BACHELOR OF COMPUTER APPLICATIONS

SEMESTER 6

DCA3243

CLOUD COMPUTING

Unit 1

Introduction to Cloud Computing

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1. INTRODUCTION

The Cloud, in terms of computer networks and its associated technology, supports delivering resources such as computing and storage to customers on demand. Rather than being a new technology in itself, the cloud is a new business model wrapped around new technologies, such as server virtualization that take advantage of economies of scale and multi-tenancy to reduce the cost of using information technology resources.

The National Institute of Standards and Technology (NIST), an agency of the US Department of Commerce, is America's first federal physical science research laboratory responsible for defining standards in science and technology. NIST defines cloud computing as " a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." This NIST definition lists five fundamental and important characteristics of cloud computing, such as:

- On-demand self-service
- Broad network access
- Resource pooling
- Rapid elasticity or expansion
- Measured service

1.1 Objectives

After studying this unit, you should be able to:

- *Discuss the history of the fundamental concepts of cloud computing.*
- *Explain the functions of cloud computing.*
- *Understand the design of cloud architecture and its functions*.

2. FROM COLLABORATIVE TO CLOUD – A SHORT HISTORY

Cloud computing has a background with the combination of both client/server computing and peer-to-peer distributed computing. Here the concept lies in how multiple computers and collaboration of centralized storage work hand in hand to escalate the computing power. Cloud computing is a natural evolution of the extensive adoption of virtualization, service-oriented architecture, and autonomic and utility computing. The various phases of the computing evolution process are illustrated in Figure 1.1. Each phase had a specific functional advantage and was passed to the later phase.

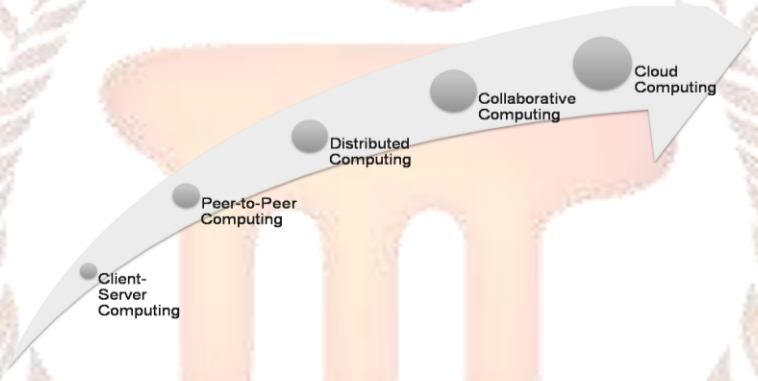

Fig: 1.1: Evolution of cloud computing

Client/Server Computing: Centralized Applications and Storage

During the period of 1980, technologies were used for computation based on client/server models. Software applications with their control and the data reside in the mainframe computers called servers. In this scenario, when the user wants to access or run any program first, he needs to get access permission from the mainframe server to access his data or any other application. The system through which the user connects to the server to access the data is called a computer terminal or workstation. These terminals are sometimes called dump terminal since it does not have memory, storage space, or processing power. It was merely a device that helped the user connect and enabled him to use the mainframe computer. Users can access the server only after getting permission from the information technology staff since they are considered to be the guardians of the processing power. Comparatively, there was less power, so getting permission to access the server was not so easy, and moreover, no two users could access the data at the same time.

Apart from all this, the customization of a report was a challenging job because you will be restricted to using the power given by the IT staff, and you cannot either filter your data or copy some other data to generate a report that you really require. The reason behind this is even though the mainframe is huge in size and more powerful, the users who want to get service are in large numbers, and they have to wait in a queue to get their turn. There isn't always immediate access in a client/server environment, and occasionally, there may be immediate fulfillment. While providing a centralized storage client/server model, it differs from cloud computing and does not have a user-centric focus. In client/server computing, all the control rests with the mainframe and with the guardians of that single computer. So, it cannot be considered a user-enabling environment.

Peer-to-Peer Computing: Sharing Resources

We can say now, as per the discussion above, that accessing a client/server system is a time-consuming process. Even the server-side faces problems serving the cumbersome queue. The reason is in spite of the efficiency of the server, all the communication should cross through the server. This obvious need forced the system to create connectivity between the computers without hitting the server first for the development of P2P (peer-to-peer) computing. In P2P architecture, all the computers that are connected have equal resources and capabilities. Whereas in the case of client/server architecture, all the computers connected are dedicated to the server. This scenario can sometimes be referred to as master-slave architecture, where the server is the master and the other dedicated systems are called slaves. In P2P, every computer has the role of client and server, and there is no role for master and slave. All the computers in the P2P will be recognized as peers and have direct access to the services and resources. Since every computer has the capability to interact with each other, there is no role for the server; thus, the process becomes easy. P2P can be considered decentralized since contents, functions, and controls are spread across the peer computers in the network.

No centralized server is assigned to host the available resources and services. The most notable implementation of P2P computing is the Internet. The early internet based on P2P was the best representative for the use of the Usenet network. The network of computers, which was accessed via the internet and created back in 1979, hosted the entire content of the network. The user who is connected to any single Usenet server can view all the messages

posted to each individual user. Although the users' connection to the Usenet server was of the traditional client/server nature, the relationship between the Usenet servers was definitely P2P and presaged the cloud computing of today.

That said, not every part of the Internet is P2P in nature. With the development of the World Wide Web came a shift away from P2P back to the client/server model. On the web, each website is served up by a group of computers, and site visitors use client software (web browsers) to access it. Almost all content is centralized, all control is centralized, and the clients have no autonomy or control in the process.

Distributed Computing: Providing more computing power

One of the most important subsets of the P2P model is that of distributed computing, where idle PCs across a network or across the Internet are tapped to provide computing power for large, processor-intensive projects. It's a simple concept, all about cycle sharing between multiple computers.

A personal computer, running full-out 24 hours a day, seven days a week, is capable of tremendous computing power. Most of us will not use the computer for a complete day; in such cases, the concept of distributed computing tries to utilize the idle computer, thus avoiding the waste of resources.

When a computer is enlisted for a distributed computing project, software is installed on the machine to run various processing activities during those periods when the PC is typically unused. The results of that spare-time processing are periodically uploaded to the distributed computing network and combined with similar results from other PCs in the project. The result, if enough computers are involved, simulates the processing power of much larger main-frames and supercomputers – which is necessary for some very large and complex computing projects.

For example, genetic research requires enormous amounts of computing power. If you use traditional means, it might take years to solve essential mathematical problems. By connecting together thousands (or millions) of in Individual PCs, more power is applied to the problem, and the results are obtained much sooner. Distributed computing dates back to 1973, when multiple computers were networked together at the Xerox PARC labs, and worm

software was developed to cruise through the network looking for idle resources. A more practical application of distributed computing appeared in 1988 when researchers at the DEC (Digital Equipment Corporation) System Research Center developed software that distributed the work to factor large numbers among workstations within their laboratory. By 1990, a group of about 100 users utilizing this software had factored a 100-digit number. By 1995, this same effort had been expanded to the web to factor a 130-digit number.

The first major Internet-based distributed computing project was distributed.net, launched in 1997, which employed thousands of personal computers to crack encryption codes. Even bigger was SETI@home, launched in May 1999, which linked together millions of individual computers to search for intelligent life in outer space. Many distributed computing projects are conducted within large enterprises, using traditional network connections to form the distributed computing network. Other, larger projects utilize the computers of everyday Internet users, with the computing typically taking place offline and then uploaded once a day via traditional consumer Internet connections.

Collaborative Computing: Working as a group

From the early days of client/server computing through the evolution of P2P, there has been a desire for multiple users to work simultaneously on the same computer-based project. This type of collaborative computing is the driving force behind cloud computing but has been around for more than a decade. Early group collaboration was enabled by the combination of several different P2P technologies. The goal was to enable multiple users to collaborate on group projects online in real-time. To collaborate on any project, users must first be able to communicate with one another. In today's environment, this means instant messaging for text-based communication, with optional audio/telephony and video capabilities for voice and picture communication. Most collaboration systems offer a complete range of audio/video options for full-featured multiple-user video conferencing. In addition, users must be able to share files and have multiple users work on the same document simultaneously. Real-time whiteboarding is also common, especially in corporate and educational environments.

Early group collaboration systems ranged from the relatively simple (Lotus Notes and Microsoft NetMeeting) to the extremely complex (the building-block architecture of the

Groove Networks system). Most were targeted at large corporations and limited to operation over the companies' private networks.

Cloud Computing: The next step in collaboration

With the growth of the Internet, there was no need to limit group collaboration to a single enterprise's network environment. Users from multiple locations within a corporation and from multiple organizations desired to collaborate on projects that crossed company and geographic boundaries. To do this, projects had to be housed in the "cloud" of the Internet and accessed from any Internet-enabled location. The concept of cloud-based documents and services took wing with the development of large server firms, such as those run by Google and other search companies. Google already had a collection of servers that it used to power its massive search engine; why not use that same computing power to drive a collection of web-based applications and, in the process, provide a new level of Internet-based group collaboration? That's exactly what happened, although Google wasn't the only company offering cloud computing solutions. On the infrastructure side, IBM, Sun Systems, and other big hardware providers are offering the hardware necessary to build cloud networks. On the software side, dozens of companies are developing cloud-based applications and storage services. Today, people are using cloud services and storage to create, share, find, and organize information of all different types. Tomorrow, this functionality will be available not only to computer users but to users of any device that connects to the Internet — mobile phones, portable music players, even automobiles, and home television sets. One of the most important subsets of the P2P model is that of distributed computing, where idle PCs across a network or across the Internet are tapped to provide computing power for large, processor-intensive projects. It's a simple concept, all about cycle sharing between multiple computers.

SELF-ASSESSMENT QUESTIONS – 1

1. Software applications with their control and the data resided in the mainframe computers called.
2. In P2P architecture, all the computers that are connected have equal resources and capabilities [True/False]
3. The first major Internet-based distributed computing project was launched in 1997.
4. Name the computing that was considered as the driving force behind cloud computing.
   a) Peer to peer
   b) Collaborative
   c) Distributed
   d) Client/server

3. TYPES OF CLOUD COMPUTING

Organizations now have a variety of interesting chances to use the cloud to reimagine, repurpose, and reinvent their operations.

However, the best cloud model for a corporation will rely on the computational and operational requirements of your company. It's crucial to pick the best cloud service deployment methodology out of the many available options.

It would guarantee that your company has all the necessary performance, scalability, privacy, security, compliance, and cost-effectiveness.

The process of delivering an application using one or more cloud-based hosting models, such as infrastructure as a service (IaaS), platform as a service (PaaS), and/or software as a service (SaaS), is known as cloud deployment. This includes designing, organizing, putting into practice, and managing cloud-based workloads.

A unique choice is making a cloud type or cloud service. Even though they are of the same sort, no two clouds are alike, and no two cloud services are employed to address the same issue. However, by recognizing the parallels, you may better understand how the limitations of each type of cloud computing and cloud service might affect your company.

A cloud can be implemented in a variety of methods, depending on the user's requirements, which are:

- The ability to handle resources with enough people
- Application and data sensitivity
- Performance level
- Business type

The epidemic has contributed to the rapid expansion of the cloud computing market. But even putting global illnesses aside, the cloud has made significant advancements for well over a decade.

Customers can access these server-based cloud networks via the Internet, as well as data storage, online streaming services (like Netflix, YouTube, and others), and infrastructure services like Google Cloud, AWS, and Azure.

As depicted, these are the types of clouds in the market.

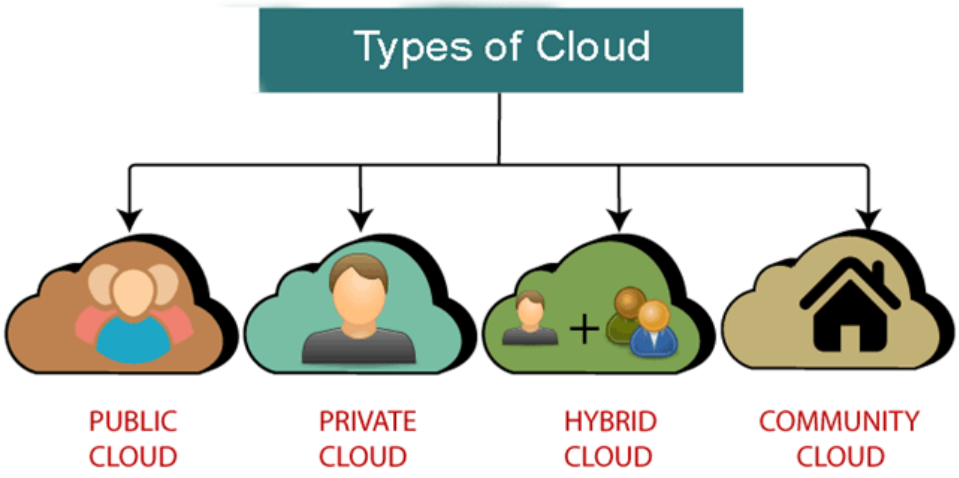

Fig: 1.2

Source: https://www.javatpoint.com/types-of-cloud

Private cloud:

Private clouds are, as the name implies, cloud environments that are only devoted to one particular group, entity, or person and are located behind the customer's firewall. Any cloud that is dedicated to one customer (one person or a group) and situated in an IT infrastructure that is private to the general public is automatically regarded as a private cloud.

A cloud is referred to as a private cloud when only one enterprise uses its infrastructure.

The physical resources in a private cloud can either be hosted internally by the company or elsewhere.

A private cloud can adhere to a company's security protocols and offer greater data and application protection than public clouds. On rented, vendor-owned, off-site data centers, clients can create private clouds. As a result, there are currently two subcategories of private clouds:

- Dedicated Clouds: This cloud, which can be found in either a public or private cloud, is a cloud inside another cloud. For instance, a company's Research & Development division can have a specific private cloud within the business' private cloud.
- Managed Private Clouds: These clouds are built and used by consumers, but they are configured, deployed, and managed by a third-party vendor. For businesses that don't

have the funding for a full IT staff to manage their cloud infrastructure and services, managed private clouds are the perfect solution. For instance, SugarCRM 1 is a private cloud managed by a third party that gives its clients the option to store their data on their premises to preserve data privacy. A good illustration of an off-premises private cloud is Amazon's virtual private cloud 2.

Public cloud:

In a public cloud, the public has access to the different cloud services. Most companies that offer public cloud services, such as Amazon, AWS, Microsoft, and Google, own and run the infrastructure and merely provide access online. A service level agreement (SLA), establishing a specific level of QoS for the services offered, may be signed by customers and providers of public cloud services. If the guaranteed QoS is not delivered, the provider must compensate the user in accordance with the SLA.

A public cloud is a virtual environment that has been divided up and distributed among numerous users, sometimes known as "tenants." Typically, these clouds are built using IT infrastructures that the clients do not own. Instances of public cloud computing include Amazon Web Services (AWS), Google Cloud, Microsoft Azure, Alibaba, and IBM.

Even while public clouds are normally operated off-site, some cloud service providers have started to provide customers with cloud services that are housed in their clients' on-site data centers. The differences between ownership and location have become hazy because of this approach.

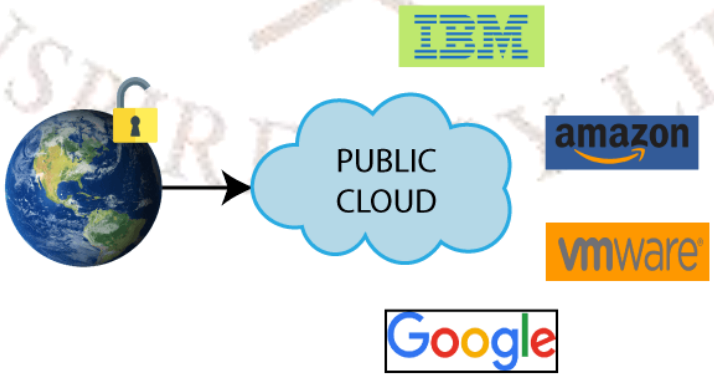

Fig: 1.3

Source: https://www.javatpoint.com/types-of-cloud

Community cloud:

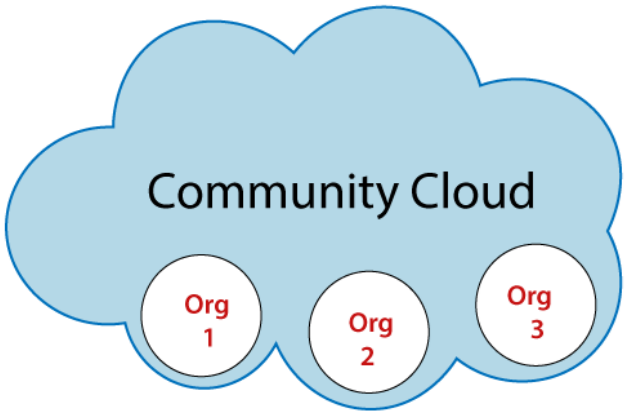

Fig: 1.4

Source: https://www.javatpoint.com/types-of-cloud

A collection of various businesses can access systems and services to exchange information through a community cloud, which is a cloud infrastructure. One or more community-based organizations, a third party, or a combination of them own, manage and run it.

A community of enterprises who share infrastructure and have similar concerns manage and use a community cloud. This cloud can be hosted internally or outside and managed internally or by a third party.

Public clouds are cheaper, but community clouds are more secure. Since each cloud member is given a limited amount of data storage and bandwidth, scaling is a little more challenging than it is for private and public clouds.

Organizations can decide to host their own data centers and divide the cost and duties to create a community cloud. This could happen on-site in a member's current infrastructure or even at facilities owned by peers. As an alternative, companies could think about hybrid cloud service providers.

Hybrid Cloud:

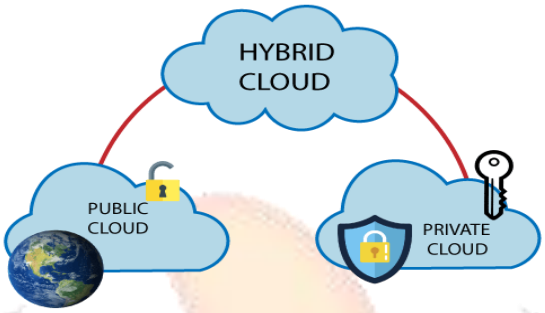

Fig: 1.5

Source: https://www.javatpoint.com/types-of-cloud

Any combination of two or more clouds is known as a hybrid cloud (private, public, and community).

A hybrid cloud is particularly beneficial for dynamic or frequently changing workloads.

An organization can use a hybrid cloud computing strategy to install a private cloud on-premises to house sensitive or crucial workloads and use a public cloud service provider from a different party to host less important resources.

An organization that owns a private cloud will find the hybrid cloud to be more cost-effective because it only pays for additional resources when they are really used.

Applications may run in a variety of different settings as part of a hybrid cloud. Since so few people currently rely only on the public cloud, hybrid cloud computing strategies are widely used.

If you want to benefit from the size and security of a public cloud, like Google Cloud, while retaining your data on-premises to adhere to data residency requirements or meet computing needs closer to your consumers, a hybrid cloud solution is right for you. Hybrid computing is a fantastic choice for some of you whose important systems are running in both private and public clouds.

Different Cloud Service Models:

The structure and types of services are represented by a service model.

A model for providing all-encompassing, practical, and on-demand network access to a shared resource pool is called cloud computing. These computing resources are easily deployed quickly and released. Three service models make up the cloud model, as shown:

IaaS - Infrastructure as a Service

PaaS - Platform as a Service

SaaS - Software as a Service

Pay-per-use, subscription-based, and hybrid cloud service pricing models—a blend of pay-per-use and subscription pricing models—are the three categories under which they fall.

Let us look at the key roles of the service models:

1: SaaS

Customer's responsibility: People, Data

CSP responsibility: Applications, Runtime, Middleware, Operating System, Virtual Network, Hypervisor, Servers, Storage, Physical Network

2: PaaS

Customer's responsibility: People, Data, Applications

CSP responsibility: Runtime, Middleware, Operating System, Virtual Network, Hypervisor, Servers, Storage, Physical Network

3: IaaS

Customer's responsibility: People, Data, Applications, Runtime, Middleware, Operating System, Virtual Network

CSP responsibility: Hypervisor, Servers, Storage, Physical Network

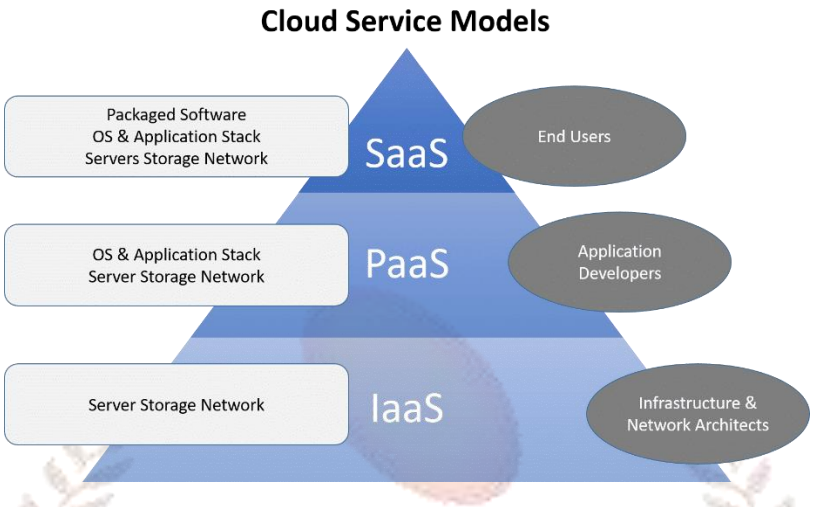

Fig: 1.6

Source: uniprint.net/en/7-types-cloud-computing-structures/

Software-as-a-Service (SaaS) :

SaaS is the type of cloud service that users are most accustomed to.

SaaS transfers the responsibility for managing software and its deployment to outside providers.

It is a technique for delivering software that gives users access to programs and the features that are housed within clouds.

SaaS apps are created utilizing cutting-edge web technologies that are ideal for use on the Internet and as a service.

The installation, upkeep, support, and upgrades of the software are handled by the SaaS provider, so the customer doesn't have to bother about them.

We have two different SaaS service models:

1. multi-tenant:
    - The same software application with the same functionality and configurable capabilities can be used by several customers.
    - In a software architecture known as multitenancy, one software instance can serve several different user groups. Multitenant architecture is exemplified by software-as-a-service (SaaS) products.
    - Multi-tenancy aids in the standardization of functionalities because the same software can be utilized by several clients.

2. Single-tenant:
    - Each client's isolated environment for the software program is unique.
    - The tenant is the client in a single-tenant cloud environment. By design, this kind of architecture permits just one instance or piece of software to be used by each client on the cloud server. Consider the server environment to be an ecosystem for businesses.
    - Customers can also customize the program to suit their needs. Therefore, it can be said that this method is more secure than the multi-tenant model.

SaaS eliminates the need for IT professionals to download and install software on each individual computer thanks to its web delivery methodology.

With SaaS, vendors take care of all potential technical problems, including data, middleware, servers, and storage, which streamlines corporate maintenance and support.

1. Google Workspace, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting, and Google Apps are well-known examples of Saas Cloud. SaaS may be the most beneficial option in several situations, including:
2. Startups or small businesses that must immediately establish e-commerce but don't have time to deal with server problems or software
3. Short-term initiatives that call for quick, simple, and reasonably priced partnership
4. Applications that aren't frequently used, like tax preparation software
5. Applications that require access to both the web and mobile

Platform as a service(PaaS):

Platform as a Service (PaaS) is a cloud computing concept in which consumers receive hardware and software resources via the internet from a third-party supplier. These tools are typically required for the creation of applications.

The platform to construct apps and software is made available to users by PaaS providers.

Programming languages, widely used libraries, GUIs, sandboxed software testing environments for running untested code isolated from production environments, APIs, etc., might all be utilized as the platform, and developers who use PaaS are able to concentrate more on software development rather than platform upkeep and maintenance.

Here we have a few examples of public PaaS cloud:

- Google App Engine: enables hosting and developing web applications in Google-managed data centers.
- Amazon's Elastic Beanstalk is providing sandbox capabilities on Amazon's infrastructure.
- Microsoft's Azure provides enterprise database services by way of APIs and software development kits (SDKs) for programming languages like .NET, Java, PHP, Python, and many other services.

Infrastructure-as-a-Service (IaaS):

It is a type of cloud computing that offers consumers pay-as-you-go access to basic computing, network, and storage capabilities on demand over the Internet.

The IaaS approach involves offering consumers access to physical machines (PMs) or virtual machines (VMs), as well as other hardware resources, as a service.

Because VM is an abstraction of the underlying hardware, it allows for greater customer flexibility, and by enabling cloud users to install their own stack of software in the isolated VM environment, VM offers a controlled, isolated environment that is completely under the authority of the customer.

Examples of IaaS cloud:

1. Elastic Compute Cloud is known as EC2. On the AWS cloud platform, EC2 is a service for on-demand computing. All the services a computing device can provide you with, as well as the adaptability of a virtual environment, are collectively referred to as computing.
2. Google Compute Engine: The Infrastructure as a Service part of Google Cloud Platform, which is built on the same worldwide infrastructure as Google's search engine, Gmail, YouTube, and other services, is called Google Compute Engine.
3. The Rackspace Cloud is a collection of cloud computing services and products offered by the US-based business Rackspace. Offerings include virtual private servers, load balancers, databases, backup, and monitoring in addition to cloud storage ("Cloud Files"). Cloud by Rackspace.

Cloud Enabling Technologies:

Service-oriented Architectures: Service-oriented Architectures:

- A software development technique known as service-oriented architecture (SOA) uses software elements called services to build business applications.
- In essence, SOA is a design pattern made up of services that communicate with one another over a clear interface.
- Services are autonomous, loosely connected functional units in this architecture.
- Cloud utilizes SOA service paradigms. With service discovery protocols, the services that the cloud provides can be automatically found and used by users (or cloud brokers).
- Using industry-standard protocols like SOAP (Simple Object Access Protocol) and REST, many service providers, like Amazon, Facebook, and Google, make their service APIs available to the general public (Representational State Transfer)

Grid Computing:

- Grid computing is a type of computing infrastructure that pools computer resources dispersed over numerous sites to accomplish a single objective and allows for the use of federated computer resources from various places to complete a single task.
- Grid resource provisioning techniques are implemented in the cloud, typically with the use of middleware, and typically, resources consumed by a work are not shared, using middleware to control the diverse nodes. Resources can be found, obtained, used, and released on their own. Resources are found depending on the specifications of their properties.

Utility Computing:

- In a utility computing approach, customers receive computing resources depending on their individual demands. The provision of computer services (hardware or software) to the customer as a utility is known as utility computing (metered service). The pay-per-use model is made possible by the idea of metered service in the cloud. This means that the user must pay for the resources he has used without worrying about where to find them.

Autonomic Computing:

- With no manual assistance or outside assistance, autonomous computing utilizes the self-managing properties of distributed computing resources, adjusting to unforeseen changes while hiding inherent complexity from operators and customers.
- Autonomic computing refers to a computer's ability to govern itself automatically through adaptive technologies that expand computing capabilities and reduce the amount of time that computer experts must spend resolving system issues and performing other maintenance, such as software updates.

A few important advantages are:

- It is crucial to manage computer systems autonomously because of their rising complexity.
- To run their data centers effectively, cloud computing providers follow known autonomic computing best practices.
- Autonomous processes are used to carry out a variety of functions, including VM provisioning, disaster recovery, capacity management, etc.

Virtualization:

- To imitate hardware functions and build a virtual computer system, virtualization uses software. This makes it possible for IT companies to run different operating systems, applications, and virtual systems on a single server. More efficiency and scale economies are two advantages that follow.
- It is the main and crucial cloud computing enabling technology, and because numerous VMs from various clients can use a single physical computer, virtualization also uses multi-tenancy in clouds.
- It enables server consolidation, increasing server utilization and the effectiveness of cloud systems. Also, it allows for the projection of virtual resources in the form of Virtual Machines (VMs) and the abstraction of the underlying resources.
- If necessary, VMs can be instantiated at run-time, and it enables the on-demand provisioning of resources, a key component of the cloud.

4. CLOUD ARCHITECTURE

The key to cloud computing is the "cloud," a massive network of servers or even individual PCs interconnected in a grid. These computers run in parallel, combining the resources of each to generate supercomputing-like power. What, exactly, is the "cloud"? Put simply, the cloud is a collection of computers and servers that are publicly accessible via the Internet. This hardware is typically owned and operated by a third party on a consolidated basis in one or more data center locations. The machines can run any combination of operating systems; it's the processing power of the machines that matters, not what their desktops look like. As shown in Figure 1.2, individual users connect to the cloud from their own personal computers or portable devices over the Internet. To these individual users, the cloud is seen as a single application, device, or document. The hardware in the cloud (and the operating system that manages the hardware connections) is invisible.

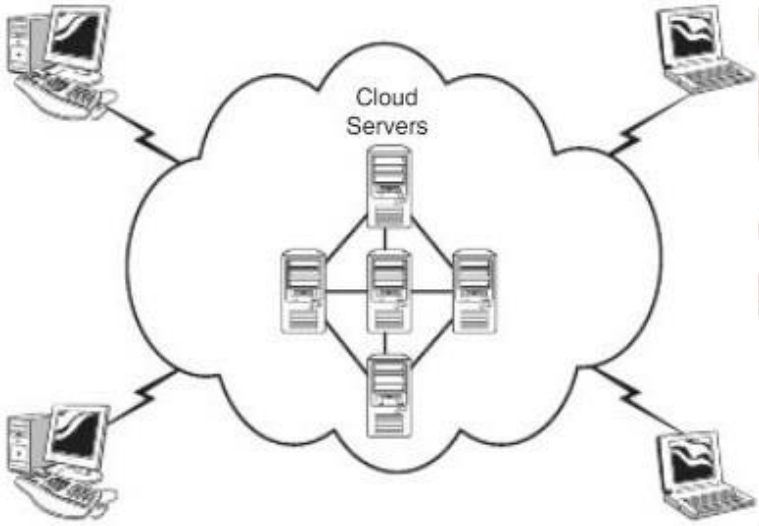

Fig: 1.7: cloud architecture

This cloud architecture is deceptively simple, although it does require some intelligent management to connect all those computers together and assign task processing to multitudes of users.

Through a local network or the Internet, cloud users can typically access cloud resources using devices, including mobile phones, tablets, laptops, and workstations. A front-end component of a cloud provider typically communicates with cloud users. Via this front-end element, the cloud provider offers users on-demand access to computing resources in the

form of infrastructure, platform, or software. The front end is a component of the cloud operating system (cloud OS), a piece of software that organizes and controls resource provisioning and provides resources to users.

SELF-ASSESSMENT QUESTIONS – 2

5. _____ cloud computing technology takes up the idea of using the internet to run software on any individual's computer.
6. The key to cloud computing is a massive network of servers, or even individual PCs interconnected in a grid [True/False]
7. Name the component through which the cloud user interacts.

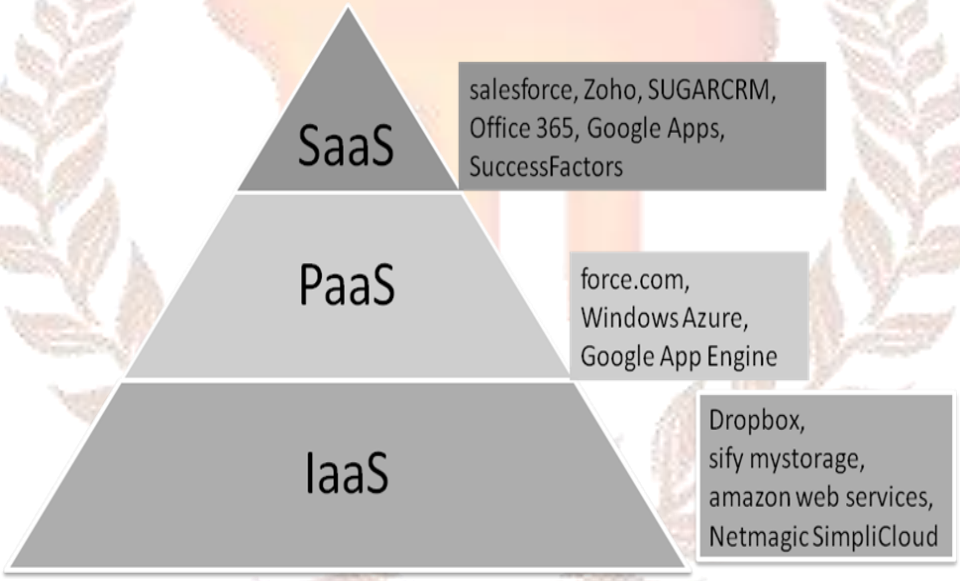

Fig: 1.8

Fig: 1.9

Fig: 1.10

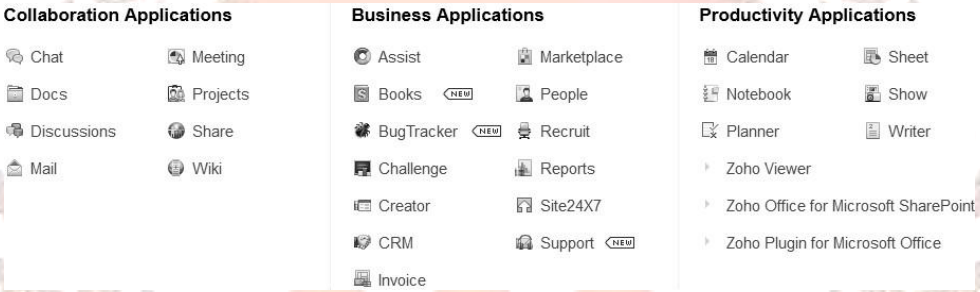

Fig: 1.11

SELF-ASSESSMENT QUESTIONS – 3

8. In cloud storage, data is stored on multiple.
9. Name the three broad categories of cloud services.
10. Name the first software with a multitenant platform that is charged based on usage instead of buying the software.
11. _____ is the familiar Microsoft Office now available on cloud as SaaS
12. AWS stands for.

5. SUMMARY

- Cloud computing has two precursors: client-server computing and peer-to-peer distributed computing.
- The technology defines how centralized storage facilitates collaboration and how multiple computers work jointly to enhance computing power.
- The term 'cloud' is used as a metaphor for the Internet, based on the cloud drawing used in the past to represent the telephone network and later to depict the Internet in computer network diagrams as an abstraction of the underlying infrastructure it represents. In this unit, we discussed the history and evolution of computing, which consists of different computing processes like client-server, peer-to-peer, distributed, collaborative, and cloud computing. In this unit, we also discussed the functioning of cloud computing, including the architecture, storage, services, and cloud industrial applications.

6. TERMINAL QUESTIONS

1. Discuss the history of progression from collaborative to cloud.
2. Describe the functioning of cloud computing.
3. Explain cloud architecture.
4. What are cloud services?
5. Explain the role of cloud computing in industrial applications.

7 ANSWERS

Self Assessment Questions

1. Server
2. True
3. distributed.net
4. b) collaborative
5. Cloud
6. True
7. User interface
8. third-party servers
9. SaaS, PaaS, IaaS
10. Salesforce
11. Office 365
12. Amazon Web Services.

Terminal Questions

1. We can say collaborative computing is the driving force to reach cloud computing technology. (For more details, refer section 2)
2. Fundamentally, cloud computing technology is different as compared to the traditional method because cloud computing is the delivery of computing as a service rather than a product. (For more details, refer section 3)
3. The key to cloud computing is the "cloud," a massive network of servers or even individual PCs interconnected in a grid. (For more details refer to section 4)
4. Different categories of cloud services are software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). (For more details, refer section 5)
5. The cloud computing industry has seen a rapid rise in the number of vendors, with each vendor trying to get the first mover advantage. (For more details, refer section 6)

E-References:

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