Notes

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NEW TRENDS IN COMPUTING

You have learnt to insert images and lists in a web page in the previous lesson. This lesson is aimed to provide awareness about some of the latest technologies in the domain of computing and IT. With increase in usage of internet connectivity and need of high end computing, today's world is witnessing a shift from the era of mainframe computing and individual computing to a new era of mobile and green computing where the computing power, software and data are not necessarily located in office premises, rather, these can be stored somewhere in a "cloud" and can be accessed via internet at anytime and anywhere.

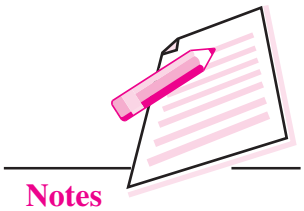
OBJECTIVES

After reading this lesson, you will be able to:

- define virtualization;
- list the types of computing;
- describe cloud computing;
- explain mobile computing;
- explore grid computing;
- use green computing.

26.1 VIRTUALIZATION

Literal meaning of virtualization is simulation. Virtualization allows the pooling and sharing of the computational power (processor, server) and storage of multiple computers, network and other resources among multiple users. This



simulation technique is adopted to give user a feel that all infrastructure (whether hardware or software) belong to user only. This is achieved by simulating the computational facility by creating a virtual version of given resource like for hardware platform virtual version of storage device, network resources can be made, and for software platform virtual version of operating system and other software is created. This virtual version provides a complete execution environment. A user is able to interact with these virtual resources as if it were a real single logical resource.

Concept of virtualization can be made clear with a common example of division of hard disk into different partitions. A partition is a logical division of a hard disk and it creates an effect of two separate hard disks to the user. This partition makes the management of files easier.

Virtualization is the ability to create a virtual copy of a device or some type of resource like server, storage, device, network and even operating system. It divides the multiple resources into different execution environments. Thus, one of the main objectives of virtualization is to centralize administrative tasks while improving scalability and workloads.

26.1.1 Architecture

Virtualization can be achieved at different levels. If you consider hardware, the organization needs:

- A large data storage system where complete data of an organization can be kept with complete security. Further, there should be a secured and reliable intra department access to database as per the policy.
- A high end server that can retrieve the data from the storage and process it with fast speed.
- A fast and reliable internet connectivity.

All these are required with an objective that the process is completed almost at the same instant the user has entered the necessary input data. As discussed earlier it is not possible to provide dedicated resources to each user, however we can give an illusion of dedicated resource through virtualization. Let us see how the server, network and storage virtualization is done.

26.1.2 Server Virtualization

It is a partition of a physical server into smaller virtual server. i.e., logically server resources were divided into multiple copies. The idea is to present the illusion of one huge machine that looks like many machines or multiple machines tied together to look like a single system.

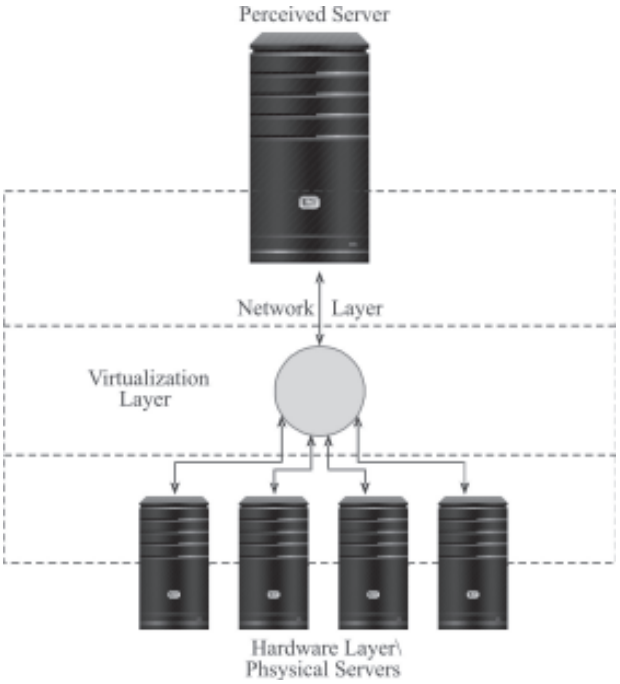


Fig. 26.1: Server Virtualization

26.1.3 Network Virtualization

The bandwidth available in the network environment is much more than is needed for a single user. Thus, for complete utilization of this bandwidth, it is required to partition the available bandwidth into channels. Each of which is independent from the other and each of which can be assigned to a particular server or device in real time.

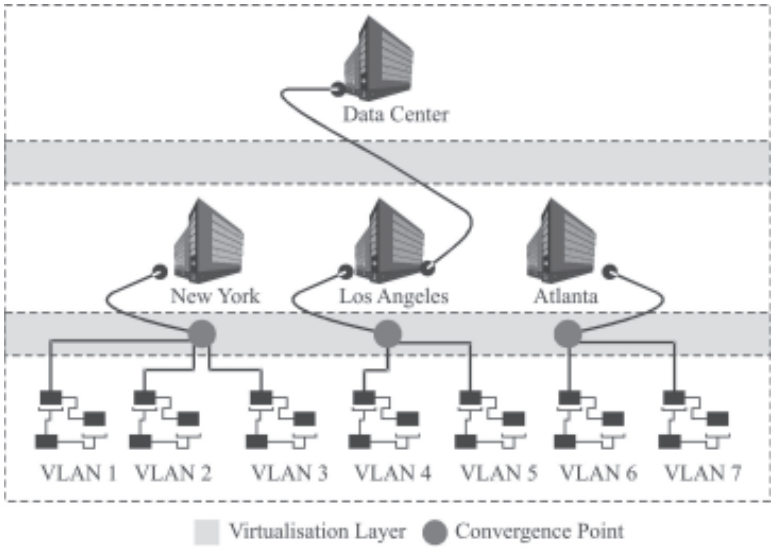
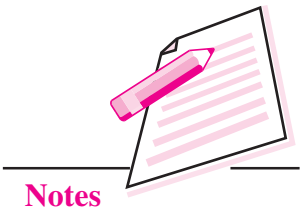


Fig. 26.2: Network Virtualization



26.1.4 Storage Virtualization

This is perhaps the most widely deployed and highly used virtualization practice. Storage virtualizaon allows separate storage devices to be combined into a perceived single unit. Storage virtualization attempts to maximize the efficiency of storage devices in information architecture.

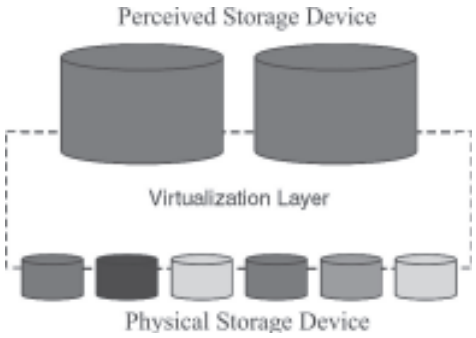


Fig. 26.3: Storage Virtualization

26.1.5 Software Virtualization

Operating system virtualization is to allow a piece of hardware to run multiple operating system images at the same time. It helps to accommodate multiple platforms simultaneously providing user more flexibility. Application software virtualization leads to create a logical image of application software to the user.

A system that provides both virtualizations of hardware as well as software is referred to as **Universal Virtualization**, as shown below:

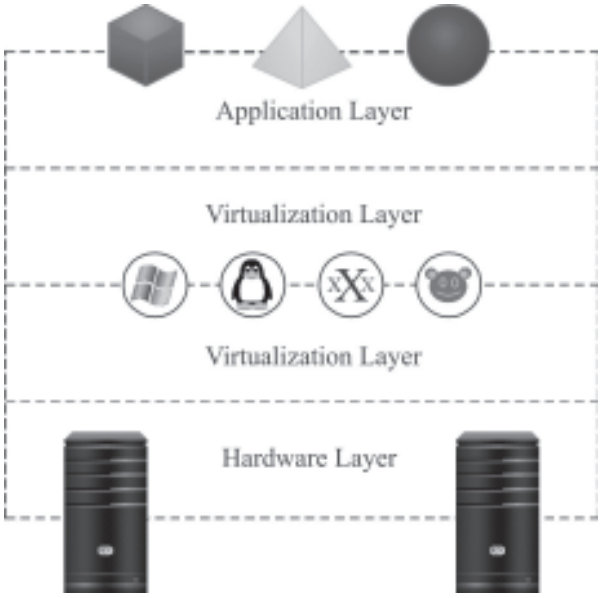


Fig. 26.4: Universal Virtualization

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Advantages of Virtualization

- Improved hardware utilization: As the same resource is used by many users, utilization of resources is increased.
- Lesser hardware cost: You need lesser number of hardware resources, thus overall cost is reduced .
- Increased operational agility and reduced downtime: As more alternative resources are available, the system does not crash even if any one component goes out of order.
- As lesser resources are needed, this approach is considered to be more environment- friendly.
- Lower total cost of ownership.
- It improves overall efficiency and effectiveness of the system.
- Increased network capacity: channelizing the network increases the transmission capacity.

Disadvantages of Virtualization

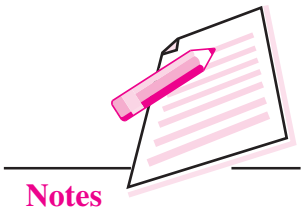
- The various advantages of virtualization can be appreciated only if these benefits are achieved without compromising the overall security, reliability and availability of the IT infrastructure.
- The virtualized environment is considered more vulnerable as there are more chances of potential attack to gain unauthorized access to resources from guest operating systems.

26.2 CLOUD COMPUTING

As virtualization allows the user to access any resource by simulating a logical version of it, this technology gave an idea if you need any particular facility only for say one hour a day then why to pay for it for whole day or why to maintain the complete infrastructure if you can get this facility just by creating a logical version of it. Keeping these objectives in mind the idea of **pay-per-use** services was implemented through cloud computing. Cloud computing in simple words refers to selling any type of IT services including:

- delivery of resources via creating a virtual simulation of the resource.
- selling of application software.
- platform on which we need to execute the application.

All of these services are delivered through internet.



Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at some remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. Thus, through cloud computing, one can increase its storage capacity, usage of high end server or adding computational capabilities without investing in new infrastructure, training new personnel, or licensing new software.

The cloud computing model allows access to information and computer resources from anywhere where a network connection is available. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications. Cloud computing encompasses any subscription-based or pay-per-use service, that too, in real time over the Internet, thereby it extends existing IT capabilities of any organization by letting organization to pay just for the service it needs. The best feature of cloud computing is that it provides the end user many flexibilities like:

- Anything (i.e., any IT related service)
- Anywhere (at any place via internet)
- Anytime(at any instant of time)
- With any device that is compatible with internet usage

The following definition of cloud computing has been developed by the U.S. National Institute of Standards and Technology (NIST):

> "*Cloud computing is a model for enabling 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 cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models.

26.2.1 Essential Characteristics

The five essential characteristics that should be there in a computing environment so that it can be considered as cloud computing are:

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

On-demand Self-service: As user you can request and manage your own computing resources as per your need i.e., the user can choose the computing capabilities, such as server time, network bandwidth, storage capacity etc. These requests are fulfilled automatically without requiring human interaction.

Broad Network Access: You can access the given service over the internet or private network. Thus it is required that all cloud services should always be available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).

Resource Pooling: Pooled resources mean that user can select any resource from a pool of computing resources. Examples of resources include storage, processing, memory, network bandwidth, and virtual machines. The cloud service provider need pool of all computing resources to serve multiple users using a multi-tenant model, with different physical and virtual resources. These resources are dynamically assigned and reassigned according to user demand. The user generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or data centre). Thus, for the end user, resource usage is independent of its location.

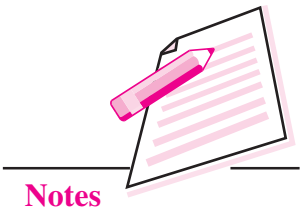
Rapid Elasticity: The services, which are provided, can be rapidly and elastically changed. To the user all these services are available and can choose any one of them. It should appear to the user that all services are unlimited and can be purchased in any quantity at anytime from anywhere.

Measured Service: Cloud systems automatically control and optimize resource use by leveraging a metering capability according to the type of service (e.g., storage, processing, bandwidth, and active user accounts) i.e., the service provider will charge the user as per the usage of IT services. Resource usage can be monitored, controlled, and reported providing transparency for both the service provider and user who are utilizing the service. The resource service which is provided can be scaled larger or smaller; and according to the use of a service (type of service and amount of time which this service is used, also on number of user) the customers are billed.

You can say, through cloud computing, service provider provide access to software, platform or infrastructure on a basis of demand raised by user and user has to pay for it on a metered basis.

26.2.2 Three Services

The cloud computing can be accessed for usage of any particular software, platform or the complete infrastructure. Based on these the following three services are characterized:



Cloud Software as a Service (SaaS): This service provides user a capability to use any applications (which are developed by service provider) by executing it on a cloud infrastructure i.e., any pre-made application, along with the required software, operating system, hardware and network, is provided by the service provider. The applications are accessible from various client devices through Internet via a thin client interface such as a web browser (e.g., web-based email). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

Examples: Many of the most popular cloud-based applications are business productivity tools such as email (e.g., Gmail, Hotmail), online productivity software (e.g., Google Docs, Microsoft Office 365), conferencing services (e.g., Microsoft LiveMeeting,WebEx), and customer relationship management software (e.g., Salesforce).

Cloud Platform as a Service (PaaS): This service provides user a capability to deploy user-created or acquired applications onto the cloud infrastructure. This application is created using programming languages and tools supported by the cloud service provider. Thus cloud service provider provides an operating system, hardware, and network where the user installs or develops their own software and applications. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

*Examples:*Google App Engine allows developers to create and run web applications that run on top of a custom Google platform and use Google's computing resources.

Cloud Infrastructure as a Service (IaaS): This service provides user a provision processing, storage, networks, and other fundamental computing resources, such that, the user is able to deploy and run arbitrary software, which can include operating systems and applications. Thus IaaS model provides just the hardware and network, and the user can install operating systems, software and applications. Although here also user does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of selected networking components (e.g., host firewalls).

Examples: cloud storage (e.g., Data centres), providing users access to scalable online storage.

26.2.3 Cloud computing Deployment Models

There are four different ways through which a cloud computing can be deployed.

Private Cloud: The cloud infrastructure is used exclusively by an organization. These are usually used by large organizations which have multiple business units. It may be managed by the organization itself or by some other third party. It can be deployed either in premises (on-site) or off premises (off site).

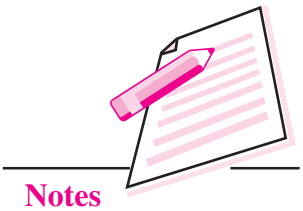
Community Cloud: The cloud infrastructure is shared exclusively by a specific group of organizations, especially those, sharing common concern (e.g., business interest, mission or goal, security requirements, policy, and compliance considerations). Similar to private cloud, it may be managed by the organizations or a third party and may exist on premises or off premises.

Public Cloud: The cloud infrastructure is made available for the use to the general public or a large industry group and is owned by an organization selling cloud services. Examples of public clouds are Amazon EC2, Amazon S3, Google, Microsoft Azure etc.

Hybrid Cloud: The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., "cloud bursting" for "load-balancing" between clouds).

Advantages of Cloud Computing

- It creates a more flexible environment that allows organizations to "rent" computing power on requirement.
- An organization can scale up or down its IT usage, according to demand.
- No need to procure space for creating infrastructure.
- Provide more mobile solution i.e., it is not necessary for the user to be in office to access the information. He or she can access the information through mobile also.
- Organization can build its infrastructure on its actual use of IT resources, rather than creating an overbuilt capacity, based on potential demand. Potential demands can be met by renting services through cloud.
- Organizations can easily upgrade their applications as they can change platforms simply by switching cloud service providers.



INTEXT QUESTIONS 26.1

Choose the appropriate answer.

1. ..... allows the pooling and shaing of resources among multiple users.
   (a) Virtualization
   (b) Resource pooling
2. Which of the following is not an essential characteristics of cloud computing.
   (a) On demand self service
   (b) Static environment
   (c) Resource pooling
   (d) Rapid elastisity
3. A system that provides both virtualizations of hardware as well as software is referred to as .....
   (a) Universal virtualization (b) Storage virtualization

26.3 MOBILE COMPUTING

The advancement in technology of portable computers, which are capable of accessing the wireless technology, has made a huge revolution in the domain of Information and Communication Technology. It has given birth to new era of mobile computing, a platform that allows mobile user to have a versatile communication with other people and notification of events, messages and allows continuous access to services and resources of land based network.

Mobile computing is an umbrella term used for describing the technologies that enable people to access network services any place, any time, and anywhere. It is an extension of mobile voice communication technology which is capable of sending and receiving data across the cellular network.

Mobile computing basically involves designing of application and resolving technical issues of the people who are on move around within a region or country, or travel between countries and continents. 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 to the biggest problem of business people who are frequently on the move.

Notes

In simple terms Mobile computing can be defined as a computing environment over physical mobility.

OR

"*A technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link.*"

OR

"*Mobile computing is the ability to use computing capability without a pre-defined location and/or connection to a network to publish and/or subscribe to information.*"

Here you need a computing environment which is mobile and moves along with the user. For that you need a computing environment which fulfils the three important needs namely:

- Wireless communication
- Mobility
- Portability

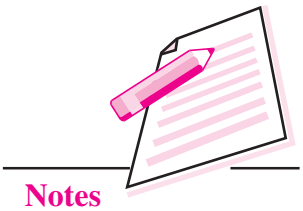
Wireless Communication: In mobile computing platform, information between processing units flows through wireless channels. The demand for mobile communication creates the need for integration of wireless networks and existing fixed networks.

- **Local Area Networks:** standardization of IEEE 802.11 or HIPERLAN for handling interoperability and issues between different wireless LANs.
- **Wide Area Networks:** GSM and ISDN for global access.
- **Internet:** Mobile IP extension of the Internet protocol (IP).

Common technologies used are IR (Infrared Receivers), BlueTooth, W-LANs, Cellular, W-Packet Data networks, SAT, etc.,

Mobility: Mobile computing needs that device should be able to remain connected with network while changing its location. Different aspects of mobility are:

- **User Mobility:** Users communicate "any time, anywhere, with anyone" (example: read/write email on web browser).
- **Device Mobility:** A small battery driven devices that can be connected any time, anywhere to the network.
- **Session Mobility:** A user session should be able to move from one user-agent environment to another.
- **Service Mobility:** User should be able to move from one service to another.



Portability: It is not feasible to carry a desktop because of its size, weight and heat dissipation. You need a portable device that is small, light weighted, durable, capable to be operational under wide environmental conditions and having a battery with long life. To develop a mobile computing environment, you need a wireless communication facility, a mobile PC or mobile device and software which is specially designed keeping in mind the needs of mobile device and the user of mobile device.

Mobile Data Communication: Whenever a user is using a mobile, he / she will be using different networks at different places at different times as discussed earlier. Some common examples are GSM, CDMA, Ethernet, Wireless LAN, Bluetooth etc. Mobile laptop and notebook computers can use one of two types of wireless access services when away from home or office. The most commonly used and least expensive is Wireless Fidelity also known as WiFi. The WiFi uses radio waves to broadcast an Internet signal from a wireless router to the immediate surrounding area. An alternative to WiFi is cellular broadband. This type of mobile computing technology utilizes a cellular modem to connect to cell towers for Internet access.

Mobile Device: Mobile telephony took off with the introduction of cellular technology which allowed the efficient utilization of frequencies, enabling the connection of a large number of users. There are many different types of mobile computing devices designed to make it easier to travel and conveniently access technology on the go. Notebooks are small laptop computers that typically feature built-in wireless networking, and are great choices for those who want to work even while travelling. Mobile computing devices with a smaller size, such as smart phones or tablet computers, are becoming very popular as they are much easier to carry and now-a-days, these devices include many advanced features of computing, even comparable to those found on a laptop computer. Common devices that are used in mobile computing are

- Notebook PCs
- Personal digital assistant/enterprise digital assistant
- Smartphone
- Tablet computer
- Ultra-Mobile PC
- Wearable computer
- Palmtops
- Cell phones
- Pagers
- Sensors

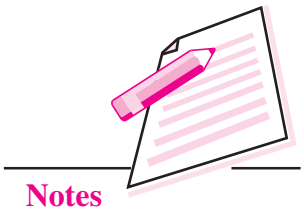
Notes

Mobile Software: Mobile applications commonly called mobile apps are the applications that run on a mobile device. These usually run on web browser (HTML, JavaScript, Flash, server-side components, etc). Designing software of mobile application is a challenging task.

One of the major constraint is that user of this technology demands intuitive user interfaces, fast response times, and deep relevant content, high processing (specially for gaming and multimedia application) but the device which are used for mobile applications usually have limited processing speed, storage, power backup and display facilities.

Mobile computing is widely used in:

- **Vehicles:** use of GPS in vehicles for identifying the area.
- **Nomadic User:** user usually uses laptop and connects to network.
- **Smart mobile phone:** widely used for playing games, up-to date information, e-mail facility.
- **Invisible computing, Wearable computing:** These are tiny embedded "computers" that can be worn by the user as an accessory and use Bluetooth over cable connections, for providing connectivity.
- **Intelligent house or office:** Using mobile computing control various functions of computers and embedded systems that are used in office or home.
- **Meeting Room/Conference:** Share data instantly, send a message to someone else in the room or secretly vote on controversial issues.
- **Taxi/Police/Fire Squad Fleet:** use this computing facility for remaining connected, for controlling and communicating.
- **Emergency Services:** Received information regarding the address, type and other details of an incident can be dispatched quickly, via a CDPD (Cellular Digital Packet Data) system using mobile computers, to one or several appropriate mobile units which are in the vicinity of the incident.
- **Disaster Relief:** After earthquake, tsunami, volcano eruption, etc. infrastructure cannot be established immediately but mobile communication is established via satellite or Ad-Hoc network and proves very advantageous for relief and early transmission of patient data to hospital.
- **Disaster Alarm:** With help of satellite communication and sensors one might be able to alarm disaster early, example: Tsunami.
- **Military / Security:** can be widely used during war for communication and controlling the weapons in real time environment.



Advantages of Mobile Computing

- As devices used in mobile computing are portable, it can be easily carried by the user. Hence it provides an opportunity to develop an environment, where user always has a computing facility.
- As these devices have Internet access, these provide the user a facility to seek any information at any time.
- These devices are typically GPS enabled.
- Usually devices are multimedia enabled and typically have cameras and microphones.
- Apps are free or low-cost.

Disadvantages of Mobile Computing

The following are not exactly disadvantages; rather these are some of the limitations of mobile computing:

- Limited screen size.
- Limited battery life.
- Limited processor speed.
- Limited and sometimes slow network access.
- Limited or awkward input: soft keyboard, phone keypad, touch screen, or stylus.
- Limited web browser functionality.
- Range of platforms and configurations across devices.

26.4 GRID COMPUTING

Grid computing applies the resources of numerous computers in a network to work on a single problem at the same time. Usually this environment is used for solving large scientific or technical problem where huge amount of computing is involved. A large project is divided among multiple computers to make use of their resources. However, in cloud computing, small applications run on different systems, simultaneously, enables communities ("virtual organizations") to share geographically distributed resources as they pursue common goals.

The prime objective of grid computing are:

- Sharing computing resources between organisations.
- Solving complex and other software applications that demand high computing by providing widespread access to powerful computers and storage.
- Integrating existing systems together.

"*A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational facilities*".

As explained in the beginning of the lesson, this decade has emphasized on community learning, which use to develop a low cost high performance computing system, popularly called **clusters**. These clusters share their resources to overcome the resource related problems in application domains. Grid is an infrastructure that involves the integration of different application such that they collaborate with each other to get complex problem solved with an ease. It involves integration of various resources of computers, networks, database and scientific instruments, owned and managed by multiple organizations. This is an environment which provides a secure resource sharing across organizational boundaries i.e., through intra cluster communications.

Solving complex problems can be achieved through grid computing by:

- Simulation of large complex systems.
- Large scale multi site data mining, distributed data sets.
- Sharing the resources by simulating their virtual version.
- Interactive collaboration.
- Real-time access to remote resources.

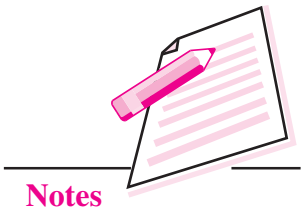
Common grid applications are

- Distributed supercomputing
- High-throughput computing
- On-demand computing
- Data-intensive computing
- Collaborative computing

Advantages of Gird Computing

Cost effective way to utilize the given amount of computing resources by

- Virtualizing resources across an enterprise.
- Enabling collaboration of all virtual resources across the organizations or community.
- Identifying the underutilized resources.
- Performing load balancing of resources so that all resources are used equally.



26.5 GREEN COMPUTING

Popularity of Information and Communication Technology (ICT) has increased among common man and the hardware devices used in it have become an integral part of daily routine activities. Hence, it is very important to analyse the impact of this technology on the environment. Also, to make an attempt to develop a system which is environment friendly. The relationship of ICTs and the environment is studied in terms of three distinct kinds of effects:

- **Direct Effects:** This effect includes issues related to environmental changes that arise because of the design, production, distribution, maintenance and disposal of ICT goods and services.
- **Indirect Effects:** This effect includes issues related to environmental changes that arise because of the application and use of ICTs in different domains of society.
- **Systemic Effects:** This effect includes issues related to environmental changes that arise because of the changes in economic and social structures due to use of ICT products and services.

Impact of computer on environment needs to be studied from its manufacturing to its usage and disposal stages. As thousands of computers are used in every domain of life, great amount of power is used and a great amount of both paper and electronic wastes are produced.

Common hazards that arise as result of massive usage of computers and other computing devices in our life are:

1. Computers and office equipment play an increasingly large role in energy consumption. Desktop computers, fan, screen savers, scanners and other electronic technology account for the fastest growing source of energy consumption. Even presently, people do not use energy saving CRT and processor. Further, they keep the computer "ON" even when not in use and also do not adopt power saving strategies such as 'sleep' and 'standby' modes. As a result, such a system remains active 24 hours per day, 7 days per week.

   Possible solution: all computers in offices or home or any organization should have

   - LCD energy saving monitors.
   - CPUs that are ENERGY STAR. (ENERGY STAR certified technology allows computers to automatically switch to standby mode when inactive for a certain amount of time) and allowing for energy savings.
   - Making a practice of switching off equipments when not in use. The usual usage should be 8 hours per day, 5 days per week.

Notes

2. **Paper usage:** Eventhough it is believed that using an automated system will reduce the paper work in any organization but practically it is observed that it has increased the paper consumption as

   - Printing is often wasteful – It is common practice that the people take print outs of emails or meeting agendas.
   - printing out partial drafts.
   - maintain a hardcopy backup of entire data which often becomes obsolete once data changes.

   Possible Solutions:

   - Do not print unless not very urgent.
   - Awareness should be provided to the users that all information is stored in the computer and can be retrieved any time hence they need not maintain a hardcopy backup of every partial drafts also.

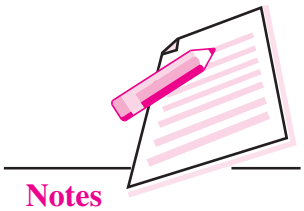
3. **Manufacturing and packing of computing devices:** Pollution is increased because there are toxic chemicals used in the manufacturing of computers and components.

   Solution: manufactures should use non toxic and recyclable material for manufacturing the products

4. **Disposal of unused devices:** The hardware technology changes very fast and as a result often people feel to replace their existing system. Disposal of these devices constitutes 20-50 million tons per year (about 5% of the total waste of the planet). This waste is also known as e-waste. The improper disposal of computers and components may lead to entry of these toxic material in our food chain and water

   Solution: proper reuse and recycling of the products.

   - ***Reuse:*** Organizations like play way schools, libraries etc. may not need a high end latest configuration system, and instead of disposing the entire system, one can donate a computer or even its components to organizations who need lesser quality computers.
   - ***Refurbish:*** Rather than discarding the computer completly on release of the next generation. One can even upgrade the system by just replacing the processor and memory chips. Hence, many components like monitor, cables, UPS, speakers, keyboard, mouse etc., can be used (i.e., need not be replaced). This results in upgrading of computing facility without increasing the e-waste.
   - ***Recycle:*** The companies that can recycle the plastics and other components, can also recycle the e-waste components.



The prime objective of green computing is study and practice of environmentally sustainable computing through Information Technology.

The objectives of green computing are similar to green chemistry i.e.,

- It should reduce the usage of hazardous materials for manufacturing any product.
- Enhance the energy efficiency of any product by reducing the power consumption of that product.
- Promote the recyclability.
- Usage of biodegradable products and factory waste.

Many corporate IT departments have taken lot of green computing initiatives to reduce the environmental impact. Green ICT and its services present opportunities to deliver low carbon footprints and mitigate carbon emissions because of the unique ability to make energy consumption and green house gas emissions visible through its products and services.

INTEXT QUESTIONS 26.2

Fill in the blanks.

1. ..... computing allows transmission of data via computer without having to be connected to a fixed physical link.
2. Solving complex problems can be achieved through ..... computing.
3. Prime objective of ..... computing is study and practice of environmentally sustainable computing through Information Technology.

WHAT YOU HAVE LEARNT

- Virtualization allows pooling and sharing of the computational power and storage of multiple computers, network and other resources among multiple users.
- Cloud computing model allows access to information and computer resources from anywhere where a network connection is available.
- Mobile computing is the ability to use computing capability without a pre-defined location and /or connection to a network to publish and / or subscribe to information.

- Grid computing applies the resources of numerous computers in a network to work on a single problem at the same time.
- Objective of green computing is study and practice of environmentally sustainable computing through information technology.

TERMINAL EXERCISE

1. What is cloud computing?
2. What is virtualization and how does it improve resource utilization?
3. How can we develop eco-friendly environment for computing?
4. What is mobile computing and what are its applications?
5. What is grid computing and in which environment it is found very useful?

ANSWERS TO INTEXT QUESTIONS

26.1

1. (a) Vitualization
2. (b) Static Environment
3. (a) Universal virtualization

26.2

1. Mobile 2. Grid 3. Green