Communication Technologies - Networking Concepts and Fundamentals

Contents

1. What is a Network?

Source: Wikipedia

A computer network is a digital telecommunications network for sharing resources between nodes, which are computing devices that use a telecommunications technology.

Data transmission between nodes is supported over data links consisting of physical cable media, such as twisted pair or fibre-optic cables, or by wireless methods, such as Wi-Fi, microwave transmission, or free-space optical communication.

Source: CBSE

A network is any collection of independent computers that communicate with one another over a shared network medium. In simple terms, a computer network is a collection of two or more computers linked together for the purpose of sharing information and resources.

1.1. Need for Networking

1. Resource sharing - files and peripherals
    i. Sharing of files and software - data files
    ii. Sharing Peripherals - printers, fax systems, audio/video
    iii. Sharing storage
2. Improving Communication - powerful, fast and reliable communication medium among the users via email, instant messaging, chat rooms, telephone
3. Access to Remote database

1.2. Requirements of a Network

1. At least two computers - Server or Client workstation
2. Network Interface Cards (NIC)
3. A connection medium, usually a wire or cable, although wireless communication between networked computers and peripherals is also possible
4. Network Operating system software

1.3. Network Terminologies

1. **Nodes (Workstations)**: A computer becomes a node (also called a workstation) as soon as it is attached to a network. Each user on a network works on a workstation. If there are no nodes there would be no network.
2. **Server**: A computer that facilitates sharing of data, software and hardware resources on the network is known as the server. A network can have more than one server. Each server has a unique name by which it is identified by all the nodes on the network.
   Servers can be of two types:
   i. *Dedicated Servers*: One computer is reserved for server's job. It helps all nodes access data, software and hardware resources.
   ii. *Non Dedicated Servers*: A workstation can double up as a server.
3. **Network Interface Unit (NIU)**: A network interface unit is a device that is attached to each of the workstations and the server which helps to establish communication between the server and workstations.
   As soon as a standalone computer becomes a workstation, it needs an interface to help establish connection with the network because without this the workstations will not be able to share network resources or communicate with each other.

   The **Network Interface Card/Controller (NIC)** basically acts like an interpreter and is also known as **Terminal Access Point (TAP).** The NIC manufacturer assigns a unique physical address to each NIC known as **Media Access Control (MAC)** address.

1.4. Switching Techniques

Switching techniques are used to efficiently transmit data across the network. The two types of switching techniques are employed nowadays to provide communication between two computers on a network are: CircuitSwitching and PacketSwitching.

Circuit Switching

Circuit Switching is a technique in which a dedicated and complete physical connection is established between two nodes and through this dedicated communication channel, the nodes may communicate.

The circuit guarantees the full bandwidth of the channel and remains connected for the duration of the communication session. Even if no communication is taking place in a dedicated circuit, that channel still remains unavailable to other users (idle channels).

Packet Switching

Packer switching is a switching technique in which packets (discrete blocks of data of fixed size and of any content, type or structure) are routed between nodes over data links shared with other traffic.

The term “packets” refers to the fact that the data stream from your computer is broken up into packets of about 200 bytes (on average), which are then sent out onto the network. Each packet contains a “header” with information necessary for routing the packet from source to destination. Each packet in the data stream is independent.

The main advantage of packet-switching is that the packets from many different sources can share a line, allowing for very efficient use of the communication medium.

Packets are generally accepted onto the network on a first-come, first-served basis. If the network becomes overloaded, packets are delayed or discarded (“dropped”).

1.5. Types of Networks

A network may be a small group of interlinked computers to a change of a few hundred computers of different types. Networks vary in terms of their size and complexity.

PAN (Personal Area Network)

A Personal Area Network is a computer network organized around an individual person. Personal area networks typically involve a mobile computer, a cell phone and or a handheld computing device.

Personal are networks can be constructed with cables or be wireless. Wireless PANs typically use bluetooth or sometimes infrared connections. Bluetooth PANs generally cover a range of less than 10 meters.

LAN (Local Area Network)

In a LAN, network devices are connected over a relatively short distance. They are privately owned networks within a single building or campus, of up to a few kilometers in size.

We also have **WLAN (Wireless LAN)** which is based on wireless network.

LANs can be small, linking as few as three computers, but often link hundreds of computers used by thousands of people.

MAN (Metropolitan Area Network)

This is basically a bigger version of LAN and normally uses similar technology. It might cover few buildings in a city and might either be private or public. This is a network which spans a physical area (~ 5 to 50 km diameter) that is larger than a LAN.

MANs are usually characterized by very high-speed optical connections or other digital media and provides up-link services to wide area networks (WANs) and the internet.

WAN (Wide Area Network)

WAN spans a large geographical area, often a country or a continent and uses various commercial and private communication lines to connect computers. Typically, a WAN combines multiple LANs that are geographically separated.

This is accomplished by connecting the different LANs using services such as dedicated leased phone lines, dial-up phone lines, satellite links, fibre optic cables and data packet carrier services.

1.6. Data Communication Terminologies

Channel

A communication channel is a medium that is used in the transmission of a message from one point to another. It may refer to the entire physical medium, such as a telephone line, optical fibre, or, it may refer to one of the several carrier frequency transmitted simultaneously within the line.

Depending on the speed, we have three broad categories of communication channels - **narrow band** which is slow and used for telegraph lines and low speed terminals; **voice band** used for ordinary telephone communication and **broad band** which is fastest and is used for transmitting large volumes of data at high speed.

Bandwidth

Bandwidth refers to the range of frequencies available for transmission of data. It is expressed as the difference in Hertz(Hz) between the highest frequency and the lowest frequency.

Wider the bandwidth of a communication system, greater is the capacity and hence greater is the amount of data that can be transmitted over a period of time.

Data Transfer Rate (DTR)

DTR is the amount of data in digital form that is moved from one place to another in a given time on a network. The greater the bandwidth of a given medium, the higher is the data transfer rate. This can also be referred to as throughput, although data transfer rate applies specifically to digital data streams.

DTR is often measured in bits per second (bps) - which is a measure of how fast data is transferred from one location to another.

2. Transmission Medium

A transmission medium is one which carries a signal from one computer to another. It is also known as communication channel. It can wired or wireless. We also name them as Guided and Unguided Media respectively.

2.1. Wired Transmission Media

The wired of guided transmission media physically connects the two computers. The data signal physically gets transferred from the transmitting computer to the receiving computer through the wired transmission medium.

2.1.1. Twisted Pair Cables

This is one of the most common forms of wiring in networks, especially in LANs and it consists of two insulated wires arranged in a regular spiral pattern (double helix). It is generally used for telephone communications in offices and also in modern Ethernet networks.

Advantages:

1. It is capable of carrying a signal over long distances without amplification.
2. It is simple, low weight, easy to install and easy to maintain
3. It is an adequate and least expensive medium for low speed (up to 10 mbps) applications where the distance between the nodes is relatively small.

Disadvantages:

1. It can easily pick up noise signals.
2. Being thin in size, it is likely to break easily.
3. It is unsuitable for broadband applications.

Types of Twisted Pair Cables:

1. Shielded Twisted Pair (STP) Cable
2. Unshielded Twisted Pair (UTP) Cable

The STP cable comes with shielding of the individual pairs of wires, which further protects it from external interference and crosstalk. But STP is heavier and costlier than UTP and also requires proper grounding at both the ends.

2.1.2. Coaxial Cables

It is the most commonly used transmission media for LANs. It consists of solid wire cores surrounded by one or more foil or wire shields, each separated by some kind of plastic insulator. The inner core carries the signal and the shield provides the ground.