Unit 1 Introduction to Cloud Computing

Structure:

1.1 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

Objectives:

After studying this unit, you should be able to:

- discuss the history about the collaborative to cloud
- explain the functions of cloud computing
- understand the design cloud architecture
- discuss the cloud storage and cloud services
- list and explain the industrial application

1.2 From Collaborative to Cloud- A Short History

Cloud computing has the background with the combination of both client/server computing and peer-to-peer distributed computing. Here the concept lies on 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, autonomic and utility computing. The various phases of computing evolution process are illustrated in Figure 1.1. Each phase had a specific functional advantage and was passed to the later phase.

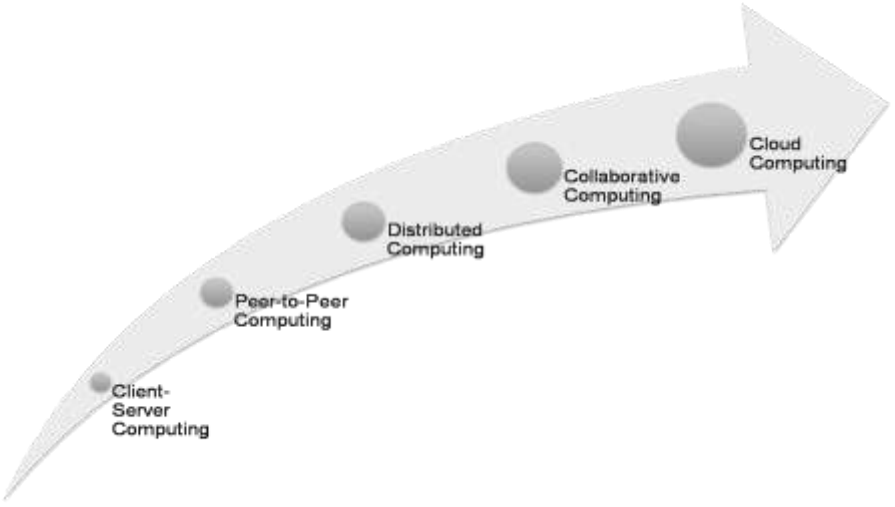

Figure 1.1: Evolution of cloud computing

Client/Server Computing: Centralized Applications and Storage

During the period of 1980, technologies were used for computation based on client/server model. Software applications with its control and the data

resided in the mainframe computers called server. In this scenario when the user wanted to access or run any program first, he need to get the access permission from mainframe server to access his data or any other application. The system through which the user connected to the server to access the data is called as computer terminal or workstation. These terminals are sometimes called as dump terminal since it does not have memory, storage space or processing power. It was merely a device that helps the user to connect and enable him to use the mainframe computer. Users can access the server only after getting permission from the information technology staff, since they are considered as the guardians of the process power. Comparatively there was a less power, so getting permission to access the server is not so easy as well, and moreover no two users can access the data at the same time.

Apart from all these, customization of a report was a challenging job, because you will be restricted to use the power given by the IT staff and you cannot either filter your data or copy some other data to generate a report what you really require. The reason behind this is even though the mainframe is huge in size and more powerful, the users those who want to get service are in large number 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 an immediate fulfillment. While providing centralized storage client/server model it is differ 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 as user-enabling environment.

Peer-to-Peer Computing: Sharing Resources

We can say now, as per the discussion above that it is a time consuming process to access a client/server system. Even the server side faces the problem to serve for the cumbersome queue. The reason is, in spite of efficiency of the server all the communication should cross through the server. This obvious need forced the system to create the connectivity between the computers without hitting the server first for the development of P2P (peer-to-peer) computing. In P2P architecture, all the computers those are connected have the equal resources and capabilities. Where as in case of client/server architecture all the computers connected is dedicated to the server. This scenario sometimes can be referred as master slave

architecture where server is the master and the other dedicated systems are called as 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 with the services and resources. Since every computer is having the capability to interact with each other there is no role for server thus the process becomes easy. P2P can be considered as 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 net-work. The network of computers which was accessed via internet created back in the year 1979, hosted the entire content of the network. 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 sites' 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, 7 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 try to utilize the idle computer thus avoiding wastage 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 take a traditional means, it might take years to solve essential mathematical problems. By connecting together thousands (or millions) of 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 in1997, 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 collaboration group projects online, in real time. To collaborate on any project, users must first be able to communicate 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 the 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 white boarding is also common, especially in corporate and education 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 farms, 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. Software applications with its control and the data resided in the mainframe computers called _____.
2. In P2P architecture all the computers those are connected have the equal resources and capabilities [True/False]
3. The first major Internet based distributed computing project was_____ , launched in1997.
4. Name the computing which was considered as driving force behind cloud computing.
   a. Peer to peer
   b. Collaborative
   c. Distributed
   d. Client/server

1.3 Functioning of Cloud Computing

Before even getting deep into the cloud computing technology, it is important to understand the key element "cloud" which represents computers which are organized in the form of a network which fulfill the purpose of service oriented architecture to give out information and software. Basically the cloud computing technology is set apart from the traditional method because the resources from computers are arranged in such a manner that the applications can function irrespective of the server configuration which uses them.

This methodology makes less use of the resources degrading the necessity of using hardware for working of the applications. Cloud in cloud computing technology takes up the idea of using internet to run software on any individual's computer. These days internet seems to be a hub of everything

therefore everyone prefers to use software which is entirely based on the web and can also work on this software using a simple web browser.

To understand the cloud computing technology, think of cloud so that it will have layers inside divided into two parts: back end and front end. Front end layer consists of everything visible to a normal human who is using the technology and also gets an opportunity to interact with it. Back end consists of both hardware and software required to make the front end interface functioning properly.

The set of computers in the cloud computing technology are put together so that any applications can take any resource it wishes to take and also use up the complete power as it usually does if it functions on one single machine. Cloud computing also provides scope for flexibility that is the number of resources being consumed can vary depending on the task at hand, which means that the resources can either decrease or increase according to the job.

Trends have been changing rapidly, the number of people using this cloud computing methods have only seen to be increasing without any questions of halting. Though it is a good thing to know, however it has its own set of risks of which the most primary one is that if for any reason the internet is down, access to data over other system will be tampered therefore stopping the work at least for some time. It might even disappear for longer durations if the internet bill is not paid at specified time.

1.4 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 matter, 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 hard-ware in the cloud (and the operating system that manages the hardware connections) is invisible.

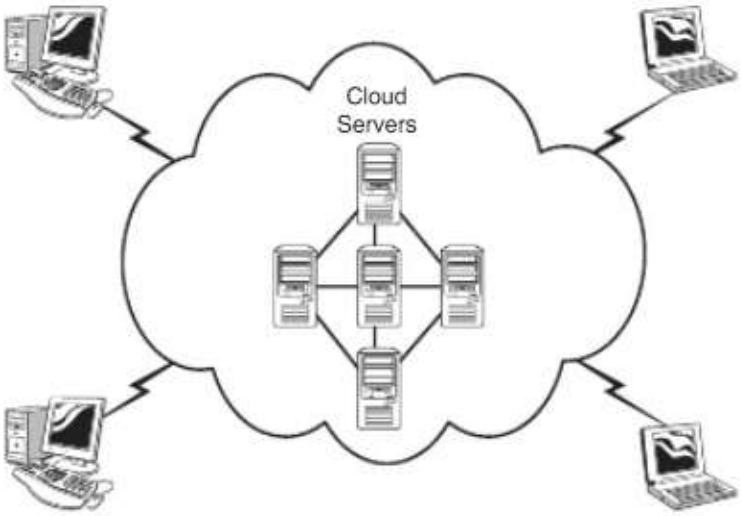

Figure 1.2: cloud architecture

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. As you can see in Figure 1.3, it all starts with the front-end interface seen by individual users. This is how users select a task or service (either starting an application or opening a document). The user's request then gets passed to the system management, which finds the correct resources and then calls the system's appropriate provisioning services. These services carve out the necessary resources in the cloud, launch the appropriate web application and either creates or opens the requested document. After the web application is launched, the system's monitoring and metering functions track the usage of the cloud so that resources are apportioned and attributed to the proper user(s).

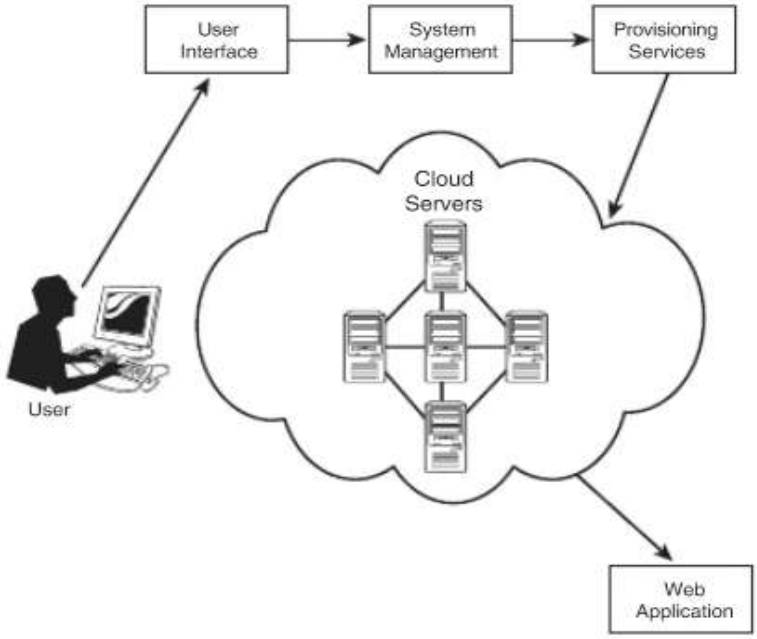

Figure 1.3: Process in cloud management

As you can see, key to the notion of cloud computing is the automation of many management tasks. The system isn't a cloud if it requires human management to allocate processes to resources. What you have in this instance is merely a twenty-first-century version of old-fashioned data center–based client/server computing. For the system to attain cloud status, manual management must be replaced by automated processes.

Self Assessment Questions

5. _____ in cloud computing technology takes up the idea of using internet to run software on any individual's computer.
6. 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.

1.5 Cloud Storage and cloud services

Cloud storage is a model of networked online storage where data is stored in virtualized pools of storage which are generally hosted by third parties Any web-based application or service offered via cloud computing is called cloud service.

Cloud storage

Cloud storage is a system of networked machine aggregation hardware where information is stored on multiple virtual servers, rather than being hosted on a single hard server. Hosting companies operate huge server hubs with backup and data protection systems; and people who use the service.

One of the primary uses of cloud computing is for data storage. With cloud storage, data is stored on multiple third-party servers, rather than on the dedicated servers used in traditional networked data storage. When storing data, the user sees a virtual server, that is, it appears as if the data is stored in a particular place with a specific name. But that place doesn't exist in reality. It's just an assumed name used to reference virtual space carved out of the cloud. In reality, the user's data could be stored on any one or more of the computers used to create the cloud. The actual storage location may even differ from day to day or even minute to minute, as the cloud dynamically manages available storage space. But even though the location is virtual, the user sees a "static" location for his data and can actually manage his storage space as if it were connected to his own PC. Cloud storage has both financial and security-associated advantages. Financially, virtual resources in the cloud are typically cheaper than dedicated physical resources connected to a personal computer or network. As for security, data stored in the cloud is secure from accidental erasure or hardware crashes, because it is duplicated across multiple physical machines; since multiple copies of the data are kept continually, the cloud continues to function as normal even if one or more machines go offline. If one machine crashes, the data is duplicated on other machines in the cloud.

Cloud service

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories:

- Infrastructure-as-a-Service (IaaS),
- Platform-as-a-Service (PaaS)
- Software-as-a-Service (SaaS).

The name cloud computing was inspired by the cloud symbol that's often used to represent the Internet in flowcharts and diagrams.

A cloud service has three distinct characteristics that differentiate it from traditional hosting. It is sold on demand, “typically by the minute or the hour; it is elastic -- a user can have as much or as little of a service as they want at any given time;” and the service is fully managed by the provider (the consumer needs nothing but a personal computer and an Internet access). Significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet and a weak economy, have accelerated interest in cloud computing.

A cloud can be private or public. A public cloud sells services to anyone on the Internet. (Currently, Amazon Web Services is the largest public cloud provider.) A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people. When a service provider uses public cloud resources to create their private cloud, the result is called a virtual private cloud. Private or public, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

Infrastructure-as-a-Service like Amazon Web Services provides virtual server instance API (Application programming interface) to start, stop, access and configure their virtual servers and storage. In the enterprise, cloud computing allows a company to pay for only as much capacity as is needed, and bring more online as soon as required. Because this pay-for-what-you-use model resembles the way electricity, fuel and water are consumed, it's sometimes referred to as utility computing.

Platform-as-a-service in the cloud computing is defined as a set of software and product development tools hosted on the provider's infrastructure. Developers create applications on the provider's platform over the Internet. PaaS providers may use APIs, website portals or gateway software installed on the customer's computer. Force.com, (an outgrowth of Salesforce.com) and GoogleApps are examples of PaaS. Developers need to know that currently there are not standards for interoperability or data portability in the cloud. Some providers will not allow software created by their customers to be moved off the provider's platform.

In ***software-as-a-service*** cloud model, the vendor supplies the hardware infrastructure, the software product and interacts with the user through a front-end portal. SaaS is a very broad market. Services can be anything

from Web-based email to inventory control and database processing. Because the service provider hosts both the application and the data, the end user is free to use the service from anywhere.

1.6 Industrial Applications

The cloud computing industry has seen a rapid rise in the number of vendors, with each vendor trying to get the first mover advantage. In Figure 1.4, some example of vendors and users are provided for various cloud services, i.e, IaaS, PaaS and SaaS.

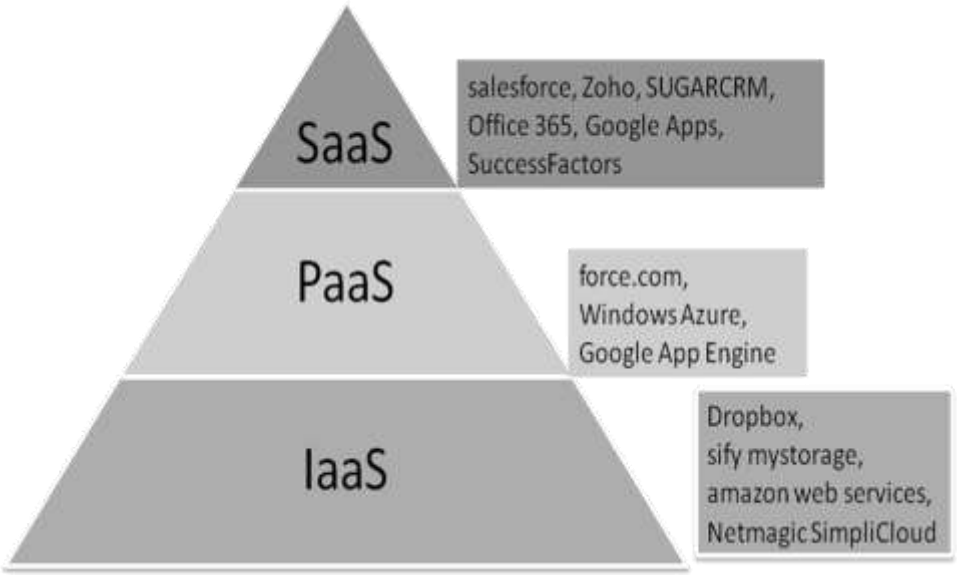

Figure 1.4: Responsibilities of vendor and user for different types of services

salesforce: One of the most popular cloud computing SaaS application is salesforce CRM. This was one of the first software with multitenant platform that charged based on usage instead of buying the software, deploying and maintaining the same. You access the software over the Internet.

Google Apps: Google Apps is a suite of cloud computing SaaS applications that includes e-mail (Gmail), Organizer (Google Calendar), Word Processing documents (Google Docs) and others. Figure 1.5 illustrates the various components of Google Apps. It has a free edition with few applications and other editions with lot more functionality. Google's Web-based messaging and collaboration apps require no server side hardware or software and

need minimal administration, creating tremendous time and cost savings for businesses.

Figure 1.5: Components of Google Apps

Office 365: Office 365 is the familiar Microsoft Office now available on cloud as SaaS. It is now available as a per-user per-month subscription. You do not need to install the software on your PC. You just need a web browser to access the service. Figure 1.6 illustrates the various components of Office 365.

Figure 1.6: Components of Office 365

Zoho: One of the leading companies which was started in India that has cloud based SaaS is Zoho. It has applications similar to the ones offered by salesforce, Office 365 and Google Apps. Figure 1.7 illustrates the various components which the Zoho supports.

Figure 1.7: Components of Zoho

Force.com: Force.com is PaaS offering from salesforce.com. It is a platform for creating and deploying applications for the social enterprises. Because there are no servers or software to buy or manage, you can focus solely on building applications that include built-in social and mobile functionality, business processes, reporting and search. Your applications run on a secure, proven service of salesforce.com that scales, tunes and backs up data automatically.

Windows Azure iPlatform: Windows Azure iPlatform is a cloud platform (PaaS) that enables you to quickly build, deploy and manage Windows applications across a global network of Microsoft managed datacenters.

Google App Engine: Google App Engine is a PaaS cloud computing platform used for developing and hosting web applications in Google managed datacenters.

Dropbox - Dropbox is an IaaS that provides Web-based file hosting service. It uses cloud storage to enable users to store and share files and folders with others across the Internet using file synchronization.

sify mystorage: sify mystorage is a IaaS and provides a cloud-based online storage and backup solution.

Amazon Web Services: Amazon Web Services (AWS) is a collection of remote computing services (also called web services) that together make up a cloud computing IaaS platform, offered over the Internet by Amazon.com. The most central and well-known of these services are Amazon EC2 for resizable compute capacity and Amazon S3 Cloud Storage.

Netmagic SimpliCloud: Netmagic SimpliCloud is an IaaS Cloud Computing Platform that features instant online provisioning of virtual machines and

virtual appliances. It also features ‘Elastic’ plans where customers can pay for their cloud infrastructure by the hour, thereby availing of true ‘Pay-As-You-Use’ and ‘On-Demand’ infrastructure.

Traditional companies like Oracle and SAP sold software as licenses with Annual Maintenance Contract. The cloud companies on the other hand have a subscription model where customers pay based on usage. This allows companies to try new applications at a very low cost and when they are comfortable, move all users to use the service. Cloud computing technology implies the fundamental challenges of how IT operations are managed and therefore, business as a whole. The traditional companies such as SAP, Oracle, Microsoft and Google are now trying to get big piece of data in the cloud.

Self Assessment Questions

8. In cloud storage, data is stored on multiple _____.
9. Name the three broad categories of cloud services
10. Name the first software with multitenant platform that 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 _____

1.7 Summary

- Cloud computing has its two precursors as 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 the 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. I
- In this unit we discussed the history and its evolution which consists of different computing process like client server, peer to peer, distributed, and collaborative and cloud computing. In this unit we also discussed the functioning of cloud computing includes the architecture, storage, services and cloud industrial applications.

1.8 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 application.

1.9 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 1.2)
2. Fundamentally, the 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 1.3)
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 section 1.4)
4. Different categories of cloud services are software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS). (For more details refer section 1.5)

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 1.6)

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