What is Cloud Computing?

- **Cloud computing** is the on-demand availability of computer system resources, especially data storage (cloud storage) and computing power, without direct active management by the user

- For the Cloud you do not need to manage your own compute resources

History of Cloud Computing

1. Before Computing was come into existence, client Server Architecture was used where all the data and control of client resides in Server side. If a single user wants to access some data, firstly user need to connect to the server and after that user will get appropriate access.
2. After Client Server computing, Distributed Computing was come into existence, in this type of computing all computers are networked together with the help of this, user can share their resources when needed.
3. During 1961, John MacCarthy delivered his speech at MIT that “Computing Can be sold as a Utility, like Water and Electricity.” According to John MacCarthy it was a brilliant idea. But people at that time don't want to adopt this technology. Later this is implemented by Salesforce.com in 1999.
4. In 2002, Amazon started Amazon Web Services (AWS), Amazon will provide storage, computation over the internet. In 2006 Amazon will launch Elastic Compute Cloud Commercial Service which is open for Everybody to use.
5. After that in 2009, Google Play also started providing Cloud Computing Enterprise Application as other companies will see the emergence of cloud Computing they also started providing their cloud services. Thus, in 2009, Microsoft launch Microsoft Azure and after that other companies like Alibaba, IBM, Oracle, HP also introduces their Cloud Services. In today the Cloud Computing become very popular and important skill.

Need of Cloud Computing

To build/deploy applications with traditional approach, we need to buy lot of hardware such as servers, operating system and their licenses, firewalls, routers, databases, switches. You require lot of capital expenditure and operational expenditure .

Capital expenditure:- It is the amount of money which you need to invest for buying hardware and software's .

Operational expenditure :- The cost required for maintaining the hardware such as electricity cost, manpower cost, air conditioning cost and so on.

With traditional approach both capex and opex were high.

Benefits of using cloud computing

- It is easier to get back up in cloud.
- It allows us easy and quick access stored information anywhere and anytime.
- It allows us to access data via mobile.
- It reduces both hardware and Software cost, and it is easily maintainable.

Disadvantages of Cloud Computing

- Internet Connectivity – Network connection Dependency (Internet is required)
- Vendor lock-in - Transferring an organization's services from one vendor to another could provide challenges. Moving from one cloud to another might be challenging because different vendors offer various platforms.
- Limited Control - Cloud customers have less control over how services within a cloud infrastructure operate and are carried out because the cloud infrastructure is entirely owned, maintained, and watched over by the service provider.

Real-World Applications of Cloud Computing

1. Online File Storage and Sharing:

- Cloud services like Google Drive, Dropbox, and OneDrive allow users to store files, photos, videos, and other documents online, accessible from any device with an internet connection.
- This eliminates the need for physical storage devices and simplifies file sharing among individuals or teams.

2. Streaming Services:

- Platforms like Netflix, Spotify, and YouTube rely heavily on cloud computing to store and deliver vast libraries of content to millions of users worldwide.
- Cloud infrastructure enables these services to handle the high volume of data and user traffic required for on-demand streaming.

3. Email and Communication Platforms:

- Services like Gmail, Outlook.com, and WhatsApp utilize cloud computing to store and manage user emails, contacts, messages, and other data.
- This allows users to access their communication platforms from any device and location with an internet connection.

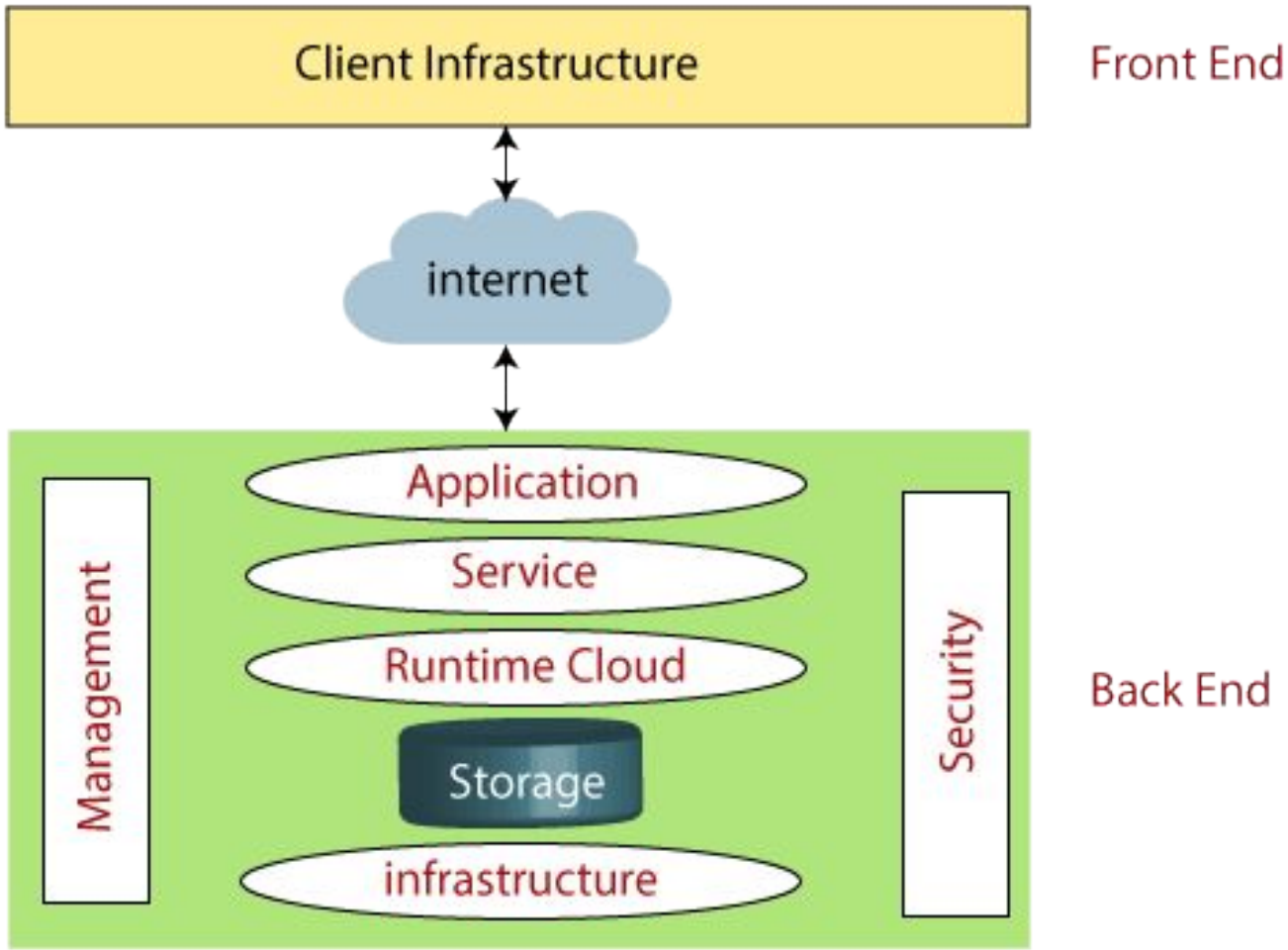
4. Ride-sharing and Transportation:

- Companies like Uber and Ola use cloud computing to manage their platforms, including real-time location tracking, ride requests, payment processing, and driver availability.
- The scalability of cloud computing allows these services to handle fluctuating demand and provide reliable transportation services.

5. Social Media:

- Social media platforms like Facebook, Twitter, and Instagram rely on cloud computing to store and manage user-generated content, posts, messages, and other data.
- This allows users to access their social media accounts and content from anywhere in the world.

Cloud Computing architecture



The front-end

Front-end cloud architecture refers to the user- or client-side of the cloud computing system. It consists of graphic user interfaces (GUIs), dashboards and navigation tools that provide on-demand access to cloud services and resources. Key components include software apps and programs installed on devices (such as., mobile phone, laptop or desktop) to access the cloud platform or service. Accessing a web-based video communications application (for example, Zoom, Webex) via a laptop computer or ordering food through a mobile delivery platform (Uber, Swiggy) are both examples of front-end cloud architecture capabilities.

The back-end

While the front-end includes all elements related to the client (for example, a visitor to an e-commerce site), the back-end (or ‘server-side’) refers to the structuring of the site and the programming of its main functionalities.

Back-end cloud architecture components include the following:

- Applications: Back-end apps are the software or platforms that deliver the client service requests on the front-end.
- Cloud computing service: The back-end service provides utility in cloud architecture and manages the accessibility of cloud-based resources (such as, cloud-based storage services, application development services, web services, security services, and more).
- Cloud runtime: Runtime provides the environment (operating system, hardware, memory) for executing or running services. Virtualization plays a crucial role in enabling multiple runtimes on the same server.
- Cloud storage: Cloud storage in the back-end refers to the flexible and scalable storage service and management of data stored to carry out applications.
- Infrastructure: Infrastructure consists of all the back-end resources or hardware (such as, servers, databases, CPU (central processing unit), network devices like routers and switches, graphics processing unit (GPU), and so on.) and all the software used to run and manage cloud-based services.
- Management software: Middleware coordinates communication between the front-end and back-end in a cloud computing system. This component allows for the delivery of services in real-time to ensure smooth front-end user experiences.
- Security tools: Security tools provide the back-end security (also referred to as service-side security) for potential cyberattacks or system failures. Virtual firewalls protect web applications, prevent data loss and ensure backup and disaster recovery.

Cloud computing Deployment models

- **Public cloud** is a cloud service offered to multiple customers by a cloud provider.

- **Private** cloud is defined as computing services offered either over the Internet or a private internal network and only to select users instead of the general public.

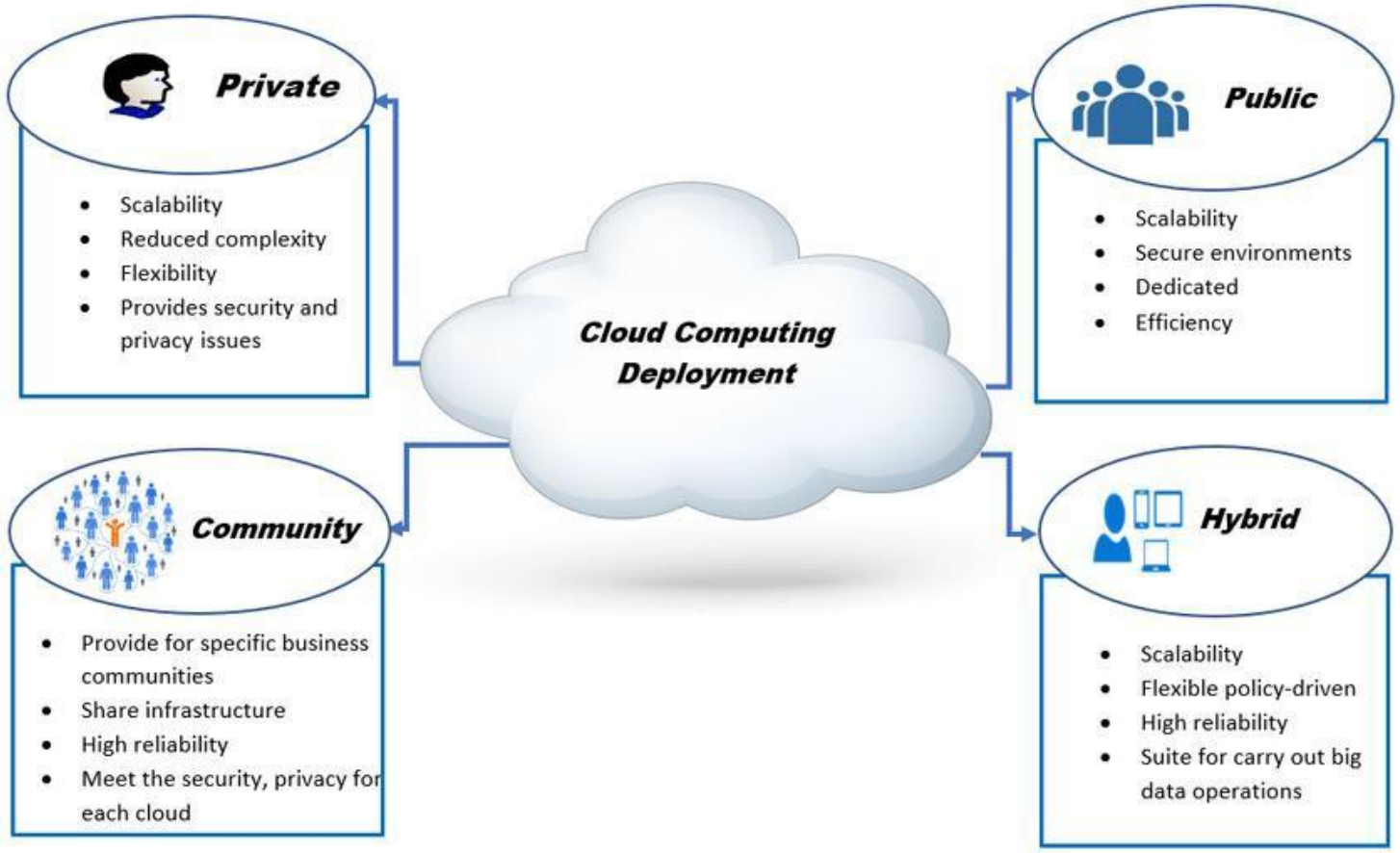
- **Community cloud** is a collaborative effort in which infrastructure is shared between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally.

Cloud computing Deployment models

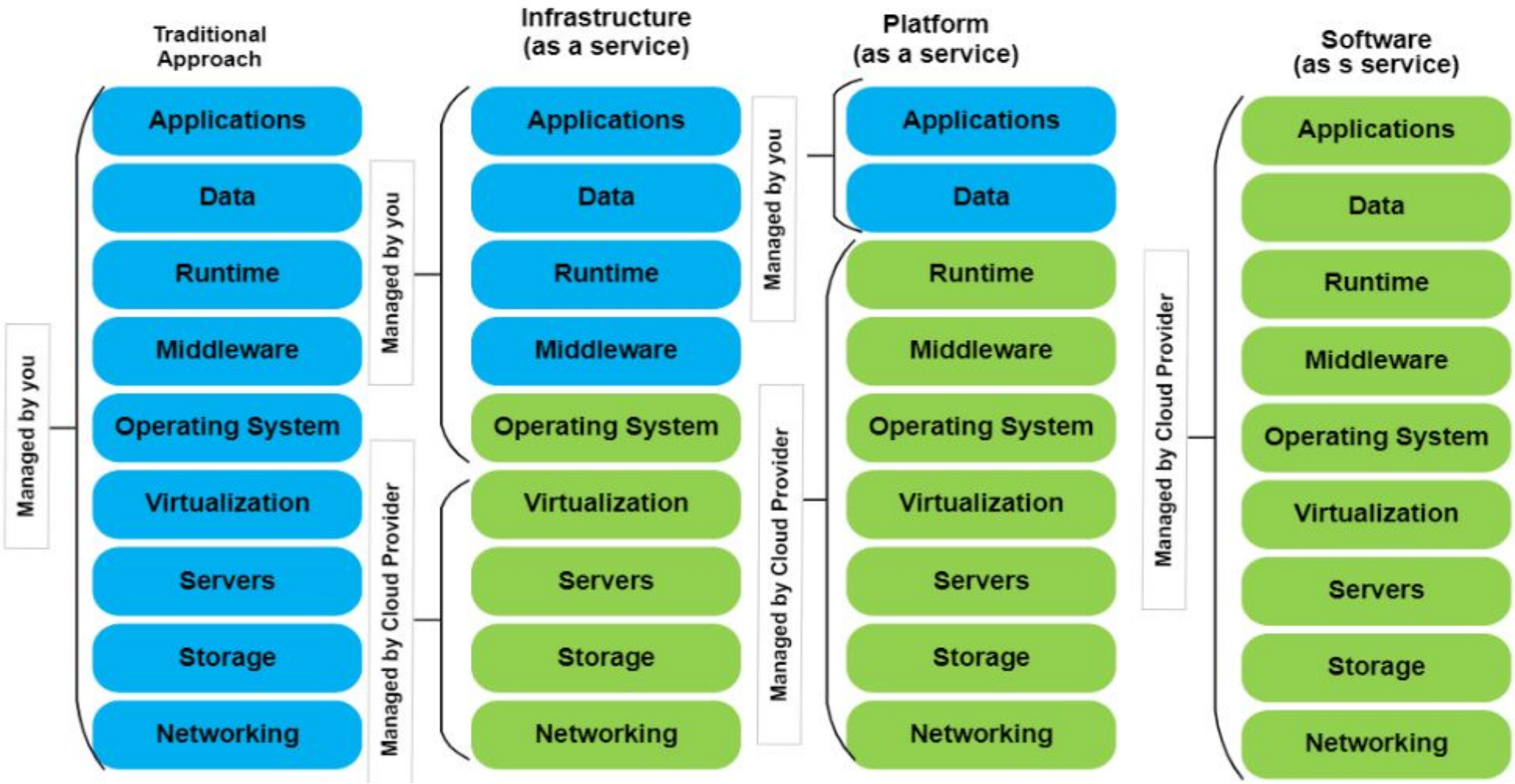
- **Hybrid cloud** refers to a mixed computing, storage, and services environment made up of on-premises infrastructure, private cloud services, and a public cloud—such as Amazon Web Services (AWS) or Microsoft Azure—with orchestration among the various platforms.
- Using a combination of public clouds, on-premises computing, and private clouds in your data centre
- means that you have a hybrid cloud infrastructure.

- **Multi-cloud** is a model of cloud computing where an organization utilizes a combination of clouds— which can be two or more public clouds, two or more private clouds, or a combination of public, private and edge clouds—to distribute applications and services

Cloud computing deployment models



Cloud computing Service models



Few Relevant Terms

Virtual Machine

Its is a closely detached software device that could run its own operating system and application as if it is running on a physical machine. It contains its own virtual RAM,CPU,Disk,Network etc.

Hypervisor

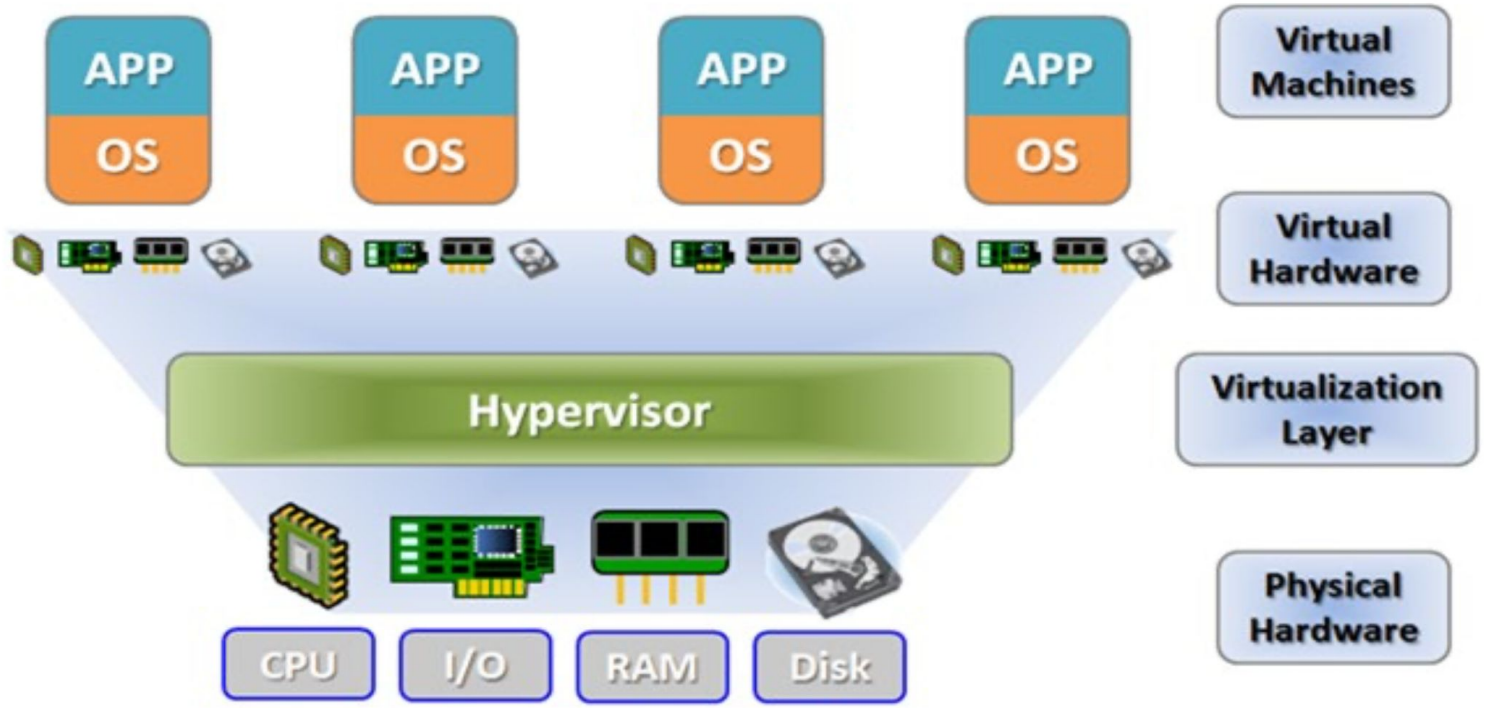
It is a thin layer of software that provides virtual partitioning abilities that run directly on hardware, but underneath higher-level virtualization services.

Virtual machine monitor

This can be a part of hypervisor or can be a separate software entity, that runs between the host operating system and hypervisor.

Virtual Environment

Virtualized Environment Looks like



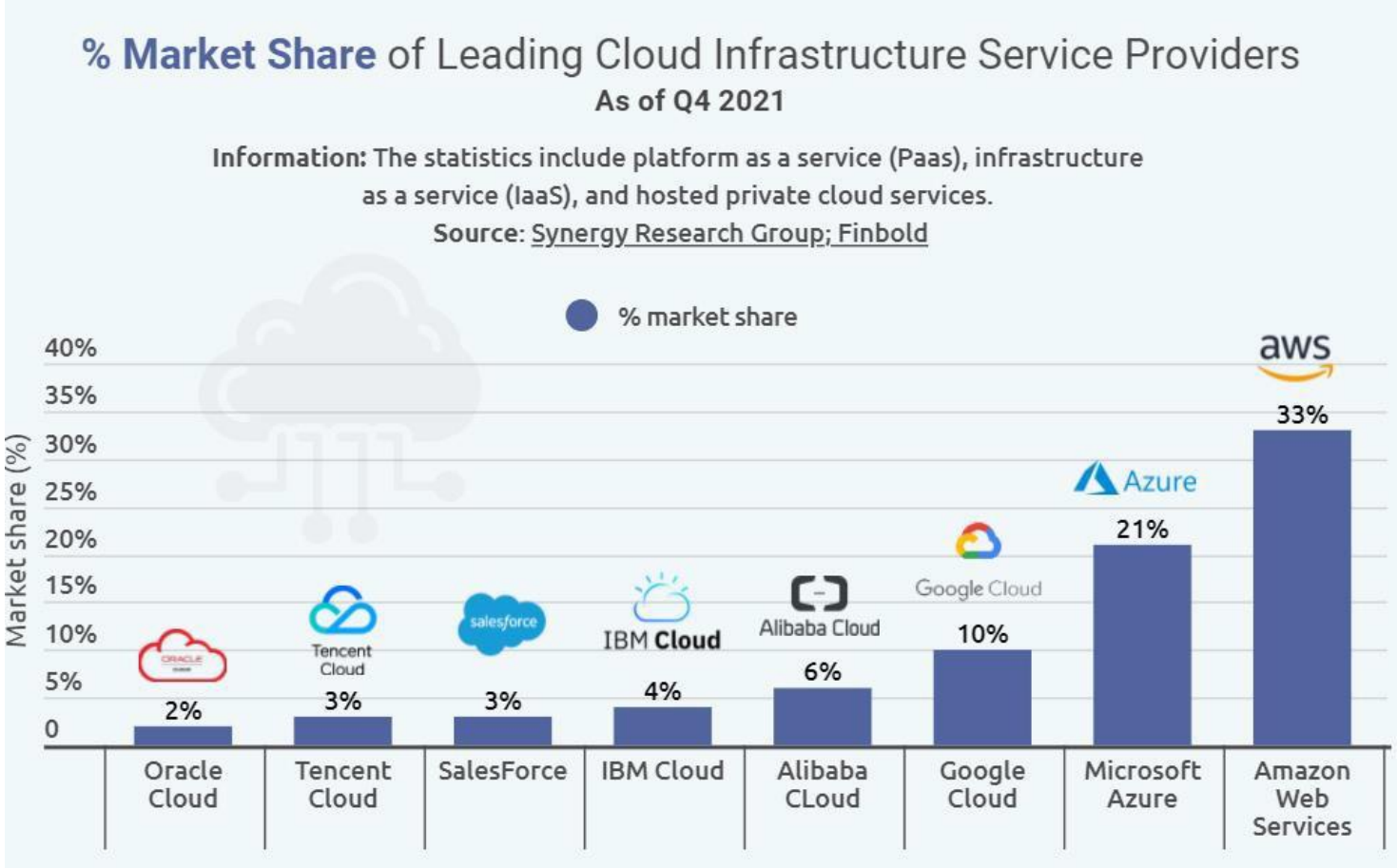
Role of Virtualization

- Virtualization is fundamental to cloud computing.
- It Creates a secure, customizable and isolated execution environment.
- Hardware virtualization provides virtual resources like Virtual machines, Storage, Virtual Memory and virtual networks.
- System software enabling the virtualization is known as Hypervisor. Also known as Virtual machine manager

Why Virtualization?

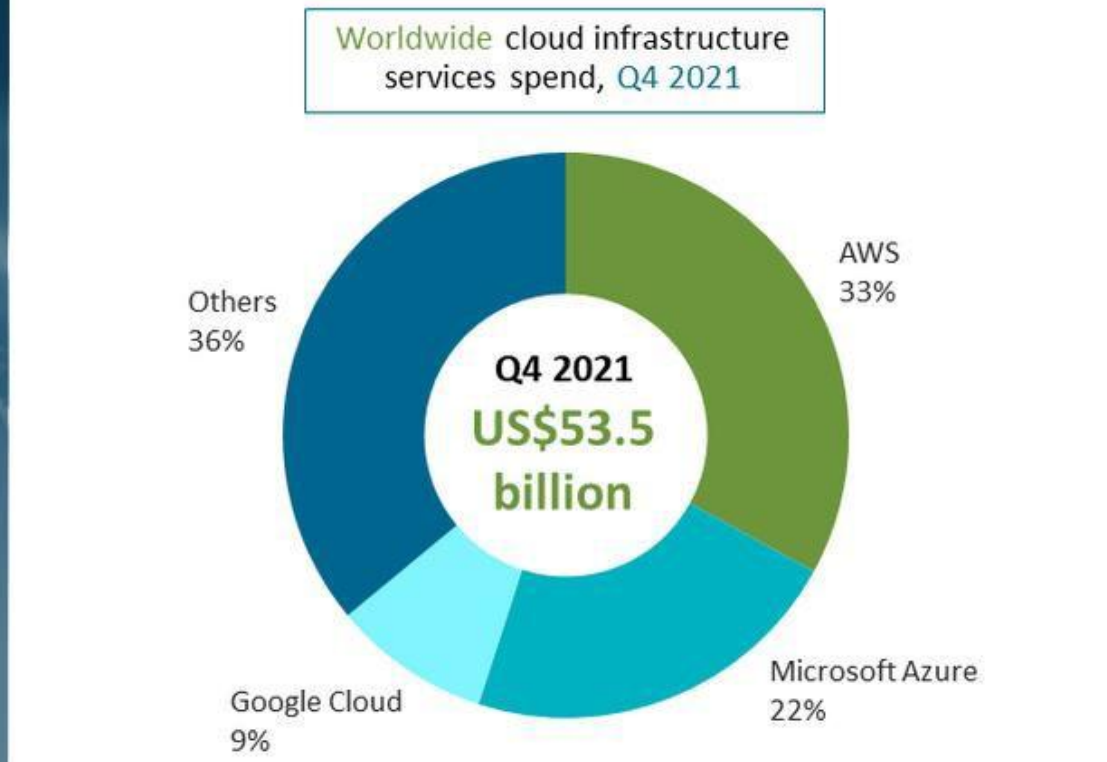
- In order to have a lab environment set up, we have to run multiple operating systems.
- Unlike physical data centres, the cost involved in procuring hardware, power utilization, and networking in virtual infrastructure is reduced.
- Server provisioning becomes easier. A single server can host multiple VMs and each VM can run different applications.
- Server capacity utilization has improved.

Cloud providers



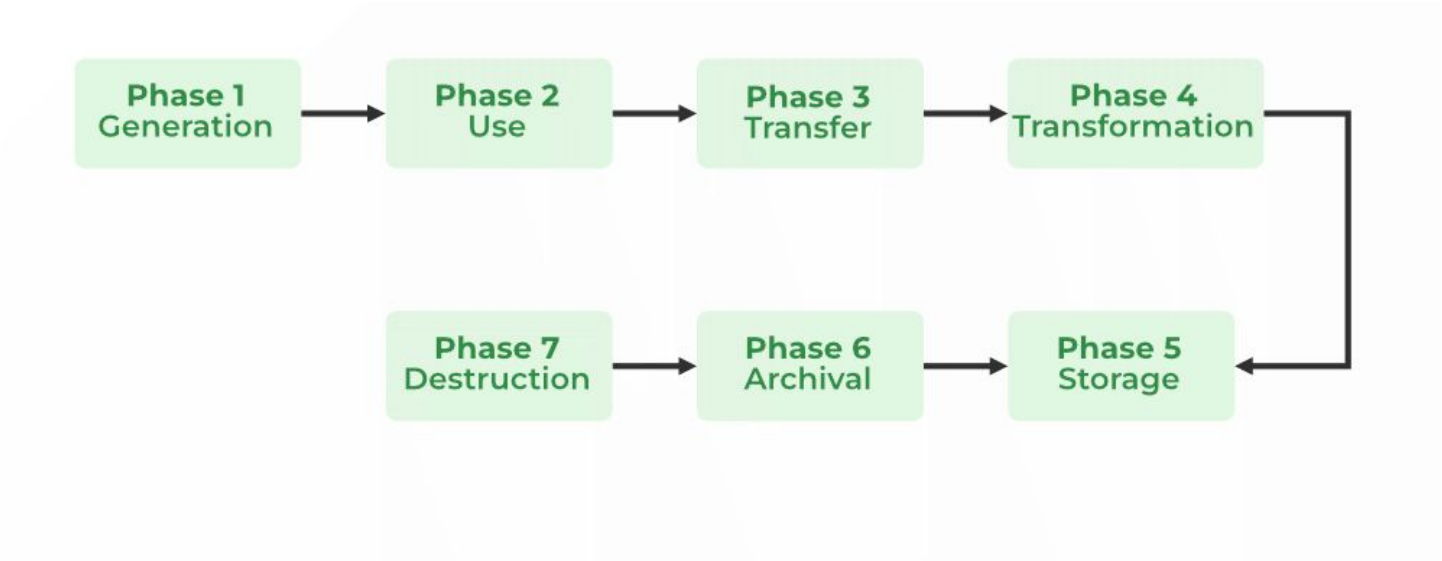
Cloud providers

The top three cloud service providers accounted for 61% of total cloud spend in 2021



What is Cloud Data Lifecycle?

The cloud data lifecycle encompasses the various phases that a specific piece of data undergoes, starting with its initial creation or capture and concluding with its eventual archival or deletion when it’s no longer needed.



Generation of the Information

- **Ownership:** Who in the organization owns the user's data, and how is the ownership of data maintained within the organization?
- **Classification**: How and when is personally identifiable information classified? Are there any limitations on cloud computing on specific data cases?
- **Governance:** To ensure that personally identifiable information is managed and protected throughout its life-cycle

Use of the Information

- **Internal v/s External:** Are personally identifiable information used only inside the organization or they are used outside the organization?
- **Third Party:** Is the personally identifiable information shared with third parties(organizations besides the parent company having data).
- **Appropriateness:** Is the personally identifiable information of users being correctly used for which it is intended?
- **Discovery:** Is the information stored in the cloud will enable the organization to comply with legal requirements in legal proceedings?

Transfer of the Data

- **Public v/s Private Network:** Are the public networks secure(protected) enough while the personally identifiable information is transferred to the cloud?
- **Encryption Requirements:** Is the personally identifiable information encrypted while transmitted via a public network?
- **Access Control:** Appropriate access control measures should be taken on personally identifiable information when it is in the cloud.

Transformation of Data

- **Derivation:-** While data is being transformed in the cloud, it should be protected and user limitations should be imposed on it.
- **Aggregations:-** The data should be aggregated so that we can ensure that it is no longer identifying any personal individual.
- **Integrity:-** Is the integrity of personally identifiable information maintained while it is in the cloud?

Storage of Data

- **Access Control:** Appropriate access controls should be used on personally identifiable information while it is stored in the cloud so that only individuals with a need to know will be able to access it.
- **Structured v/s Unstructured:** How the stored data will enable the organizations in accessing and managing the data in the future.
- **Integrity/Availability/Confidentiality:** How data integrity, availability, and confidentiality are maintained in the cloud?
- **Encryption:** The personally identifiable information should be encrypted while it is in the cloud.

Archival

- **Legal and Compliance:** Personally identifiable information should have specific requirements that will instruct how long the data should be stored and archived.
- **Off-site Considerations:** Does the cloud service provider have the ability for long-term off-site storage and should also support the archival requirement?
- **Media Concerns:** Who will control the media and what is the organization's ability to recover in such cases when the media is lost?
- **Retention:** For how long the data should be retained on the cloud by the cloud service providers?

Destruction of the Data

- **Secure:** Does the cloud service providers destroy the personally identifiable information obtained by the customers to avoid a breach of information?
- **Complete:** Does the personally identifiable information be completely destroyed? (erase the data, or it can be recovered)