UNIT 1

UNIT 1

(1) CLOUD COMPUTING

Defining Cloud Computing Cloud computing takes the technology, services, and applications that are similar to those on the Internet and turns them into a self-service utility. The use of the word "cloud" makes reference to the two essential concepts:

Abstraction: Cloud computing abstracts the details of system implementation from users and developers. Applications run on physical systems that aren't specified, data is stored in locations that are unknown, administration of systems is outsourced to others, and access by users is ubiquitous.

Virtualization: Cloud computing virtualizes systems by pooling and sharing resources. Systems and storage can be provisioned as needed from a centralized infrastructure, costs are assessed on a metered basis, multi-tenancy is enabled, and resources are scalable with agility

To help clarify how cloud computing has changed the nature of commercial system deployment, consider these three examples:

Google: In the last decade, Google has built a worldwide network of data centers to service its search engine. In doing so Google has captured a substantial portion of the world's advertising revenue. That revenue has enabled Google to offer free software to users based on that infrastructure and has changed the market for user-facing software.

Azure Platform: Microsoft is creating the Azure Platform. It enables .NET Framework applications to run over the Internet as an alternate platform for Microsoft developer software running on desktops.

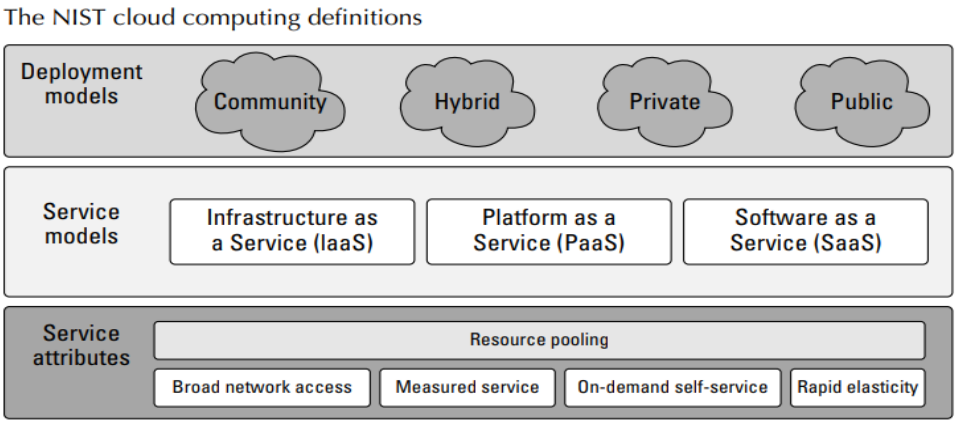
Amazon Web Services: One of the most successful cloud-based businesses is Amazon Web Services, which is an Infrastructure as a Service offering that lets you rent virtual computers on Amazon's own infrastructure

(2) NIST (NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY)

NIST has developed guidelines and drafted them into a formal publication available specifically for cloud adopters. These include a roadmap for organizations in depicting the ideal methods by which an organization can transform their current enterprise IT to the cloud.

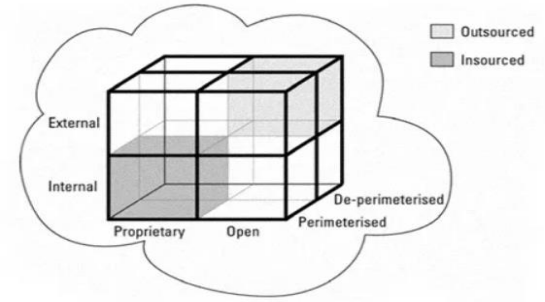
The NIST model The United States government is a major consumer of computer services and, therefore, one of the major users of cloud computing networks. The U.S. National Institute of Standards and Technology (NIST) has a set of working definitions that separate cloud computing into service models and deployment models.

The NIST model originally did not require a cloud to use virtualization to pool resources, nor did it absolutely require that a cloud support multi-tenancy in the earliest definitions of cloud computing. Multi-tenancy is the sharing of resources among two or more clients. The latest version of the NIST definition does require that cloud computing networks use virtualization and support multi-tenancy



(3) CLOUD CUBE MODEL

There is an open-group association Jericho Forum & their focus is on how to protect and secure cloud network. They put forward a model that helps to categorize a cloud network based on four-dimensional factors. The figure is drawn below showing the Cloud Cube model.



As the name Four-Dimensional, the working is also categorized into four parts viz:

1. **Physical Location of Data**: The location of data may be Internal (I) / External (E)which ultimately defines the organization's boundary.
2. **Ownership**: Ownership is Proprietary (P) / Open (O) is a measurement for not only ownership of technology but also its interoperability, use of data & ease of data-transfer & degree of vendor's application's lock-in.
3. **Security Range**: is Perimeterised (Per) / De-perimiterised (D-p) which measures whether the operations are inside or outside the security boundary, firewall, etc.
4. **Sourcing**: In-sourcing or out-sourcing; which defines whether the customer or the service provider provides the service.

Taken together, the fourth dimension corresponds to two different states in the eight possible cloud forms: Per (IP, IO, EP, EO) and D-p (IP, IO, EP, EO). The sourcing dimension addresses the deliverer of the service. What the Cloud Cube Model is meant to show is that the traditional notion of a network boundary being the network's firewall no longer applies in cloud computing.

The Jericho Forum has designed the Cloud Cube Model to help select cloud formations for security cooperation. Their fascinating new cloud model helps IT managers and business tycoons assess the benefits of cloud computing. The Cloud Cube Model looks at the several different "cloud formations". They amount to the cloud service and deployment models. The sourcing dimension addresses the delivery of service. The Cloud Cube Model may be designed to let users show that the traditional notion of network ranges & its boundaries with network firewall no longer applies in Cloud computing.

(4) DEPLOYMENT MODELS

1. PUBLIC CLOUD

- Public Cloud provides a **shared platform** that is the services offered are made available to anyone, from anywhere, and at any time through the Internet..
- Public cloud operated on the **pay-as-per-use model** and administrated by the **third party**, i.e., Cloud service provider.
- From a structural point of view they are a distributed system.
- In public clouds one or more datacenters connected together.
- In the Public cloud, the same storage is being used by multiple users at the same time.
- Public cloud is **owned, managed,** and **operated** by businesses, universities, government organizations, or a combination of them.
- Amazon Elastic Compute Cloud (EC2), Microsoft Azure, IBM's Blue Cloud, Sun Cloud, and Google Cloud are examples of the public cloud.

Advantages

1. Flexible
2. Reliable and Scalability : Public cloud offers scalable (easy to add and remove) and reliable (24*7 available) services to the users at an affordable cost.
3. High Scalable
4. Low cost
5. Place independence : Public cloud is location independent because its services are offered through the internet

Disadvantages

1. Less Secured
2. Poor Customizable
3. Performance: In the public cloud, performance depends upon the speed of internet connectivity.

2. PRIVATE CLOUD

- Private cloud is also known as an **internal cloud** or **corporate cloud**.
- In private cloud sensitive informations are kept in house.
- Private cloud provides computing services to a **private internal network (within the organization)** and **selected users** instead of the general public.
- Private cloud provides a **high level of security** and **privacy** to data through firewalls and internal hosting. It also ensures that operational and sensitive data are not accessible to third-party providers.
- HP Data Centers, Microsoft, Elastra-private cloud, and Ubuntu are the example of a private cloud.

Advantages

1. Highly private and secured: Private cloud resource sharing is highly secured.
2. Control Oriented: Private clouds provide more control over their resources than public clouds as it can be accessed within the organization's boundary.

Disadvantages

1. Poor scalability: Private type of clouds is scaled within internal limited hosted resources.
2. Costly: It provides secured and more features, so it's more expensive than a public cloud.
3. Pricing: is inflexible; i.e., purchasing new hardware for up-gradation is more costly.
4. Restriction: It can be accessed locally within an organization and is difficult to expose globally.

3. HYBRID CLOUD

- Hybrid cloud is a combination of **public and private** clouds.
  Hybrid cloud = public cloud + private cloud
- The main aim to combine these cloud (Public and Private) is to create a unified, automated, and well-managed computing environment.
- In the Hybrid cloud, **non-critical activities** are performed by the **public cloud** and **critical activities** are performed by the **private cloud**.
- Mainly, a hybrid cloud is used in finance, healthcare, and Universities.
- The best hybrid cloud provider companies are **Amazon, Microsoft, Google, Cisco,** and **NetApp.**

Advantages

1. Flexible
2. Secure
3. Cost-Effective
4. Rich Scalable
5. Risk Management : Hybrid cloud provides an excellent way for companies to manage the risk.

Disadvantages

1. Complex networking problem
2. Organization's security Compliance
3. Infrastructure Compatibility : Infrastructure compatibility is the major issue in a hybrid cloud. With dual-levels of infrastructure, a private cloud controls the company, and a public cloud does not, so there is a possibility that they are running in separate stacks.
4. Reliability : The reliability of the services depends on cloud service providers.

4. COMMUNITY CLOUD

- Community cloud is a cloud infrastructure that 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.
- Community clouds are distributed systems created by integrating the services of different clouds to address the specific needs of an industry, a community, or a business sector.

Advantages

1. Cost effective : Community cloud is cost effective because the whole cloud is shared between several organizations or a community.
2. Flexible and Scalable : The community cloud is flexible and scalable because it is compatible with every user. It allows the users to modify the documents as per their needs and requirement.
3. Security : Community cloud is more secure than the public cloud but less secure than the private cloud.
4. Sharing infrastructure : Community cloud allows us to share cloud resources, infrastructure, and other capabilities among various organizations.
5. Sectors for community clouds are as follows: (a) Media industry (b) Healthcare industry (c) Energy and other core industries (d) Public sector (e) Scientific research

Disadvantages

1. Community cloud is not a good choice for every organization.
2. Slow adoption to data
3. The fixed amount of data storage and bandwidth is shared among all community members.
4. Community Cloud is costly than the public cloud.
5. Sharing responsibilities among organizations is difficult.

(5) SERVICE MODELS

There are the following three types of cloud service models -

Infrastructure as a Service (IaaS)
Platform as a Service (PaaS)
Software as a Service (SaaS)

1. SOFTWARE AS A SERVICE (SAAS)

- It is a software distribution model in which services are hosted by a cloud service provider. These services are available to end-users over the internet so, the end-users do not need to install any software on their devices to access these services.
- It is also known as "on-demand software" or "pay-as-you-go application".
- Here the customer licenses their product via SaaS-providers.
- SaaS is the service with which end users interact directly.
- **Example:** Big Commerce, Google Apps, Salesforce, Drop box, ZenDesk, Cisco Webex, Slack, and GoToMeeting.

Examples of SaaS cloud service providers are:

- GoogleApps
- Oracle On Demand
- SalesForce.com
- SQL Azure

Popular SaaS Providers

Characteristics of SaaS

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

Advantages

- Easy to buy
- Less hardware required

- Low Maintenance
- No special software or hardware versions required:
- **No client-side installation :** SaaS services are accessed directly from the service provider using the internet connection, so do not need to require any software installation.

Disadvantages

- Latency factor comes due to a variable distance of data between the cloud & the end-user.
- Internet Connection: Without an internet connection, SaaS applications are unusable.
- Switching between SaaS vendors in case of any change is very difficult.
- The SaaS cloud service is not very secure as in-house deployment.

2. PAAS (PLATFORM AS A SERVICE)

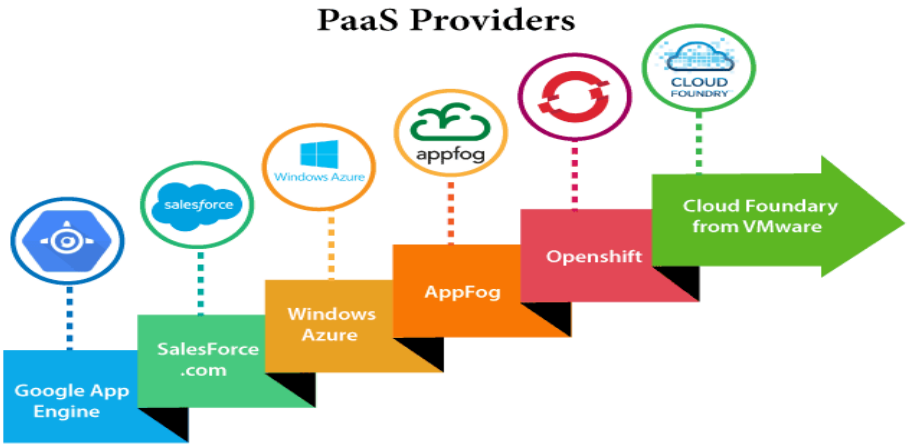
- PaaS cloud computing platform is created for the programmer to develop, test, run, and manage the applications.
- You can purchase these applications from a cloud service provider on a pay-as-per use basis and access them using the Internet connection. In PaaS, back end scalability is managed by the cloud service provider, so end- users do not need to worry about managing the infrastructure.
- It is the computer platform that provides the facility to use web applications quickly. With ease, without buying & maintaining web-development
- PaaS offered to the user is a development platform
- PaaS solutions generally include the infrastructure as well.
- **Example:** AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, Magento Commerce Cloud, and OpenShift.

A PaaS service adds integration features, middleware, and other orchestration and choreography services to the IaaS model.

Examples of PaaS services are-

- Force.com
- GoGrid CloudCenter
- Google AppEngine
- Windows Azure Platform

Popular PaaS Providers



Characteristics of PaaS

- Accessible to various users via the same development application.
- Integrates with web services and databases.
- Builds on virtualization technology, so resources can easily be scaled up or down as per the organization's need.

- Support multiple languages and frameworks.
- Provides an ability to "**Auto-scale**".

Advantages of PaaS:
- Scalability
- Prebuilt Business Plan: PaaS vendors provide pre-defined business functionality for users to directly start the project.
- Low Cost
- Instant Community
- **Simplified Development :** PaaS allows developers to focus on development and innovation without worrying about infrastructure management.
- **Lower risk :** No need for up-front investment in hardware and software. Developers only need a PC and an internet connection to start building applications.

Disadvantages of PaaS:
- **Vendor lock-in :** One has to write the applications according to the platform provided by the PaaS vendor, so the migration of an application to another PaaS vendor would be a problem.
- **Data Privacy :** Corporate data, whether it can be critical or not, will be private, so if it is not located within the walls of the company, there can be a risk in terms of privacy of data.
- **Integration with the rest of the systems applications :** It may happen that some applications are local, and some are in the cloud. So there will be chances of increased complexity when we want to use data which in the cloud with the local data.

3. IAAS (INFRASTRUCTURE AS A SERVICE)

- IaaS is also known as **Hardware as a Service (HaaS)**.
- It is one of the layers of the cloud computing platform.
- It allows customers to outsource their IT infrastructures such as servers, networking, processing, storage, virtual machines, and other resources. Customers access these resources on the Internet using a pay-as-per use model.
- It is a computing infrastructure managed over the internet.
- IaaS cloud computing platform layer eliminates the need for every organization to maintain the IT infrastructure.
- It helps users to avoid the cost and complexity of purchasing and managing the physical servers.
- Infrastructure as service or IaaS is the basic layer in Cloud computing model.
- IaaS offers servers, network devices, load balancers, database, Web servers etc.
- **Example:** DigitalOcean, Linode, Amazon Web Services (AWS), Microsoft Azure, Google Compute Engine (GCE), Rackspace, and Cisco Metacloud.

Examples of IaaS service providers include:
- Amazon Elastic Compute Cloud (EC2)
- Eucalyptus
- GoGrid
- FlexiScale
- Linode
- RackSpace Cloud
- Terremark

IaaS provides users with:

- Load balancers
- Disk storage via virtual machines
- Software Packages
- IP address
- VLANs

Characteristics of IaaS

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

Advantages of IaaS:

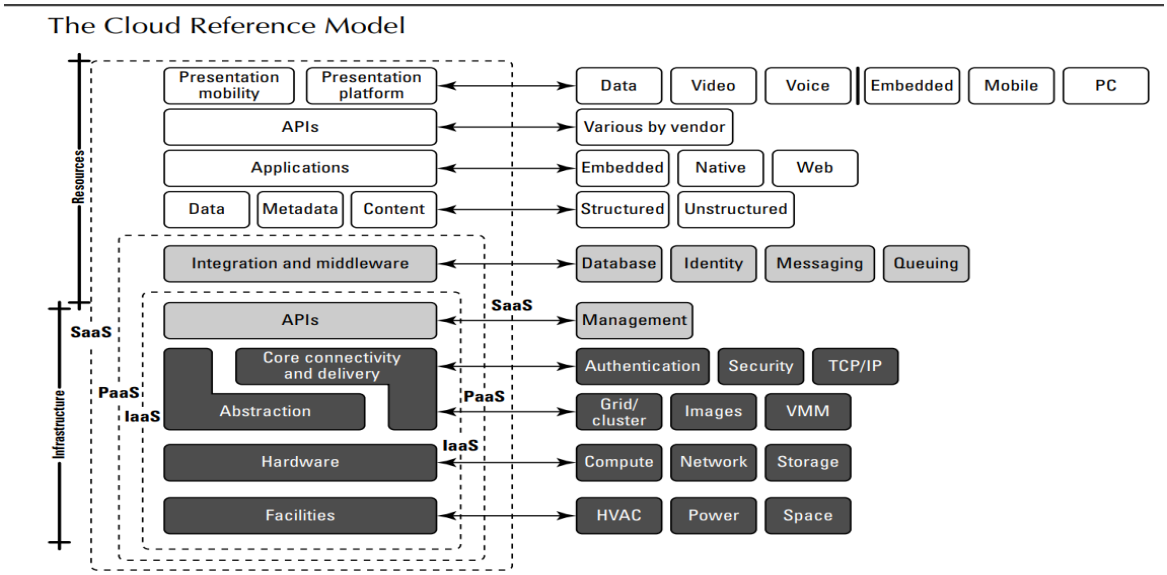
- **Shared infrastructure :** IaaS allows multiple users to share the same physical infrastructure.
- **Web access to the resources :** Iaas allows IT users to access resources over the internet.
- **Pay-as-per-use model :** IaaS providers provide services based on the pay-as-per-use basis. The users are required to pay for what they have used.
- **Focus on the core business :** IaaS providers focus on the organization's core business rather than on IT infrastructure.
- **On-demand scalability :** On-demand scalability is one of the biggest advantages of IaaS. Using IaaS, users do not worry about to upgrade software and troubleshoot the issues related to hardware components.

Disadvantages of IaaS:

- Internet connection is a must.
- IaaS depends on virtualization services.
- This service restricts user-privacy & customization

4. IDAAS (IDENTITY AS A SERVICE)

- **What is an identity**? An identity is a set of characteristics or traits that make something recognizable or known. In computer network systems, it is one's digital identity that most concerns us. A digital identity is those attributes and metadata of an object along with a set of relationships with other objects that makes an object identifiable. Not all objects are unique, but by definition a digital identity must be unique, if only trivially so, through the assignment of a unique identification attribute. An identity must therefore have a context in which it exists.
- The establishment and proof of an identity is a central network function. An identity service is one that stores the information associated with a digital entity in a form that can be queried and managed for use in electronic transactions. Identity services have as their core functions: a data store, a query engine, and a policy engine that maintains data integrity
- **IDAAS may include:**
  - Directory services
  - Registration information
  - Authentication services
  - Risk & event monitoring
  - Profile management
  - Sign-on services



(6) BENEFITS OF CLOUD COMPUTING

On-demand self-service: A client can provision computer resources without the need for interaction with cloud service provider personnel.

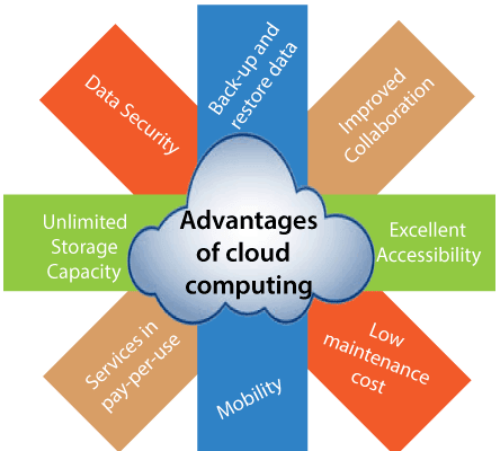
Broad network access: Access to resources in the cloud is available over the network using standard methods in a manner that provides platform-independent access to clients of all types. This includes a mixture of heterogeneous operating systems, and thick and thin platforms such as laptops, mobile phones, and PDA.

Resource pooling: A cloud service provider creates resources that are pooled together in a system that supports multi-tenant usage. Physical and virtual systems are dynamically allocated or reallocated as needed. Intrinsic in this concept of pooling is the idea of abstraction that hides the location of resources such as virtual machines, processing, memory, storage, and network bandwidth and connectivity.

Rapid elasticity: Resources can be rapidly and elastically provisioned. The system can add resources by either scaling up systems (more powerful computers) or scaling out systems (more computers of the same kind), and scaling may be automatic or manual. From the standpoint of the client, cloud computing resources should look limitless and can be purchased at any time and in any quantity.

Measured service: The use of cloud system resources is measured, audited, and reported to the customer based on a metered system. A client can be charged based on a known metric such as amount of storage used, number of transactions, network I/O (Input/Output) or bandwidth, amount of processing power used, and so forth. A client is charged based on the level of services provided.

(7) ADVANTAGES OF CLOUD COMPUTING:



1) Back-up and restore data
Once the data is stored in the cloud, it is easier to get back-up and restore that data using the cloud.

2) Improved collaboration
Cloud applications improve collaboration by allowing groups of people to quickly and easily share information in the cloud via shared storage.

3) Excellent accessibility
Cloud allows us to quickly and easily access store information anywhere, anytime in the whole world, using an internet connection. An internet cloud infrastructure increases organization productivity and efficiency by ensuring that our data is always accessible.

4) Low maintenance cost
Cloud computing reduces both hardware and software maintenance costs for organizations.

5) Mobility
Cloud computing allows us to easily access all cloud data via mobile.

6) IServices in the pay-per-use model
Cloud computing offers Application Programming Interfaces (APIs) to the users for access services on the cloud and pays the charges as per the usage of service.

7) Unlimited storage capacity
Cloud offers us a huge amount of storing capacity for storing our important data such as documents, images, audio, video, etc. in one place.

8) Data security
Data security is one of the biggest advantages of cloud computing. Cloud offers many advanced features related to security and ensures that data is securely stored and handled.

Lower costs: Because cloud networks operate at higher efficiencies and with greater utilization, significant cost reductions are often encountered.

Ease of utilization: Depending upon the type of service being offered, you may find that you do not require hardware or software licenses to implement your service.

Quality of Service: The Quality of Service (QoS) is something that you can obtain under contract from your vendor.

Reliability: The scale of cloud computing networks and their ability to provide load balancing and failover makes them highly reliable, often much more reliable than what you can achieve in a single organization.

Outsourced IT management: A cloud computing deployment lets someone else manage your computing infrastructure while you manage your business. In most instances, you achieve considerable reductions in IT staffing costs.

Simplified maintenance and upgrade: Because the system is centralized, you can easily apply patches and upgrades. This means your users always have access to the latest software versions.

Low Barrier to Entry: In particular, upfront capital expenditures are dramatically reduced. In cloud computing, anyone can be a giant at any time.

(8) DISADVANTAGES OF CLOUD COMPUTING

1) Internet Connectivity

As you know, in cloud computing, every data (image, audio, video, etc.) is stored on the cloud, and we access these data through the cloud by using the internet connection. If you do not have good internet connectivity, you cannot access these data. However, we have no any other way to access data from the cloud.

2) Vendor lock-in

Vendor lock-in is the biggest disadvantage of cloud computing. Organizations may face problems when transferring their services from one vendor to another. As different vendors provide different platforms, that can cause difficulty moving from one cloud to another.

3) Limited Control

As we know, cloud infrastructure is completely owned, managed, and monitored by the service provider, so the cloud users have less control over the function and execution of services within a cloud infrastructure.

4) Security

Although cloud service providers implement the best security standards to store important information. But, before adopting cloud technology, you should be aware that you will be sending all your organization's sensitive information to a third party, i.e., a cloud computing service provider. While sending the data on the cloud, there may be a chance that your organization's information is hacked by Hackers.

ASSESSING THE ROLE OF OPEN STANDARDS

The cloud computing industry is working with these architectural standards:

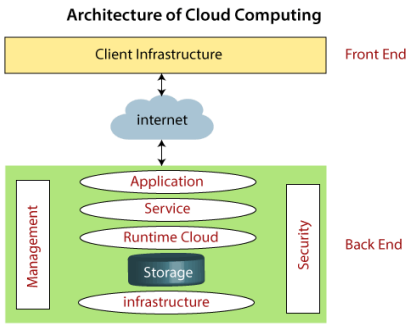
Platform virtualization of resources
Service-oriented architecture
Web-application frameworks
Deployment of open-source software
Standardized Web services
Autonomic systems
Grid computing

(9) CLOUD COMPUTING ARCHITECTURE

- As we know, cloud computing technology is used by both small and large organizations to store the information in cloud and access it from anywhere at anytime using the internet connection.
- Cloud computing architecture is a combination of service-oriented architecture and event-driven architecture.

Cloud computing architecture is divided into the following two parts –

Front End Back End



Front End

The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.

Back End

The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc.

COMPONENTS OF CLOUD COMPUTING ARCHITECTURE

1. Client Infrastructure : Client Infrastructure is a Front end component. It provides GUI (Graphical User Interface) to interact with the cloud.

2. Application : The application may be any software or platform that a client wants to access.

3. Service : A Cloud Services manages that which type of service you access according to the client's requirement. Cloud computing offers the following three type of services:

- **Software as a Service (SaaS) –** It is also known as **cloud application services**. Mostly, SaaS applications run directly through the web browser. **Example:** Google Apps, Salesforce Dropbox, Slack, Hubspot, Cisco WebEx.
- **Platform as a Service (PaaS) –** It is also known as **cloud platform services**. **Example:** Windows Azure, Force.com, Magento Commerce Cloud, OpenShift.
- **Infrastructure as a Service (IaaS) –** It is also known as **cloud infrastructure services**. **Example:** Amazon Web Services (AWS) EC2, Google Compute Engine (GCE), Cisco Metapod.

4. Runtime Cloud : Runtime Cloud provides the **execution and runtime environment** to the virtual machines.

5. Storage : Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage data.

6. Infrastructure : It provides services on the **host level, application level**, and **network level**. Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support the cloud computing model.

7. Management : Management is used to manage components such as application, service, runtime cloud, storage, infrastructure, and other security issues in the backend and establish coordination between them.

8. Security : Security is an in-built back end component of cloud computing. It implements a security mechanism in the back end.

9. Internet : The Internet is medium through which front end and back end can interact and communicate with each other.

Note: Both front end and back end are connected to others through a network, generally using the internet connection

(10) CLOUD COMPUTING INFRASTRUCTURE

Cloud infrastructure consists of servers, storage devices, network, cloud management software, deployment software, and platform virtualization.

- **Hypervisor** : Hypervisor is a firmware or low-level program that acts as a Virtual Machine Manager. It allows to share the single physical instance of cloud resources between several tenants.
- **Management Software** : It helps to maintain and configure the infrastructure.
- **Deployment Software** : It helps to deploy and integrate the application on the cloud.
- **Network** : It is the key component of cloud infrastructure. It allows to connect cloud services over the Internet. It is also possible to deliver network as a utility over the Internet, which means, the customer can customize the network route and protocol.
- **Server** : The server helps to compute the resource sharing and offers other services such as resource allocation and de-allocation, monitoring the resources, providing security etc.
- **Storage** : Cloud keeps multiple replicas of storage. If one of the storage resources fails, then it can be extracted from another one, which makes cloud computing more reliable.

Cloud infrastructure can be heterogeneous in nature because a variety of resources, such as

- Clusters
- Networked PCs,
- Databases
- Cloud application
- Cloud programming tools
- Hosting platforms
- Virtual machines, etc are used

(11) CLOUD COMPUTING PLATFORM

AMAZON WEB SERVICES (AWS)

- AWS provides different wide-ranging clouds **IaaS services**, which ranges from virtual compute, storage, and networking to complete computing stacks.
- AWS is well known for its storage and compute on demand services, named as Elastic Compute Cloud (EC2) and Simple Storage Service (S3).
- EC2 offers customizable virtual hardware to the end user which can be utilize as the base infrastructure for deploying computing systems on the cloud. It is likely to choose from a large variety of virtual hardware configurations including GPU and cluster instances.
- EC2 also offers the capability of saving an explicit running instance as image, thus allowing users to create their own templates for deploying system.
- S3 stores these templates and delivers persistent storage on demand. S3 is well ordered into buckets which contains objects that are stored in binary form and can be grow with attributes.
- End users can store objects of any size, from basic file to full disk images and have them retrieval from anywhere.

GOOGLE APP ENGINE

- Google App Engine is a scalable runtime environment frequently dedicated to executing web applications.
- These utilize benefits of the large computing infrastructure of Google to dynamically scale as per the demand.
- AppEngine offers both a secure execution environment and a collection of which simplifies the development if scalable and high-performance Web applications.
- These services include: in-memory caching, scalable data store, job queues, messaging, and corn tasks. Developers and Engineers can build and test applications on their own systems by using the AppEngine SDK, which replicates the production runtime environment, and helps test and profile applications.

MICROSOFT AZURE

- Microsoft Azure is a Cloud operating system and a platform in which user can develop the applications in the cloud.
- Generally, a scalable runtime environment for web applications and distributed applications is provided.
- Application in Azure are organized around the fact of roles, which identify a distribution unit for applications and express the application's logic.
- Azure provides a set of additional services that complement application execution such as support for storage, networking, caching, content delivery, and others.

HADOOP

- Apache Hadoop is an open source framework that is appropriate for processing large data sets on commodity hardware.

- Hadoop is an implementation of MapReduce, an application programming model which is developed by Google.
- This model provides two fundamental operations for data processing: map and reduce.
- Yahoo! Is the sponsor of the Apache Hadoop project, and has put considerable effort in transforming the project to an enterprise-ready cloud computing platform for data processing.
- Hadoop is an integral part of the Yahoo! Cloud infrastructure and it supports many business processes of the corporates.
- Currently, Yahoo! Manges the world's largest Hadoop cluster, which is also available to academic institutions.

FORCE.COM AND SALESFORCE.COM

- Force.com is a Cloud computing platform at which user can develop social enterprise applications.
- The platform is the basis of SalesForce.com – a Software-as-a-Service solution for customer relationship management.
- Force.com allows creating applications by composing ready-to-use blocks: a complete set of components supporting all the activities of an enterprise are available.
- From the design of the data layout to the definition of business rules and user interface is provided by Force.com as a support.
- This platform is completely hostel in the Cloud, and provides complete access to its functionalities, and those implemented in the hosted applications through Web services technologies.

(12) VIRTUAL APPLIANCE

Ques : What Does Virtual Appliance Mean?

Ans : A virtual appliance is a software application residing and operating in a preconfigured virtual environment or platform. Virtual appliances are accessed remotely by users and do not require locally-installed hardware.

- A virtual appliance is a pre-installed and pre-configured software solution on one or more virtual machines that is optimized for a specific function
- Applications of all sizes and complexity can be hosted through remote infrastructures.
- A virtual appliance is essentially a software appliance that is installed on a virtual machine.
- Virtual appliances have several benefits, particularly ease of deployment.
- Users are not responsible for managing hardware and software compatibility or OS considerations such as integration and isolation in the event of a system crash.
- Virtual appliances play a significant role in cloud computing's software as a service (SaaS) model where remote software access is delivered through a Web browser.

(13) COMMUNICATION PROTOCOLS

- Cloud computing arises from services available over the Internet communicating using the standard Internet protocol suite underpinned by the HTTP and HTTPS transfer protocols.
- The other protocols and standards that expose compute and data resources in the cloud either format data or communications in packets that are sent over these two transport protocols.
- In order to engage in interprocess communication (IPC) processes, many client/server protocols have been applied to distributed networking over the years.

- Various forms of RPC (Remote Procedure Call) implementations (including DCOM, Java RMI, and CORBA) attempt to solve the problem of engaging services and managing transactions over what is essentially a stateless network.
- The first of the truly Web-centric RPC technologies was XML-RPC, which uses platform independent XML data to encode program calls that are transported over HTTP, the networking transport to which nearly everyone is connected

(14) CONNECTING TO THE CLOUD CLIENTS

Connecting to the Cloud Clients can connect to a cloud service in a number of different ways. These are the two most common means:

- A Web browser
- A proprietary application
  These applications can be running on a server, a PC, a mobile device, or a cell phone. What these devices have in common with either of these application types is that they are exchanging data over an inherently insecure and transient medium. There are three basic methods for securely connecting over a connection:
- Use a secure protocol to transfer data such as SSL (HTTPS), FTPS, or IPsec, or connect using a secure shell such as SSH to connect a client to the cloud.
- Create a virtual connection using a virtual private network (VPN), or with a remote data transfer protocol such as Microsoft RDP or Citrix ICA, where the data is protected by a tunnelling mechanism.
- Encrypt the data so that even if the data is intercepted or sniffed, the data will not be meaningful.
  The best client connections use two or more of these techniques to communicate with the cloud. In current browser technology, clients rely on the Web service to make available secure connections, but in the future, it is likely that cloud clients will be hardened so the client itself enforces a secure connection.

(15) SERVICES AND APPLICATIONS BY TYPE

- The service models described here—Infrastructure as a Service **(IaaS)**, Software as a Service (**SaaS**), and Platform as a Service (**PaaS**)—are useful in categorizing not only cloud computing capabilities, but specific vendor offerings, products, and services. Infrastructure as a Service allows for the creation of virtual computing systems or networks.
- Software as a Service represents a hosted application that is universally available over the Internet, usually through a browser. With Software as a Service, the user interacts directly with the hosted software. SaaS may be seen to be an alternative model to that of **shrink-wrapped** software and may replace much of the boxed software that we buy today.
- Platform as a Service is a cloud computing infrastructure that creates a development environment upon which applications may be build. PaaS provides a model that can be used to create or augment complex applications such as Customer Relation Management (CRM) or Enterprise Resource Planning (ERP) systems. PaaS offers the benefits of cloud computing and is often componentized and based on a service-oriented architecture model.
- As cloud computing matures, several service types are being introduced and overlaid upon these architectures. The most fully developed of these service types is Identity as a Service (IDaaS). Identity as a Service provides authentication and authorization services on distributed networks.

IaaS workloads

- **The fundamental unit of virtualized client in an IaaS deployment is called a workload**.
- A workload simulates the ability of a certain type of real or physical server to do an amount of work.
- The work done can be measured by the number of Transactions Per Minute (TPM) or a similar metric against a certain type of system.

Consider a transactional E-Commerce system, for which a typical stack contains the following components:

- Web server
- Application server
- File server
- Database
- Transaction engine

This E-Commerce system has several different workloads that are operating:

- Queries against the database
- Processing of business logic S
- Serving up clients' Web pages.