



COMPUTER NETWORKING

Learning objectives

After learning this chapter the students will be able to:

- Define what a Computer Network is
- List the benefits of networking
- List different wired and wireless media for communication
- Identify different network devices
- Identify the type of network on the basis of area covered
- Describe various terms associated with computer networks.
- List various security threats to computer networks
- List the preventive and corrective measures against these threats

Have you ever worked on Internet? Have you ever used an ATM? Have you ever given the print command on a computer to get the printout on a printer attached to some other computer? Have you ever transferred songs from your computer to a cell phone or vice-versa? If the answer to any of these questions is YES, then you have experienced and utilized the services of a computer network. In this chapter you will study about various types of computer networks, their benefits, and what is required to create computer networks.

Puzzle¹

Can you place 10 coins in such a way that they lie in 5 straight lines and on each line there are exactly 4 coins?

Such situations are faced by the designers of computer networks. They have to think of various ways of interconnecting the computers so that the specific goals of network setup are achieved.





Networking - a brief overview

A computer network is a collection of interconnected computers and other devices which are able to communicate with each other. In this context, the term interconnected means that there exists a path through which data can be transmitted from one computer/device to another.

A computer network is a collection of interconnected computers and other devices which are able to communicate with each other and share hardware and software resources.

Why do we have computer networks? Are there any advantages of networked computers over stand alone computers? Yes, there are many. A few of these advantages are:

- Resource Sharing
- Cost saving
- Collaborative user interaction
- Time saving
- Increased storage

Let us discuss these advantages in some details.

Resource Sharing:

In a networked computer lab when print command is given on one computer the document may be printed by the printer which is attached to some other computer. This printer is able to print documents from multiple users on the network. It means that the printer is being shared by more than one users. This is an example of resource sharing, and this is possible only when the computers are interconnected to form a network. Similarly other resources like Hard Disk, DVD Drive, and Scanner etc. can also be shared on a computer network. Software resources like Application Softwares, Anti-Virus tools etc. can also be shared on computer networks. You can very easily conclude that this resource sharing also leads to cost-saving.





Collaborative User Interaction:

Let us take one more example of a school. Here we assume that all the computers in the school are connected to one main computer (called server). After the exams, teachers have to exchange marks with each other for result preparation. So all the teachers enter the marks class wise for their respective subjects at one centralized location and from there the class teachers can copy the marks of their classes and can prepare the result. This way data is shared on a computer network. Similar is the case with other computerized organizations also.

Let us take another example of collaborative user interaction. If we are working on a computer which is a part of a computer network, we can communicate with any other user of the network through e-mail or chatting. It takes negligible time to send and receive messages and watch live videos of one another irrespective of terrestrial distances. If the e-mail or chatting is done for some useful purpose, it leads to **increased productivity, cost-saving as well as time-saving**.

Increased Storage:

On a network, same data may be replicated on multiple computers to ensure the availability of data in the case of some computer getting faulty. For example, when you save your java applications on your computer, you can also store their copies on some other networked computers in your lab. This way your work will be available even if your computer develops some fault or somehow your programs are deleted from your computer. Similarly, on large networks also the data is replicated on multiple computers as if a huge storage area is available to store multiple copies of the data.

All these advantages are there for a small organization like a school as well as for big business organizations and for governments. Today, small as well as big organizations, and governments keep their data on secured large scale computers called servers. They share this data with authorized users. This ensures security. Customer care cells of companies share the resources and data and they also communicate among themselves as well as with customers with the help of computer networks only.





Networking Hardware

To form a computer network a lot of hardware devices are required. Some of these devices along with their functionalities are mentioned below :

Transmission Media

Computers on a network are able to share data and other resources. They are also able to communicate among themselves. To make all this possible there must be some medium over which the data can travel from one computer to another. A medium of data transmission over a computer network is called a channel or a transmission medium. Channels may be guided (wired) or unguided (wireless).

A transmission medium is a medium of data transfer over a network. It can be wired or wireless.

Wired Media

A number of various types of cables are used to transfer data over computer networks. These are Twisted Pair Cable, Co-axial Cable, and Optical Fiber Cable. Let us know about these in some details.

Twisted Pair Cable - This is probably the most widely used cable for creating small computer networks. It contains four twisted pairs covered in an outer shield. These pairs are colour coded. An RJ-45 connector is used to connect this cable to a computer. It is of two types:

UTP (Unshielded Twisted Pair): As the name suggests in UTP cables individual pairs are not shielded.



UTP Cable



UTP Cable
With RJ-45 Connector





Characteristics of UTP cable:

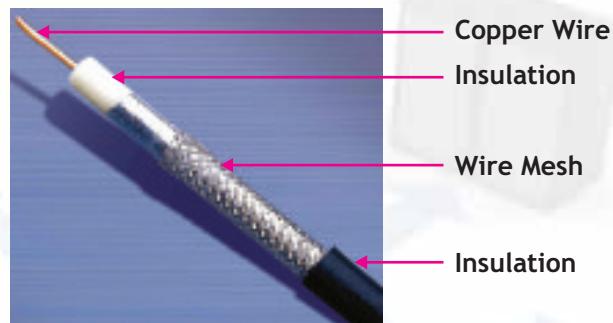
- It is a low-cost cable available for setting up small networks.
- It is a thin (External diameter app. 0.43cm) and flexible cable and therefore it offers ease of installation.
- It can carry data upto a length of 100m at a stretch.

STP (Shielded Twisted pair): It is the same cable as the UTP, but with each pair shielded individually. An outer shield then covers all the pairs like in UTP. STP data connectors are used to connect STP cable to the computer. RJ-45 connectors can also be used to connect this cable to a computer.

Characteristics of STP cable:

- As compared to UTP, STP offers better immunity against internal and external electromagnetic interferences.
- It is expensive than UTP cable.
- As compared to UTP cable, STP cable is difficult to install.

Co-axial cable (or coax) - A coaxial cable consists of two conductors that share a common axis. The inner conductor is a straight wire and the outer conductor is a shield that might be braided or a foil.



Characteristics of Co-axial cable:

- It can carry data for a larger distance (185m - 500m) at a stretch.
- Less susceptible to electromagnetic fields
- Bulkier and less flexible than twisted pair.
- Due to its thickness (1cm diameter) and less flexibility, it is difficult to install as compared to twisted pair cable.

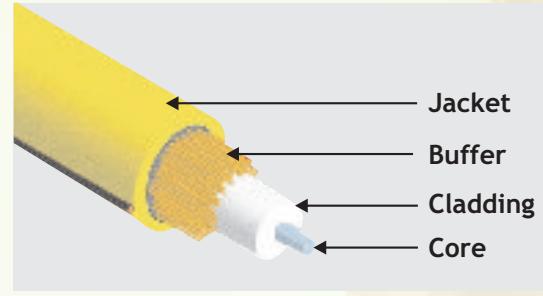
Earlier coaxial cable was also used for connecting computers in small networks but now UTP/STP cables are more commonly used for this purpose.





Optical Fiber cable - Optical Fibers are long, thin strands of glass about the thickness of a human hair. They are arranged in bundles called optical fiber cables and used to transmit data through light signals over long distances.

An optical fiber has following parts:



- **Core** - It is the thin glass rod at the center through which the light travels
- **Cladding** - It is the outer optical material surrounding the core that reflects the light back into the core
- **Buffer coating** - It is the plastic coating that protects the cable from damage and moisture

These optical fibers are arranged in bundles of hundreds and thousands and are protected by the cable's outer covering, called jacket.

Characteristics of Optical Fiber Cable:

- It can carry data for a very large distance at a stretch.
- Not susceptible to electromagnetic fields
- Specially skilled people are required to install optical fiber cables.
- Till date it is the most expensive and at the same time the most efficient cable available for computer networks.

Comparison of wired media

Parameter	Cable	Twisted Pair Cable	Coaxial Cable	Optical Fiber Cable
Data Transfer Rate		10Mbps-10Gbps	100 Mbps	More than 100 Gbps
Data Transfer Range		100 m	185m-500 m	-
Interference Susceptibility		More	Less than Ethernet cable	NIL
Cost of Cable		Least Cost	More than Ethernet	Very Expensive

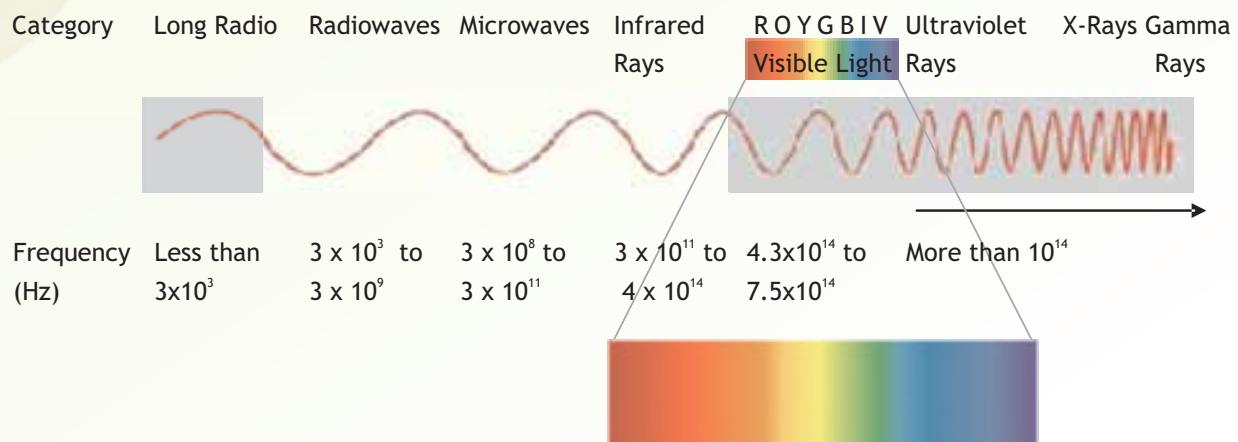




Wireless Media

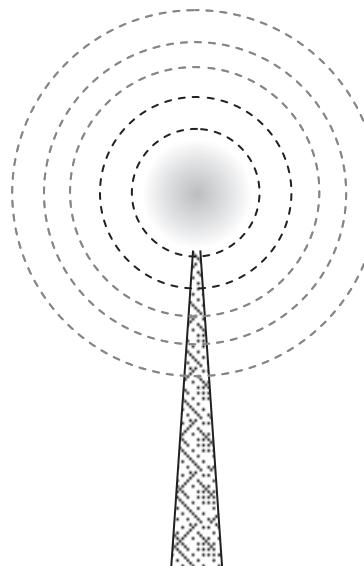
Electromagnetic waves are used for wireless communication over computer networks. Frequencies of waves are measured in Hertz (Hz). As the frequencies of electromagnetic waves change, their properties also change. Based on their frequencies, electromagnetic waves are categorized into various categories. These categories are (in increasing order of frequencies): radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and Gamma rays.

Electromagnetic Spectrum



Out of these only radio waves, microwaves, and infrared rays are used for wireless communication. Let us now study about these waves in some details.

Radio Waves - Radio waves have a frequency range of 3 KHz to 3GHz. Radio waves are used for communication over distances ranging from a few meters (in walkie-talkies) upto covering an entire city. These waves are easy to generate, can travel long distances and can penetrate buildings easily. That's why they are widely used for communication, both indoors and outdoors. Cordless phones, AM and FM radio broadcast, Garage door openers etc. are examples of radio wave transmission.



Omni Directional Radio Waves





Characteristics of Radio Wave Transmission:

- These waves are omni-directional, so the transmitting and receiving antennas need not be aligned.

(Recall when you throw a stone in a pond, circular waves are generated and spread outwards. Similarly, radio waves are generated by the transmitter and spread in all the directions.)

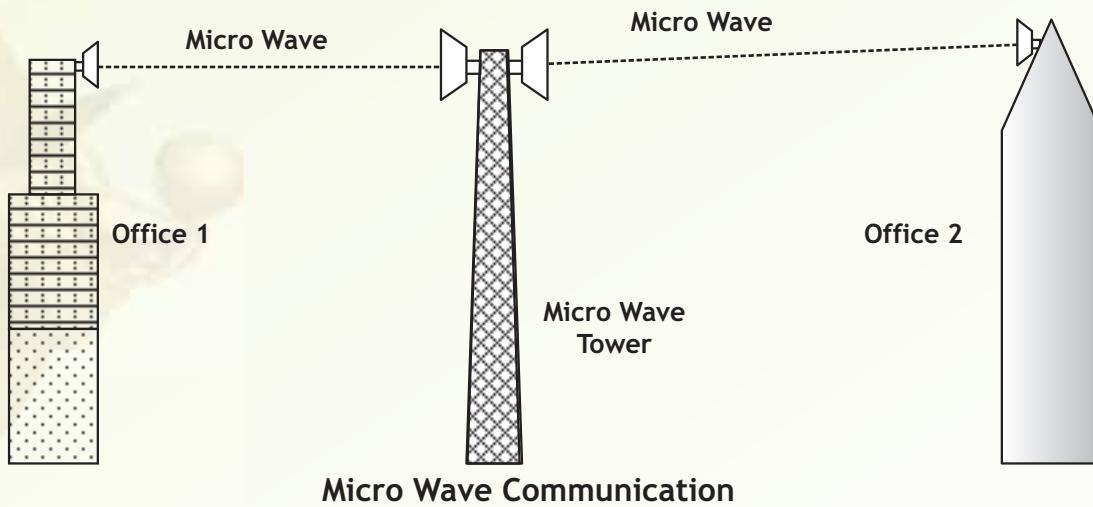
- Relatively inexpensive than wired media.
- It offers ease of communication over difficult terrain
- The transmission can be interfered by motors or other electrical equipment
- Permission from concerned authorities is required for use of radio wave transmission
- Less secure mode of transmission

Micro Waves - Micro waves have a frequency range of 300MHz (0.3 GHz) to 300 GHz. This range has some overlapping portion (0.3GHz - 3GHz) with radio waves as there is no clear-cut demarcation between radio waves and micro waves. Microwaves travel in straight lines and cannot penetrate any solid object. Therefore for long distance microwave communication, high towers are built and microwave antennas are put on their tops. Distance between two microwave towers depends on many factors including frequency of the waves being used and heights of the towers. These waves travel in straight lines and therefore the sending and receiving antennas have to be aligned with each other.

An example of usage of microwaves for communication is as follows:

In the big cities where land is very costly and a lot of formalities have to be completed to get permission to dig land for cabling, microwave antennas can be put on top of high rise buildings and communication can be started in a short time.





Characteristics of Micro Wave Transmission:

- Free from land acquisition rights
- Relatively inexpensive than wired media
- Offers ease of communication over difficult terrain
- The transmission is in straight lines so the transmitting and receiving antennas need to be properly aligned (line of sight transmission)

Infrared Waves - Infrared waves have a frequency range of 300 GHz to 400 THz. If you recall VIBGYOR spectrum of light, you will also recall that red light has the lowest frequency (400THz - 484THz) in this spectrum. Infrared waves are so called because they have a frequency range of just less than that of red light. These waves are used for short range communication (approx. 5m) in a variety of wireless communications, monitoring, and control applications. Home-entertainment remote-control devices, Cordless mouse, and Intrusion detectors are some of the devices that utilize infrared communication. These waves are easy to build but have a major drawback- they do not pass through solid objects (try standing between your remote control and your television and see if it still works). On the other hand, these waves do not pass through solid walls is a plus point also. Because of this, infrared system in one room of a building will not interfere with a similar system in adjacent rooms (you cannot control TV in another room with the remote in your hand in a room).





Characteristics of Infrared Wave Transmission:

- It is a line of sight transmission; therefore information passed to one device is not leaked to another device.
- No government license is required for their use
- It is a line of sight transmission, therefore at a time only two devices can communicate.
- The waves do not cross any solid object in between
- Performance drops with longer distances

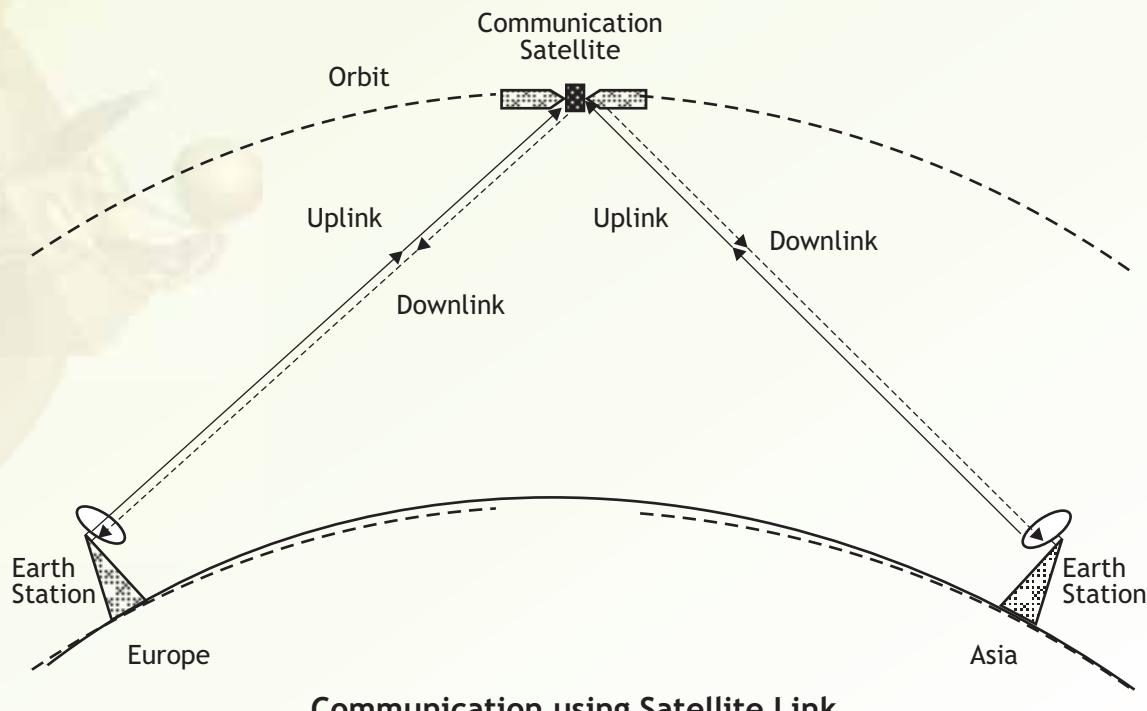
Bluetooth - Bluetooth technology uses radio waves in the frequency range of 2.402 GHz to 2.480 GHz. This technology is used for short range communication (approx. 10m) in a variety of devices for wireless communication. Baby monitors, door openers, and cell phones are some of the devices that utilize Bluetooth communication.

Characteristics of Bluetooth Transmission:

- Line of sight between communicating devices is not required. (Think Why?)
- Bluetooth can connect upto eight devices simultaneously.
- Slow data transfer rate (upto 1Mbps).

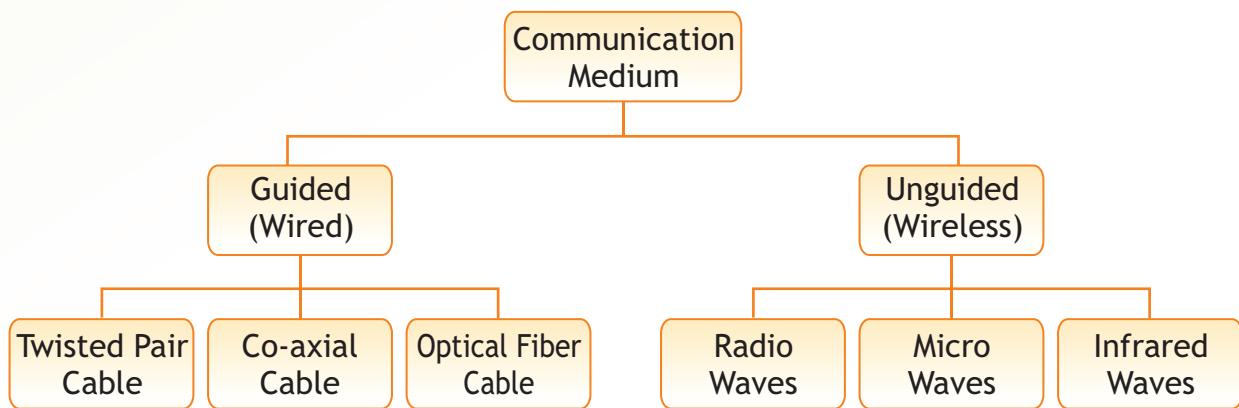
Satellite Link - Satellite links are used for very long distance wireless communication which may range from intercity to intercontinental. Transmission from the earth to a satellite is known as **uplink**. Transmission from a satellite to the earth is known as **downlink**. There are multiple micro wave frequency bands which are used for satellites links. Frequency used for uplink varies from 1.6 GHz to 30.0 GHz and that for downlink varies from 1.5GHz to 20.0GHz. Downlink frequency is always lower than the uplink frequency. For example, the uplink frequency is 6.0GHz, and the corresponding downlink frequency is 4.0 GHz. A communications satellite is a relay station in orbit above the earth that receives, regenerates, and redirects signals carried on a specific frequency. The satellite system is very expensive but its area coverage and fringe benefits compensate for the expenses. Communication satellites are normally owned by governments or by government approved organizations of various countries





Characteristics of Transmission using satellite link:

- Satellites cover large area of earth
- Since communication over very long distances is possible, this becomes a commercially attractive option.
- This system is expensive
- Requires legal permissions.

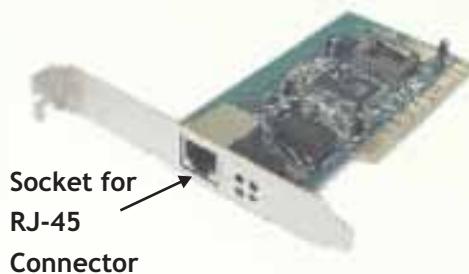




Network Devices

Other than the transmission media many other devices are required to form computer networks. Some of these devices are:

NIC: Any computer which has to be a part of a computer network must have an NIC (Network Interface Card / Unit) installed in it. A computer communicates with other computers on a network with the help of an NIC only. Now a days, in most of the PCs and the laptops, NIC is an integral part of the motherboard.



A Network Interface Card

An **NIC (Network Interface Card)** is a device that enables a computer to connect to a network and communicate.

Hub: Hub is a device that allows us to connect multiple computers/devices together in a network. A hub has ports into which the cables from individual computers' NICs are inserted. This way each computer's NIC is connected to hub and hence all the computers are connected together. Whenever a computer has to send some information to some other computer(s), the information is sent by the NIC to the hub. Then the hub re-transmits this information to the other computers attached to it. The computer(s) for which the information is intended receive(s) this information and accept(s) it. Other computers on the network simply reject this information.



Hub/Switch





A Hub is an electronic device that connects several nodes to form a network and redirects the received information to all the connected nodes in broadcast mode.

Switch: A switch is an intelligent hub. It looks exactly like a hub. It has the same function as that of a hub: to connect multiple computers/devices in a network. But the difference between the two is in the way they re-transmit the received information. Unlike a hub, instead of broadcasting (sending to each device attached to it) the received information, a switch sends the information selectively only to those computers for which it is intended. This makes a switch more efficient than a hub.

A Switch is an intelligent device that connects several nodes to form a network and redirects the received information only to the intended node(s).

Repeater: When the data is transmitted over a network for long distances, the data signal gets weak after certain distance. This distance depends on the data transfer range of transmission channel being used and can be from a few meters to a few kilometers. If the signal becomes weak, it cannot reach its destination. Therefore, some device is required which can re-strengthen the data signal before it gets too weak. Repeater is such a device. A repeater regenerates the received signal and re-transmits it to its destination.

A Repeater is a device that is used to regenerate a signal which is on its way through a communication channel. A repeater regenerates the received signal and re-transmits it to its destination.

Gateway: There are a large number of computer networks in this world. As common examples you can consider your school's computer network, ATM network of a bank, a big company's computer network spread over a city, etc. There are thousands of computer networks that exist. These networks use different hardware and software. Many times these networks need to communicate with each other. For example, companies X, Y, and Z do business with each other and therefore they want to interconnect their computer networks. Another example is the internet which contains a large number of different types of networks spread over the globe. Different networks are sometimes incompatible





with each other. It is like a group of persons using different languages for conversation. When two or more networks using different hardware and software have to be connected, some device is needed which can translate one network's language into the other's. A gateway is a device, which is used to connect different types of networks. A gateway is capable of understanding address architectures used in different networks and seamlessly translate between these address architectures.

A Gateway is a device, which is used to connect different types of networks and perform the necessary translation so that the connected networks can communicate properly.

Network Topologies

Before we start discussion on network topologies, let us understand the term 'NODE'.

Any device (Computer, Scanner, Printer, etc.) which is directly connected to a computer network is called a node. Suppose you are working on a PC at your home and then you connect it to internet. As soon as it becomes a part of internet (which is a computer network), it becomes a node. Similarly, in your school, all the computers which are linked to school's computer network are nodes.

A Node is a device, which is directly connected to a computer network. It can be a computer or any other device like printer, scanner etc.

Once we know about different communication media and devices to form a computer network, we can procure these media and devices and start constructing a computer network. Suppose we have 10 computers and we want to interconnect them to form a network. How can we interconnect them?

Recall the puzzle given in the beginning of this lesson. Is that not similar to the problem of connecting nodes in a network?

Similarly, when we have to connect computers/devices in a network, there may be certain conditions which have to be satisfied. Depending upon these conditions, there may be different ways of interconnecting the computers/devices. The way in which the



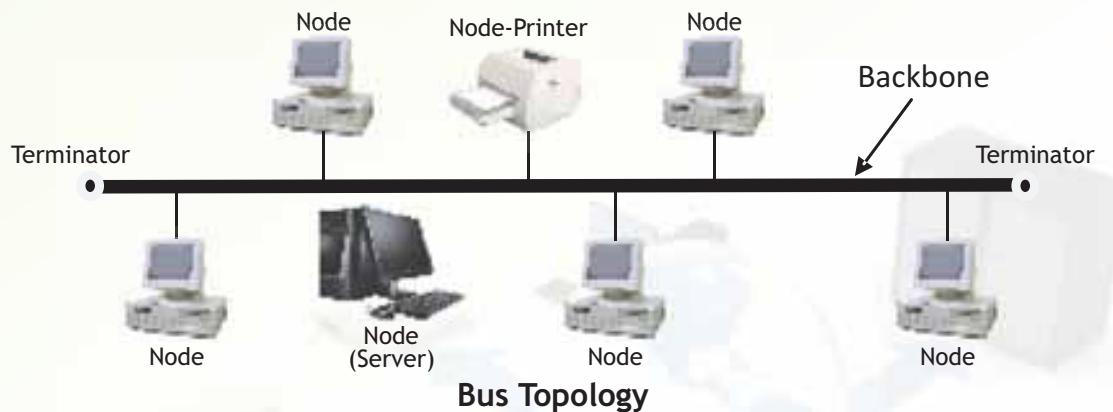


computers/devices are physically interconnected to form a network is called a Topology.

A Topology is an arrangement of physical connections among nodes in a network.

There exist different network topologies. Let us discuss a few of them.

Bus Topology: In bus topology all the nodes are connected to a main cable called backbone. If any node has to send some information to any other node, it sends the signal to the backbone. The signal travels through the entire length of the backbone and is received by the node for which it is intended. A small device called terminator is attached at each end of the backbone. When the signal reaches the end of backbone, it is absorbed by the terminator and the backbone gets free to carry another signal. This prevents the reflection of signal back on the cable and hence eliminates the chances of signal interference.



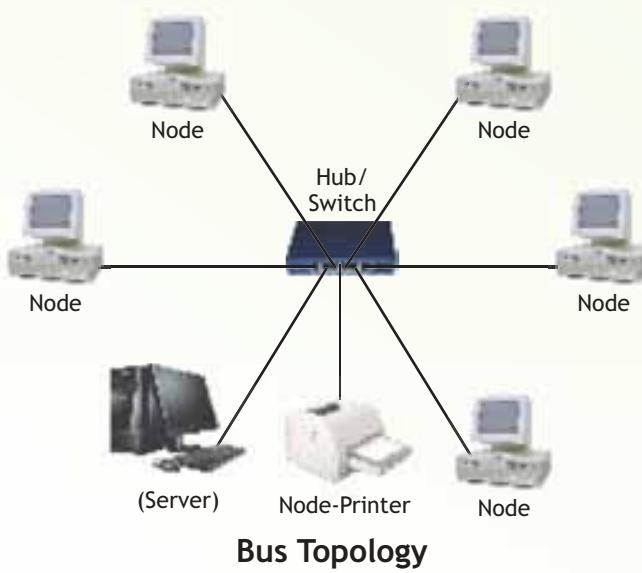
Characteristics of Bus topology:

- It is easy to install.
- It requires less cable length and hence it is cost effective.
- Failure of a node does not affect the network.
- In case of cable (backbone) or terminator fault, the entire network breaks down.
- Fault diagnosis is difficult.
- At a time only one node can transmit data.





Star Topology: In star topology each node is directly connected to a hub/switch. If any node has to send some information to any other node, it sends the signal to the hub/switch. This signal is then broadcast (in case of a hub) to all the nodes but is accepted by the intended node(s). In the case of a switch the signal is sent only to the intended node(s).



Bus Topology

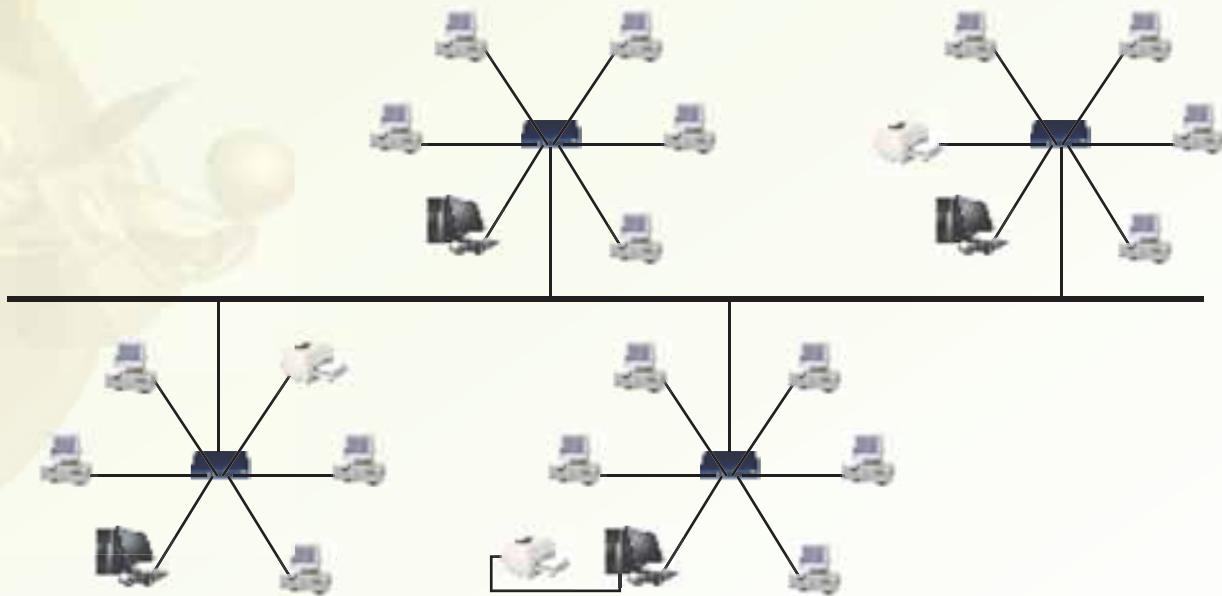
Star topology generally requires more cable than bus topology.

Characteristics of Star topology:

- It is more efficient topology as compared to bus topology.
- It is easy to install
- It is easy to diagnose the fault in Star topology.
- It is easy to expand depending on the specifications of central hub/switch
- Failure of hub/switch leads to failure of entire network
- It requires more cable length as compared to bus topology.

Tree Topology: Tree topology is a combination of bus and star topologies. It is used to combine multiple star topology networks. All the stars are connected together like a bus. This bus-star hybrid approach supports future expandability of the network



**Tree Topology**

Characteristics of Tree topology:

- It offers easy way of network expansion
- Even if one network (star) fails, the other networks remain connected and working.

Network Protocols

A computer network can be set up after procuring all the required hardware. But the network devices will be able to communicate with each other only after they know the rules of communication. Think of a group discussion session where all the participants can speak. Each participant can speak a lot. But the group discussion can be started and can be conducted well if each participant knows the rules of discussion. If all the participants start speaking suddenly and suddenly they stop, or a person stands up randomly and starts interrupting the discussion, or any such thing happens, the group discussion cannot be conducted at all. A more complex situation exists in the case of computer networks where the participating devices have no common sense and they follow each defined rule to the T. So it is essential that the rules of communication are very well defined. A set of rules is also known as a protocol.





A **network protocol** is a set of rules for communication among networked devices. Protocols generally includes rules of how and when a device can send or receive the data, how is the sent data packaged, and how it reaches its destination.

There are a number of protocols defined for computer networks. Here we discuss three of them - HTTP, TCP/IP, PPP.

HTTP (Hyper Text Transfer Protocol): HTTP is used to transfer all files and other data (collectively called resources) from one computer to another on the world wide web. When an HTTP client (a browser) sends a request to an HTTP server (web server), the server sends responses back to the client. This transfer of requests and responses is done following HTTP protocol.

TCP/IP (Transmission Control Protocol / Internet Protocol): It is the basic protocol of the Internet. Communication between two computers on internet is done using TCP/IP protocol. TCP/IP can also be used as a communications protocol in a private network. TCP/IP is a two-layer protocol. When data is to be sent from one computer to another over internet, it is first broken into smaller packets which are actually sent. When these packets are received by the receiver computer, they are assembled into the original message. This job of dividing the original message into packets and re-assembling the received packets into the original message is done following TCP protocol. Internet protocol is followed to ensure that each of these packets gets to the right destination. Different packets from the same message may be routed differently, but they reach the same destination and are reassembled there.

PPP (Point to Point Protocol): It is a protocol for direct communication between two computers, typically a personal computer connected by phone line to a server. Most Internet service providers (ISPs) use PPP for customer dial-up access to the Internet. PPP is used over many types of physical networks including cellular telephone, serial cable, phone line, trunk line, specialized radio links, and fiber optic links.

Know More!

There are a lot of other communication protocols like SMTP, POP, UDP etc. You can explore the net to find more about these protocols.





Types of Networks

A computer network may span any amount of geographical area. It can be on a table, in a room, in a building, in a city, in a country, across continents or around the world. On the basis of area covered computer networks are classified as:

- PAN - Personal Area Network
- LAN - Local Area Network
- MAN - Metropolitan Area Network
- WAN - Wide Area Network

PAN (Personal Area Network): A PAN is a network of Communicating devices (Computer, Phone, MP3/MP4 Player, Camera etc.) in the proximity of an individual. It can cover an area of a few meters radius.

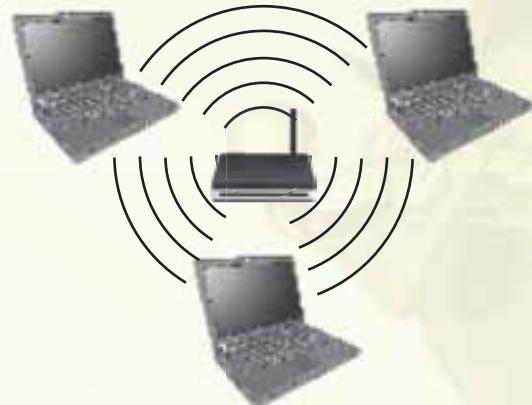


When you have to transfer songs from one cell phone to another, you set up a PAN of two phones. When files are transferred from a PC to an MP3 player, a PAN is set up between the two. There can also be multiple devices in PAN. A PAN can be set up using guided media (USB cable) or unguided media (Bluetooth, Infrared).





LAN (Local Area Network): A LAN is a network of computing/Communicating devices in a room, building, or campus. It can cover an area of a few meters to a few kilometers radius. A networked office building, school, or home usually contains a single LAN, though sometimes one building can contain a few small LANs (Like some schools have independent LANs in each computer lab.). Occasionally a LAN can span a group of nearby buildings.

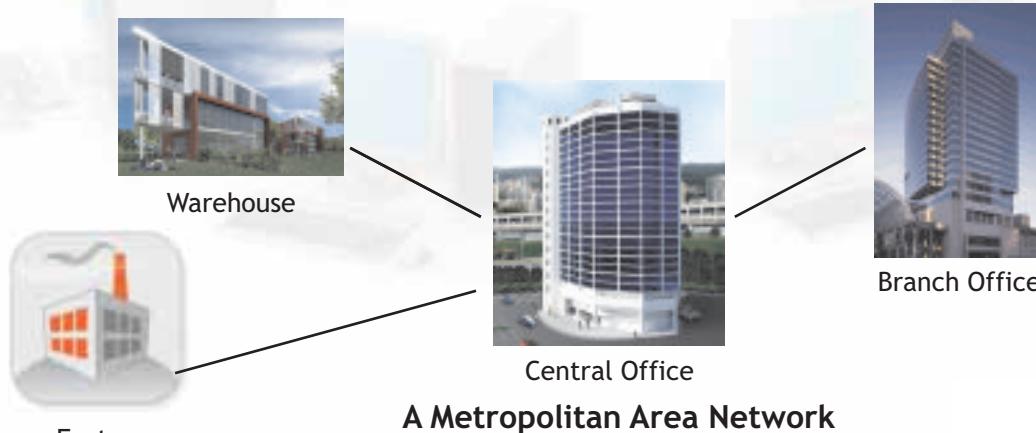


Wireless LAN

In addition to operating in a limited space, a LAN is owned, controlled, and managed by a single person or organization.

A LAN can be set up using wired media (UTP cables, Co-axial cables etc.) or wireless media (Infrared, radio waves). If a LAN is setup using unguided media, it is known as WLAN (wireless LAN).

MAN (Metropolitan Area Network): A MAN is a network of computing/communicating devices within a city. It can cover an area of a few kilometers to a few hundred kilometers radius. A network of schools, or banks, or Government offices etc., within a city, are examples of MANs. A MAN is usually formed by interconnecting a number of LANs and individual computers. All types of communication media (guided and unguided) are used to set up a MAN. A MAN is typically owned and operated by a single entity such as a government body or a large corporation. A good example of a MAN is the interconnected offices of a state government.

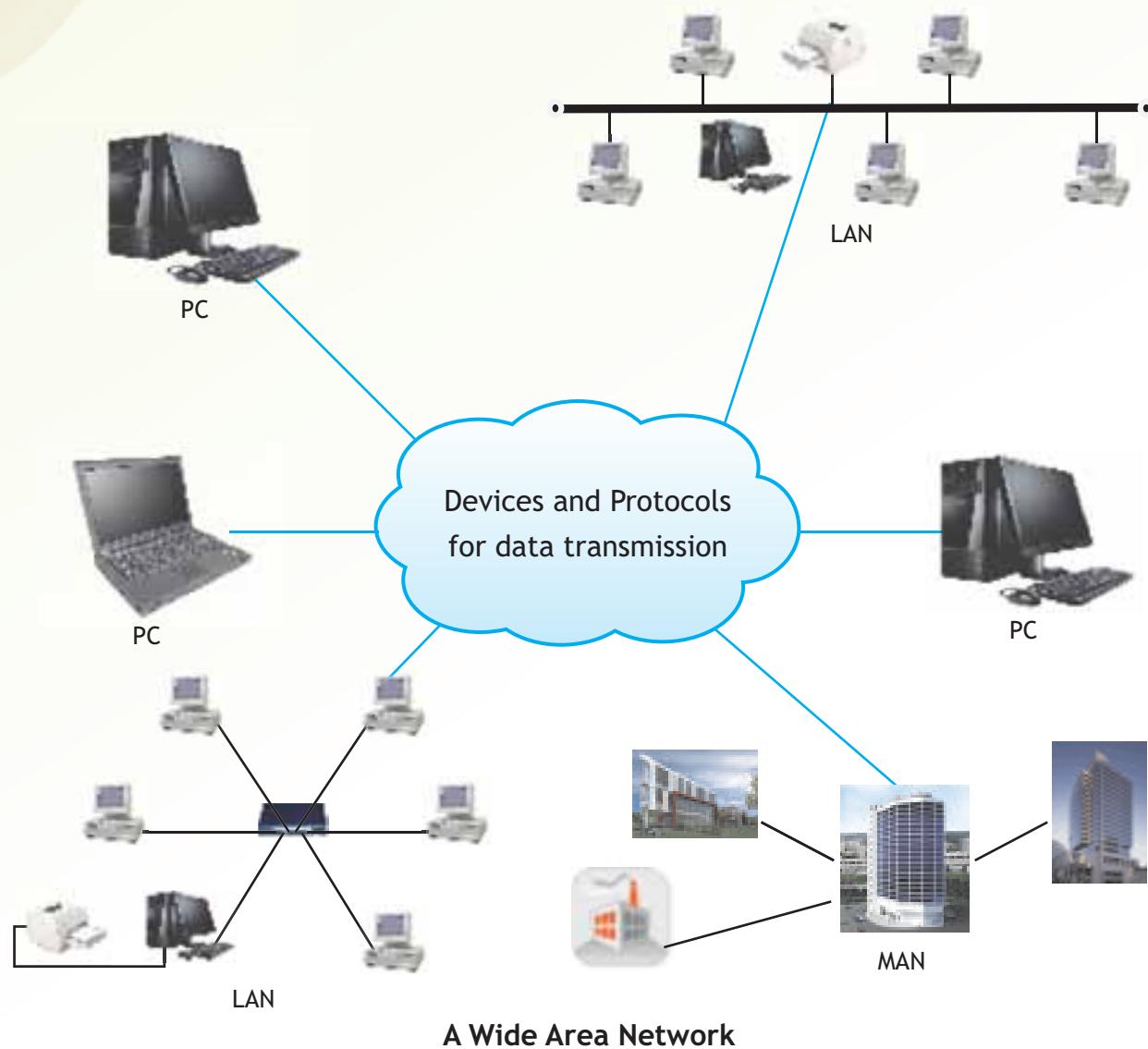


A Metropolitan Area Network





WAN (Wide Area Network): A WAN is a network of computing/communicating devices crossing the limits of a city, country, or continent. It can cover an area of over hundreds of kilometer radius. A network of ATMs, BANKs, National Government Offices, International Organizations' Offices etc., spread over a country, continent, or covering many continents are examples of WANs. WANs usually contain a number of interconnected individual computers, LANs, MANs, and maybe other WANs. All types of communication media (guided and unguided) are used to set up a WAN. The best known example of a WAN is the internet.





The following table summarizes the characteristics of PANs, LANs, MANs, and WANs.

Network → Parameter ↓	PAN	LAN	MAN	WAN
Area Covered	Small Area (Upto 10m radius)	A few meters to a few kilometers (Upto 10Km radius)	A city and its vicinity (Upto 100Km radius)	Entire country, continent, or globe (No upper limit)
Error Rates	Lowest	Lowest	Moderate	Highest
Transmission Speed	High Speed	High Speed	Moderate Speed	Low speed
Networking Cost	Negligible	Inexpensive	moderately expensive equipment	Expensive

Identification of computers and users over a network

Once a network has been set up, the nodes can communicate among themselves. But for proper communication, the nodes should be uniquely identifiable. If a node X sends some information for node Y on a network, then it is mandatory that nodes X and Y are uniquely identifiable on the network. Let us see how this is achieved.

MAC (Media Access Control) address: Each NIC has a universally unique address assigned to it by its manufacturer. This address is known as the MAC (Media Access Control) address of the card. It means that a machine with an NIC can be identified uniquely through its NIC's MAC address. MAC address of an NIC is permanent and does never change.

MAC addresses are 12-digit hexadecimal (or 48 bit) numbers. By convention, MAC addresses are usually written in one of the following two formats:

MM:MM:MM:SS:SS:SS

MM-MM-MM-SS-SS-SS





The first half (MM:MM:MM) of a MAC address contains the ID number of the adapter manufacturer. The second half (SS:SS:SS) of a MAC address represents the serial number assigned to the adapter (NIC) by its manufacturer.

For example, in the following MAC address,

00:A0:C9 : 14:C8:35

The prefix 00:A0:C9 indicates that the manufacturer is Intel Corporation. And the last three numbers 14:C8:35 are given by the manufacturer (Intel in this example) to this NIC.

A MAC (Media Access Control) address is a unique 12 digit (6 digits for manufacturer code and 6 digits for serial number) hexadecimal number assigned to each NIC. MAC address of an NIC never changes.

IP Address: Every machine in a network has another unique identifying number, called its IP Address. An IP address is a group of four bytes (or 32 bits) each of which can be a number from 0 to 255. A typical IP address looks like this:

59.177.134.72

To make it easier for us to remember, IP addresses are normally expressed in decimal format as a "dotted decimal number" like the one above.

On a network, IP address of a machine, and not the MAC address of its NIC, is used to identify it. Do you recall IP protocol? IP protocol identifies a machine with its IP address to route the packets.

MAC address is used only when a specific machine is to be targeted. For example, suppose we want to block a specific PC to access some network resource. If we use the PCs IP address, then the PC is not blocked permanently as its IP address may change when it connects to the network next time. Instead, if the PCs MAC address is used for the purpose, then the job is done!

An IP (Internet Protocol) address is a unique 4 digit hexadecimal number assigned to each node on a network. IP address settings of a node can be changed by the user





Know More!

There are two versions of IP addresses: version 4 (IPv4) and version 6 (IPv6). IPv6 uses 128 bits (IPv4 uses 32 bits) for an IP address. Using IPv4 only 2^{32} (approximately 4 billion) distinct devices can be addressed. In the current scenario and in the near future, this is a small fraction of the number of objects which need to be allocated IP addresses. As the human population and also the number of devices which need to be online (mobile phones, home appliances, personal communication devices, etc.) is increasing at a very fast pace, IPv4 addresses are being exhausted. To address this problem IPv6 was developed and it is now being deployed. Using IPv6 2^{128} (approximately $4 \text{ Bn} \times 4 \text{ Bn} \times 4 \text{ Bn} \times 4 \text{ Bn}$) distinct devices can be addressed. IPv6 also includes an important feature: a set of possible migration and transition plans from IPv4. There are many other features of IPv6. You can explore the internet and find more information about IPv6.

IP Address Vs MAC Address: You might wonder how an IP address differs from a MAC address. In fact, the IP address is assigned by the network administrator or the internet service provider while the MAC address is assigned by the manufacturer. Thus if a computer is transferred from one network to another, its IP address gets changed whereas the MAC address remains the same.

From the IP address it is usually possible to track the tentative location of the computer but this is not the case with a MAC address.

Domain Name: So, whenever we have to communicate with a computer on internet, we can do so by using its IP address. But it is practically impossible for a person to remember the IP addresses of all the computers one may have to communicate with. Therefore, a system has been developed which assigns names to some computers (web servers) and maintains a database of these names and corresponding IP addresses. These names are called Domain Names. Examples of some domain names are cbse.nic.in, sikkimipr.org, indianrailway.gov.in etc. Domain names are used in URLs to identify particular Web servers. For example, in the URL <http://www.cbse.nic.in/welcome.htm>, the domain name is www.cbse.nic.in.





A domain name usually has more than one parts: top level domain name or primary domain name and sub-domain name(s). For example, in the domain name **cbse.nic.in**, **in** is the primary domain name; **nic** is the sub-domain of **in**; **cbse** is the sub-domain of **nic**.

There are only a limited number of top level domains, and these are divided into two categories: Generic Domain Names and Country-Specific Domain Names. For example:

Generic Domain Names:

- com** - commercial business
- edu** - Educational institutions
- gov** - Government agencies
- mil** - Military
- net** - Network organizations
- org** - Organizations (nonprofit)

Country Specific Domain Names:

- .in** - India
- .au** - Australia
- .ca** - Canada
- .ch** - China
- .nz** - New Zealand
- .pk** - Pakistan
- .jp** - Japan
- .us** - United States of America

*In context of internet, a **Domain Name** is a name assigned to a server through Domain Name System (DNS). A domain name usually has more than one parts: top level domain name or primary domain name and sub-domain name(s).*





Domain Name Resolution: Domain Name Resolution is the process of getting the corresponding IP address from a domain name. It happens as follows:

Suppose you mention a URL in the web-browser to visit a website. The browser first checks your computer to find if the IP address of the server corresponding to the Domain Name (embedded in the URL) is present. If this address is present then with the help of this address, the corresponding server is contacted and then the website opens in your browser. Otherwise the browser sends this domain name to some specific servers (called domain name servers) to find the corresponding IP address. Once the IP address is known, the server is contacted and then the website opens in your browser.

Domain Name Resolution is the process of getting corresponding IP address from a domain name.

Know More!

The Internet Corporation for Assigned Names and Numbers (ICANN) is an internationally organized, non-profit corporation that has responsibility for Internet Protocol (IP) address space allocation, protocol identifier assignment, generic (gTLD) and country code (ccTLD) Top-Level Domain name system management, and root server system management functions. These services were originally performed under U.S. Government contract by the Internet Assigned Numbers Authority (IANA) and other entities. ICANN now performs the IANA function.

Network Security

Computer networks are communication highways on which the data travels. Data travels on a network when an e-mail is sent or received, any transaction is made using a credit or a debit card, a web site is accessed, chatting is done, or any other work is done on a network. Data travelling over a network is vulnerable to attacks and thefts. There are some people who want to illegally access this data for any reason: using a credit/debit card data for shopping, using a company's data to sell it to some rival company, to find the kind of web sites a person accesses, or may be hundreds of other reasons. These people





may sometimes also want to destroy the data on its way, or block the services of some resources or sites. As the data goes from one point to another point on the Internet, for example, it may pass through several points along the way, giving other users the opportunity to access, and even alter it. Even other users on your system may maliciously transform your data. Unauthorized access to your system may be obtained by intruders, who then use advanced knowledge to impersonate you, steal information or even deny your access to your own resources.

Therefore, there is always a threat of some kind of attacks on computer networks' security. Some kinds of attacks on network security are as follows:

Denial of service attacks: A Denial of Service (DoS) attack is an attempt to make one or more network resources unavailable to their legitimate users. Examples of such attacks are:

- **Denial of Access to Information:** Corrupting, Encrypting, or changing the status of information so that it is not accessible to its legitimate user.
- **Denial of Access to Application:** Forced shutting of an application as soon as the user opens it.
- **Denial of Access to Resources:** Blocking a resource, may be a printer or scanner or USB port, of a computer from proper working.
- **Denial of Access to a Website:** Continuously sending bulk requests to a website so that it is not available to any other user.

Intrusion Problems: An Intrusion problem is an attempt to mischievously steal some information from someone's computer. Examples of Intrusion are:

Snooping - Have you ever tried to read someone else's slam book secretly? This is snooping. Have you ever tried to read what someone else is writing in his/her letter/email to someone else? This is snooping. Do you think your parents try to secretly check your mobile phone to find its contents? If yes, then what your parents are doing is snooping.

In context of network security, snooping refers to gaining unauthorised access to another person's or organization's data. This may be done in a number of ways:





- By getting someone's login information by casually watching what he/she is typing.
- Reading the files on someone's computer in an unauthorised manner
- Using some softwares which keeps track of the activities and data being sent or received on someone's computer.

Snooping refers to gaining unauthorised access to another person's or organization's data.

Eavesdropping - Do you ever find that when you are talking to someone else, another person is secretly trying to listen to your talks? What that person is doing is 'eavesdropping'. Have you ever tried to secretly listen to the conversation between two teachers regarding your class? If yes, then what you have done is 'eavesdropping'.

In context of network security Eavesdropping refers to unauthorised access to another person's or organization's data while the data is on its way on the network.

This may be done in a number of ways:

- By setting up parallel telephone lines.
- By installing some software (spyware) in the target computer.
- By installing some receiver which captures the data while on its way.

Eavesdropping refers to gaining unauthorised access to another person's or organization's data while the data is on its way on the network

It is the responsibility of a person/organization to protect its network from such attacks. The term **Network Security** refers to all activities undertaken to protect a computer network from attacks to its security. This covers protection of computers in the premises and data on the network from both internal and external attacks. To protect a network from security attacks, a number of steps are taken. These steps include:

Login-Password: By assigning login names and strong passwords to the users of a system, it can be ensured that only authorized people access a computer. This helps in increasing the computer as well as network security. A strong password is the one which is easy to





remember for the user but difficult (almost impossible) for the others to guess successfully. On the other hand a weak password is generally the name of a person or organization, the registration number of a vehicle, year of birth of a person and so on. A weak password can be cracked in a few attempts. Examples of strong passwords may be raavanisdead (raavan is dead - with spaces removed), 2aur2paanch (name of an old Hindi movie) or anything like that.

Firewall: A firewall is a hardware device or a software that is installed to monitor the data entering the computer/Network or leaving it. A firewall permits only that data to enter or leave a computer/Network for which permissions have been granted by the computer/network administrator.

Anti Virus Software: These days anti-virus softwares work against not only the virus but also against almost all kinds of malware. Therefore by installing a full version legal (not the pirated one or freeware) anti-virus software network security can be increased.

File Permissions: A data file on a computer can be created, read, or modified. An application file can be run or executed. Accordingly, different rights (privileges) can be given to different users of a computer to perform one or more of these tasks. For example, suppose there is a data file containing students' marks in a school. The system administrator has created that file. If there is a need to create another such file, then again only the system administrator can create it. So, system administrator is given the 'Create' right. A teacher can read this file to go through the marks of the students. She can also enter or alter the marks in this file. Therefore a teacher has 'Read', 'Write', and 'Modify' rights to this file. The students can only view their marks; therefore, the students are given only the 'Read' right to this file. If report cards have to be printed for a class, the class teacher makes a request to the computer operator, who can run a program to print the report cards. This computer operator has been given the 'Execute' right to the application program which prints the report cards. This way by giving appropriate rights to respective users, computer security as well as network security can be increased.

Setting up a computer network

Let us now take an example to see how can a computer network be setup.

Think of a hypothetical Educational Society (say XYZ Educational Society) with its head

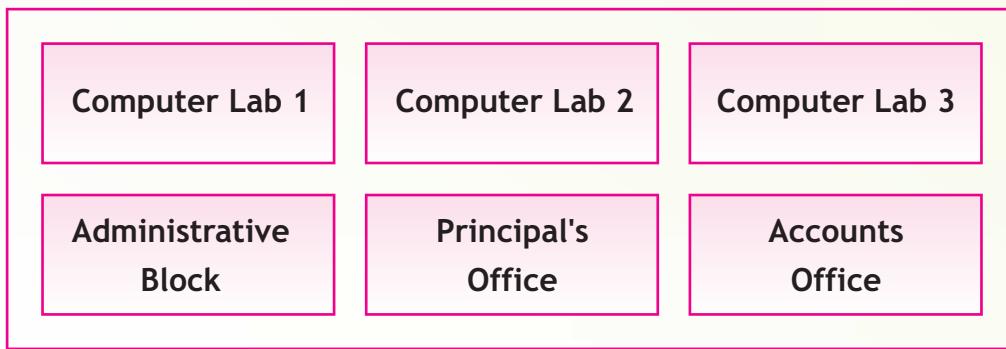




office in Chennai (Tamil Nadu) and schools in various parts of the globe. The society is setting up a new senior secondary school, 'SF School', in Bahadurgarh (Haryana).

The 'SF School' will have 3 computer labs with 30 computers in each, 1 Accounts office with 3 computers, 1 Administrative block with 5 computers, and 1 Principal's office with 1 computer. Let us see how a computer network can be set up in the school.

First of all we can draw a rough sketch of the school with computers at various locations as follows:



Independent LANs can be set up in each of the following buildings:

Computer Lab1, Computer Lab2, Computer Lab3, Administrative Block, Accounts Office.

These LANs can be set up in STAR topology using UTP cable (economical, reliable, and easily available). For this 1 switch (with suitable number of ports) will be required in each of these buildings. More than one switches can be used in computer labs if a switch with more than 30 ports is not available.

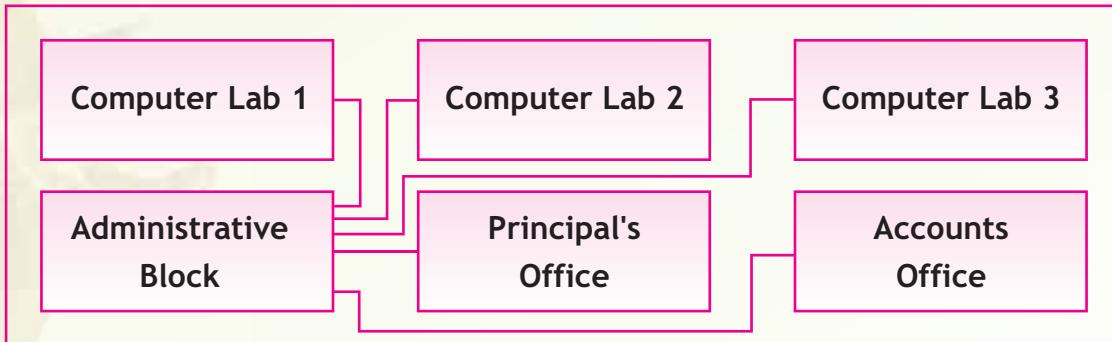
Two internet connections (broadband for high speed) can be procured in Administrative Office. Two connections should be procured from two different ISPs so that

- (i) Internet connection in Administrative office can be kept separate from the other Computer labs where students may do a lot of experimentation.
- (ii) If one internet connection is not working, the other can be used in case of urgent requirements.





These buildings can then be connected as follows:



This interconnection will ensure that each building is directly connected to Adminisntrative block. This way internet connection will be available in each building irrespective of the status of the other building.

Server (if any) of the school may be placed in Administrative block so that it remains safe (physically) and a firewall can be set up so that the whole network remains safe from any kinds of virus or intrusion attacks.

There is no need to do any extra efforts or expenses to link the school to its head office. This can be taken care of using the internet connections.

SUMMARY

- A computer network is a collection of interconnected computers and other devices which are able to communicate with each other.
- Communication Media are the links over which the data is sent from one node to another over a network.
- Hardware devices used to form a network are: Cables, NIC, Hub, Switch, Repeater, and Gateway.
- Repeaters are used to regenerate the signal which gets weakened during its transmission. Repeater are generally used to connect two networks which are more than 80 m apart.
- Gateway is a device which connects two different types of networks.
- On the basis of area covered by a network it is categorized as PAN, LAN, MAN, or WAN.





- Physical arrangement of computers in a network is called network topology.
Basic network topologies are bus, star and tree.
- Each machine on a network is identified by its IP address.
- Conversion of domain name into IP address is done by DNS (Domain Name Server)
- Denial of service, snooping and intrusion are some common threats for network security.
- Network security can be increased by applying some preventive methods.

Future Trends

4G Technology

The scenario of how computers are networked is changing very fast. Before full implementation of a technology, a new technology is visible at the horizon. One such new technology is 4G. 4G stands for fourth generation of mobile technology. Change from one generation to another involves a major advancement in the technology used. 1G technology was used in the first mobile phones. 1G used analog radio signals. 1G was introduced in 1980s and continued until 1992 when 2G was introduced. 2G technology used a digital format and introduced text messaging. 2G also introduced data services for mobiles, starting with SMS. 3G technology has introduced more efficient ways of carrying data, making it possible to have faster web-services, live chat, fast downloading, video conferencing etc. over mobile phones. Today we are living in the world of 3G. Soon, 4G will rule the mobile market. Unlike previous generations of mobile technology, 4G mobile technology will be used for internet access on computers also, and it will be totally wireless! 4G will provide internet access, high quality streaming video and "anytime, anywhere" voice and data transmission at a much faster speed than 3G. The "anytime, anywhere" feature of 4G is also referred to as "MAGIC" (Mobile multimedia; Anytime/anywhere; Global mobility support; Integrated wireless solution; Customized personal services).

You can explore more about 4G technology on the internet.





Cloud Computing

This is an emerging area of demand based resource sharing, resulting into drastic saving of energy and cost. This is also referred to as 'Green IT'.

You can explore more about Cloud Computing on the internet.

EXERCISES

MULTIPLE CHOICE QUESTIONS

1. Which of the following topologies is a combination of more than one topologies?
 - a. Bus
 - b. Tree
 - c. Star
 - d. None of these

2. Which of the following is used for wireless communication?
 - a. Optical Fiber
 - b. UTP cable
 - c. Radio Waves
 - d. Coaxial Cable

3. Which of the following is not a transmission medium?
 - a. Telephone Network
 - b. Coaxial Cable
 - c. Modem
 - d. Microwaves

4. IP addresses of two computers on a network:
 - a. Can be the same
 - b. Cannot be the same
 - c. Are not defined
 - d. Must match with a third computer

5. Bluetooth can be used for
 - a. Long distance communication
 - b. Short distance communication
 - c. In mobile phones only
 - d. None of the above

6. Micro waves are
 - a. Uni directional
 - b. Omni directional
 - c. Guided media
 - d. Not used for communication.





7. Snooping is
 - a. A threat to data security
 - b. Not a threat to data security
 - c. Good for laptops
 - d. A topology
8. A repeater
 - a. Regenerates the received signal
 - b. Destroys the received signal
 - c. Can be used as a hub
 - d. None of the above
9. Satellite links are generally used for
 - a. PANs
 - b. LANs
 - c. MANs
 - d. All of the above
10. A domain name maps to
 - a. A URL
 - b. An IP address
 - c. A website
 - d. All of the above

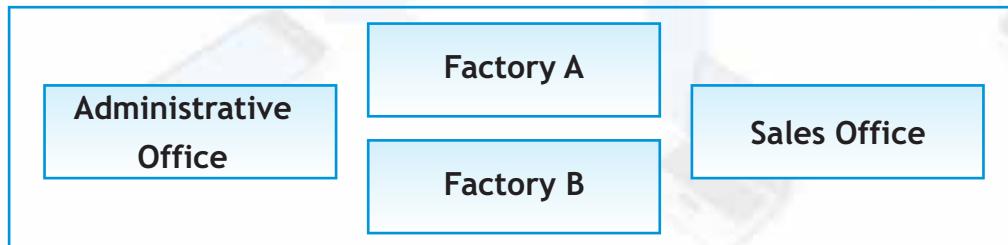
ANSWER THE FOLLOWING QUESTIONS

1. What is a computer network? What are its advantages?
2. What is meant be communication channels? Give two examples of guided media and two examples of unguided media.
3. Which communication channel(s) is/are suitable in each of the following situations:
 - a. Setting up a LAN
 - b. Transfer of data from a laptop to a mobile phone.
 - c. Transfer of data from one mobile phone to another.
 - d. Creating a remote control that can control multiple devices in a home.
 - e. Very fast communication between two offices in two different countries.
 - f. Communication in a hilly area
 - g. Communication within a city and its vicinity where cost of cabling is too high.
4. Why is a switch called an intelligent hub?





5. When is a repeater used in a computer network?
6. Diagrammatically show how would you connect 6 PCs, 1 server, 1 printer, and 2 scanners in
 - a. Star topology
 - b. Bus topology
7. Two engineers in the same room have connected their Palm-tops using bluetooth for working on a Group presentation. Out of the following, what kind of Network have they formed?
LAN, MAN, PAN, WAN
8. What is a MAC address? What is the difference between a MAC address and an IP address?
9. Give some examples of domain names and URLs. How is a domain name different from a URL?
10. What is domain name resolution?
11. Define Network security? What kind of attacks can be made on data and computer networks?
12. List some methods which are used for network security.
13. Differentiate (with examples wherever possible) between :
 - a. LAN and MAN
 - b. MAN and WAN
 - c. Hub and Switch
 - d. Guided and Unguided media
14. Write one advantage of star topology over bus topology and one advantage of bus topology over star topology.
15. Ishika Industries has set up its new production unit and sales office at Ranchi. The company compound has 4 buildings as shown in the diagram below:





Distances between these buildings are as follows:

Administrative Office to Factory A	150 m
Factory A to Factory B	50 m
Factory B to Sales Office	100m
Sales Office to Administrative office	200m
Administrative Office to Factory B	125 m

Number of Computers in each of the buildings is follows:

Administrative Office	15
Factory A	25
Factory B	18
Sales Office	15

1. Suggest a cable layout of connections between the buildings so that each building is directly connected to Administrative Office.
2. Suggest the most suitable place (i.e. building) to house the server of this production unit with a suitable reason.
3. Suggest the placement of the following devices with justification:
 - (i) Repeater
 - (ii) Hub/Switch
4. The Administrative office of this unit is to be linked with the head office situated in Patiala (Punjab). What will be the most economical way to do this? Justify your answer.





LAB EXERCISES

1. Find the IP addresses of at least five computers in your school.
2. Find the MAC addresses of at least 2 computers in your lab. Then verify their manufacturer's name on the net.
3. Find the layout of LAN in your school's labs. If you think some modifications can be done in the layout, note these down in your notebook.
4. Find the name of Internet Service Provider of your school.
5. Find the IP address of your school's web site.

TEAM BASED TIME BOUND EXERCISES

(Team size recommended: 3 students each team)

1. A school building is divided into 4 blocks (A, B, C, and D). Each block is at a distance of 25m from its adjacent blocks. Each block has 1 computer lab with 15 computers each. Each block also has some other rooms (maximum 10) with 1 computer each. The school has only one internet connection. The computer network in the school has to be restructured with the following goals in mind:
 - Each lab has to have an independent LAN.
 - All the computers in the school should have internet access. (The school does not want to have any other new internet connection.)
 - For internet access a computer should be dependent only on one point and not on multiple points. It means that if the internet connection is active, any computer should be able to access it directly irrespective of whether some other computer in the school is ON or OFF.
 - Any two computers in the school should be able to communicate with each other irrespective of whether any other computer in the school is ON or OFF.

The job of each team is to design a layout for this new network structure. Each team has to specify

- The layout of the network structure diagrammatically.





- Topology/topologies is/are used in the layout.
 - How the design will be able to fulfill all the mentioned requirements.
2. Find the average price and specifications of each of the following network devices in the market: Switch , Cable (UTP), LAN Card. Each team has to specify:
- Different types of switches available in the market, their prices, and number of ports.
 - Names of brands of UTP Cable available in the market, along with their prices.
 - Different types of LAN cards available in the market along with their prices.





OPEN SOURCE CONCEPTS

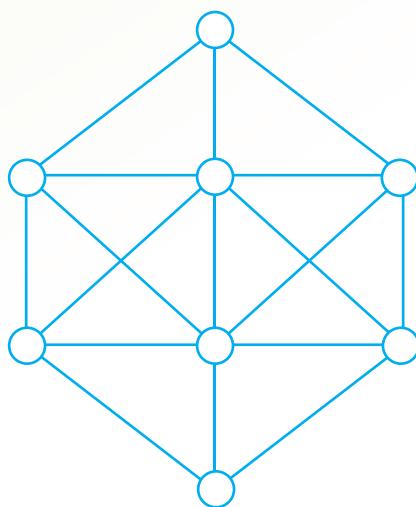
Learning objectives

After learning this chapter the student will be able to:

- Understand about OSS/FOSS/FLOSS
- Cite different examples of OSS
- Describe open document format
- Understand character encoding in Indian languages
- Know about open type/true type/static/dynamic fonts

Puzzle²

Write the numbers 1 to 8 in the given circles so that no two numbers joined by a line differ by 1.



Introduction

Computers and internet have transformed our lives. Software is required to work on a computer but the software that we buy or download only comes in the **compiled ready-**





to-run version. It is next to impossible to modify the compiled version of the software. At times we feel the need to change certain features of the software but are unable to do so.

In this chapter we will study about software which are developed collaboratively and they can be modified as well. Such software are available in many forms like Free Software, Open Source Software (OSS), Free Open Source Software (FOSS) and Free/Liberal Open Source Software (FLOSS). Well, have you noticed something common in all these terms. That's right! It is the word free. People often correlate this word with the cost. They think that these software are available for free. Practically, these software can be acquired at very little or no cost. But, here, "free" means freedom to use.

These software can be studied, copied, redistributed freely and even modified according to one's need without seeking any kind of permission. In order to modify such software the developers also provide the source code to the users.

There do exist software which are actually "free" in the sense of price. These are known as Freeware. Lots of freeware can be downloaded from the internet for various different purposes such as currency converters, drawing graphs and charts etc. But freeware may not come with the source code. Therefore freeware differ from free software. The focus in this chapter is on free software rather than freeware.

The first formal definition of "free software" was given in 1983 by Richard Stallman, a long time member of the hacker community at the MIT Artificial Intelligence Laboratory. He insisted that a free software should give the following four freedoms to users:

- Freedom 0: The freedom to run the program for any purpose.
- Freedom 1: The freedom to study how the program works, and change it to make it do what you wish.
- Freedom 2: The freedom to redistribute copies so as to help your neighbour.
- Freedom 3: The freedom to improve the program, and release your improvements (and modified versions in general) to the public, so that the whole community benefits.

Examples of free software include the Linux Kernel, MySQL Relational Database, Apache web server, OpenOffice.org office suite and TeX and LaTeX typesetting systems.





Later on, the term "free software" was coined as "open source software (OSS)" and soon after as "free open source software (FOSS)". In order to avoid the ambiguity in the word "free", in 2001, FOSS was termed as FLOSS, short form of "free/liberal open source software".

Know More!

You can get more information on open source software from opensource.org.

NRCFOSS :

National Resource Centre for Free and Open Source Software (NRCFOSS) is an initiative of the Department of Information Technology, Ministry of Communications & Information Technology, Government of India. NRCFOSS contributes to the growth of FOSS in India through Research & Development, Human Resource Development, Networking & Entrepreneurship development, as well as serves as the reference point for all FOSS related activities in the country.

Examples of FLOSS/FOSS :

Operating systems and Desktop environments

- **Linux** - Operating system kernel
- **Ubuntu** - Linux distribution with full complement of software for everyday use.
- **Google Chrome OS** - Lightweight operating system based around the web browser
- **Android smart** - phone operating system - by Google / Open Handset Alliance
- **Symbian smart** - phone operating system - by Nokia

Graphics and multimedia

- **GIMP** - Bitmap graphics editor, similar to Adobe Photoshop
- **Blender** - Advanced 3D modelling and rendering application.
- **Songbird** - similar to iTunes with built-in browser.





- **Audacity** - digital audio editor
- **Ardour** - digital audio workstation
- **F-Spot** - Photo manager

Office software

- **OpenOffice.org** - office productivity software. Comparable to Microsoft Office. It uses an open file format and can read and write Microsoft Office files
- **NeoOffice** - Mac OS X version of OpenOffice
- **PDFCreator** - creates PDFs from any Windows program.

Internet related software

- **Apache webserver** - web server
- **Mozilla Foundation**
 - **Mozilla Firefox** - web browser
 - **Mozilla Thunderbird** - mail client
- **Google Chrome** - Google's web browser

Other

- **Celestia** - 3D space simulation software.
- **Flight Gear** - flight simulator
- **Second life** - virtual world viewer
- **Wine** - a compatibility layer for computers running Linux that enables them to run many applications that were originally written for MS Windows

Programming related

- **Eclipse** - software framework and Java IDE
- **PHP** - server-side programming language
- **PERL** - Dynamic programming language





- **Python** - versatile, clean and powerful programming language used for cross-platform desktop applications, server-side scripting for websites, and scripting within java and .net environments
- **MySQL** - Database management system
- **Java** - Programming language

More comprehensive list of open-source software can be found at :

http://en.wikipedia.org/wiki/List_of_open_source_software_packages

GNU/Linux - The GNU Project was launched in 1983 by Richard Stallman of Free Software Foundation (FSF) to develop a complete Unix-like operating system which is free software: the GNU operating system. Unix-like operating systems are built from a collection of libraries, applications and developer tools, plus a kernel to allocate resources and to talk to the hardware. GNU is often used with the Linux kernel. The combination of GNU and Linux is the GNU/Linux operating system, now used by millions.



Firefox - Firefox is a free and open source web browser produced by Mozilla Foundation. Firefox runs on various versions of GNU/Linux, Mac OS X, Microsoft Windows and many other Unix-like operating systems.



Open Office - Open Office is the leading open source office suite for word processing, spreadsheets, presentations, databases etc. It is available in many languages. It stores files in open document format (ODF) for data interchange that is its default file format.





NetBeans - NetBeans began in 1996 as verify, a Java Integrated Development Environment (IDE) student project, under the guidance of the Faculty of Mathematics and Physics at Charles University in Prague. In 1999 it was bought by Sun Microsystem which open-sourced the NetBeans IDE in June of the following year. The NetBeans community has since continued to grow, thanks to individuals and companies using and contributing to the project. NetBeans refers to both a platform framework for Java desktop applications, and an IDE for developing applications with Java, JavaScript, PHP, Python, Ruby, C, C++, and others.



BOSS (Bharat Operating Systems Solutions) - BOSS is a free Indian Operating System based on GNU/LINUX developed by C-DAC(Center for Development of Advance Computing). BOSS makes it easier for a Microsoft Windows user to shift to GNU/LINUX platform which is there with variant features. Currently BOSS GNU/Linux Desktop is available in many Indian Languages which also enables the non-English literate users in the country to be exposed to Information and communication technology and to use the computer more effectively.



Open Source Software Security

A commonly voiced concern about open source software:

"If anyone can contribute to open source software, doesn't it become a free-for-all full of loopholes?"

The Answer is while anyone can propose a contribution to an open source project, any actual change must go through a small core group of maintainers first. Getting a change incorporated into an open source project is thus rather like getting an article published in a scientific journal.

Open source software is more heavily tested than their commercial counterparts as it can be downloaded by anybody around the world and any one of them can discover a bug or security flaw and submit those reports back to the project.





Also since it's an Open Source, if any bug or flaw is found, project's core maintainers, while potentially embarrassed, have no further reason to cover up the flaw like their proprietary counterpart. Also the loop-hole or bug is available to every one and the customer can take the preventive measure accordingly and fix comes faster.

Common open standards

Open Document Format

The Open Document format (ODF) is a format for office documents, such as spreadsheets, databases, presentations and word-processing documents. Open Document is a free and open format. For governments, businesses, archivists and others, it's critical to store documents in a way that can be read for years to come. Proprietary digital file formats are typically changing with every new version of the software, so there should be some format which supports files created in any application. The data should be the center of importance not the application. Office suite applications, as always, need a file format that is designed to organize the data when it moves away from the application. People with different machines in different places should be able to open and edit the data in a file. ODF offers an open alternative to the formats used by all of the existing Office application versions for text, spreadsheet, presentation, and other kinds of documents. Open Document's main file extensions are .odt (for text documents), .ods (for spreadsheets), and .odp (for presentations). These will be more commonly recognized when more people and organizations adopt Open Document-ready software.

Ogg Vobris

Ogg Vorbis is a new audio compression format developed by Xiph.org. It is an open, patent-free, professional audio encoding and streaming technology with all the benefits of Open source. It is comparable to other formats such as MP3, VQF, AAC etc. used to store and play digital music.

Character Encoding

A character encoding system consists of a code that associates each character from a given system with something else, such as a sequence of natural numbers, binary numbers or electrical pulses, in order to facilitate the transmission of data (generally numbers and/or text) through telecommunication networks or for storage of text in





computers. ASCII, EBCDIC, and UNICODE are the most widely used character encoding systems for computers.

Indian Language Computing

Let us recall from Annexure I of Class XI that in order to communicate with the computers some kind of a binary code is required. In this regard, a detailed study was made on BCD code which is a 4 bit code. However, BCD code is not sufficient enough to accommodate even all the characters of English alphabet and digits. To accommodate all these, a higher bit code is required. Among such codes, the most popular is the ASCII code (American Standard Code for Information Interchange). It is a 7 bit code that can store $2^7 = 128$ characters. In the earlier days most computers were using an 8 bit system. This extra bit gave computer developers lot of empty spaces which was used for different purposes. In order to work with Indian languages, these unspecified spaces were used for Indic characters. The efforts were very creative and gave good results despite the fact that there was no or very little support from the operating systems. Since no general rules and methodologies were adopted in developing Indic characters, different developers developed these characters in their own ways. This created compatibility issues across different programs and across different operating systems. For example browsers like Internet Explorer did not support all Indic characters and displayed distorted texts.

On one hand, more and more work had been undertaken to facilitate the use of Indian languages on computers but on the other hand it was becoming difficult to maintain consistency across different programs developed for the same set of Indic characters. In such a scenario, it was important to have a common standard for coding Indian scripts. In 1991, the Bureau of Indian Standards (BIS) adopted the Indian Script Code for Information Interchange (ISCII), the ISCII standard that was evolved by a standardization committee, under Department of Electronics during 1986-88.

ISCII is an 8 bit encoding system as compared with the 7 bit ASCII. The lower 128 code points are plain ASCII while the upper 128 code points are ISCII specific containing the basic alphabets required for the 10 Indian scripts (Assamese, Bengali, Devanagari, Gujarat, Gurmukhi, Kannada, Malayalam, Oriya, Tamil and Telugu) which have originated from the Brahmi script.





Know More!

The Indic scripts are a family of abugida (alphabetic-syllabary) writing systems. They are used throughout South Asia, Southeast Asia, and parts of Central and East Asia, and are descended from the Brahmi script of the ancient Indian subcontinent. They are used by languages of several linguistic families: Indo-European, Dravidian, Tibeto-Burman, Mongolic, Austro-Asiatic, Austronesian, Tai, and possibly Korean (hangul). They were also the source of the dictionary order of Japanese kana.

UNICODE

For a long time ASCII has been the standard code used worldwide. ISCII was the Indian contribution to work with Indian languages. Similarly, to work with other languages of the world, people were making efforts to use ASCII along with the extra 8th bit. Efforts were continued to conceive a single standard code which could cater to all world's languages and it was UNICODE.

Unicode was developed with the aim to conceive a single standard code which could manage to represent all languages of the world.

Unicode characters are represented in one of the three encoding forms: a 32-bit form (UTF-32), a 16-bit form (UTF-16), and an 8 bit form (UTF-8). The 8-bit, byte oriented form, UTF-8, has been designed for ease of use with existing ASCII-based systems.

Advantages of Unicode

- With the usage of Unicode, single versions of software were developed instead of language-specific versions that reduced the complexity.
- UNICODE is supported by most OS and application vendors. This ensures platform, vendor and application independence.
- Incorporating Unicode into applications and websites offers significant cost savings than proprietary solutions.
- It allows data to be transported through several different systems without distortion.





- Since every number and character combination is unique, the representation results in a true standard.

Different Types of Fonts

Post Script

This font format was developed by Adobe in 1980's. This font consists of two parts which are both necessary for the font to be properly printed and displayed on screen. With most operating systems, these fonts can be installed simply by being placed in the system's folder. However, for Micro Soft operating systems predating windows 2000, they need to be installed using ATM (Adobe Type Manager) utility.

True Type

This format was jointly developed by Apple and Microsoft in the late 80s. These fonts contain both the screen and printer font data in a single component, making the fonts easier to install. And that is why these are a good choice for those who find the installation of fonts difficult.

Open Type

This is the latest font format which is a joint effort by Apple and Microsoft. Like True Type fonts, this contains both the screen and printer font data in a single component. However, open type fonts support multiple platforms and expanded character sets. Additionally, open type format allows the storage of upto 65,000 characters. This additional space provides freedom to include add-ons such as small caps, old style figures, alternate characters and other extras that previously needed to be distributed as separate fonts.

However, not all open type fonts contain additional characters. Many fonts have been converted from either PostScript or TrueType formats without expanded character sets to take advantage of the cross-platform functionality benefits of Open Type. OpenType fonts that do contain expanded character sets are referred to informally as OpenType Pro fonts. Support for OpenType Pro fonts is increasing, but the format is yet to be fully supported by all applications.





Static and Dynamic fonts

Static fonts - In these types of fonts the characters are designed and digitized and then stored in font files. Every time printing takes place, same character will appear with same shape e.g. Times New Roman, Arial etc.

Dynamic fonts - Dynamic font is a web browser technology used when visiting any website that uses fonts which are not installed on client's machine. The web browser would not be able to display the page properly, but will select one of fonts available on client machine. In this the characters are redefined at each occurrence (everytime they are displayed or printed). All hand written fonts such as handwritten alphabets, calligraphic letters, graffiti etc are dynamic fonts because of individual variations.

This technology is helpful in displaying multilingual websites.

Entering Indian language text

Many tools have been developed to facilitate the typing of Indian language text. These tools broadly support two types of text entries:

- Phonetic Text Entry
- Keymap based Text Entry

Phonetic Text Entry (Transliteration)

In this type of text entry, traditional keyboards with English keys are used. But while typing, the Indian alphabets are written phonetically (i.e., the way they sound as per the pronunciation) in English Script and then converted to corresponding language word. For e.g. we will type "mera desh mahaan" from English keyboard and the relevant phonetic key entry software will transliterate it in the language selected eg. Hindi. ("मेरा देश महान")

Keymap based Text Entry

In this method the keyboard keys are mapped to specific characters using a keymap. The whole arrangement of mapping the keyboard keys to specific language characters is known as keymap. A keymap is internally stored as a table. Multiple keymaps are used to store complete keymapping e.g. a table to represent the keymappings without any additional key press(such as shift) ; a table representing keymappings along with Shift key press; along with Ctrl key press and so on.



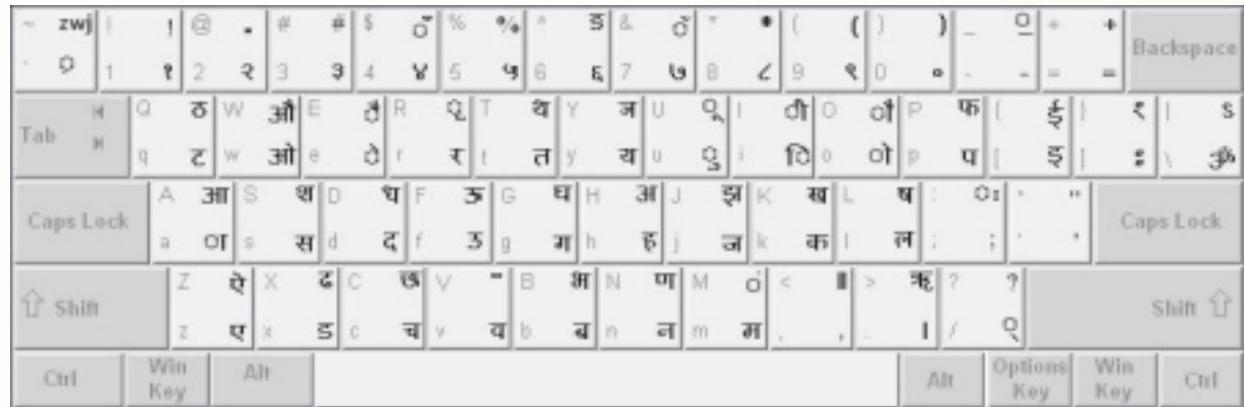


Indian language keymaps are known as INSCRIPT keymaps or Indian Script Keymaps.



ENGLISH KEYBOARD WITH INSCRIPT OVERLAY

The ASCII characters of a standard QWERTY keyboard are on the left half of a key. The INSCRIPT (Indian Script) overlay characters are shown on the right half of a key. CAPS LOCK is used to select the INSCRIPT overlay.



NUKTA CHARACTERS IN INSCRIPT OVERLAY

When Nukta “-” is typed after character, the character shown to its left on the key, is obtained.



OPEN SOURCE CONCEPTS



INSCRIPT OVERLAY FOR ASSAMESE

Know More!

You can get more information on Indian script keymaps from <http://tdil.mit.gov.in/isciichart.pdf>.

Future Trends

At present very few open source endeavors which involve few people are there and are largely unstructured and undisciplined. But as this concept matures in future more OSS projects will come up and will adopt more structured methodologies to code, control and coordinate. In future this concept will be adopted at a big level by private and government sector. This will force companies to embrace open source and will force the open source community to innovate in line with more complex need of government and business.





Summary

- Free and open source software, also OSS, FOSS, or FLOSS (free/libre open source software) is software that is liberally licensed to grant the user right to use, study, change, and improve its design through the availability of its source code.
- NRCFOSS - National Resource Centre for Free and Open Source Software.
- ODF (Open Document Format) offers an open alternative to the formats used by all of the existing software.
- Ogg Vorbis is open audio compression format.
- A character encoding system consists of a code that associates each character from a given system with something else, such as a sequence of natural numbers, binary numbers or electrical pulses, in order to facilitate the transmission of data (generally numbers and/or text) through telecommunication networks or for storage of text in computers
- ISCII - Indian Script Code for Information Interchange is common standard for coding Indian Scripts.
- UNICODE - Universal Code is a single standard code which can cater to all the world's languages.
- Post Script font consists of two parts which are both necessary for the font to be properly printed and displayed on screen.
- True type fonts contain both the screen and printer font data in a single component.
- Open type fonts support multiple platforms and expanded character sets.
- On the basis of their configuration, fonts are categorized as static fonts and dynamic fonts.
- For entering text in Indian script keymap based or phonetic text based entry can be done.





EXERCISES

MULTIPLE CHOICE QUESTIONS

- 1) Open Document's main file extensions are
 - (a) .odt
 - (b) .ods
 - (c) .odp
 - (d) All of these
- 2) Technology no longer protected by copyright, available to everyone, is considered to be
 - (a) Proprietary
 - (b) Open
 - (c) Experimental
 - (d) in the public domain
- 3) Which of the following codes uses 7 bits to represent a character
 - (a) ISCII
 - (b) ASCII
 - (c) UNICODE
 - (d) All of the above
- 4) How many bits are used by UTF-8 to represent a character
 - (a) 7
 - (b) 8
 - (c) 16
 - (d) 32
- 5) ASCII stands for
 - (a) American System Code for Information Interchange
 - (b) American Standard Code for Information Interchange
 - (c) American Standard Code for Interchange Information
 - (d) American System Code for Interchange Information
- 6) ISCII stands for
 - (a) Indian System Code for Information Interchange
 - (b) Indian Standard Code for Information Interchange
 - (c) Indian Script Code for Interchange Information
 - (d) International Standard Code for Interchange Information





- 7) ISCII is
 - (a) An 8 bit character code
 - (b) A 16 bit character code
 - (c) A 7 bit character code
 - (d) Same as ASCII
- 8) Which of the following is open source operating system
 - (a) DOS
 - (b) Windows 2010
 - (c) BOSS
 - (d) Mac
- 9) Following operations are possible with OSS
 - (a) Free download
 - (b) Source code is available
 - (c) You can redistribute the modified version
 - (d) All of the above
- 10) Platform independence is provided by
 - (a) ASCII
 - (b) ISCII
 - (c) UNICODE
 - (d) All of the above

ANSWER THE FOLLOWING QUESTIONS

- 1) Define Open source software. Give at least two examples of OSS. Justify that free software is not open source software.
- 2) Give examples of two OSS in each of the following categories :
 - (a) OS
 - (b) Graphics and animation
 - (c) Office software
 - (d) Internet related software
 - (e) Programming related software.
- 3) What is a character encoding system?
- 4) Differentiate between true type font and open type font.
- 5) What do you understand by ODF?





- 6) What is Ogg Vorbis?
- 7) Expand the following terms:
OSS, FLOSS, ISCII, ASCII, BOSS, NRCFOSS
- 8) What is UNICODE?
- 9) Write short notes on GNU, BOSS, ISCII
- 10) What is the difference between static and dynamic fonts?

LAB EXERCISES

- 1) Find out which software in your school lab are open source.
- 2) Note down the category of software (system software or application software) to which they belong to.
- 3) If any of them is application software then specify its area of application.
- 4) Search on internet about the features of mySQL and Netbeans.

TIME BOUND TEAM BASED EXERCISE

(Team size recommended: 3 students each team)

- 1) Download open office on your computer. Write down its components, their areas of applications, their file extensions.
- 2) Procure BOSS and install it (with the permission of your teacher) on your computer and write down the features which are similar to windows and also which are not similar to windows.





GUI PROGRAMMING - A REVIEW

Learning Objectives

After studying this lesson the students will be able to:

- Identify, name and state the usage of the different components of the NetBeans IDE.
- Identify and name the various methods and properties associated with the various form controls
- Create simple applications in Java using NetBeans IDE.
- Create GUI applications using the concepts of variables and control structures.

NetBeans IDE allows us to develop applications by dragging and positioning GUI components from a palette onto a container. The GUI builder automatically takes care of the correct spacing and alignment of the different components relative to each other. The JFrame acts as a container for the elements like the JLabel, JButton, JTextArea and allows direct editing of their associated properties at the design time and run time. The related methods are used in the code to develop applications for a specific task. The concept of variables and control structures are used to simplify the code of the applications.

Puzzle³

This group of phrases has something amazing hidden in it. Try and find out what is so unusual about this group of phrases? Is there any specific pattern in each line? *

Bar crab

Borrow or rob

Straw warts





Live evil

A man, a plan, a canal--Panama!

Delia failed.

Evil olive

Pull up if I pull up.

Step on no pets.

Ten animals I slam in a net.

Was it a bat I saw?

Was it a car or a cat I saw?

We found an interesting pattern in the puzzle and we will use this concept to develop an application in netbeans.

Introduction

Let us take a journey back in time and think as to what the world was like 15 years ago. Amazon was a large river in South America. Yahoo was a term from Gulliver's Travels. A googol was a very large number (one followed by a hundred zeroes) and to get our tickets booked we had to go to shops called 'travel agents'. In case we fell sick and went to a hospital, our records were maintained on paper. If the doctor wanted to refer to a particular patient's record, he had to instruct a assistant to hunt for information from the pile of files.

Nowadays hospitals use computers to keep the records of patients - medical history, details on what medication to give to a patient, the prescribed dosage and also personal details that can be accessed at the click of a button. The entire information is entered into a computer using a front end that accepts the different patient details. We learnt how to design valid front end forms in class XI in Java using the NetBeans IDE. This chapter will help us recapitulate all the concepts learnt in class XI.





NetBeans IDE

It can be used to create java applications very easily using the efficient GUI builder. Let us quickly recap the different components of the NetBeans IDE:

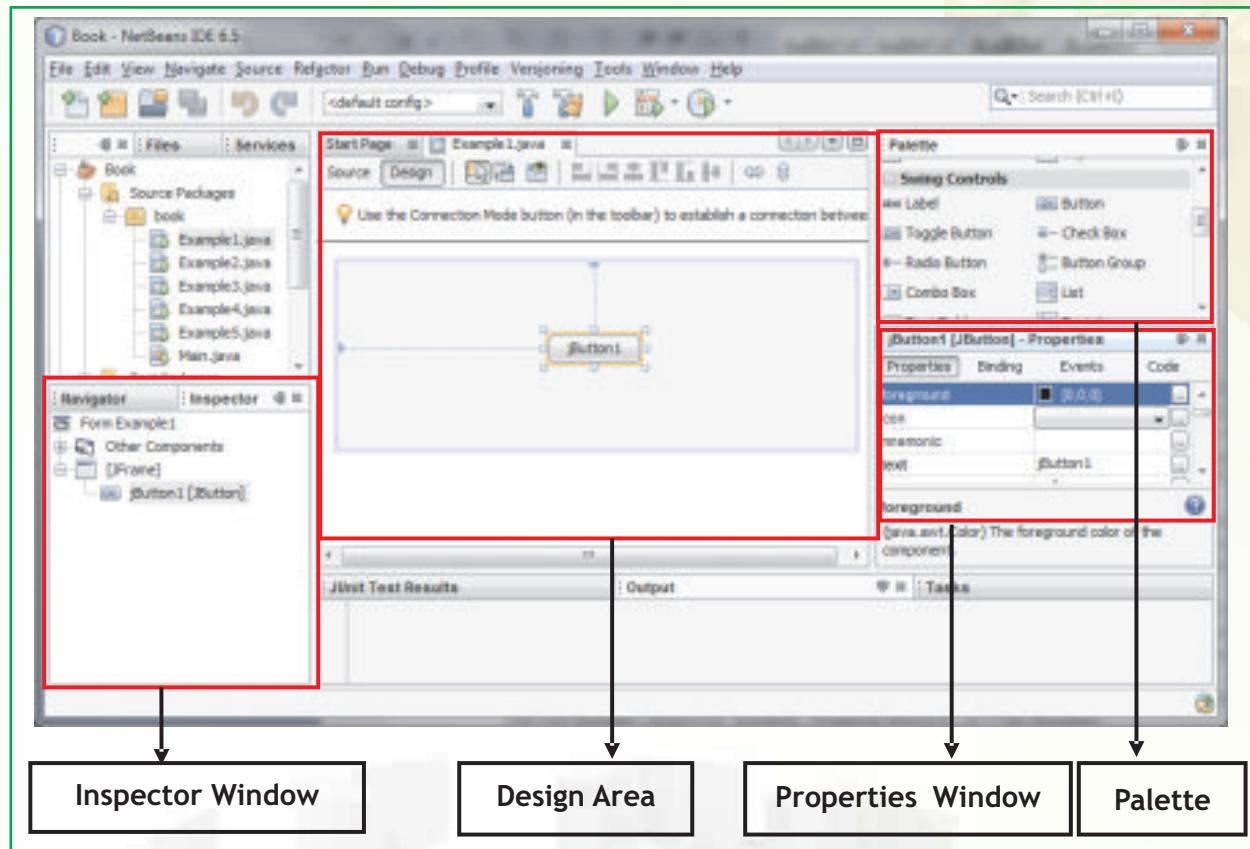


Figure 3.1 NetBeans IDE

1. Title Bar
2. Menu Bar with pull down menus
3. Toolbars
4. GUI builder: It is an area to place components on the form visually. There are two views of the GUI builder- the Design View and the Source View. We can switch over from one view to another by simply clicking on the source and design tabs directly above the Design Area.
5. Palette: Palette contains controls or components used to create GUI applications.





6. Inspector Window: This window is used to display a hierarchy of all the components or controls placed on the current form.
7. Properties Window: Using this window we can make changes in the properties of currently selected control on the form.
8. Code Editor Window: - It is the area where we write code for our java application.

Components

Components (also known as "widgets") are the basic interface elements the user interacts with: jlabels, jbuttons, jtextfields etc. Components are placed on a container (like the JFrame). There are two types of controls :

- **Parent or container controls:** They act as a background for other controls. For example-Frame. When we delete a parent control, all its child controls get deleted. When we move a parent control all its child controls also move along with it.
- **Child controls:** controls placed inside a container control are called child controls. For example-Text Field, Label, Button etc.

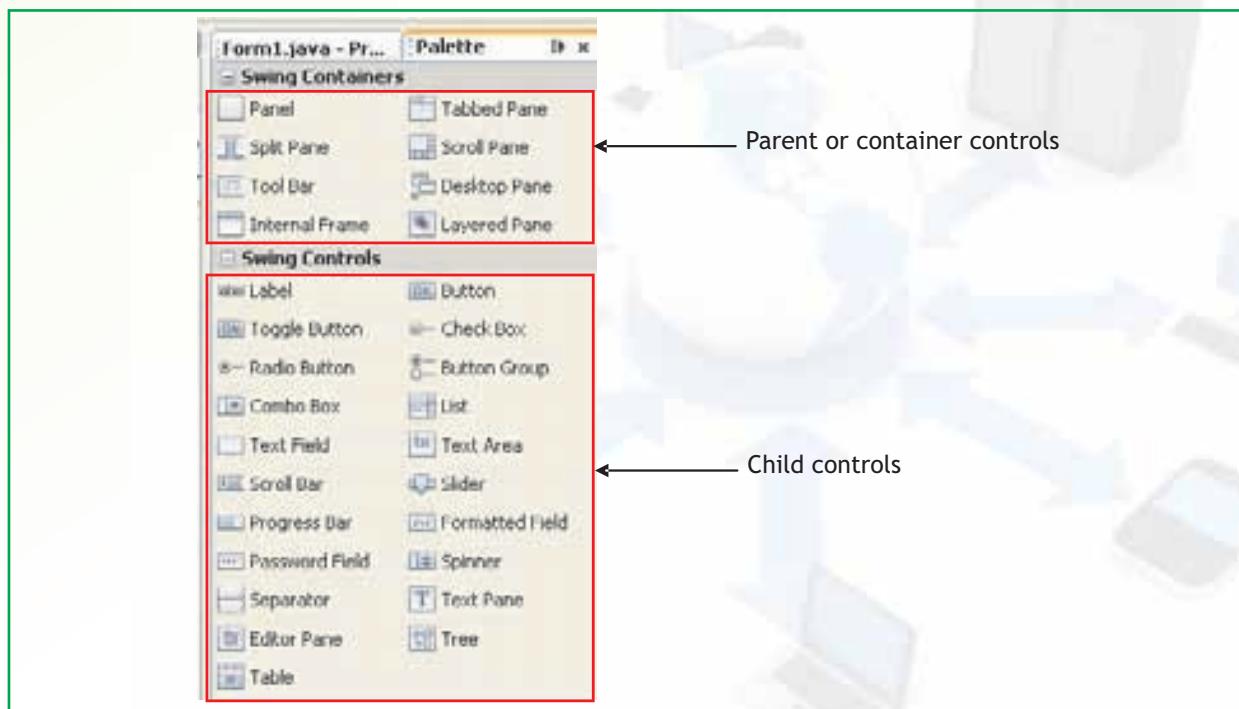


Figure 3.2 Parent and Child controls





Creating a New Project

The steps to create a new project are:

1. Select New Project from the File menu. You can also click the New Project button in the IDE toolbar.
2. In the Categories pane, select the General node. In the Projects pane, choose the Java Application type. Click the Next button.
3. Enter the name of the project in the Project Name field and specify the project location. Do not create a Main class here.
4. Click the Finish button.

Let us recap the relation between a Project, Form and Components. Each application is treated as a Project in NetBeans and each project can have one or multiple forms and this fact is clear from the Projects window as shown in Figure 3.3.

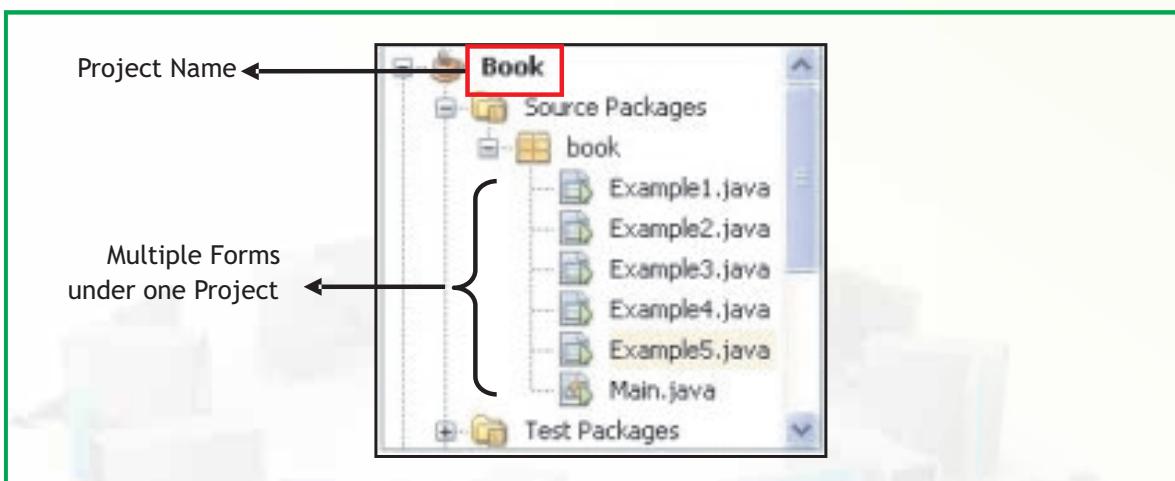


Figure 3.3 Project Window Showing Multiple Forms

Further each form can have one or more elements - some of which may be visible and some invisible. The visible components are all shown under the Frame Component and the non-visible components are part of Other components.

We use the drag and drop feature of NetBeans to place components on the form to design an effective interface for our applications. The first step that we undertook while designing our applications was adding a new jFrame form. The jFrame is a window with





title, border, (optional) menu bar and is used to contain all other components placed by the user on the form. Some of the properties of the `jFrame` form are `defaultCloseOperation` and `Title`.

Property	Description
<code>defaultCloseOperation</code>	Sets action to be performed when the user attempts to close the form.
<code>Title</code>	Sets the text to be displayed in the Title bar of the form window.

Figure 3.4 Properties of the `jFrame` Form

Any component of GUI front-end (the form itself and the swing containers and controls placed in the form) of an application is an object. Each of these objects belongs to its corresponding class predefined in Java. For example, a form is an object of `JFrame` class, all the textfields are objects of `JTextField` class, and so on. Each object has some properties, methods, and events associated with it using which you can control the object's appearance and behaviour.

Properties of an object are used to specify its appearance on the form. For example to set the **background** colour of a textfield you change its `background` property; to set its **font** you change its `font` property; and so on.

Methods are used to perform some action on the object. For example to display something in a textfield you can use its `setText()` method, to extract the contents of a textfield you can use its `getText()` method. Methods can be divided into two categories- **getters** and **setters**.

- Getters are the methods which extract some information from the object and return it to the program. Getters start with the word `get`. Examples of getters are: `getText()`, `getForeground()`, `getModel()`, `isEditable` etc.
- Setters are the methods which set some properties of the object so that the object's appearance changes. Setters start with the word `set`. Examples of setters are: `setText()`, `setForeground()`, `setModel()` etc.

Events are the actions which are performed on controls. Examples of events are: `mouseClick`, `mouseMoved`, `keyPressed` etc. When the user performs any action on a





control, an event happens and that event invokes (sends a call to) the corresponding part of the code and the application behaves accordingly.

After setting the properties of the jFrame we can start placing components like jButton on the jFrame form. A button is a component that the user presses or pushes to trigger a specific action. When the user clicks on the button at runtime, the code associated with the click action gets executed. The various methods and properties associated with the jButton are summarized in Figure 3.5.

Property	Description
Background	Sets the background color.
Enabled	Contains enabled state of component - true if enabled else false.
Font	Sets the font.
Foreground	Sets the foreground color.
horizontal alignment	Sets the horizontal alignment of text displayed on the button.
Label	Sets the display text.
Text	Sets the display text
Method	Description
getText()	Retrieves the text typed in jButton. <code>String result=<button-name>.getText();</code>
setEnabled	Enables or disables the button. <code><button-name>.setEnabled(boolean b) ;</code>
setText()	Changes the display text at runtime. <code><button-name>.setText(String text) ;</code>
setVisible	Makes the component visible or invisible - true to make the component visible; false to make it invisible. <code><button-name>.setVisible(boolean aFlag) ;</code>

Figure 3.5 Properties and Methods of the jButton





We developed simple real life applications wherein on the click of the button we accepted the data from the user in the jTextField and after processing the data the result was displayed in a jTextField or a jLabel. jTextField allows editing/displaying of a single line of text. jTextField is an input area where the user can type in characters whereas a jLabel provides text instructions or information. It displays a single line of read-only text, an image or both text and image. The various methods and properties associated with the jTextField and jLabel are summarized in Figure 3.6 and 3.7 respectively.

Property	Description
Background	Sets the background color.
Border	Sets the type of border that will surround the text field.
editable	If set true user can edit textField. Default is true.
enabled	Contains enabled state of component- True if enabled else false.
font	Sets the font.
foreground	Sets the foreground color.
horizontalAlignment	Sets the horizontal alignment of text displayed in the textField.
text	Sets the display text
toolTipText	Sets the text that will appear when cursor moves over the component.

Method	Description
getText()	Retrieves the text in typed in jTextField. String result=<textfield-name>.getText();
isEditable()	Returns true if the component is editable else returns false. boolean b=<textfield-name>.isEditable();





isEnabled()	Returns true if the component is enabled, else returns false. <code>boolean b = <textfield-name>.isEnabled();</code>
setEditable	Sets whether the user can edit the text in the textField. true if editable else false. <code><textfield-name>.setEditable(boolean b);</code>
setText()	Changes the display text at runtime. <code><textfield-name>.setText(String t);</code>
setVisible()	Makes the component visible or invisible - true to make the component visible; false to make it invisible. <code><textfield-name>.setVisible(boolean b);</code>

Figure 3.6 Properties and Methods of the jTextField

Property	Description
background	Sets the background color.
enabled	Contains enabled state of component- true if enabled else false.
font	Sets the font.
foreground	Sets the foreground color.
horizontalAlignment	Sets the horizontal alignment of text displayed in the component.
text	Sets the display text





Method	Description
getText()	Retrieves the text in typed in jLabel. <code>String result=<label-name>.getText();</code>
isEnabled()	Returns true if the component is enabled,else returns false. <code>boolean b=<label-name>.isEnabled();</code>
setText()	Changes the display text at runtime. <code><label-name>.setText(String t);</code>
setVisible()	Makes the component visible or invisible - true to make the component visible; false to make it invisible. <code><label-name>.setVisible(boolean b);</code>

Figure 3.7 Properties and Methods of the jLabel

When we had become familiar with the usage of jTextField and jLabel controls then we developed an application in which we wanted to accept multiline input and display multiline output. Well can you recall the name of the component. Exactly the component is Text Area component. This component allows us to accept multiline input from the user or display multiple lines of information. This component automatically adds vertical or horizontal scroll bars as and when required during run time. The various methods and properties associated with the jTextArea are summarized in Figure 3.8.

Property	Description
background	Sets the background color.
columns	Sets number of columns preferred for display.
editable	If set true user can edit textfield. Default is true.
enabled	Contains enabled state of component- true if enabled else false.
font	Sets the font.





foreground	Sets the foreground color.
lineWrap	Indicates whether line of text should wrap in case it exceeds allocated width. (Default is false)
rows	Sets number of rows preferred for display.
text	Sets the display text
wrapStyleWord	Sends word to next line in case lineWrap is true and it results in breaking of a word, when lines are wrapped.

Method	Description
append()	Adds data at the end. <code><textarea-name>.append(String str);</code>
getText()	Retrieves the text in typed in jTextArea. <code>String str = <textarea-name>.getText();</code>
isEditable()	Returns true if the component is editable else returns false. <code>boolean b = <textarea-name>.isEditable();</code>
isEnabled()	Returns true if the component is enabled, else returns false. <code>boolean b = <textarea-name>.isEnabled();</code>
setText()	Changes the display text at runtime. <code><textarea-name>.setText(String t);</code>

Figure 3.8 Properties and Methods of the jTextArea

Let us try and recollect the name of the component which can be used to enter confidential input like passwords which are single line. That's right the component is jPassword. We can suppress the display of input as this component allows us to input confidential information like passwords. Each character entered can be replaced by an echo character. By default, the echo character is the asterisk, *. The properties of jPassword are summarized below:





Property	Description
background	Sets the background color.
font	Sets the font.
foreground	Sets the foreground color.
text	Sets the display text
echoChar	Sets the character that will be displayed instead of text.

Figure 3.9 Properties of jPassword

Well we used radio buttons when we wanted to provide the user several choices and allowed him to select one of the choices (the radio buttons belong to a group allowing the user to select single option). But radio buttons occupy a lot of space. Thus, in case of too many options we used Combo boxes as they help save space and are less cumbersome to design as compared to radio button. We used check box and list when we wanted to display multiple options like selecting favourite sports or ordering multiple food items in a restaurant. The list is a preferred option over check box in situations wherever multiple options are required to be selected from a large number of known set of options as they help save space and are less cumbersome to design as compared to check boxes. The properties and methods of jRadioButton are summarized below:

Property	Description
background	Sets the background color.
buttonGroup	Specifies the name of the group of button to which the jRadioButton belongs.
enabled	Contains enabled state of component -true if enabled else false.
font	Sets the font.
foreground	Sets the foreground color.
label	Sets the display text.
text	Sets the display text.
Selected	Sets the button as selected, if set to true, default is false.





Method	Description
getText()	Retrieves the text displayed by radio button. <code>String str = <radiobutton-name>.getText();</code>
isSelected()	Returns true if the component is checked else returns false. <code>boolean b = <radiobutton-name>.isSelected();</code>
setText()	Changes the display text at runtime. <code><radiobutton-name>.setText(String t);</code>
setSelected()	Checks(true) or unchecks the radio button. <code><radiobutton-name>. setSelected(boolean b);</code>

Figure 3.10 Properties and methods of the jRadioButton

jCheckBox is a small box like component that is either marked or unmarked. When you click on it, it changes from checked to unchecked or vice versa automatically. The properties and methods of jCheckBox are summarized below:

Property	Description
background	Sets the background color.
buttonGroup	Specifies the name of the group of button to which the jCheckBox belongs.
font	Sets the font.
foreground	Sets the foreground color.
label	Sets the display text.
text	Sets the display text
selected	Sets the check box as selected if set to true, default is false.





Method	Description
getText()	Retrieves the text typed in <code>String str = <checkbox-name>.getText();</code>
isSelected()	Returns true if the component is checked else returns false. <code>boolean b = <checkbox-name>.isSelected();</code>
setText()	Changes the display text at runtime. <code><checkbox-name>.setText(String t);</code>
setSelected()	Checks(true) or unchecks the checkbox. <code><checkbox-name>.setSelected(boolean b);</code>

Figure 3.11 Properties and methods of the jCheckBox

jComboBox is like a drop down box - you can click a drop-down arrow and select an option from a list whereas jList provides a scrollable set of items from which one or more may be selected. The properties and methods of jComboBox and jList are summarized below:

Property	Description
background	Sets the background color.
buttongroup	Specifies the name of the group of button to which the jComboBox belongs.
editable	If set true user can edit ComboBox. Default is true.
enabled	Contains enabled state of component- True if enabled else false.
font	Sets the font.
foreground	Sets the foreground color.
model	Contains the values to be displayed in the combobox.
text	Sets the display text
selectedIndex	Sets the index number of the element which should be selected by default.
selectedItem	Sets the selected item in the combobox. selectedItem and selectedIndex are in synchronization with each other.





Method	Description
getSelectedItem()	Retrieves the selected item. <code>Object result = <combobox-name>.getSelectedItem();</code>
getSelectedIndex()	Retrieves the index of the selected item. <code>int result = <combobox-name>.getSelectedIndex();</code>
setModel()	Sets the data model that the combo box uses to get its list of elements. <code><combobox-name>.setModel (ComboBoxModel aModel);</code>

Figure 3.12 Properties and methods of the jComboBox

Property	Description
background	Sets the background color.
enabled	Contains enabled state of component- true if enabled else false.
font	Sets the font.
foreground	Sets the foreground color.
model	Contains the values to be displayed in the list.
selectedIndex	Contains the index value of selected option of the control.
selectionMode	Describes the mode for selecting values. - SINGLE (List box allows single selection only) - SINGLE_INTERVAL (List box allows single continuous selection of options using shift key of keyboard) - MULTIPLE_INTERVAL (List box allows multiple selections of options using ctrl key of keyboard)





Method	Description
getSelectedValue()	Returns the selected value when only a single item is selected, if multiple items are selected then returns first selected value. Returns null in case no item selected <pre>Object result= <list-name>.getSelectedValue();</pre>
isSelectedIndex()	Returns true if specified index is selected. <pre>boolean b = <list-name>.isSelectedIndex(int index);</pre>

Figure 3.13 Properties and methods of the jList

We used JOptionPane when we wanted to request information from the user, display information to the user or a combination of both. It required an import statement at the top of the program. Well can you recollect the import statement? That's right it is:

```
import javax.swing.JOptionPane;
```

OR

```
import javax.swing.*;
```

Either of them is acceptable. The difference is that the latter will import the entire library as denoted by the star whereas the first statement will just import the JOptionPane library.

Method	Description
showMessageDialog()	Shows a one-button, modal dialog box that gives the user some information. Example : <pre>JOptionPane.showMessageDialog(this,"Java and NetBeans");</pre>





showConfirmDialog()	Shows a three-button modal dialog that asks the user a question. User can respond by pressing any of the suitable buttons. Example: <code>Confirm=</code> <code>JOptionPane.showConfirmDialog(null, "quit?")</code>
showInputDialog()	Shows a modal dialog that prompts the user for input. It prompts the user with a text box in which the user can enter the relevant input. Example : <code>name=</code> <code>JOptionPane.showInputDialog(this, "Name:") ;</code>

Figure 3.14 Properties and methods of the JOptionPane

Variables

Let us try and recollect why the need for variables arose. Well, we used variables when we required containers to store the values for some input, intermediate result or the final result of an operation. The characteristics of a variable are:

- It has a name.
- It is capable of storing values.
- It provides temporary storage.
- It is capable of changing its value during program execution.

Variables help us to hold value for some input coming from the user or to hold intermediate result of some calculation or the final result of an operation. In other words, variables are like containers that can be used to store whatever values are needed for a specific computation. However, as different materials require different containers, and so we used different data types to hold different values.





Java programming language requires that all variables must first be declared before they can be used.

When programming, we store the variables in our computer's memory, but the computer has to know what kind of data we want to store in them, since it is not going to occupy the same amount of memory to store a simple number or to store a single letter or a large number, and they are not going to be interpreted the same way so variables were used along with datatypes. The data types supported by java are summarized as follows:

Data type states the way the values of that type are stored, the operations that can be done on that type, and the range for that type.

Numeric Data Types :

These data types are used to store integer values only i.e. whole numbers only. The storage size and range is listed below :

Name	Size	Range	Example
byte	1 byte(8 bits)	-128 to 127(- 2^7 to +(2 7 -1))	byte rollno;
short	2 bytes(16 bits)	-32768 to 32767(- 2^{15} to +(2 15 -1))	short rate;
int	4 bytes(32 bits)	- 2^{31} to +(2 31 -1)	int num1;
long	8 bytes (64 bits)	- 2^{63} to +(2 63 -1)	long amount;

Figure 3.15 Storage size and range of numeric data types

Floating Data Types:

These data types are used to store numbers having decimal points i.e. they can store numbers having fractional values.

Name	Description	Size	Range	Example
float	Single precision floating point	4 bytes (32 bits)	(3.4×10^{-38}) to +(3.4x10 38)	float average;
double	Double precision floating point	8 bytes (64 bits)	(1.8×10^{-308}) to +(1.8x10 308)	double principal;

Figure 3.16 Storage size and range of floating data types





The decision about which numeric data type to use should be based on the range of values that a variable can take.

Character Data Types:

These data types are used to store characters. Character data types can store any type of values - numbers, characters and special characters. When we want to store a single character, we use char data type and when we want to store a group of characters we use string data type. For example to store grades (A, B, C, D, E) of a student we will use char type but to store name of a student, we will use string type. The char data type value is always enclosed inside '' (single quotes), whereas a string data type value is enclosed in "" (double quotes).

Operators are symbols that manipulate, combine or compare variables.

Operators

With the introduction of variables and constants there arose a need to perform certain operations on them. We performed operations on variables and constants using operators. The operators available in java are summarized below:

Assignment Operator :

One of the most common operator is the assignment operator "=" which is used to assign a value to a variable. We assign the value given on the right hand side to the variable specified on the left hand side. The value on the right hand side can be a number or an arithmetic expression. For example:

```
int sum = 0;  
int prime = 4*5;
```

Arithmetic Operators :

These operators perform addition, subtraction, multiplication, and division. These symbols are similar to mathematical symbols. The only symbol that is different is "%", which divides one operand by another and returns the remainder as its result.

```
+ additive operator  
- subtraction operator
```





* multiplication operator

/ division operator

% remainder operator

Relational Operator :

A relational operator is used to test for some kind of relation between two entities. A mathematical expression created using a relational operator forms a relational expression or a condition. The following table lists the various relational operators and their usage:

Operator	Meaning	Usage
==	equal to	Tests whether two values are equal.
!=	not equal to	Tests whether two values are unequal.
>	greater than	Tests if the value of the left expression is greater than that of the right.
<	less than	Tests if the value of the left expression is less than that of the right.
>=	greater than or equal to	Tests if the value of the left expression is greater than or equal to that of the right.
<=	less than or equal to	Tests if the value of the left expression is less than or equal to that of the right.

Figure 3.17 Relational Operators

Logical Operator :

A logical operator denotes a logical operation. Logical operators and relational operators are used together to form a complex condition. Logical operators are:

Operator	Use	Meaning
&&	a>10 && b<8	a and b are both true
	a>10 b<8	Either a or b is true
!	! a	a is false

Figure 3.18 Logical Operators





Unary Operators :

The unary operators perform different kind of operations on a single operand .The operations performed are increasing/decreasing a value, negating a value/ expression, or inverting a boolean value.

Symbol	Name of the Operator	Operation	Example
+	Unary plus operator	indicates positive value	<code>num = +1;</code>
-	Unary minus operator	negates an expression	<code>num = - num;</code>
++	Increment operator	increments a value by 1	<code>num = ++ num;</code>
--	Decrement operator	decrements a value by 1	<code>num = -- num;</code>

Figure 3.19 Unary Operators

Increment/Decrement Operators :

The increment/decrement (++,--) operators can be a prefix or a postfix. In a pre increment/decrement expression (++ x or -- x), an operator is applied before an operand while in a post increment/decrement expression (x++ or x --) an operator is applied after an operand. In both conditions 1 is added to the value of the variable and the result is stored back to the variable. However, in a prefix expression, value is incremented first then this new value is restored back to the variable. In postfix expression the current value is assigned to a variable then it is incremented by 1 and restored back to the original variable.

Let us now try and recollect the conversion methods that we have used in java. When a Java program receives input data from a user, it must often convert it from one form (e.g., String) into another (e.g., double or int) for processing.

Conversion methods

- To convert a string value to a number (For example, to convert the String value in a text field(jTextField1) to an int, long, float or double), we can use parse methods. Assume the following declarations:

```
String num1=jTextField1.getText();
int sum; long product;
float amount; double simple_int;
```





Type	Example statement
int	sum=Integer.parseInt(num1);
int	sum=Integer.parseInt(jTextField1.getText());
long	product=Long.parseLong(num1);
long	product=Long.parseLong(jTextField1.getText());
float	amount=Float.parseFloat(num1);
float	amount=Float.parseFloat(jTextField1.getText());
double	simple_int=Double.parseDouble(num1); OR simple_int=Double.parseDouble(jTextField1.getText());

Figure 3.20 Usage of Parse Methods

- To convert a number to string we used `valueOf` method. Assume the following code:

```

int i      = 100;
float f   = (float) 200.0;
double d = 400.0;
long l    = 100000;
string str1 = String.valueOf(i);
string str2 = String.valueOf(f);
string str3 = String.valueOf(d);
string str4 = String.valueOf(l);
jTextField1.setText("Values of int, float, double and long
are "+str1+", "+str2+", "+str3+" and "+str4);

```

Figure 3.21 Usage of `valueOf` Method



- To convert a number to string, we also used `toString` method. Assume the following code :

```
int i      = 100;
float f   = (float) 200.0;
double d = 400.0;
long l    = 100000;
String str1 = Integer.toString(i);
String str2 = Float.toString(f);
String str3 = Double.toString(d);
String str4 = Long.toString(l);
jTextField1.setText("Values of int, float, double and long
are "+str1+", "+str2+", "+str3+" and "+str4);
```

Figure 3.22 Usage of `toString` Method

- To convert a number to string, we also used concatenation operator(+). If either operand of a concatenation is a string, the other operand is converted to string. Assume the following code :

```
int sum = 103;
String convertsum;
convertsum = "" + sum;
// Converts int 103 to String "103"
convertsum = sum + " is a number";
// Assigns "103 is a number" to convertsum.
convertsum = "" + 10.9;
// Assigns "10.9" to convertsum
convertsum = "" + 10.0/3.0;
// Assigns "3.333333333333333" to convertsum
```

Figure 3.23 Concatenation operator





Control Structures

We used control structures when we wanted to control the flow of the program. We learnt two types of control structures in class XI namely, Selection statements and Iteration statements.

Control structures allow us to control the flow of our program's execution. If left unchecked by control-flow statements, a program's logic will flow through statements from top to bottom. We can have some control on the flow of a program by using operators to regulate precedence of operations, but control structures provide the power to change statement order and govern the flow of control in a program.

Selection Statements:

A selection statement selects among a set of statements depending on the value of a controlling expression. The selection statements are the if statement and the switch statement, which are discussed below:

Simple if Statement - The if statement allows selection (decision making) depending upon the outcome of a condition. If the condition evaluates to true then the statement immediately following if will be executed and otherwise if the condition evaluates to false then the statements following the else clause will be executed. The selection statements are also called conditional statements or decision statements.

The syntax of if statement is as shown below:

Syntax:

```
if (conditional expression)
{
    Statement Block;
}
else
{
    Statement Block;
}
```





Points to remember about if statement :

- The conditional expression is always enclosed in parenthesis.
- The conditional expression may be a simple expression or a compound expression.
- Each statement block may have a single or multiple statements to be executed. In case there is a single statement to be executed then it is not mandatory to enclose it in curly braces ({}) but if there are multiple statements then they must be enclosed in curly braces ({}).
- The else clause is optional and needs to be included only when some action is to be taken if the test condition evaluates to false.

Nested if . . . else - These control structures are used to test for multiple conditions as against the simple if statement which can be used to test a single condition. The syntax of nested if else is as follows:

Syntax:

```
if (conditional expression1)
{
    statements1;
}
else if (conditional expression2)
{
    statements2;
}
else if (conditional expression3)
{
    statements3;
}
else
{
    statements4;
}
```





Now let us design a form as shown in figure 3.24

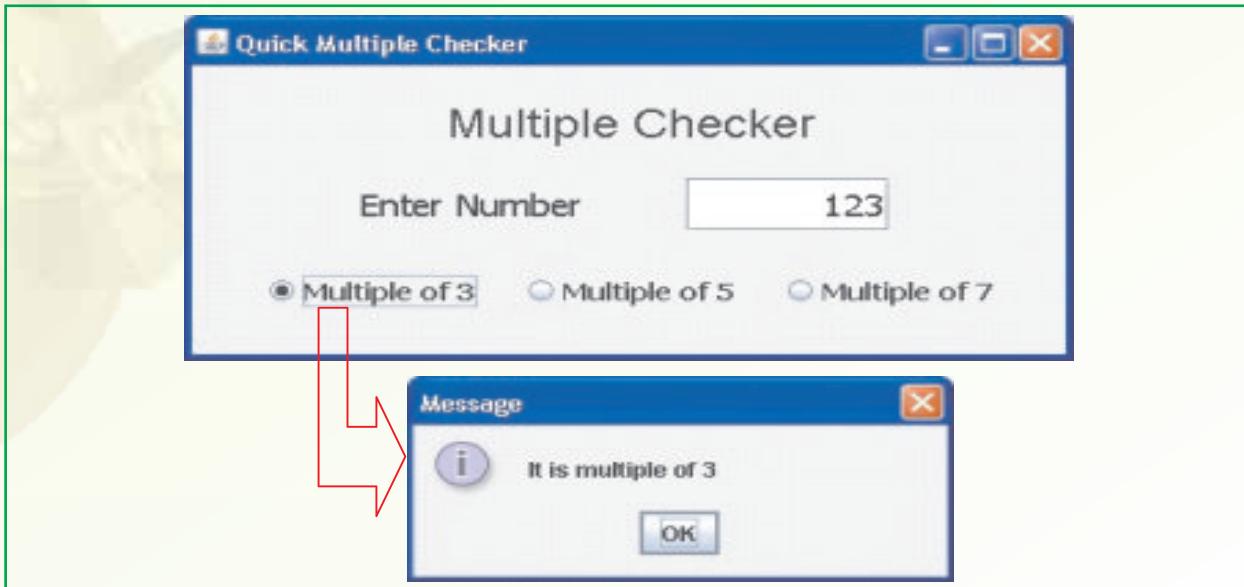


Figure 3.24 To check whether the given number is a multiple of 3,5 or 7

Follow the steps enumerated below to design the form:

1. Add a new JFrame Form and change its title property to Quick Multiple Checker.
2. Add a label set its Text as Enter Number
3. Add a jTextField and set its initial Text as ""
4. Add three radio buttons on the form - Set the text of each of them as "Multiple of 3", "Multiple of 5" and "Multiple of 7". Group the radio buttons so that only one can be selected.

In this application we ask the user to enter a number and then the user will select one of the radio buttons and depending upon the button selected the multiple check for that number will be performed. Let us now write the code for the above mentioned application. Code to check for multiple of 3 is given. Try and write the code to perform a similar check for multiple of 5 and multiple of 7.





```
private void  
jRadioButton1ActionPerformed(java.awt.event.ActionEvent evt)  
{  
    double Number=Double.parseDouble(jTextField1.getText());  
    if (Number%3==0)  
        JOptionPane.showMessageDialog(this,"It is multiple of 3");  
    else  
        JOptionPane.showMessageDialog  
            (this,"It is NOT multiple of 3");  
}
```

Figure 3.25 Code for Multiple Checker

Let us now understand this code in detail.

`Double.parseDouble(jTextField1.getText())`

- retrieves the value entered by the user in the text field using `getText()`. This value by default is treated as a string and not as a number so it needs to be converted to a double type and this is achieved using the `parseDouble()` method. The value is then stored in the variable `Number`.

`if (Number%3==0)`

- check whether the number when divided by 3 gives 0 as the remainder. If the remainder is zero then the number is divisible by 3 else it is not.

Switch Statement - This selection statement allows us to test the value of an expression with a series of character or integer values. On finding a matching value the control jumps to the statement pertaining to that value and the statement is executed, till the break statement is encountered or the end of switch is reached. The expression must either evaluate to an integer value or a character value. It cannot be a string or a real number. The syntax of the switch statement is as follows:





```

switch (Variable/Expression)
{
    case Value1: statements1 ;
        break ;

    case Value2: statements2 ;
        break ;

    .
    .

    default: statements3 ;
}

```

Comparing Switch and If..else Statements - Switch is used to select sections of code depending on specific integer or character values. If we are handling specific coded values (eg, the number of the button that was clicked in a JOptionPane), or processing characters (whose codes are treated like numbers), then switch is useful. The limitations of switch are as follows:

- It doesn't allow ranges, eg case 90-100.
- It requires either integers or characters and doesn't allow useful types like String.

```

String comment; // The generated result.

int choice = Integer.parseInt(jTextField.getText());
                //Enter 0, 1, or 2.

switch (choice)
{
    case 0: comment = "You look so much better than usual.";
        break;

    case 1: comment = "Your work is up to its usual standards.";
        break;
}

```





```
case 2: comment =  
    "You're quite competent for so little experience.";  
  
    break;  
  
default: comment =  
    "Oops -- something is wrong with this code.";  
  
}
```

Equivalent if statement

```
String comment; // The generated result.  
  
int choice= Integer.parseInt(jTextField.getText());  
//Enter is 0, 1, or 2.  
  
if (choice == 0)  
    comment = "You look so much better than usual.";  
  
else if (choice == 1)  
    comment = "Your work is up to its usual standards.";  
  
else if (choice == 2)  
    comment="You're quite competent for so little experience";  
  
else  
  
    comment = "Oops -- something is wrong with this code.";
```

A switch statement can often be rewritten as an if statement. Let us look at the example given above, when a selection is to be made based on a single value, the switch statement is generally easier to read. The switch is useful when you need to manage a lot of **if /else if / else**. It has a shorter syntax and is more appropriate in this case.

Let us now design an application in which we will calculate the selling price depending upon the profit percent selected by the user. Design the application as shown in figure 3.26. Set the relevant properties of the components.



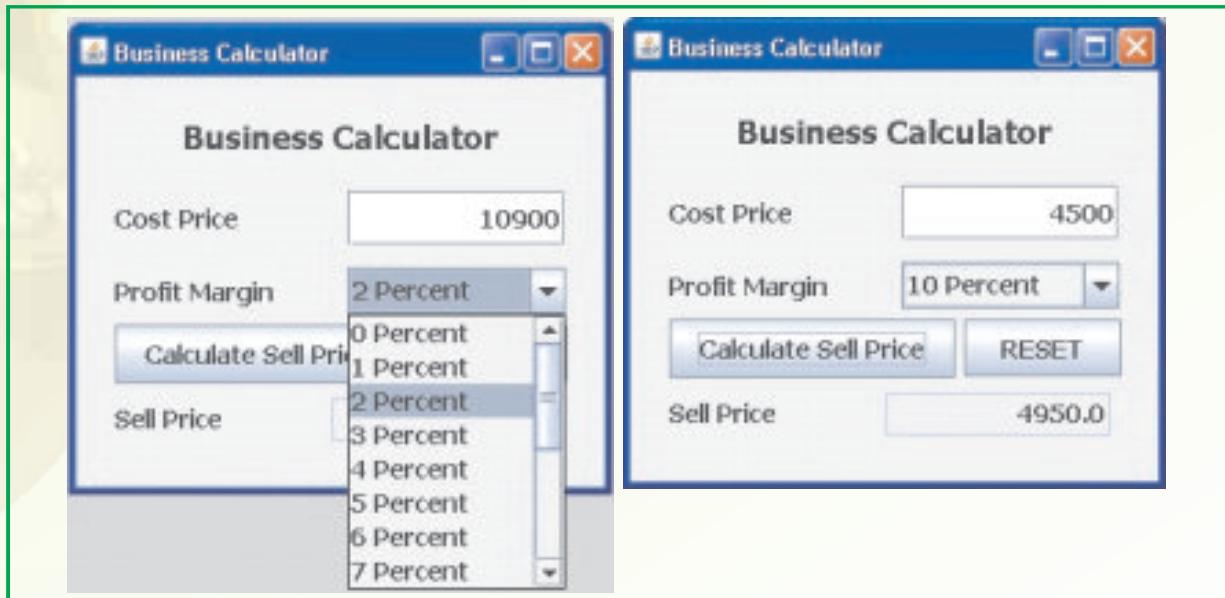


Figure 3.26 To calculate selling price depending upon profit margin

In this application depending upon the profit percent selected by the user we will calculate the selling price .Let us now write the code.

```
//Business Calculator

private void
jButton1ActionPerformed(java.awt.event.ActionEvent evt)
{
    double CP,Profit=0,SP;
    CP=Double.parseDouble(jTextField1.getText());
    Profit=jComboBox1.getSelectedIndex();
    SP=CP+CP* (Profit/100);
    jTextField2.setText(Double.toString(SP));
}
```





```
private void  
jButton2ActionPerformed(java.awt.event.ActionEvent evt)  
{  
    jTextField1.setText("");  
    jComboBox1.setSelectedIndex(0);  
    jTextField2.setText("");  
}
```

Figure 3.27 Code to calculate selling price

Let us now understand the code in detail.

Double.parseDouble(jTextField1.getText())

- retrieves the value entered by the user in the text field using `getText()`. This value by default is treated as a string and not as a number so it needs to be converted to a double type and this is achieved using the `parseDouble()` method. The value is then stored in the variable CP.

jComboBox.getSelectedIndex()

- retrieves the index of the selected item so if the user selects 1st item profit is 0 and if the user selects 3rd, item profit is 2. This value is saved in a variable profit.

SP=CP+CP* (Profit/100)

- Formula to calculate selling Price.

jTextField2.setText(Double.toString(SP))

- The variable SP is a numeric value so it is converted to a string using the `toString()` method and then the value is displayed in the text field using the `setText()` method.

In the above application the profit margin is obtained from the Index value of the selected item of the combo box but what happens if the values in the combobox are as shown in the figure 3.28.



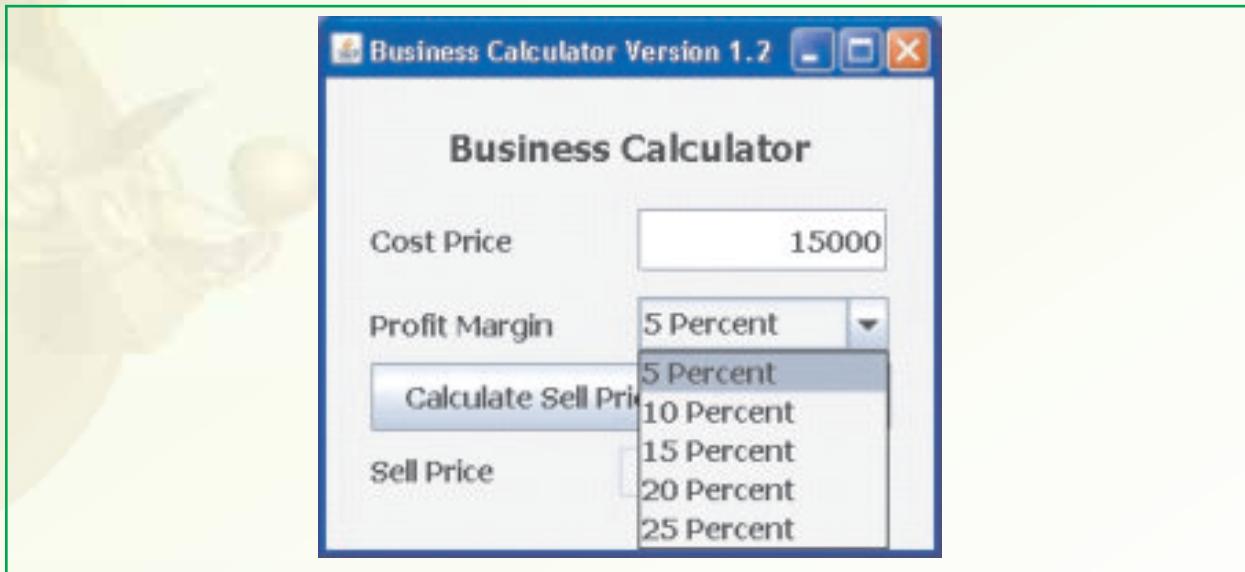


Figure 3.28 Business Calculator version 1.2

We will use switch case to write the code. Only the code using switch case is given below but it is recommended that you think and try writing the code on your own.

```
private void
jButton1ActionPerformed(java.awt.event.ActionEvent evt)
{
    double CP,Profit=0,SP;
    CP=Double.parseDouble(jTextField1.getText());
    switch (jComboBox1.getSelectedIndex())
    {
        case 0:Profit=5;break;//if first item selected profit is 5
        case 1:Profit=10;break;//if second item selected profit is 10
        case 2:Profit=15;break;
        case 3:Profit=20;break;
        case 4:Profit=25;break;
        default:Profit=0;break;
    }
}
```

Figure 3.29 Code for Business Calculator version 1.2





Iteration Statements :

These statements are used to perform a set of instructions repeatedly while the condition is true. Iteration statements are also called looping statements.

for loop - The loop has four different elements that have different purposes. These elements are:

- a) **Initialization expression:** Before entering in a loop, its variables must be initialized.
- b) **Test Expression:** The test expression decides whether the loop body will be executed or not. If the test condition is true, the loop body gets executed otherwise the loop is terminated.
- c) **Increment/Decrement Expression:** The Increment/Decrement expression changes the value of the loop variable.
- d) **The Body of the loop:** The statements, which are executed repeatedly while the test expression evaluates to true form the body of the loop.

The syntax of the for loop is:

Syntax

```
for( initialization; test exp; increment/decrement exp)
{
    statements;
}
```

The three expressions inside the round braces of for loop are optional. Using this fact an infinite loop can be created as follows:

```
for (int I = 1 ;I <= 5 ;I++)
{
    jTextArea1.setText (jTextArea1.getText()+I);
    //It will display 12345 in jTextArea1
}
```





While Loop - The while loop is an entry-controlled loop. It means that the loop condition is tested before executing the loop body. If the loop condition is initially false, for the first iteration, then loop may not execute even once. The main characteristic of the while loop is that it can be used in both cases i.e. when the number of iterations is known as well as when it is unknown. The syntax of the while loop is as follows:

Syntax

```
while (test expression)
{
    loop body
}
```

Remember that in while loop, a loop control variable should be initialized before the loop begins and the loop variable should be updated inside the body of the while loop (else it will become an endless loop).

Do..While Loop - Do..While loop is an exit-controlled loop. In the do..while loop, the test occurs at the end of the loop. This ensures that the do..while loop executes the statements included in the loop body at least once. After the first execution of the statement, it evaluates the test expression. If the expression evaluates to true, then it executes the statements of the loop body again. Like if and while statements, the condition being checked must be included between parenthesis. The while statement must end with a semicolon. The syntax of the loop is as follows:

Syntax

```
do
{
    loop body
}
while (test expression);
```





Comparing Do...While and While - The difference between do-while and while is that do-while evaluates its expression at the end of the loop instead of at the beginning. Therefore, the statements within the do block are always executed at least once. Do-while is an exit controlled loop and while is an entry controlled loop.

```
int ctr;  
  
ctr=0;  
  
while (ctr < 5) // Test and Loop  
{  
    JOptionPane.showMessageDialog(this,ctr);  
    // Display Number  
  
    ctr = ctr + 1;  
    // Increment LoopCounter  
}
```

The same code is written using do while. In do while counter is checked at the end of loop body, therefore loop body is executed at least once.

```
int ctr = 0;  
  
do // Loop Begins  
{  
    JOptionPane.showMessageDialog(this,ctr);  
    // Display Number  
  
    ctr = ctr + 1;  
    // Increment LoopCounter  
}  
  
while (ctr<5); // Testing the value of counter
```





Let us now develop a few applications which will help us to strengthen our programming concepts learnt in class XI.

Let us now design an application in which we will generate the series and its sum. Design the application as shown in figure 3.30. Set the relevant properties of the components.

Series and its Sum

$1+2+3+4$

$2+4+6+8+10$

$2+7+12+17+22$

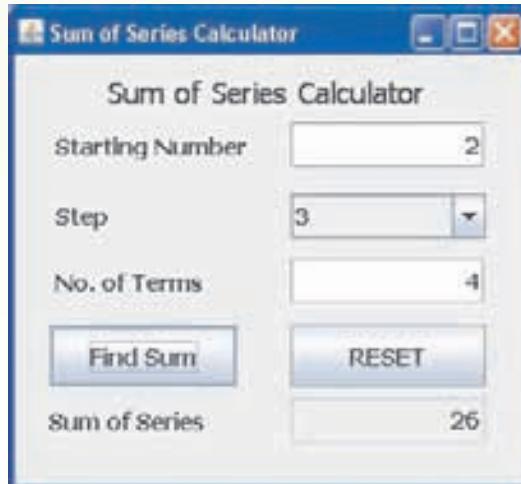


Figure 3.30 Sum of Series Calculator

Let us now write the code as follows:

```
private void
jButton1ActionPerformed(java.awt.event.ActionEvent evt)
{
    int Start, Step, Terms, Sum=0;
    Start=Integer.parseInt(jTextField1.getText());
    //Start point of series
```





```
Step =jComboBox1.getSelectedIndex()+1;  
          //step in the series  
  
Terms=Integer.parseInt(jTextField2.getText());  
          // no of terms  
  
for (int I=1;I<=Terms;I++)  
{  
    Sum+=Start;  
    Start+=Step;  
}  
  
jTextField3.setText(Integer.toString(Sum));  
}  
  
private void  
jButton2ActionPerformed(java.awt.event.ActionEvent evt)  
{  
    jTextField1.setText("");  
    jTextField2.setText("");  
    jTextField3.setText("");  
    //Index -1 indicates no selection  
    jComboBox1.setSelectedIndex(-1);  
}
```

Figure 3.31 Code to generate the series and the Sum of Series

Let us now understand the code in detail.

`Integer.parseInt(jTextField1.getText())`

- retrieves the value entered by the user in the text field using `getText()`. This value by default is treated as a string and not as a number so it needs to be converted to an integer type and this is achieved using the `parseInt()` method. The value is then stored in the variable Start.





```
jComboBox.getSelectedIndex() +1
```

- retrieves the index of the selected item so if the user selects 1st item as Step then 1 is added to the index value of the 1st item. This value is saved in a variable Step.

```
Integer.parseInt(jTextField1.getText())
```

- retrieves the value entered by the user in the text field using getText(). This value by default is treated as a string and not as a number so it needs to be converted to an integer type and this is achieved using the parseInt() method. The value is then stored in the variable Terms.

Now we have the value from where the user wants to start the series, the terms in the series and the step between numbers of the series.

```
for (int I=1;I<=Terms;I++)
{
    Sum+=Start;
    Start+=Step;
}
jTextField3.setText(Integer.toString(Sum));
```

- the for loop is executed as many times as the Terms and the Step is added to Start which in turn is added to Sum and finally the Sum of the numbers is displayed.

```
jTextField1.setText("");
jTextField2.setText("");
jTextField3.setText("");
jComboBox1.setSelectedIndex(-1);
```

- On clicking the reset button all the three textfields are set to "" and the setSelectedIndex value of combobox is set to -1. Index -1 indicates that no item is selected.





Let us now develop an application to reverse the given number and also find out whether the number is a palindrome or not.(The pattern that we found in the phrases was that each line had a palindrome hidden in it.)

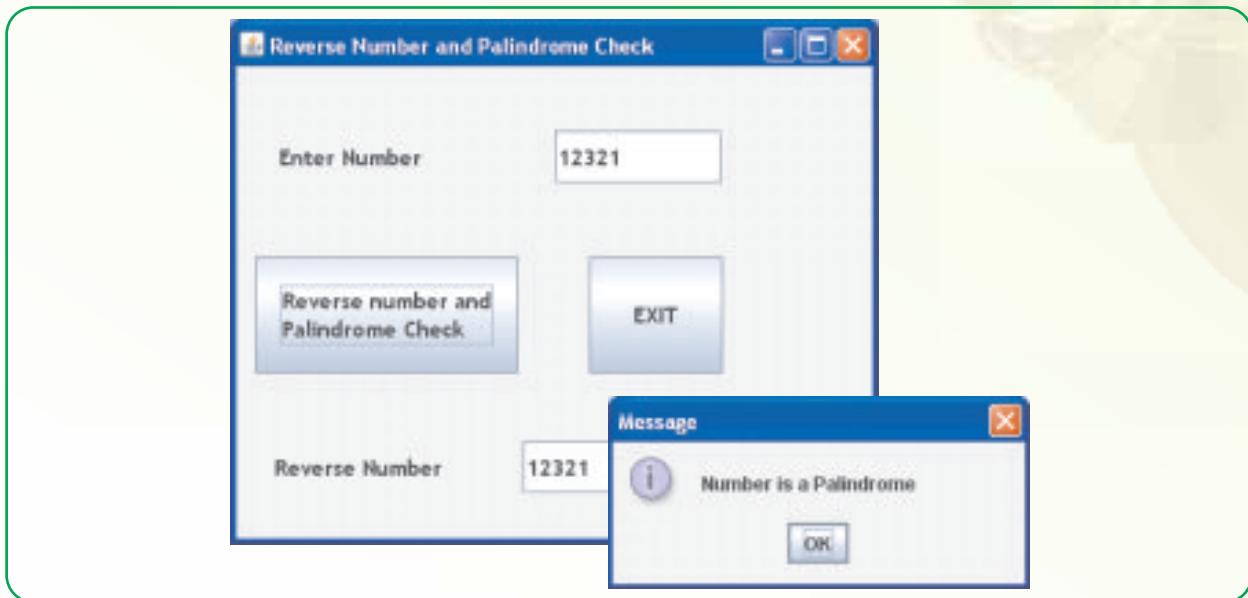


Figure 3.32 Reverse Number and Palindrome Check

Let us now write the code for reversing a given number and check whether the given number is a palindrome or not.

```
//Reverse Number Program with Palindrome Check  
  
private void  
jButton1ActionPerformed(java.awt.event.ActionEvent evt)  
{  
  
    long Number,Temp,RevNumber=0;  
  
    Number=Long.parseLong(jTextField1.getText());  
  
    Temp=Number;
```





```

while (Temp>0) // till temp > 0 continue to perform the loop

{
    RevNumber=(RevNumber*10)+(Temp%10);

    // RevNumber is multiplied by 10 and added to the
    // remainder of temp divided by 100

    Temp=Temp/10;

}

jTextField2.setText(Long.toString(RevNumber));

if (Number==RevNumber)

    JOptionPane.showMessageDialog

        (this,"Number is Palindrome");

else

    JOptionPane.showMessageDialog

        (this,"Number is not a Palindrome");

}

private void
jButton2ActionPerformed(java.awt.event.ActionEvent evt)

{
    jTextField1.setText("");
    jTextField2.setText("");
}

```

Figure 3.33 Code for Reverse Number and Palindrome Check





Let us now understand the code in detail :

```
Long.parseLong(jTextField1.getText())
```

- retrieves the value entered by the user in the text field using getText(). This value by default is treated as a string and not as a number so it needs to be converted to long type and this is achieved using the parseLong() method. The value is then stored in the variable Number.

```
Temp=Number
```

- the number is stored in another variable temp.

```
while (Temp>0)
```

```
{
```

```
    RevNumber= (RevNumber*10)+(Temp%10) ;
```

```
    Temp=Temp/10;
```

```
}
```

- while loop will continue as long as temp is greater than zero. In this loop we divide temp by 10 and obtain the remainder. The remainder is then added to the value in the variable RevNumber multiplied by 10. Initially RevNumber=0. The value of variable temp is divided by 10 every time the loop is executed. The loop is executed as long as temp is greater than 0.

```
if (Number==RevNumber)
```

```
    JOptionPane.showMessageDialog
```

```
        (this,"Number is Palindrome") ;
```

```
else
```

```
    JOptionPane.showMessageDialog
```

```
        (this,"Number is not Palindrome") ;
```

- If the reverse of the number, which is stored in variable RevNumber and the number entered by the user which is stored in Number are the same then the number is a palindrome otherwise it is not a palindrome.





We have revised the concepts learnt in class XI. Now in the next few chapters we will enhance our knowledge of NetBeans and delve further into programming concepts.

Summary

- NetBeans is an IDE using which we can develop GUI applications in Java.
- NetBeans provides various components used to create a GUI front-end interface.
- GUI components' appearance and behaviour is controlled by their properties and methods.
- We should use meaningful names for controls on the form and variables in the code. It makes programming convenient.
- Some useful Data Types supported in Java are: int, double, char and boolean.
- String is an Object (reference) type supported in Java.
- A variable must be declared before it can be used.
- Different types of operators are available in Java. Operators are used to perform various operations on data.
- Control Statements available in java are: if..else, switch..case, for, while, do..while.

EXERCISES

MULTIPLE CHOICE QUESTIONS

1. What will be the output of the program given below. Which number is printed twice?

```
int sum1 = 3;  
  
sum1++;  
  
jTextField1.setText(""+sum1);  
  
++sum1;  
  
jTextField2.setText(""+sum1);  
  
jTextField3.setText(""+(++sum1));
```





```
jTextField4.setText(""+sum1++);
```

```
jTextField5.setText(""+sum1);
```

- | | |
|------|------|
| a. 5 | b. 6 |
| c. 4 | d. 7 |

2. Consider the following code snippet :

```
int aNumber=1
```

```
if (anumber >=10) {  
    if (anumber == 10)  
        jLabel1.setText("first string");  
    else jLabel1.setText("second string");  
    jLabel2.setText("third string");
```

What will be the output when a number=14

- | | |
|-----------------|------------------|
| a. first string | b. second string |
| c. first string | d. second string |
| third string | third string |

3. What value for X above will print EXACTLY 20 lines to standard output :

```
int count = 0
```

```
while(count++ < x) {
```

```
jTextField1.setText("Line " + count);
```

}

4. What will be the value of total after the loop finishes execution.





```
int total = 0; // must be initialized before the for (int count =
5; count <=10; count++ )
```

{

```
total += count;
```

}

```
jTextField1.setText("The total is " + total);
```

- | | |
|-------|-------|
| a. 10 | b. 16 |
| c. 45 | d. 36 |

5. What's wrong with the while statement?

```
while( (ctr < 5) && (ctr > 30))
```

- a the logical operator && cannot be used in a test condition.
- b the while loop is an exit-condition loop.
- c the test condition is always false.
- d the test condition is always true.

6. If there is more than one statement in the block of a for loop, which of the following must be placed at the beginning and the ending of the loop block?

- | | |
|------------------|--------------------------|
| a parentheses () | b French curly braces {} |
| c brackets [] | d arrows < > |

7. Given the following information:

```
int a = 11;
```

```
int b = 22;
```

```
int c = 33;
```

```
int d = 11;
```

Which of the following statements are true :





- i) $a == b$ ii) $b != d$ iii) $c <= b$
iv) $a < c$ v) $a == d$ vi) $c > a$
vii) $a >= c$
- a i), iv) & vii)
c ii), iv), vi) & vii)
- b ii), iv), v) & vi)
d iii), v), vi) & vii)
8. The statement `i++;` is equivalent to
a `i = i + i;` b `i = i + 1;`
c `i = i - 1;` d `i -- ;`

ANSWER THE FOLLOWING QUESTIONS

1. Explain the following terms:
 - a) IDE
 - b) Inspector Window
 - c) Form
2. Differentiate between:
 - a) TextField and TextArea
 - b) ComboBox and ListBox
 - c) `getText()` and `setText()`
3. What is the significance of the following properties in TextArea?
`LineWrap` `WrapStyleWord`
4. What are list type controls used for?
5. How would you determine whether a combo box is editable or not?
6. List different selection modes of a list.
7. What is a button group? Which control is generally used with a buttongroup.
8. Write and explain two methods each of check box and radio button.





LAB EXERCISES

- Design a GUI application in which the user enters a number in the text field and on clicking the button the sum of the digits of the number should be displayed in a label.

Hint : Suppose user enters 123 the output should be 6(1+2+3).

- Design a GUI application to accept a String from the user in a text field and print using option pane whether it is a palindrome or not.

Hint ABBA is a palindrome.

- Design a GUI application to accept the cost price and selling price form the user in two text fields then calculate the profit or loss incurred.
- Design a GUI application to accept a character in a text field and print in a label if that character is a vowel: a, e, i, o, or u. The application should be case sensitive.
- Design a GUI application that repeatedly accepts numbers in a option pane and once the typed number is 0 the maximum and minimum of all numbers typed are displayed.
- Design a GUI application in java to convert temperature from Celsius to Fahrenheit or vice versa using radio buttons and two text fields
- Design a GUI application in java to convert kilograms into grams, litres into milliliters, rupees into paisa using combobox and text fields.
- A book publishing house decided to go in for computerization. The database will be maintained at the back end but you have to design the front end for the company. You have to accept book code, Title, Author and Quantity sold from the user. The Price will be generated depending upon the book code. Net price should be calculated on the basis of the discount given.

Bookseller - 25%

School - 20%

Customer - 5%





9. A networking company decided to computerize its employee salary . Develop an application to store employee's personal data which will be saved in the back end. The front end should accept Name, Father's Name, Mother's Name, Address, Gender, Basic Salary, Medical and Conveyance. Calculate gross and net salary.

Basic	DA	HRA
>=40000	35%	37%
>=20000	25%	32%
>=10000	25%	30%

TEAM BASED TIME BOUND EXERCISE

(Team size recommended : 3 students in each team)

1. Students will visualize the details that have to be provided while creating a member registration for an e-reservation site. Each team has to design a layout for the form. The form has to be designed using NetBeans IDE. The team has to specify the following:
 - Controls that will be used to develop the application.
 - Data types of variables to be used.
 - Validations to be performed while accepting the data.
2. Students will visualize the details that have to be provided while developing a domicile certificate for a student of class XII. Each team has to design the form using NetBeans IDE. The team has to specify the following:
 - Controls that will be used to develop the application
 - Data types of variables to be used.
 - Validations to be performed while accepting the data.

