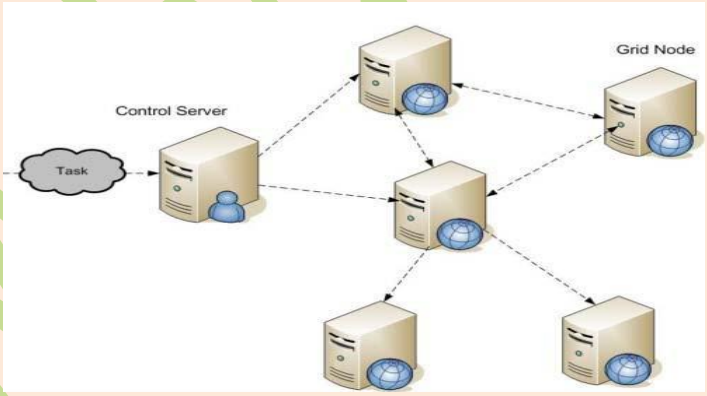
Chapter - 8
Emerging Technologies

Cloud Computing: Cloud computing simply means the use of computing resources as a service through networks, typically the Internet. Cloud computing is both, a combination of software and hardware based computing resources delivered as a networked service. This model of IT enabled services enables anytime access to a shared pool of applications and resources.

With cloud computing, companies can scale up to massive capacities in an instant without having to invest in new infrastructure, train new personnel or license new software. Cloud computing is of particular benefit to small and medium-sized business systems, who wish to completely outsource their data-center infrastructure; or large companies, who wish to get peak load capacity without incurring the higher cost of building larger data centers internally. In both the instances, service consumers use *'what they need on the Internet'* and *pay only for 'what they use'*.

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. We can see in the following diagram :



Cloud v/s Grid Computing: Some pertinent similarities and differences are**:**

1. Cloud Computing and Grid Computing both are scalable.
2. Both computing types involve multi-tenancy and multitasking, meaning that many customers can perform different tasks, accessing a single or multiple application instances.
3. 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.

4. A computational grid focuses on computationally intensive operations, while cloud computing offers two types of instances: standard and high-CPU.

Goals of Cloud Computing: The core goal of utilizing a cloud-based IT ecosystem is to pool available resources together into a highly efficient infrastructure whose costs are aligned with what resources are actually used to make the services accessible and available from anywhere at any time. To meet the requirements, some of the pertinent objectives in order to achieve the goals are as follows:

1. To access services and data from anywhere at any time
2. To consolidate IT infrastructure into a more integrated and manageable environment
3. To reduce costs related to IT energy/power consumption;
4. To enable or improve "Anywhere Access" (AA) for ever increasing users; and
5. To enable rapidly provision resources as needed.

Cloud Computing Architecture: The Cloud Computing Architecture (CCA) of a cloud solution is the structure of the system, which comprises of on-premise and cloud resources services, middleware, and software components, their geo-location, their externally visible properties and the relationships between them. Cloud architecture typically involves multiple cloud components communicating with each other over a loose coupling mechanism, such as a messaging queue

ArchitectureThe details are given as f**o**llow:

1. **Front End Architecture:** The fro**n**t end of the cloud comp**u**ting system comprises **o**f the client's **d**evices (or computer net**w**ork) and s**o**me applicati**o**ns needed **f**or accessin**g** the cloud computing system. All the **c**loud computing systems **d**o not give t**h**e same inter**f**ace to users.
2. **Back End Architecture:** Back en**d** refers to s**o**me service f**a**cilitating pe**r**ipherals. In **c**loud computi**n**g, the bac**k** end is cl**o**ud itself, **w**hich may **e**ncompass **v**arious com**p**uter machines, data stor**a**ge systems **a**nd servers. Groups of t**h**ese clouds make up a **w**hole cloud computing system.

Cloud Computing Environment: The cloud computing environment can consist of multiple types of clouds based on their deployment and usage. These are:

1. **Public Clouds:** 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.
2. **Private Clouds:** 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.
3. **Hybrid Clouds:** This is a combination of both at least one private (internal) and at least one public (external) cloud computing environments - usually, consisting of infrastructure, platforms and applications. It is typically offered in either of two ways. A vendor has a private cloud and forms a partnership with a public cloud provider or a public cloud provider forms a partnership/franchise with a vendor that provides private cloud platforms.

Cloud Computing Models: These are as follows**:**

1) **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 ourselves i.e. makes us the system administrator and manage hardware/storage, network and computing resources.

2) **Platform as a Service (PaaS):** Cloud providers deliver a computing platform including operating system, programming language execution environment, database, and web server.
3) **Software as a Service (SaaS): SaaS** provides users to access large variety of applications over internets that are hosted on service provider's infrastructure.
4) **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.
5) **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.

Characteristics of Cloud Computing: Major characteristics are:

1) High Scalability,
2) Agility,
3) High Availability and Reliability,
4) Multi-sharing,
5) Services in Pay-Per-Use Mode,
6) Virtualization,
7) Performance, and
8) Maintenance.

Advantages of Cloud Computing: Major advantages of Cloud Computing are:

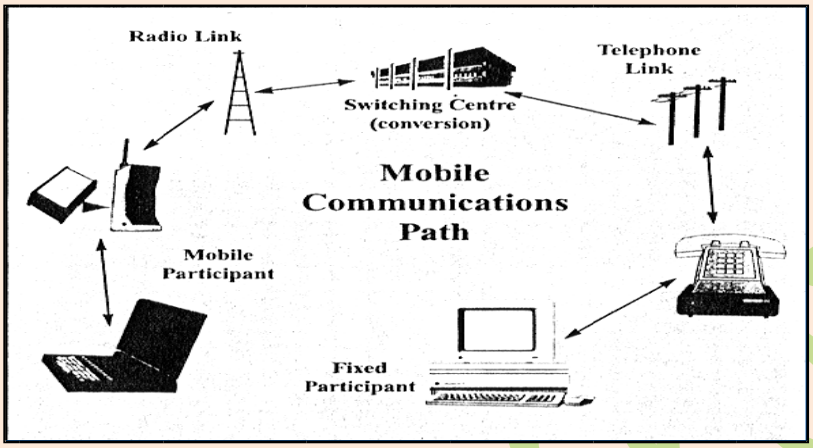
1. Cost Efficiency,
2. Almost Unlimited Storage,
3. Backup and Recovery,
4. Automatic Software Integration,
5. Easy Access to Information, and
6. Quick Deployment.

Challenges to Cloud Computing: Major challenges are**:**

1 . Confidentiality,
2. Integrity, Availability,
3. Governance,
4. Trust,
5. Legal Issues and Compliance,
6. Privacy,
7. Audit,
8. Data-Stealing,
9. Software Isolation and
10. Application Security.
11. Architure
12. Identity Management & Access control
13. Incident Response

Mobile Computing: It refers to the technology that allows transmission of data via a computer without having to be connected to a fixed physical link. Mobile data communication has become a very important and rapidly evolving

technology as it allows users to transmit data from remote locations to other remote or fixed locations. This proves to be the solution for the biggest problem of business people on the move i.e. mobility. A pri**m**itive scenario of **m**obile computing in practice is given in the following diagram:



Mobile Computing services

Various companies design and develop several wireless applications and solutions for Blackberry, iPhone, Google Android G1, iPad, Windows Mobile, Symbian, Brew devices, PDA, Palm & Pocket PC. Mobile Computing Services allow mobile workforces to access a full range of corporate services and information from anywhere, at any time and it improves the productivity of a mobile workforce by connecting them to corporate information systems.

Mobile Computing Benefits

Following are major benefits of the Mobile computing :

1. It provides mobile workforce with remote access to work order details, such as work order location, contact information, required completion date, asset history relevant warranties/service contracts.
2. It enables mobile sales personnel to update work order status in real-time, facilitating excellent communication.
3. It facilitates access to corporate services and information at any time, from anywhere.
4. It provides remote access to the corporate Knowledgebase at the job location.
5. It enables to improve management effectiveness by enhancing information quality, information flow, and ability to control a mobile workforce.

BYOD: BYOD (Bring Your Own Device) refers to business policy that allows employees to use their preferred computing devices, like smart phones and laptops for business purposes. It means employees are welcome to use personal devices (laptops, smart phones, tablets etc.) to connect to the corporate network to access information and application.

Emerging BYOD Threats: Overall, these can be classified into four areas as outlined below:

1) **Network Risks:** It is normally exemplified and hidden in 'Lack of Device Visibility'. When company-owned devices are used by all employees within an organization, the organization's IT practice has complete visibility of the devices connected to the network. As BYOD permits employees to carry their own devices (smart phones, laptops for business use), the IT practice team is unaware about the number of devices being connected to the network.
2) **Device Risks:** It is normally exemplified and hidden in 'Loss of Devices'. A lost or stolen device can result in an enormous financial and reputational embarrassment to an organization as the device may hold sensitive corporate information.

3) **Application Risks:** It is normally exemplified and hidden in 'Application Viruses and Malware'. A related report revealed that a majority of employees' phones and smart devices that were connected to the corporate network weren't protected by security software.

4) **Implementation Risks:** It is normally exemplified and hidden in 'Weak BYOD Policy'. The effective implementation of the BYOD program should not only cover the technical issues mentioned above but also mandate the development of a robust implementation policy.

Social Media: A social network is usually created by a group of individuals, who have a set of common interests and objectives. There are usually a set of network formulators followed by a broadcast to achieve the network membership. This happens both in public and private groups depending upon the confidentiality of the network.

Web 2.0: Web 2.0 is the term given to describe a second generation of the World Wide Web that is focused on the ability for people to collaborate and share information online. Web 2.0 basically refers to the transition from static HTML Web pages to a more dynamic Web that is more organized and is based on serving Web applications to users.

Components of Web 2.0 for Social Networks: Major components that have been considered in Web 2.0 include the following:

1. **Communities:** These are an online space formed by a group of individuals to share their thoughts, ideas and have a variety of tools to promote Social Networking. There are a number of tools available online, now-a-days to create communities, which are very cost efficient as well as easy to use.
2. **Blogging:** Blogs give the users of a Social Network the freedom to express their thoughts in a free form basis and help in generation and discussion of topics.
3. **Wikis:** A Wiki is a set of co-related pages on a particular subject and allow users to share content. Wikis replace the complex document management systems and are very easy to create and maintain.
4. **Folksonomy:** Web 2.0 being a people-centric technology has introduced the feature of Folksonomy where users can tag their content online and this enables others to easily find and view other content.
5. **File Sharing/Podcasting:** This is the facility, which helps users to send their media files and related content online for other people of the network to see and contribute.
6. **Mashups:** This is the facility, by using which people on the internet can congregate services from multiple vendors to create a completely new service. An example may be combining the location information from a mobile service provider and the map facility of Google maps in order to find the exact information of a cell phone device from the internet, just by entering the cell number.

Benefits and Challenges for Social Networks using Web 2.0

There are following benefits of using Web 2.0

1. It provides a platform where users of the network need not to worry about the implementation or underlying technology at a very affordable cost and a very easy pickup time.
2. Concepts of Web 2.0 like blogging are some things that people do on a day-to-day basis and no new knowledge skills are required.
3. Web 2.0 techniques are very people centric activities and thus, adaptation is very fast.

There are following challenges of using Web 2.0

1) One of the major aspects is data security and privacy and in such public domains,
2) there is a huge chance of data leak and confidentiality loss because
3) there are usually no centrally mandated administrative services to take care of such aspects.
4) Privacy of individual users also arises and
5) can create a huge problem if malicious users somehow manage to perpetuate the social networks

Green IT: Green IT refers to the study and practice of establishing / using computers and IT resources in a more efficient and environmentally friendly and responsible way. Green computing is the environmentally responsible use of computers and related resources .Some of such steps for Green IT include the following:

1. Power-down the CPU and all peripherals during extended periods of inactivity.
2. Try to do computer-related tasks during contiguous, intensive blocks of time, leaving hardware off at other times.
3. Power-up and power-down energy-intensive peripherals such as laser printers according to need.
4. Use Liquid Crystal Display (LCD) monitors rather than Cathode Ray Tube (CRT) monitors.
5. Use notebook computers rather than desktop computers whenever possible.
6. Use the power-management features to turn off hard drives and displays after several minutes of inactivity.
7. Minimize the use of paper and properly recycle waste paper.

Green IT Best Practices

From the experience of practicing professionals, there are a range of well identified best-practices. A few of those for assurance purposes are listed as follows:

1. Involving stakeholders on campus yields policies and green IT initiatives more likely to be embraced by the campus community.
2. Partnering takes advantage of existing efforts and ensures wider reach and more effective use of limited resources.
3. Guidelines for using the best practices simplify adaption of green IT by campus users and encourage them to consider green computing practices the norm.
4. On-going communication about and campus commitment to green IT best practices to produce notable results.

Green IT Security Services and Challenges

It is largely taken as the study and practice of designing, manufacturing, using, and disposing of computers, servers, associated subsystems and peripheral devices efficiently and effectively with highly mitigated negative impact on the environment. The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Many corporate IT departments have Green Computing initiatives to reduce the environmental impacts of their IT operations and things are evolving slowly but not as a revolutionary phenomenon.