**CLOUD COMPUTING**

**Overview of Cloud Computing:**

**I) Cloud Computing:**

A model for enabling convenient on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Examples of computing resources: Networks, Servers, Storage, Service, Applications.

5 – essential characteristics

3 – Deployment Models

3 – Service Models

Essential Characteristics:

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

**On-demand self-service:**

You get access to cloud resources such as the processing power, storage, and network you need, using a simple interface, without requiring human interaction with each service provider.

**Broad Network Access:**

Cloud computing resources can be accessed via the network through standard mechanisms and platforms such as mobile phone, tablets, laptops, and workstations.

**Resource Pooling:**

What gives cloud providers economies of scale, which they pass on to their customers, making cloud cost-efficient. Resources dynamically assigned based on demand.

**Rapid Elasticity:**

You can access more resources when you need them and scale back when you don’t.

**Measured Service:**

You only pay for what you use or reserve as you go. Resources usage is monitored, measured and reported transparently based on the utilization.

**Cloud Computing as a service:**

Helps in monitor usage and pay only for what you use.

Makes the cloud computing cost-efficient and agile in market change.

**Deployment Models:**

1. Public
2. Private
3. Hybrid

**Public cloud:**

Leverage cloud services over the open internet on hardware owned by the cloud provider, but its usage is shared by other companies.

**Private cloud:**

The cloud infrastructure is provisioned for exclusive use by a single organization. It could run on-premises or it could be owned, managed, and operated by a service operated by a service provided.

**Hybrid:**

Mix of both public and private clouds, working together seamlessly

**Service Models:**

1. Infrastructure (Infrastructure as a service) (Iaas)
2. Platform (Platform as a service) (Paas)
3. Application (Software) (Software as a service) (Saas)

**Infrastructure as a service (Iaas):**

You can get access to infrastructure and physical computing resources such as servers, networking, storage, and data center space – without the need to manage / operate them.

**Platform as a service (Paas):**

You get access to the platform, that is the hardware and software tools, usually those needed to develop and deploy applications to users over the Internet.

**Software as s service (Saas):**

It is a software licensing and delivery model in which software and applications are centrally hosted and licensed on a subscription basis and sometimes also referred to as “On-demand software”

**II) History and Evolution of cloud computing:**

**1950s –** Large-scale mainframes with high-volume processing power. The practice of time sharing, or resource pooling, evolved. Multiple users were able to access the same data storage layer and CPU power.

**1970s – Virtual Machines (VM)** Mainframes to have multiple virtual systems or virtual machines, on a single physical node. The virtual machine operating system with multiple distinct compute environments on the same physical hardware. Each virtual machine hosted guest operating system that behaved as though they had their own memory, CPU, and hard drives, even though these were shared resources.

**Virtualization:** A huge catalyst for evolutions in computing. Shared hosting environments, virtual private servers, virtual dedicated servers.

**Hypervisor:** A hypervisor is a small software layer, that enables multiple operating system to run along-side each other, sharing same physical computing resources.

Cloud computing with many servers and lot of Virtual Machines. They have pay-as-you-go subscription model. It is a key driver behind cloud computing taking off. This leads the companies to switch from CapEx (Capital expense (High up-front costs)) model to OpEx (Operating Expense (No or low up-front costs)) model. Also helps in scale and up at peak and scale down at subsided situation based on their usage.

**III) Key Drivers for moving to cloud:**

1. Agility
2. Competitiveness
3. Flexibility

**Infrastructure and Workloads:**

The cost of building and operating data centers can become astronomical. Low initials costs and pay-as-you-go attributes of cloud computing can add up to significant cost savings.

**Software as a Service (Saas) and development platforms:**

Organizations need to consider if paying for applications access is a more viable option than purchasing off-the-shelf software and subsequently investing in upgrades.

**Speed and Productivity:**

Organizations also need to consider what it means for them to consider what it means for them to get a new application up and running in ‘x’ hours on the cloud versus a couple of weeks, even months on traditional platforms.

Also, the person-hour cost efficiencies increase from using cloud dashboards, real-time statistics, and active analytics.

**Risk Exposure:**

Organizations need to consider the impact of making a wring decision their risk exposure. It is safer for an organization to work on a 12-month plan to build, write, test, and release the code adoption? And is it better for them to “try” something new paying-as-you-go rather than making long-term decisions based in little or no trial or adoption?

**Benefits of Cloud Adoption:**

1. Flexibility
2. Efficiency
3. Strategic Value

**Flexibility:**

Users can scale back or scale up services to fit their needs. Customize applications and access cloud services from anywhere. Virtual Private clouds, Encryption and API keys help keep data secure.

**Efficiency:**

Enterprise users can get applications to market without worrying about underlying infrastructure costs or its maintenance. Cloud based applications and data are accessible from virtually any internet-connected device. Hardware failure do not result in data loss because of networked backups.

**Strategic Values:**

Helps the customers on their priorities due to technological advancements.

**Challenges of cloud adoptions:**

Data security, associated with loss or unavailability of data causing business disruption.

Governance and sovereignty issues.

Legal, regulatory, and compliance issues.

Lack of standardization in how the constantly evolving technologies integrate and interoperate.

Choosing the right deployment and service models to serve specific needs.

Partnering with the right cloud service providers.

Concerns related to business continuity and disaster recovery.

**IV) Key Service Providers and their Service:**

**1) Alibaba Cloud (Aliyun):**

Largest Chinese, offers to public and alibaba groups. Helps in Compute, Analytics, Network, Storage, IOT, Communication, Application Development.

**2) Amazon Web Service (AWS):**

Providing DevOps, IoT, Machine Learning, Networking, Robotics, Data Analytics, Content Delivery, Compute.

**3) Google Cloud Platform (GC):**

ProvidingInfrastructure, Platform, Serverless Computing, Communication, Productivity, Storage.

**4) IBM Cloud:**

It is full stack cloud platform that has Public, Private, and Hybrid environment, providing Product & services such as Data & Analytics, Compute, Network, Storage, Management and Prominent Offerings such as Bare metal Servers, VMWare Hosting, Virtual Private Cloud, Blockchain, AI etc. IBM is the leading hybrid cloud provider.

**5) Microsoft Azure:**

It provides Building, testing, Deploying, Managing along with other platforms.

**6) Oracle Cloud:**

It provides ERP, Cloud Databases Services, Sales, Marketing, HCM, SCM.

**7) Sales Force Cloud:**

ItprovidesSales Cloud, Service Cloud, Marketing Cloud with analytics in real-time, customer success and support, social platforms.

**8) SAP:**

It provides ERP, CRM, HR, & FINANCE.

**Summary of Module I:**

Cloud computing is the delivery of on-demand computing resources over the internet on a pay-as-you-go basis; resources are dynamically assigned and reassigned among multiple users and scale up and down in response to users’ needs.

The origins of cloud computing can be traced back to the mainframes of the 1950s, with virtualization technologies and hypervisors serving as catalysts for the emergence of modern-day cloud computing.

Organizations must consider their business needs, investment viability, and risk capacity in order to create a cloud adoption strategy that delivers desired benefits without causing business disruptions and security, compliance, or performance issues.

Cloud adoption is growing faster than predicted. Driving this technological wave are cloud service providers with a host of services ranging from Infrastructure, Platform, and Software services. Some major Cloud providers of our times include AWS, Alibaba Cloud, Google, IBM Cloud, and Microsoft Azure.

**MCQ:**

**1)** In the US National Institute of Standards and Technology, NIST, definition of "cloud computing", what does the statement "shared pool of configurable computing resources" include?

1. Leverage cloud services over the open internet on hardware owned by the cloud provider
2. Data security, associated with loss or unavailability of data causing business disruption
3. Networks, servers, storage, applications, and services
4. Five essential characteristics, three deployment models, three service models

**Answer**

c) These are all recognized as computing resources that can be configured as needed and shared.

2) What tasks do hypervisors accomplish? Select two.

Note: Make sure you select all of the correct options!

1. Enable multiple operating systems to run alongside each other, sharing the same physical computing resources.
2. Facilitate access to mainframes for multiple users to access the same data storage layer.
3. Scale on demand to support fluctuating workloads.
4. Separates VMs logically and assigns each a share of the underlying computing power, memory, and storage.

**Answer**

a), d) A hypervisor is a small software layer that enables multiple operating systems to run alongside each other, sharing the same physical computing resources. Hypervisors also separate virtual machines logically, assigning each its own slice of the underlying computing power, memory and storage, preventing the virtual machines from interfering with each other.

3) What are some of the cloud benefits that make it lower risk for enterprises to adopt cloud? Select two.

Note: Make sure you select all of the correct options!

1. Data security associated with loss or unavailability of data causing business disruption
2. The pay-as-you-go model allows enterprises to experiment with technologies as opposed to making long-term decisions based on little or no trial.
3. Diversity of standardization in how the constantly evolving technologies integrate and interoperate.
4. The speed with which applications can be up and running on the cloud versus months on traditional platforms, means enterprises can experiment, fail fast, learn, and course correct without setting them back significantly.

**Answer**

b), d) Renting by the hour as opposed to the huge upfront cost of investing and re-investing in hardware and software make cloud adoption a low-risk option for enterprises. The speed and productivity provided by the cloud makes cloud adoption lower-risk for enterprises.

**Cloud Adoption and Emerging Technologies:**

**I) Cloud adoption:**

Cloud adoption is no longer a thing of future. Anybody can access the cloud computing capacity they need on the cloud. The companies will no longer take a long time to make decision and action it with high upfront capital. Cloud makes it possible for business to experiment, fail, and learn much faster than ever before with low risk of exposure.

According to IBM Institute for Business Value Study, more than 74% are using cloud to improve customer experience, and 71% use cloud to create enhanced products and services – while simultaneously downsizing the legacy systems and reducing costs.

Quick response by analytics to upgrade products & services for customers experience based on data. Cognitively enabler for AI, Automation, IoT, Blockchain to span new and legacy solutions.

Open, Hybrid, Secure multi-cloud infrastructures to Grow, Agility & Innovation. The Power, Scalability, flexibility, and pay-as-you-go economics of cloud has made it the underpinning foundation for digital transformation.

The international Data Corporation predicts that by 2025, the amount of digital data created worldwide will rise to 163 zettabytes (A trillion gigabytes). 3% will be real-time information. Cloud computing is essential to succeed, sustain, & compete in decision driven situations. A cloud strategy is a core component of any business strategy. Speed, Agility, Innovation, Decision making capacities.

**II) Cloud Case Studies:**

**American Airlines:**

**Challenge:**

1) Improve customer & digital channels

2) Improve response time to customer needs

**Solutions:**

1) New Cloud-based technology platform

2) Upgrade approach to delivering digital self-service tools

3) Remove constraints of existing applications

**Implementation of cloud-based technology benefitted with**

1) Faster Development & release of new apps.

2) Better operational reliability, productivity, & end customer response times

3) Avoiding existing upgrade costs via migration to IBM cloud.

**U-BANK:**

**Challenge:**

1) Removing barrier to development

2) Give more control to developers

3) Reduce need for additional resources

4) Faster speed to market

**Solutions:**

1) Virtual assistant using IBM Watson technology

2) Used Paas(Platform as a service) cloud development tools

**Implementation of IBM Cloud services:**

1) including IBM Watson to support online home loan application

2) Faster time to market through cloud platform

3) Quicker, Easier & more Cost-efficient innovation

4) More efficient Operation.

**Bitly:**

**Challenge:**

1) Cloud-based model with pay-as-you-go pricing

2) Ability to Scale-up

3) Greater global presence

4) Geo-distribute into more POPs

**Solutions:**

1) Establish scalable hosting platform

2) Migrate to IBM Cloud Environment

**Implementation of IBM:**

1) 25-Billion data-infused links migrated from one hosting site to cloud.

2) 1 billion user data stored & managed in a flexible, cost-effective cloud.

3) Scaled for growth, control costs & focus resources on product development

**ActivTrades:**

**Challenge:**

1) Cut Latency

2) Accelerate execution

3) Streamline delivery of new functions

**Solutions:**

1) Migrate trading system to IBM Cloud

2) Back data storage, networking, & security on IBM Cloud.

**Implementation:**

1) Migrated on-premises to cloud based on VMWare solution.

2) 3x performance Boost

3) Security-rich cloud platform

4) Faster response to new requirements

**III) IOT:**

AI, Big data, IoT, Blockchain are disrupting business models and industries by creating opportunities for business & value for clients. Power, scale, dynamic nature and economics. IoT is a network of connectivity between things and people. Smart devices are tracking and connecting data like Thermal, Optical, Structural, Environmental Stimuli. By connecting the IoT to Cloud, we can use it for Device Registration, Device identity, Storing Data, access enterprise data. Helpful for moving IoT for uploading data and receiving responses.

By IoT platform connected with cloud and interfaces used by Applications, to the backend analytics platform.

**IV) Artificial Intelligence on the cloud:**

AI is used for endless streams of data. Many of apps by AI also used cloud for storage. Cloud provides scalable on-demand resources, IOT behavior based on AI responses, AI acts on data from IoT devices. Smart Assistant (learns the users preferences over time) and over time will learn to anticipate and give insights. (Symbiotic relationship b/w IOT, AI and Cloud). USTA (United States Tennis Association) uses IoT, AI and Cloud of IBM.

**V) Blockchain & Cloud:**

Blockchain: A secure, immutable network that allows members to view only the transactions that are relevant to them. 85% of businesses today relly on multiple clouds to meet their IT needs. More than 70% uses 3 clouds. They need to be able to move the data from one to another cloud. Cloud provides globally distributed, scalable and cost-efficient computing resources, connected with AI (powers the analytics and decision-making from the data-collected) and blockchain (provides the trusted, decentralized source of truth) in a (3-way relationship). Blockchain records data and variables into decisions made by algorithms. Greater trust and transparency in the conclusions and decisions made by AI algorithms. By increasing traceability and transparency in the food supply chain, they reduce waste and increase productivity.

Analytics technology leverage the cloud: (Data Analytics & Predictive Maintenance Solution based on Cloud & IoT technologies)

1) Track trends on social media to predict future events.

2) Analyze data to build machine learning models in cognitive.

3) Data analytics and predictive maintenance solutions for city infrastructure.

**Summary:**

The adoption of cloud technologies is enabling enterprises, big and small, to be agile, innovative, and competitive, and to create differentiated customer experiences. The question organizations are asking is not whether they should move to the cloud, rather what strategy they should adopt to move to the cloud.

Some case studies that demonstrate the impact businesses have created by adopting cloud

o American Airlines adopting cloud technologies to deliver customer value rapidly across its enterprise

o UBank leveraging cloud platform services to give more control to their developers thereby removing barriers to innovation

o Bitly leveraging the scalability offered by cloud infrastructure for low-latency delivery to its geographically disbursed enterprise customers

o ActivTrades leveraging the infrastructure, storage, network, and security offerings on the cloud to accelerate execution and delivery of new functions in their online trading systems to their customers

● Emerging technologies, powered by the cloud, are disrupting existing business models and creating unprecedented opportunities for businesses to grow, innovate, and create value for their customers.

● Some case studies that demonstrate how the use of emerging technologies on the cloud is creating value for millions around the world.

o The use of the Internet of Things on the cloud to combat poaching of endangered rhinos in South Africa

o Artificial Intelligence on the cloud being leveraged to deliver unique digital experiences to millions of fans around the world by the United States Tennis Association

o Blockchain on the cloud helping farmers reduce waste by building traceability and transparency in the food supply chain

o The use of data analytics for driving predictive maintenance solutions for a city’s infrastructure by KONE

**MCQ:**

1) An IBM Institute for Business Value study says that more than three-quarters of enterprises today are using cloud computing to expand into new industries. What additional benefits do organizations find when adopting the cloud:

a) Improve customer experience and create enhanced products and services

b) Lengthen product lifecycles to ensure higher quality offerings

c) Continue making expensive decisions because it often worked in the past

d) Avoid having to fail at all

**Answer**

Cloud enables businesses to respond quickly to marketplace changes, use analytics to understand customer experience, and to apply that understanding to adapt their products and service from what they learn.

2) What is the three-way symbiotic relationship between IoT, AI, and Cloud?

a) AI consumes the data produced by IoT devices

b) IoT delivers the data, AI powers the insights, and both emerging technologies leverage cloud's scalability and processing power

c) Power, scale, dynamic nature, and economics of the cloud resources

d) Making sense of the endless streams of data from IoT devices

**Answer**

This is the three-way relationship between IoT, AI, and Cloud.

**Cloud Computing service and Deployment Models:**

**Service Models:**

Iaas: (Data Centres, Cooling, Power, Networking & security, Servers & Storage)

Paas: (OS, Development tools, Databases, Business Analytics)

Saas: (Applications, Data)

**I) Iaas (IS) (Information as a Service): (Managed by provider infrastructure)**

It is the fastest growing cloud model, and a form of cloud computing that delivers fundamental: (Compute, Network, Storage) to consumers on-demand, over the internet, on a pay-as-you-go basis. The cloud provider hosts the infrastructure components traditionally present in an on-premises data center as well as the virtualization or hypervisor layer

VM’s are installed which has data, applications, middleware, OS, Hypervisor. And Storage with backups and workloads.

Key Components of cloud infrastructure:

1. Physical data centers (Physical machines)
2. Compute (compute memory storage)
3. Network (virtualization or API’s)
4. Storage (Object, file and block)

Applications:

1. Test and development (to set-up test and development environments faster, helping developers focus more on business logic than infrastructure management.)
2. Business Continuity and Disaster Recovery (Requires a significant amount of technology and staff investments. Make applications and data accessible as a usual during a disaster or outage)
3. Faster Deployment and scaling (To deploy web applications faster and scale infrastructure up and down as demand fluctuate)
4. High performance (To solve complex problems involving millions of variables and calculations)
5. Big Data Analysis (Pattern, trends and associations requires a huge amount of processing power, provides the required high-performance computing but also makes in economically viable)

**II) Paas (PS)(Platform as a service): (Managed by provider)**

It is a cloud computing model that provides a complete application platform to Develop, Deploy, Run, Manage. The installation, Configuration, Operation of Application Infrastructure:

1. Servers
2. Networks
3. Storage,
4. Operation system
5. Application runtimes
6. APIs
7. Middleware
8. Databases

Characteristics of Paas:

High level of Abstraction: (Eliminate complexity of deploying applications)

Supports Services and APIs: (Simplify the job of developers)

Run-time environments: (Executes code according to application owner and cloud provider policies.)

Rapid deployments mechanisms: (Deploy, run, and scale applications efficiently)

Middleware capabilities (Supports a range of application infrastructure capabilities)

Applications:

1. API developments and Managements
2. Internet of Things (IoT)
3. Business analytics/intelligence
4. Business Process Management (BPM)
5. Master data Management (MDM)

Advantages:

1. Scalability
2. Faster time to market
3. Greater agility and innovation

Paas Available offerings:

1. AWS Elastic Beanstalk
2. Cloud Foundry
3. IBM Cloud Paks
4. Azure
5. RedHat OpenShift
6. Magneto
7. Force.com
8. Apache Stratos

Risks:

Information Security Threats

Dependency on service provider’s infrastructure

Customers lack of control over changes in strategy, service offerings, or tools

**IiI) Saas (SS) (Software as a service)**

Largest segment on the cloud market. It is a cloud offering that provides access to a service provider’s cloud-based software. Tahy include Email and collaboration (Microsoft Office, Gmail), Customer Relationship Management (NetSuite CRM and Salesforce), Human Resources Management (Workdays, SAP Successfactors), Financial Management.

Providers maintain:

1. Servers
2. Databases
3. Application code
4. Security

Providers man0ges Applications:

1. Security
2. Availability
3. Performance

Characteristics:

Multitenant Architecture

Manages privileges and Monitor Data

Security, compliances, Maintenance

Customize applications

Subscription Model

Scalable Resources

Applications:

Organizations are moving to Saas to:

Reduce on-premises IT infrastructure and capital expenditure

Avoid ongoing upgrades, maintenance, and patching

Run Applications with minimal input

Manage websites, marketing, sales, and operations

Gain resilience and business continuity of the cloud provider

Concerns:

Data ownership and data safety

Third-party maintain business-critical data

Needs good internet connection

**IV) Public Cloud Deployment Model:**

Users get access to Servers, Storage, Network, Security and Applications using web consoles and APIs, users can provision the resources and services they need. The cloud provider owns, manages, provisions and maintains the infrastructure. Users don’t own the servers their applications run on or storage their data consumes, or manages the operations of the servers, or manages the operations of the servers, or even determines how the platforms are maintained. It is cost saving as the capital, operational and maintenance expenses for the infrastructure and the facilities they are hosted in. the user doesn’t have any control over the computing environment, subject to the performance and security of the cloud provider’s infrastructure

Virtualized multi-tenant architecture enabling tenants or users to share computing resources. The cloud providers pool of resources, including infrastructure, platforms, and software, are NOT dedicated for use by a single tenant or organization. Virtualized multi-tenant architecture enabling tenants or users to share computing resources. Resources are distributed on an as-needed basis offered through a variety of subscription and pay-as-you-go models.

On-demand resources: (Allowing applications to respond seamlessly to fluctuations in demand)

Economies of scale: (Considering the large number of users that share the centralized resources on-demand)

Highly reliable: (if one physical component fails, the services still runs unaffected on the remaining available components)

Concerns:

Security: Data breaches, data loss, account hijacking, insufficient due to diligence, an system and application vulnerability

Data sovereignty compliance: It’s increasingly critical for companies to be compliant with data sovereignty regulations governing the storage, transfer, and security of data

Applications:

1. Building and testing applications, and reducing time-to-market for their products and services.
2. Business with fluctuating capacity and resourcing needs.
3. Build, secondary infrastructures for disaster recovery, data protection, and business continuity.
4. Cloud storage and data management services for greater accessibility, easy distribution, and backing up their data.
5. IT departments are outsourcing the management of less critical and standardized business platforms and applications to public cloud providers.