Unit 1: Introduction to cloud computing

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1.1 Introduction to Cloud Computing

- Nowadays, **Cloud computing** is adopted by every company, whether it is an MNC or a startup many are still migrating towards it because of the cost-cutting, lesser maintenance, and the increased capacity of the data with the help of servers maintained by the cloud providers.

1.1 Introduction to Cloud Computing

- One more reason for this drastic change from the On-premises servers of the companies to the Cloud providers is the '**Pay as you go**' principle-based services provided by them i.e., you only have to pay for the service which you are using.
- The disadvantage On-premises server holds is that if the server is not in use the company still has to pay for it.

What Is Cloud Computing?

- **Cloud Computing** means storing and accessing the data and programs on remote servers that are hosted on the internet instead of the computer's hard drive or local server.
- Cloud computing is also referred to as Internet-based computing, it is a technology where the resource is provided as a service through the Internet to the user.

What Is Cloud Computing?

- The data that is stored can be files, images, documents, or any other storable document.
- The following are some of the Operations that can be performed with Cloud Computing

•Storage, backup, and recovery of data

•Delivery of software on demand

•Development of new applications and services

•Streaming videos and audio

Understanding How Cloud Computing Works?

- Cloud computing helps users in easily accessing computing resources like storage, and processing over internet rather than local hardwares.

•**Infrastructure:** Cloud computing depends on remote network servers hosted on internet for store, manage, and process the data.

Understanding How Cloud Computing Works?

- **On-Demand Acess:** Users can access cloud services and resources based on-demand they can scale up or down the without having to invest for physical hardware.
- **Types of Services:** Cloud computing offers various benefits such as cost saving, scalability, reliability and acessibility it reduces capital expenditures, improves efficiency.

Origins Of Cloud Computing

- Mainframe computing in the 1950s and the internet explosion in the 1990s came together to give rise to cloud computing.
- Since businesses like Amazon, Google, and Salesforce started providing web-based services in the early 2000s.
- The term “cloud computing” has gained popularity.

Origins Of Cloud Computing

- Scalability, adaptability, and cost-effectiveness are to be facilitated by the concept's on-demand internet-based access to computational resources.
- These days, cloud computing is pervasive, driving a wide range of services across markets and transforming the processing, storage, and retrieval of data.

1.2 History and Evolution of Cloud Computing

- Cloud computing allows users to access a wide range of services stored in the cloud or on the Internet.
- **Cloud computing** services include computer resources, data storage, apps, servers, development tools, and **networking protocols**.
- It is most commonly used by IT companies and for business purposes.

Evolution of Cloud Computing

- The phrase “Cloud Computing” was first introduced in the 1950s to describe internet-related services, and it evolved from distributed computing to the modern technology known as **cloud computing**.
- Cloud services include those provided by Amazon, Google, and Microsoft.

Evolution of Cloud Computing

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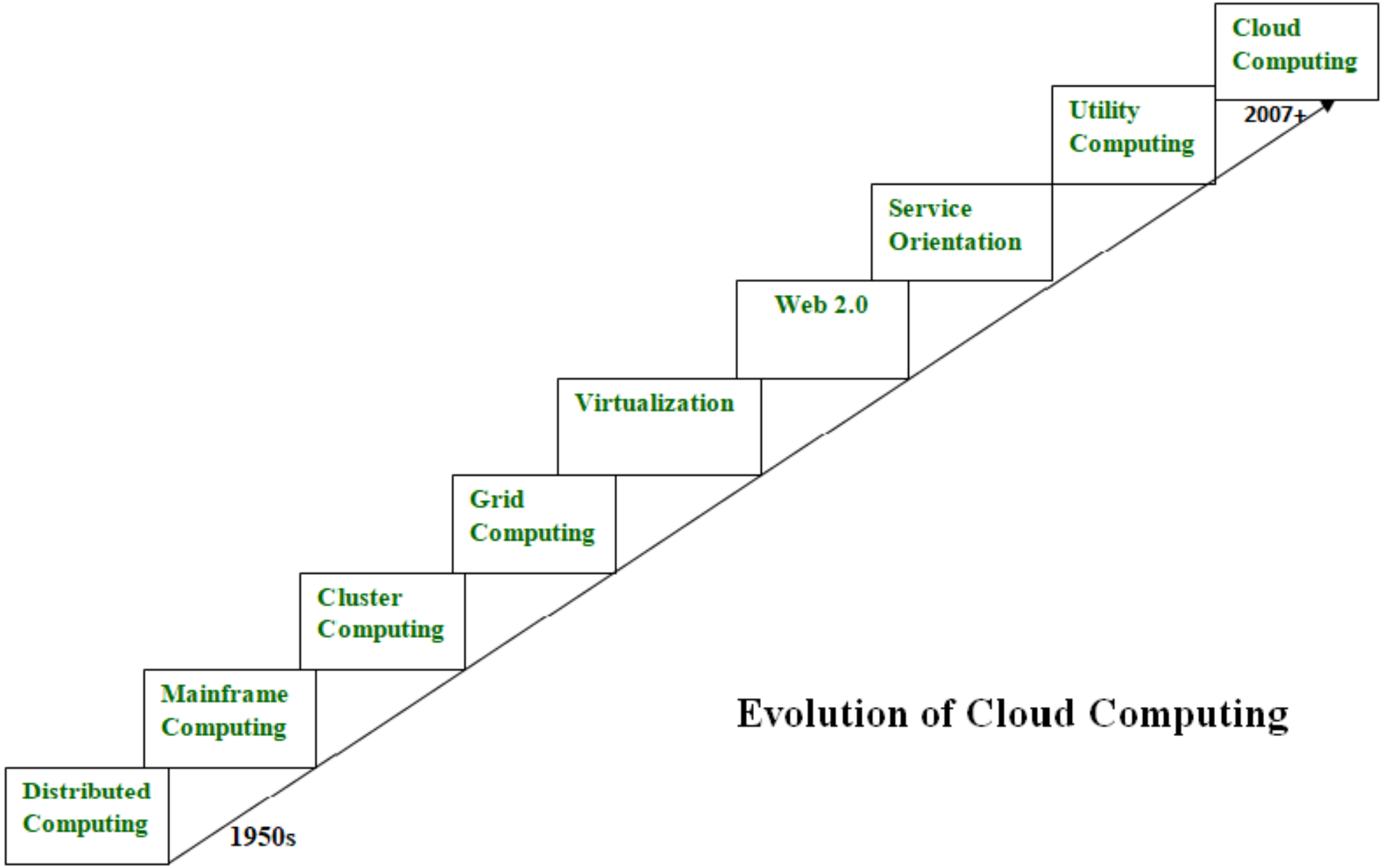

Evolution of Cloud Computing

Distributed Systems

- Distributed System is a composition of multiple independent systems but all of them are depicted as a single entity to the users.
- The purpose of distributed systems is to share resources and also use them effectively and efficiently.
- Distributed systems possess characteristics such as scalability, concurrency, continuous availability, heterogeneity, and independence in failures.
- But the main problem with this system was that all the systems were required to be present at the same geographical location.
- Thus to solve this problem, distributed computing led to three more types of computing and they were-Mainframe computing, cluster computing, and grid computing.

Mainframe Computing

- Mainframes which first came into existence in 1951 are highly powerful and reliable computing machines.
- These are responsible for handling large data such as massive input-output operations.
- Even today these are used for bulk processing tasks such as online transactions etc.
- These systems have almost no downtime with high fault tolerance.
- After distributed computing, these increased the processing capabilities of the system.
- But these were very expensive.
- To reduce this cost, cluster computing came as an alternative to mainframe technology.

Cluster Computing

- In 1980s, cluster computing came as an alternative to mainframe computing.
- Each machine in the cluster was connected to each other by a network with high bandwidth. These were way cheaper than those mainframe systems.
- These were equally capable of high computations.
- Also, new nodes could easily be added to the cluster if it was required.
- Thus, the problem of the cost was solved to some extent but the problem related to geographical restrictions still pertained.
- To solve this, the concept of grid computing was introduced.

Grid Computing

- In 1990s, the concept of grid computing was introduced.
- It means that different systems were placed at entirely different geographical locations and these all were connected via the internet.
- These systems belonged to different organizations and thus the grid consisted of heterogeneous nodes.
- Although it solved some problems but new problems emerged as the distance between the nodes increased.
- The main problem which was encountered was the low availability of high bandwidth connectivity and with it other network associated issues.
- Thus. cloud computing is often referred to as “Successor of grid computing”.

Virtualization

- Virtualization was introduced nearly 40 years back.
- It refers to the process of creating a virtual layer over the hardware which allows the user to run multiple instances simultaneously on the hardware.
- It is a key technology used in cloud computing.
- It is the base on which major cloud computing services such as Amazon EC2, VMware vCloud, etc work on.
- Hardware virtualization is still one of the most common types of virtualization.

Web 2.0

- Web 2.0 is the interface through which the cloud computing services interact with the clients.
- It is because of Web 2.0 that we have interactive and dynamic web pages.
- It also increases flexibility among web pages.
- Popular examples of web 2.0 include Google Maps, Facebook, Twitter, etc.
- Needless to say, social media is possible because of this technology only.
- It gained major popularity in 2004.

Service Orientation

- A service orientation acts as a reference model for cloud computing.
- It supports low-cost, flexible, and evolvable applications.
- Two important concepts were introduced in this computing model.
- These were Quality of Service (QoS) which also includes the SLA (Service Level Agreement) and Software as a Service (SaaS).

Utility Computing

- Utility Computing is a computing model that defines service provisioning techniques for services such as compute services along with other major services such as storage, infrastructure, etc which are provisioned on a pay-per-use basis.

Cloud Computing

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- Cloud computing is also referred to as Internet-based computing, it is a technology where the resource is provided as a service through the Internet to the user.
- The data that is stored can be files, images, documents, or any other storable document.

1.3 Merits of Cloud computing

- **Data Backup and Restoration:**

Cloud computing offers a quick and easy method for data backup and restoration. Businesses may simply access and restore their data in the event of any data loss or system failure by keeping it in the cloud.

- **Improved Collaboration:**

Collaboration is improved because cloud technologies make it possible for teams to share information easily. Multiple users may work together on documents, projects, and data thanks to shared storage in the cloud, enhancing productivity and teamwork.

- **Excellent Accessibility:**

Access to information stored in the cloud is made possible. Users can access their data from anywhere in the world with an internet connection, making remote work, flexibility, and effective operations possible.

1.3 Merits of Cloud computing

Cost-effective Maintenance:
Organizations using cloud computing can save money on both hardware and software upkeep. Because cloud service providers manage the maintenance and updates, businesses no longer need to make costly infrastructure investments or set aside resources for continuous maintenance.

Updates:

Cloud service providers take care of infrastructure upkeep, security patches, and updates, freeing organizations from having to handle these duties themselves.

This frees up IT teams' time and resources to work on higher-value projects like application development, data analysis.

Mobility:

Cloud computing makes it simple for mobile devices to access data. Utilizing smartphones and tablets, users can easily access and control their cloud-based applications and data, increasing their mobility and productivity.

1.3 Merits of Cloud computing

Pay-per-use Model:

Cloud computing uses a pay-per-use business model that enables companies to only pay for the services they really utilize. This method is affordable, eliminates the need for up-front investments, and offers budget management flexibility for IT.

Scalable Storage Capacity:

Businesses can virtually store and manage a limitless amount of data in the cloud. The cloud offers a scalable and centralized storage option for all types of data, including documents, photos, audio, video, and other kinds of files.

Enhanced Data Security:

Cloud computing places a high focus on data security. To guarantee that data is handled and stored safely, cloud service providers offer cutting-edge security features like encryption, access limits, and regular security audits. Businesses can rest easy knowing that their important data is secure.

1.3 Merits of Cloud computing

Disaster Recovery and Business Continuity:

Cloud computing provides reliable options for these two issues. Businesses can quickly bounce back from any unforeseen disasters or disruptions thanks to data redundancy, backup systems, and geographically dispersed data centers.

Green Computing:

By maximizing the use of computer resources, lowering energy use, and minimizing e-waste, cloud computing may support environmental sustainability.

1.4 Obstacles for cloud technology

- **Vendor Reliability and Downtime:**

Because of technological difficulties, maintenance needs, or even cyberattacks, cloud service providers can face outages or downtime. Users may not be able to access their data or applications during these times, which can interfere with business operations and productivity.

- **Internet Dependency:**

A dependable and fast internet connection is essential for cloud computing. Business operations may be delayed or interrupted if there are connectivity problems or interruptions in the internet service that affect access to cloud services and data.

- **Limited Control and Customization:**

Using standardized services and platforms offered by the cloud service provider is a common part of cloud computing. As a result, organizations may have less ability to customize and control their infrastructure, applications, and security measures. It may be difficult for some organizations to modify cloud services to precisely match their needs if they have special requirements or compliance requirements.

1.4 Obstacles for cloud technology

- **Data Security and Concerns about Privacy:**

Concerns about data security and privacy arise when sensitive data is stored on the cloud. Businesses must have faith in the cloud service provider's security procedures, data encryption, access controls. Unauthorized access to data can have financial loss, reputational harm, and legal obligations.

- **Dependency on Service Provider:**

When an organization depends on a cloud service provider, it is dependent on that provider's dependability, financial security, and longevity. Users may have disruptions and difficulties switching to alternate options if the provider runs into financial difficulties, changes their pricing policy, or even closes down their services.

1.5 Cloud service provider – role and responsibility

- A **cloud service provider (CSP)** is an organization that offers computing resources and services to businesses and individuals over the internet.
- These services can include storage, computing power, networking, analytics, and more.
- Below are the key **roles and responsibilities** of a cloud service provider:

1.5 Cloud service provider – role and responsibility

Roles:

1. **Resource Provider:**
    1. Offer infrastructure, platform, or software resources (IaaS, PaaS, SaaS) to meet client needs.
2. **Enabler of Scalability:**
    1. Provide resources that scale up or down based on demand, ensuring flexibility for businesses.
3. **Technology Innovator:**
    1. Continuously update and enhance offerings with new features and technologies.
4. **Compliance Supporter:**
    1. Help clients meet regulatory and industry standards by providing compliant services.

1.5 Cloud service provider – role and responsibility

Responsibilities:

1. Infrastructure Management

- **Provisioning Resources**: Ensure availability of servers, storage, and network infrastructure.
- **Uptime**: Guarantee high service availability (usually through Service Level Agreements or SLAs).
- **Monitoring and Maintenance**: Continuously monitor systems for performance and proactively address issues.

2. Data Security

- Protect customer data through robust encryption, firewalls, and multi-layered security measures.
- Manage access controls and ensure proper identity and access management (IAM).

1.5 Cloud service provider – role and responsibility

3. Service Continuity and Disaster Recovery

- Provide reliable backup and recovery solutions.
- Ensure systems are resilient to failures with disaster recovery planning.

4. Technical Support

- Offer 24/7 customer support to resolve technical issues.
- Provide self-service portals, knowledge bases, and community forums for user assistance.

5. Education and Training

- Provide tutorials, certifications, and training resources to customers for effective utilization of services.

1.5 Cloud service provider – role and responsibility

6. Cost Management and Transparency

- Offer clear pricing models and usage reports.
- Provide tools for customers to optimize costs.

7. Innovation and Customization

- Introduce new technologies like AI, ML, and edge computing.
- Offer APIs and customizable solutions for specific business needs.

8. Ecosystem Integration

- Support seamless integration with third-party tools and existing IT infrastructure.
- Facilitate hybrid or multi-cloud strategies if required.

1.5 Cloud service provider – role and responsibility

9. Service Agreement Management

- Define SLAs clearly and ensure adherence to uptime and performance commitments.
- Provide regular updates and communication about system changes or downtimes.

1.6 Cloud service consumer – Expectations

- A **cloud service consumer** refers to an individual or organization that uses the services provided by a cloud service provider.
- Their **expectations** typically revolve around service quality, performance, security, and flexibility.
- Below are the key expectations of cloud service consumers:

1. Reliability and Availability

•High uptime and consistent access to services without interruptions.

•Clear Service Level Agreements (SLAs) outlining performance and availability guarantees.

2. Scalability and Flexibility

•The ability to scale resources (compute, storage, etc.) up or down based on demand.

•Flexible pricing models, including pay-as-you-go options, to match resource usage.

1.6 Cloud service consumer – Expectations

3. Data Security and Privacy

•Robust security measures, including encryption, firewalls, and access controls.

•Compliance with industry-specific standards (e.g., GDPR, HIPAA) to ensure data privacy.

•Transparent policies about where and how data is stored and processed.

4. Cost-effectiveness

•Competitive pricing for services, with no hidden costs.

•Tools to monitor and optimize resource usage to control expenses.

5. Performance

•High-speed networks, fast data processing, and low-latency operations.

•Regular updates and upgrades to ensure efficient service performance

6. Customization and Integration

•Support for integration with existing IT infrastructure and third-party tools.

•Customizable services to meet unique business requirements.

1.6 Cloud service consumer – Expectations

7. Easy Deployment and Management

•Intuitive platforms or dashboards for managing cloud resources.

•Self-service portals for provisioning and de-provisioning resources.

8. Support and Guidance

•24/7 technical support to resolve issues quickly.

•Documentation, tutorials, and training resources to help users maximize the value of cloud services.

9. Data Backup and Disaster Recovery

•Built-in solutions for automated backups and data recovery.

•Clear disaster recovery plans to ensure business continuity during outages.

10. Transparency

•Real-time monitoring and reporting tools for tracking resource usage and performance.

•Clear and detailed billing and invoicing.

1.7 Service level agreement (SLA)

- A **Service Level Agreement (SLA)** is a formal contract or agreement between a **cloud service provider (CSP)** and a **cloud service consumer**, defining the expected level of service, performance metrics, responsibilities, and remedies in case of non-compliance.
- It is a critical document in cloud computing that ensures transparency and trust between the provider and the consumer.

1.7 Service level agreement (SLA)

Key Components of an SLA

1.Service Description

1. Details the services provided, including their scope and limitations.
2. Defines what is included (e.g., compute power, storage) and what is excluded.

2.Performance Metrics

1. Specifies measurable benchmarks, such as:
    1. **Uptime/Availability**: e.g., "99.9% availability per month."
    2. **Response Time**: Speed of service response to requests or queries.
    3. **Latency**: Network or processing delays tolerated.
    4. **Throughput**: The data transfer rate or number of requests handled.

1.7 Service level agreement (SLA)

- **Responsibilities**
- **Provider Responsibilities**:
  - Maintain infrastructure, security, and performance.
  - Monitor systems and provide updates or notifications.
- **Consumer Responsibilities**:
  - Use services according to terms, manage access credentials, and follow security guidelines.
- **Monitoring and Reporting**
- Specifies how performance metrics will be monitored.
- Defines reporting frequency (e.g., daily, weekly) and formats for presenting performance data.
- **Downtime and Maintenance**
- Outlines acceptable maintenance windows.
- Details how scheduled downtime or outages are communicated in advance.

1.7 Service level agreement (SLA)

- **Disaster Recovery and Backup**
- Defines data backup frequency and recovery time objectives (RTO).
- Ensures business continuity plans in case of service interruptions.
- **Penalties for Non-Compliance**
- Remedies or compensations for failing to meet SLA terms, such as:
    - **Service Credits**: Discounts or credits for future usage.
    - **Refunds**: Partial or full refunds for affected services.
- **Exclusions**
- Specifies scenarios outside the provider's control that are not covered (e.g., force majeure, user misconfigurations).
- **Change Management**
- Process for amending or updating the SLA to accommodate changes in services or consumer needs.
- **Termination Conditions**
- Circumstances under which the SLA or service can be terminated (e.g., breach of agreement, non-payment).

Importance of SLAs in Cloud Services

- **Transparency**: Clearly defines what the consumer can expect from the provider.
- **Accountability**: Holds the provider accountable for service quality and performance.
- **Consumer Protection**: Provides remedies for non-compliance, ensuring consumer satisfaction.
- **Benchmark for Evaluation**: Helps consumers compare providers based on promised SLAs.

Assignment

1. What is Cloud Computing?
2. How did Cloud Computing evolve?
3. What are the key benefits of Cloud Computing?
4. What are the obstacles to adopting cloud technology?
5. What are some common vulnerabilities in the cloud?
6. What is Cloud Migration?
7. What is the role of a Cloud Service Provider?
8. What are the primary expectations of a Cloud Service Consumer?
9. What is a Service Level Agreement (SLA)?
10. What are common performance metrics in an SLA?