory Allocated (in GB) x 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**:

     API Call Cost = Number of API Calls x 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

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

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,
    4. Aligned with the organization's business goals
    5. Risks are managed effectively
    6. IT investments deliver value
    7. Support overall business success
- **Critical Challenges**:
    1. Alignment with business goals
    2. Risk management
    3. Resource optimization
    4. *Regulatory compliance* - strict regulations and compliance requirements related to data privacy, security, and reporting
    5. *Decision- making* – need a structured framework for making informed and strategic decisions about technology investments, projects, and operations.
    6. *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 contribute 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.

CLOUD GOVERNANCE DEFINITION

- **Definition:** It refers to the *set of policies, processes, and controls that organizations establish and implemen*t 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:**

S. No.	Characteristics	IT Governance	Cloud Governance
1.	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.

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 over-provisioning.
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

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.

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
  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 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.
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.

❖ **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.

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
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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.

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**:

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)

❖ **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.

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	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

- **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.

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
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

- **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.

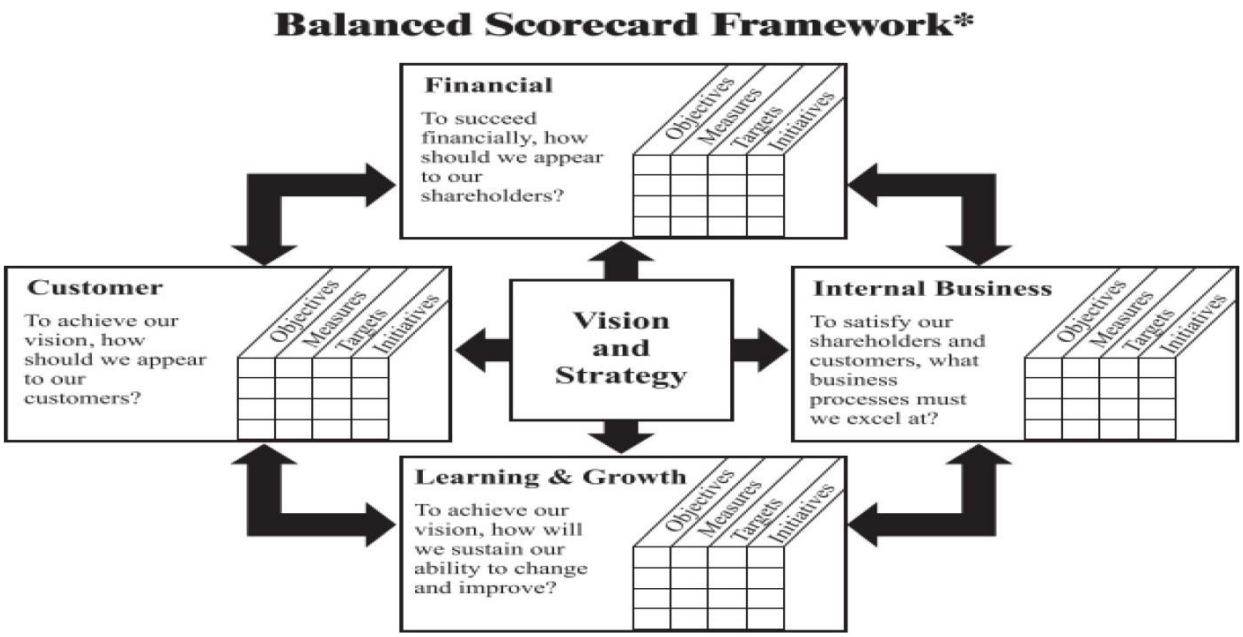
❖ **Limitations:** There are some limitations to consider when measuring the values of cloud services.

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.

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.*
- **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



❖ **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-a-service (SaaS) company

KPI(s)	Goal	Calculation
Financial Perspective	Cost Savings from Cloud Adoption	(Previous IT Costs) - (Current Cloud Costs)
Customer Perspective	Customer Satisfaction with Service Availability	(Number of Uptime Hours) / (Total Hours) * 100
Internal Process Perspective	Time-to-Market for New Features	Time taken to Develop and Deploy New Feature
Learning and Growth Perspective	Employee Training and Skill Development	Number of Employees Who Completed Training

❖ **Example 2**: Strategic map for an E-Commerce Business

	Objectives	Goals	Indicators	Initiatives
Financial Perspective	*To increase sales and reduce costs*	*15% increase in net sales and 10% decrease in operating costs*	*Financial statements*	*Negotiate with suppliers*
Customer Perspective	*To be a reference for a variety of products*	*Increase in launching new products every quarter by 15%*	*Number of new products launched per quarter*	*Create an innovation and development committee*
Internal Process Perspective	*To be able to develop new products constantly*	*Start at least five new product development projects every month*	*Project innovation reports*	*Acquire specific software for managing product development*
Learning and Growth Perspective	*To have extremely knowledgeable staff in product development*	*Have at least 2 professionals with masters degrees in product development*	*Number of product development professionals with masters degrees*	*Select an employee to receive masters training and hire another with a masters degree*

❖ **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.
3. *Multiple Metrics* - By using a variety of metrics, it offers a well-rounded evaluation of cloud services' impact.

4. *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.
5. *Strategic Focus* - It assists in focusing on long-term goals.
6. *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

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:**

TCO = Initial Costs + Ongoing Costs + Maintenance Costs + Downtime Costs + Upgrade Costs + 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.