Unit 1: Cloud Computing: An Introduction

1.1. Traditional Computing Approaches

Previously, the power of computing was considered to be costly and scarce. Today, with the emergence of cloud computing, it is plentiful and inexpensive, causing a profound paradigm shift — a transition from scarcity computing to abundance computing. This computing revolution accelerates the commoditization of products, services and business models and disrupts current information and communications technology (ICT) Industry .It supplied the services in the same way to water, electricity, gas, telephony and other appliances. Cloud Computing offers on-demand computing, storage, software and other IT services with usage-based metered payment. Cloud Computing helps re-invent and transform technological partnerships to improve marketing, simplify and increase security and increasing stakeholder interest and consumer experience while reducing costs. With cloud computing, you don't have to over-provision resources to manage potential peak levels of business operation. Then, you have the resources you really required. You can scale these resources to expand and shrink capability instantly as the business needs evolve. This computing paradigm gave rise to many forms of distributed computing such as grid computing and cloud computing.

These vast applications required high-performance computing systems for their execution wherein the concept of cluster computing, grid and cloud computing came into existence. Some of the examples are:

- Numerous Scientific and engineering applications
- Modeling, simulation and analysis of complex systems like climate, galaxies, molecular structures, nuclear explosions, etc.
- Business and Internet applications such as e-commerce and web-servers, file servers, databases, etc.

For running these applications, the traditional approach to computing in the form of parallel computing was used. But, then, the dedicated parallel computers were very expensive and were not easily extensible. Hence, as per the users' demand, the computer scientists or engineers designed the cost-effective approaches in the form of cluster, grid and cloud computing.

1.2. Evolution of Cloud Computing

Today's PCs have remarkably high computing power. In the last few years, networking capabilities have also improved phenomenally. It is now possible to connect clusters of workstations with latencies and bandwidths comparable to tightly coupled machines. The concept of "Clusters" started to take off in the 90's. The term "grid computing" also originated in the early 1990s as a metaphor for making the computer power as easy to access as an electric power grid. The grids were considered as an innovative extension to the distributed computing technology. However, the development of Cloud Computing through various phases, including Grid Computing, Utility Computing, Application Service Provision and Software as a Service, etc., has taken place in a remarkable way. But the overall (whole) concept of the provision of computing resources via a global network began in the 1960s. But the history of cloud computing is how we got there and where all that started. Cloud computing has a history that is not that old, the first business and consumer cloud computing website was launched in 1999 (Salesforce.com and Google). Cloud computing is directly connected to Internet development and the development of corporate technology as cloud computing is the answer to the problem of how the Internet can improve corporate technology. Business technology has a rich and interesting background, almost as long as businesses themselves, but the development

that has influenced Cloud computing most directly begins with the emergence of computers as suppliers of real business solutions. History of Cloud Computing Cloud computing is one of today's most breakthrough technologies.

- Early Phases of 1960s

Computer scientist John McCarthy had the concept of time-sharing that allowed the organization to use an expensive mainframe at the same time. This machine is described as a major contribution to Internet development, and as a leader in cloud computing.

- 1969

  J.C.R. Licklider, responsible for the creation of the Advanced Research Projects Agency (ARPANET), proposed the idea of an "Intergalactic Computer Network" or "Galactic Network" (a computer networking term similar to today's Internet). His vision was to connect everyone around the world and access programs and data from anywhere.
- 1970s
- Usage of tools such as VMware for virtualization. More than one operating system can be run in a separate environment simultaneously. In a different operating system it was possible to Cloud Computing: Unedited Version pg. 15 operate a completely different computer (virtual machine). IN 1997 Prof Ramnath Chellappa in Dallas in 1997 seems to be the first known definition of "cloud computing," "a paradigm in which computing boundaries are defined solely on economic rather than technical limits alone." IN 1999 Salesforce.com was launched in 1999 as the pioneer of delivering client applications through its simple website. The services firm has been able to provide applications via the Internet for both the specialist and mainstream software companies. IN 2003 This first public release of Xen ,is a software system that enables multiple virtual guest operating systems to be run simultaneous on a single machine, which also known as the Virtual Machine Monitor (VMM) as a hypervisor. IN 2006 The Amazon cloud service was launched in 2006. First, its Elastic Compute Cloud (EC2) allowed people to use their own cloud applications and to access computers. Simple Storage Service (S3) was then released. This incorporated the user-as-you-go model and has become the standard procedure for both users and the industry as a whole.

1.3. Comparison between Cluster, Grid and Cloud Computing

FEATURES	*CLUSTER COMPUTING*	*GRID COMPUTING*	*CLOUD COMPUTING*
Characteristics	Tightly coupled systems, Single system image, Centralized Job management & scheduling system	Loosely coupled (Decentralization) Diversity and Dynamism Distributed Job Management & scheduling	Dynamic computing infrastructure, IT service-centric approach, Self-service based usage model, Minimally or self-managed platform, Consumption-based billing
Physical Structure	In cluster computing, a bunch of similar/identical computers are hooked	In grid computing, the computers do not have to be in the same physical location and	In cloud computing, the computers need not to be in the

	up locally (in the same physical location, directly connected with very high speed connections) to operate as a single computer	can be operated independently. As far as other computers are concerned each computer on the grid is a distinct computer	same physical location.
Hardware	The cluster computers all have the same hardware and OS	The computers that are part of a grid can run different operating systems and have different hardware	The memory, storage device and network communication are managed by the operating system of the basic physical cloud units. Open source Software such as LINUX can support the basic physical unit management and virtualization computing.
Resources	The whole system (all nodes) behaves like a single system view and resources are managed by centralized resource manager.	Every node is autonomous i.e. it has its own resource manager and behaves like an independent entity	Every node acts as an independent entity
Applications	1. Educational resources 2.Commercial sectors for industrial promotion 3.Medical research	1.Predictive Modeling and Simulations 2.Engineering Design and Automation 3.Energy Resources Exploration 4.Medical, Military and Basic Research 5.Visualization	1.Banking 2.Insurance 3.Weather Forecasting 4.Space Exploration 5.Software as a service 6.PaaS 7.Infrastructure-as -a-Service
Networking	Dedicated, high-end with low latency and high bandwidth Interconnection Network	Mostly Internet with high latency and low Bandwidth Interconnection Network	Dedicated, high-end with low latency and high Bandwidth Interconnection Network
Scalability	Size or scalability is 100s	Size or scalability is 1000s	Size or scalability is 100s to 1000s

1.4. Utility Computing

Utility computing basically refers to the utility computing technologies and the business models that are offered by a service provider to the IT customers. The client is charged as per their consumption. Examples of these IT services are storage, computing power, and applications.

The term utility is basically the utility services like water, telephone, electricity, and gas that are provided by any utility company. In a similar manner, the customer when receives utility computing, its computing power on the shared computer network bills is decided on the basis of the consumption which is measured.

Utility computing is similar to virtualization and the total web storage space amount with the computing power that is made available to the user is higher as compared to a single time-sharing computer. The web service is possible through a number of backend web servers. The web servers could be dedicated and used as a cluster form which is created and then gets leased to the end-user. Distributed computing is the method where a single such calculation is done on multiple web servers.

In utility computing, there is a provider who will own the storage or power resources. The customer is charged based on how much they make use of the services. The customer is not charged each month and the services are not sold outright. Depending on the resources that are offered utility computing could also be called Infrastructure as a Service or IaaS and Hardware as a Service or HaaS.

Their function is similar to the other basic utilities. It is like you or any major company uses electricity. Both of you do not pay a flat monthly rate but pay the amount as per the electricity that you consume.

There are companies that offer a different kind of utility computing where the user will rent a cloud computer and use it in order to run the applications or an algorithm or anything that may need a lot of computing power. You pay per second or per hour and do not pay a flat fee to use the service.

Utility computing is beneficial because of its flexibility. Since you do not own the resource and are not leasing them for long it is easy to change the amount of power that you buy. You are free to grow or to shrink the service amount within a few seconds based on your business requirements.

1.5. Characteristics of Cloud Computing

- *On-demand Self Service:* A consumer can request and receive access to a service offering, without an administrator or some sort of support staff having to fulfil the request manually.
- *Broad network Access:* The servers can be accessed from any location using any type of device – anywhere access and anytime.
- *Resource Pooling*: Resource can be storage, memory, network bandwidth, virtual machines, etc. which can be consumed by the cloud users. Resource Pooling means that multiple customers are serviced from the same physical resources.
- *Measured Services:* Pay according to the services you use.
- *Rapid Elasticity and Stability*: One of the great things about cloud computing is the ability to quickly provision resources in the cloud as organizations need them and then to remove them when they don't need them.
- *Easy maintenance:* Maintenance of the cloud is easier.
- *Security:* Copy of our data on various servers i.e., if 1 fails, data is safe on the other.

1.6. Benefits of Cloud Computing

- Resources accessible anywhere, anytime
- On-demand self-service
- Reduced IT cost(We need not purchase hardware, no maintenance, etc.)
- Scalability- If traffic on website is more, we can scale up anytime and similarly scale down also.

- Online development and deployment tools
- Collaboration – People sitting in different countries can do a project through collaborating and getting their data stored on the cloud
- Offers security as data stored is stored at multiple locations.
- Location and device independence
- Saves our time – we need not update the softwares, or maintain the hardware.

1.7. Applications of Cloud Computing

1. *Online Data Storage :*

   Cloud computing allows storing data like files, images, audios, and videos, etc on the cloud storage. The organization need not set physical storage systems to store a huge volume of business data which costs so high nowadays. As they are growing technologically, data generation is also growing with respect to time, and storing that becoming problem. In that situation, Cloud storage is providing this service to store and access data any time as per requirement.
2.
3. *Backup and Recovery:*

   Cloud vendors provide security from their side by storing safe to the data as well as providing a backup facility to the data. They offer various recovery application for retrieving the lost data. In the traditional way backup of data is a very complex problem and also it is very difficult sometimes impossible to recover the lost data. But cloud computing has made backup and recovery applications very easy where there is no fear of running out of backup media or loss of data.
4.
5. *Big data Analysis:*

   We know the volume of big data is so high where storing that in traditional data management system for an organization is impossible. But cloud computing has resolved that problem by allowing the organizations to store their large volume of data in cloud storage without worrying about physical storage. Next comes analyzing the raw data and finding out insights or useful information from it is a big challenge as it requires high-quality tools for data analytics. Cloud computing provides the biggest facility to organizations in terms of storing and analyzing big data.

6. *E-commerce Application:*
   Cloud-based e-commerce allows responding quickly to the opportunities which are emerging. Users respond quickly to the market opportunities as well as the traditional e-commerce responds to the challenges quickly. Cloud-based e-commerce gives a new approach to doing business with the minimum amount as well as minimum time possible. Customer data, product data, and other operational systems are managed in cloud environments.

7. *Cloud computing in education :*

Cloud computing in the education sector brings an unbelievable change in learning by providing e-learning, online distance learning platforms, and student information portals to the students. It is a new trend in education that provides an attractive environment for learning, teaching, experimenting, etc to students, faculty members, and researchers. Everyone associated with the field can connect to the cloud of their organization and access data and information from there.

6.*E-Governance Application :*

Cloud computing can provide its services to multiple activities conducted by the government. It can

support the government to move from the traditional ways of management and service providers to an advanced way of everything by expanding the availability of the environment, making the environment more scalable and customized. It can help the government to reduce the unnecessary cost in managing, installing, and upgrading applications and doing all these with help of could computing and utilizing that money public service.

7. *Cloud Computing in Medical Fields :*

In the medical field also nowadays cloud computing is used for storing and accessing the data as it allows to store data and access it through the internet without worrying about any physical setup. It facilitates easier access and distribution of information among the various medical professional and the individual patients. Similarly, with help of cloud computing offsite buildings and treatment facilities like labs, doctors making emergency house calls and ambulances information, etc can be easily accessed and updated remotely instead of having to wait until they can access a hospital computer.

8. *Entertainment Applications:*

Many people get entertainment from the internet, in that case, cloud computing is the perfect place for reaching to a varied consumer base. Therefore different types of entertainment industries reach near the target audience by adopting a multi-cloud strategy. Cloud-based entertainment provides various entertainment applications such as online music/video, online games and video conferencing, streaming services, etc and it can reach any device be it TV, mobile, set-top box, or any other form. It is a new form of entertainment called On-Demand Entertainment (ODE).

1.8. Challenges of Cloud Computing

- *Availability of Services*
- *Data Lock-In:* Shifting of large volume of data from one platform to another.
- *Data Seggregation:* Isolation of data of each user.
- *Scaling Resources:* Sudden demand of increased resources may arise.
- *Location of Data:* Geographically stored(Each country has its own rule)
- *Deletion of Data:* User demands complete removal of data
- *Recovery and Backup:* How frequently and how fast a cloud system recovers from failure.