Ch. 8 Emerging Technologies

1. Emerging Technologies

· **Emerging Technologies** are contemporary advances and innovation in various fields of technology.
Various *converging technologies* have emerged in the technological convergence of different systems evolving towards similar goals. i.e. *potential to meet global Challenges*

· technical innovations in the field of Storage, mining & services may be the key to emerging *Challenge*

· Examples of currently emerging technologies are:

synthetic biology, Nano-scale design,
systems biology, wireless networks,
ICT-enhanced educational systems etc.

· In order to address the Challenges - Some of the technologies, which have recently emerged and are being rapidly adapted include

- ✓ cloud computing,
- ✓ grid computing,
- ✓ mobile computing,
- ✓ and green computing.

2. Cloud Computing

- Cloud computing simply means the use of computing resources as a service through a real time communication networks, such as Internet.
- The Internet is commonly visualized as clouds; hence the term "cloud computing" for computation done through the Internet
- Cloud computing is a combination of software and hardware based computing resources delivered as a network service.
- Cloud computing is designed to enable users:-
  - ✓ enables anytime access to a shared pool of applications and resources.
  - ✓ To access data using a simple front-end interface such as a Web browser.
  - ✓ To develop, deploy and manage their resources on the Internet/ cloud i.e. Vertulization of Resources
- Objectives of Cloud Computing
  - ✓ Bring all It Resources in an eco friendly/ cost saving way
  - ✓ Enable It services to be accessible from anywhere – "Anywhere Access"
  - ✓ Promote scalability/ Upgradation
  - ✓ Integrate IT Infrastucture and
  - ✓ Reduce cost relating to IT Energy

3. Features/ Characteristics Of Cloud computing

- ✓ High Scalability: Cloud environments enable servicing of business requirements for larger audiences, through high scalability.
- ✓ Agility: The cloud works in the 'distributed mode 'environment. It shares resources among users and tasks, while improving efficiency and agility (responsiveness).
- ✓ High Availability and Reliability: Availability of servers is supposed to be high and more reliable as the chances of infrastructure failure are minimal.
- ✓ Multi-sharing: With the cloud working in a distributed and shared mode, multiple users and applications can work more efficiently with cost reductions by sharing common infrastructure.
- ✓ Services in Pay-Per-Use Mode: SLAs between the provider and the user must be defined when offering services in pay per use mode. This may be based on the complexity of services offered. Application Programming Interfaces (APIs) may be offered to the users so they can access services on the cloud by using these APIs.
- ✓ Virtualization: This technology allows servers and storage devices to increasingly share and utilize applications, by easy migration from one physical server to another.
- ✓ Performance: It is monitored and consistent and loosely coupled architectures are constructed using web services as the system interface.
- ✓ Maintenance: The cloud computing applications are easier, because they are not to be installed on each user's computer and can be accessed from different places.

4. Advantages of Cloud Computing : Major advantages of Cloud Computing are given as follows:

- Cost Efficient methods
- Almost Unlimited Storage
- Backup and Recovery much simpler than other traditional methods of data storage.
- Automatic Software Integration
- Easy Access to Information
- Quick Deployment

5. Goals of Cloud Computing {CA AR RaRE}

- To **c**onsolidate IT infrastructure into a more integrated and manageable environment;
- To **a**ccess services and data from anywhere at any time;
- To enable or improve "**A**nywhere Access" (AA) for ever increasing users; and
- To **r**educe costs related to IT energy/power consumption;
- To enable **ra**pidly provision resources as needed.
- To create a highly efficient IT ecosystem, where **r**esources are pooled together and costs are aligned with what resources are actually used;
- To scale the IT **e**cosystem quickly, easily and cost-effectively based on the evolving business needs;

Cloud Computing Architecture

It refers to the components and subcomponents required for cloud computing. These components typically consist of a front end platform (fat client, thin client, mobile device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combined, these components make up cloud computing architecture.

In cloud computing, protection depends on having the Right Architecture for the Right Application (RARA). Organizations must understand the individual requirements of their applications, and if already using a cloud platform, understand the corresponding cloud architecture.

A cloud computing architecture consists of a front end and a back end. They connect to each other through a network, usually the Internet.

Front End Architecture: Cloud computing architectures consist of front-end platforms called clients or cloud clients. These clients comprise servers, fat (or thick) clients, thin clients, zero clients ,tablets and mobile devices. These client platforms interact with the cloud data storage via an application (middleware), via a web browser, such as Firefox, Microsoft's internet explorer or Apple's Safari. Other types of systems have some unique applications which provide network access to its clients.

Back End Architecture: it refers to some service facilitating peripherals. In cloud computing, the back end is cloud itself, which may encompass various computer machines, data storage systems and servers. Groups of these clouds make up a whole cloud computing system. It include any type of web application program such as video games to applications for data processing, software development and entertainment.

CLOUD COMPUTING ENVIRONMENT

The cloud computing environment consists of multiple types of cloud based on their deployment and usage. Following are the types of cloud computing:

<table>
<tr><td rowspan="2">Public Cloud</td><td colspan="2">This environment can be used by the general public. This includes individuals, corporations and other types of organizations. Typically, public clouds are administrated by third parties or vendors over the Internet, and the services are offered on pay-per-use basis. These are also called provider clouds. Business models like SaaS (Software-as-a-Service) and public clouds complement each other and enable companies to leverage shared IT resources and services.</td></tr>
<tr><td>Advantages of public cloud includes
• widely used in the development, deployment and management of enterprise applications, at affordable costs.
• It allows the organizations to deliver highly scalable and reliable applications rapidly and at more affordable costs.</td><td>limitations is security assurance and thereby building trust among the clients is far from desired but slowly liable to happen.</td></tr>
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<tr><td>Private Clouds</td><td colspan="2">This cloud computing environment resides within the boundaries of an organization and is used exclusively for the organization's benefits. These are also called internal clouds. They are built primarily by IT departments within enterprises, who seek to optimize utilization of infrastructure resources within the enterprise by provisioning the infrastructure with applications using the concepts of grid and virtualization.</td></tr>
<tr><td></td><td>advantages of private clouds include the following:
· They improve average server utilization; allow usage of low-cost servers and hardware while providing higher efficiencies;
· High levels of automation is largely responsible for reducing operations costs and administrative overheads</td><td>major limitation is that IT teams in the organization may have to invest in buying, building and managing the clouds independently.</td></tr>
<tr><td>Hybrid Clouds</td><td colspan="2">it is a combination of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models. A hybrid cloud service as a cloud computing service that is composed of some combination of private, public & community cloud services, from different service providers.</td></tr>
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Cloud Computing Models

Infrastructure as a Service (IaaS):	IaaS providers offer computers, more often virtual machines and other resources as service. It provides the infrastructure / storage required to host the services by ourselves i.e. makes us the system administrator and manage hardware/storage, network and computing resources. In order to deploy their applications, cloud clients install operating-system images and their application software on the cloud infrastructure. Examples of IaaS providers include: Amazon EC2, Azure Services Platform, Dyn DNS, Google Compute Engine, HP Cloud etc.
(ii) Platform as a Service (PaaS):	Cloud providers deliver a computing platform including operating system, programming language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of acquiring and managing the underlying hardware /software layers. In PaaS, one can make applications and software on other's database. Thus, it gives us the platform to create, edit, run and manage the application programs we want. All the development tools are provided. Some of examples of PAAS include: AWS Elastic Beanstalk, Cloud Foundry, Heroku, Force.com, EngineYard etc.
(iii) Software as a Service (SaaS):	**SaaS** provides users to access large variety of applications over internets that are hosted on service provider's infrastructure. For example, one can make his/her own word document in Google docs online, s/he can edit a photo online on pixlr.com so s/he need not install the photo editing software on his/her system- thus Google is provisioning software as a service.
(iv) Network as a Service (NaaS):	It is a category of cloud services where the capability provided to the cloud service user is to use network/transport connecting services. NaaS involves optimization of resource allocation by considering network and computing resources as a whole. Some of the examples are: Virtual Private Network, Mobile Network Virtualization etc.
(v) Communication as a Service (CaaS):	CaaS has evolved in the same lines as SaaS. CaaS is an outsourced enterprise communication solution that can be leased from a single vendor. The CaaS vendor is responsible for all hardware and software management and offers guaranteed Quality of Service (QoS). It allows businesses to selectively deploy communication devices and modes on a pay-as-you-go, as-needed basis. This approach eliminates large capital investments. Examples are: Voice over IP (VoIP), Instant Messaging (IM), Collaboration and Videoconferencing application using fixed and mobile devices.

Challenges relating to Cloud Computing

Major challenges are discussed following:

- Confidentiality: Prevention of the unauthorized disclosure of the data is referred as Confidentiality.
- Integrity: Integrity refers to the prevention of unauthorized modification of data and it ensures that data is of high quality, correct, consistent and accessible. Strong data integrity is the basis of all the service models such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).
- Availability: Availability refers to the prevention of unauthorized withholding of data and it ensures the data backup through **B**usiness **P**lanning **C**ontinuity Planning (**BCP**) and **D**isaster **R**ecovery **P**lanning (**DRP**).
- Trust: Deployment model provide a trust to the Cloud environment.
- Legal Issues and Compliance
- Privacy: privacy issues are embedded in each phase of the Cloud design. It should include both the legal compliance and trusting maturity. The Cloud decreases the privacy risk.
- Audit: Auditing is type of checking that 'what is happening in the Cloud environment'.
- Data Stealing: In a Cloud, data stored anywhere is accessible in public form and private form by anyone at any time. In such cases, an issue arises as data stealing.
- Architecture: In the architecture of Cloud computing models, it should be a control over the security and privacy of the system.
- Identity Management and Access control
- Incident Response: It ensures to meet the requirements of the organization during an incident

Grid computing

- Grid computing may or may not be in the cloud paradigm depending on what type of users are using it.
- Grid computing requires the use of software that can divide and carve out pieces of a program as one large system image to several thousand computers. One concern about grid is that if one piece of the software on a node fails, other pieces of the software on other nodes may fail
- Which can be solved if that component has a failover component on another node, but problems can still arise if components rely on other pieces of software to accomplish one or more grid computing tasks
- **Grid computing** is the collection of computer resources from multiple locations to reach a common goal.
- The **grid** can be thought of as a distributed system with non-interactive workloads that involve a large number of files. Grids are often constructed with general-purpose grid middleware software libraries.

Some pertinent similarities and differences between cloud and grid computing are highlighted as follows:

- Cloud computing and grid computing both are scalable. Scalability is accomplished through load balancing of application instances running separately on a variety of operating systems and connected through Web services.
- Both computing types involve multi-tenancy and multitasking, meaning that many customers can perform different tasks, accessing a single or multiple application instances.
- Sharing resources among a large pool of users assists in reducing infrastructure costs and peak load capacity.
- Cloud and grid computing provide Service- Level Agreements (SLAs) for guaranteed uptime availability of, say, 99 percent - credit for not receiving data within stipulated time.
- While the storage computing in the grid is well suited for data-intensive storage, it is not economically suited for storing objects as small as 1 byte. In a data grid, the amounts of distributed data must be large for maximum benefit.
- While in cloud computing, we can store an object as low as 1 byte and as large as 5 GB or even several terabytes.
- A computational grid focuses on computationally intensive operations, while cloud computing offers two types of instances: standard and high-CPU.