Unit I Introduction to Computer Networks and Internet

1.1 Understanding of Network and Internet

Network : Network is the connection between two & more Computers, To share information & Resources.

"A group of computer & other devices such as (Printer, Workstation, server) that are linked together is called as network.

The fundamental purpose of a Computer Network is the exchange of data between two parties. The communication between a workstation and a server over a public telephone network. Another example is the exchange of voice signals between two telephones over the same network. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. All networks, whether big or small, are typically created so that users on the network can share resources and communicate.

The list that follows breaks down some of the reasons for networking computers:

Uses of Computer Networks -

File sharing: Networking computers makes it very easy for the users on the network to share application files.

Hardware sharing: Users can share devices such as printers, CD-ROM drives, and hard drives.

Program sharing: Applications such as spreadsheets and word processors can be run over the network.

User communication: Network allows users to take advantage of communication media such as electronic mail, newsgroups, and video conferencing.

Internet Connection Sharing: The organization can provide network users with access to the internet, via an internet gateway. Small computer networks allow multiple users to share a single Internet connection. Special hardware devices allow the bandwidth of the connection to be easily allocated to various individuals as they need it,

and permit an organization to purchase one high speed connection instead of many slower ones.

User access control: Modern networks almost always have one or more servers which allows centralized management for users and for network resources to which they have access. User credentials on a privately-owned and operated network may be as simple as a user name and password, but with ever- increasing attention to computing security issues, these servers are critical to ensuring that sensitive information is only available to authorized users.

Information storing and sharing: Computers allow users to create and manipulate information. Information takes on a life of its own on a network. The network provides both a place to store the information and mechanisms to share that information with other network users Connections.

Data Security and Management: In a business environment, a network allows the administrators to much better manage the company's critical data. Instead of having this data spread over dozens or even hundreds of small computers in a haphazard fashion as their users create it, data can be centralized on shared servers.

Entertainment: Networks facilitate many types of games and entertainment. The Internet itself offers many sources of entertainment, of course.

Home Applications: Probably the biggest reason now is for Internet access. Some of the more popular uses of the Internet for home users are as follows:

1. Access to remote information.
2. Person-to-person communication.
3. Interactive entertainment.
4. Electronic

- **Internet**
    - The Internet is a global system of interconnected computer networks that use the standard Internet Protocol Suite (TCP/IP) to serve billions of users worldwide. It is a network

of networks that consists of millions of private, public, academic, business, and government networks of local to global scope that are linked by a broad array of electronic and optical networking technologies. The Internet carries a vast array of information resources and services, most notably the inter-linked hypertext documents of the World Wide Web (WWW) and the infrastructure to support electronic mail.

- The United States to create the Advanced Research Projects Agency (ARPA or DARPA) in February 1958 to regain a technological lead. The ARPANET was one of the eve networks of today's Internet.
- Internet It is a collection of interconnected documents and other resources, linked by hyperlinks and URLs
- The Internet is allowing greater flexibility in working hours and location, especially with the spread of unmetered high-speed connections and web applications.
- Now a day’s internet is prime medium for communication over web.
- numerous means, especially through mobile Internet devices. Mobile phones, data cards, handheld game consoles and cellular routers allow users to connect to the Internet from anywhere there is a wireless network supporting that device's technology.
- Most Useful services of the Internet is email, chatting, Video Conferencing, play online games, online E-Learning, E-Commerce, E-Banking.
- Download text information, Software, Music, Videos, Image, Web Page from the web.
- Social networking websites such as Facebook, Twitter, Orkut and MySpace have created new ways to socialize and interact. Users of these sites are able to add a wide variety of information to pages, to pursue common interests, and to connect with others.

1.2 Network edge

An access network is a type of network which physically connects an end system to the immediate router (also known as the “edge router”) on a path from the end system to any other distant end system. Examples of access networks are ISP, home networks, enterprise networks, ADSL, mobile network, FITH etc.

Types of access networks:

Ethernet – It is the most commonly installed wired LAN technology and it provides services on the Physical and Data Link Layer of OSI reference model. Ethernet LAN typically uses coaxial cable or twisted pair wires.

DSL – DSL stands for Digital Subscriber Line and DSL brings a connection into your home through telephone lines and a DSL line can carry both data and voice signals and the data part of the line is continuously connected. In DSL you are able to use the Internet and make phone calls simultaneously. DSL modem uses the telephone lines to exchange data with digital subscriber line access multiplexer (DSLAMs). In DSL we get 24 Mbps downstream and 2.5 Mbps upstream.

FTTH –Fiber to the home (FTTH) uses optical fiber from a central Office (CO) directly to individual buildings and it provides high-speed Internet access among all access networks. It ensures high initial investment but lesser future investment and it is the most expensive and most future-proof option amongst all these access networks.

Wireless LANs – It links two or more devices using wireless communication within a range. It uses high-frequency radio waves and often include an access point for connecting to the Internet.

3G and LTE – It uses cellular telephony to send or receive packets through a nearby base station operated by the cellular network provider. The term “3G internet” refers to the third generation of mobile phone standards as set by the International Telecommunications Union (ITU).

Long Term Evolution (LTE) offers high-speed wireless communication for mobile devices and increased network capacity.

1.3 Core Network

Definition - A core network is a telecommunication network's core part, which offers numerous services to the customers who are interconnected by the access network. Its key function is to direct telephone calls over the public-switched telephone network.

In general, this term signifies the highly functional communication facilities that interconnect primary nodes. The core network delivers routes to exchange information among various sub-networks. When it comes to enterprise networks that serve a single organization, the term backbone is often used instead of core network, whereas when used with service providers the term core network is prominent.This term is also known as network core or backbone network.

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The facilities and devices used for the core or backbone networks are usually routers and switches, with switches being used more often. The technologies used for the core facilities are mainly network and data link layer technologies, including asynchronous transfer mode (ATM), IP, synchronous optical networking (SONET) and dense wavelength division multiplexing (DWDM). For backbone networks used for enterprises, a 10 Gb Ethernet or gigabit Ethernet technology is also used in many instances.

Core networks usually offer the following features:

Aggregation: The top degree of aggregation can be seen in a service provider network. Next in the hierarchy within the core nodes is the distribution networks, followed by the edge networks.

Authentication: Determines whether the user demanding a service from a telecom network is permitted to complete the task within the network.

Call Control or Switching: Determines the future span of a call depending on the processing of call signaling.

Charging: Deals with the processing and collation of charging the data created by multiple network nodes.

Service Invocation: A core network executes the service invocation task for its customers. Service invocation may occur in line with some precise activity (such as call forwarding) by the users or unconditionally (such as for call waiting).

Gateways: Should be used in core network for accessing other networks. The functionality of gateways depends on the kind of network to which it is connected

1.4 Understanding of delay

When a package is sent from one host (source) to another host (destination), it travels through a series of nodes and routers. Travelling from one of these nodes/routers and on to a subsequent node/router, the packet will suffer from different types of delay. The most notable and important delays are the nodal processing delay, queuing delay, transmission delay, and propagation delay. All these different delays sums up in a total nodal delay.

Types of Delay

A packet is sent from the upstream node through router A and then to router B. Let’s have a look at the process and analyze the total no of delay.

1. Processing Delay

The time used to examine the packet's header and determine where to direct it, and check for bit-level errors in the packet that occurred in transmission is called the processing delay. There are also several other factors that affects this delay, for example: The need to check for bit-level errors that has occurred during transmission to the router.

2. Queuing Delay

The queuing delay is the time it takes for the packet to be transmitted onto the link. Naturally; the length of this time is defined by the number of packets that was added to the queue prior to this packet. It is also very important that the rate of incoming packets does not exceed the rate of outgoing packets. If this happens, the delay will approach infinity, and the transmission could suffer packet losses.

3. Transmission Delay

Packets are commonly transmitted in a first-come-first-serve manner, and it is realistic to assume that a packet will not be transmitted until all prior packets are transmitted. The transmission delay is the amount of time used to transmit (push) all of the packets bits from the queue and into the link. To calculate the delay, the following formula is used:

L

R

, where L is the length of the packet (in bits), while R is the transmission speed of the Ethernet link in Mbps (Megabits per second).

4. Propagation delay

As the packet does not magically appear straight away on router B after it has been pushed into the link from router A, there is of course a propagation delay. This is the time required to propagate from the beginning of the link and to router B. The speed of the propagation heavily depends on the physical medium of the link (fibre optics, twisted pair, copper wire, etc). This delay can be calculated by the formula:

d

s

, where d is the distance between router A and router B, and s is the propagation speed between the two routers. The speed is usually in the range 2 · 108 meter/sec to 3 · 108 meter/sec, which basically is around the speed of light.

Packet Loss in Package-Switched Networks

In the queuing delay section earlier, it was mentioned that the delay time will approach infinity; this is of course not realistic as the queues usually has a finite number of packets which can be queued. Basically this means that when sending a lot of packets in to a queue at a high rate (or at the same time), packet loss will be experienced as the queue will be maxed out and the router will drop packets. This will start a “chain-reaction” of increasing the rate of incoming packets, as the dropped packets will need to be retransmitted to the router. A lost packet can be retransmitted on an end-to-end basis in order to ensure that all data are eventually transferred from source to destination.

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Throughput in Computer Networks

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Imagine a large file being sent from Host A to Host B across a computer network. ==

The instantaneous throughput at any instant of time is the rate (in bits/sec) at which Host B is receiving the file.

The average throughput of the file is

F

T

bits/sec, where the file consists of F bits and the transfer time is T (in seconds)..

1.6 Computer networking history

Year	Event
1961	The idea of ARPANET, one of the earliest computer networks, was proposed by Leonard Kleinrock in 1961, in his paper titled "Information Flow in Large Communication Nets."
1965	The term "packet" was coined by Donald Davies in 1965, to describe data sent between computers over a network.
1969	ARPANET was one of the first computer networks to use packet switching. Development of ARPANET started in 1966, and the first two nodes, UCLA and SRI (Standford Research Institute), were connected, officially starting ARPANET in 1969.
1969	The first RFC surfaced in April 1969, as a document to define and provide information about computer communications, network protocols, and procedures.
1969	The first network switch and IMP (Interface Message Processor) was sent to UCLA on August 29, 1969. It was used to send the first data transmission on ARPANET.
1969	The Internet was officially born, with the first data transmission being sent between UCLA and SRI on October 29, 1969, at 10:30 p.m.
1971	Ray Tomlinson sent the first e-mail in 1971.
1973	Ethernet is developed by Robert Metcalfe in 1973 while working at Xerox PARC.

1973 The first international network connection, called SATNET, is deployed in 1973 by ARPA.

1974 The first routers were used at Xerox in 1974. However, these first routers were not considered true IP routers.

1976 Ginny Strazisar developed the first true IP router, originally called a gateway, in 1976.

1978 Bob Kahn invented the TCP/IP protocol for networks and developed it, with help from Vint Cerf, in 1978.

1981 Internet protocol version 4, or IPv4, was officially defined in RFC 791 in 1981. IPv4 was the first major version of the Internet protocol.

1983 ARPANET finished the transition to using TCP/IP in 1983.

1983 Paul Mockapetris and Jon Postel implement the first DNS

1986 BITNET II was created in 1986 to address bandwidth issues with the original BITNET.

1988 The first T1 backbone was added to ARPANET in 1988.

1990 Kalpana, a U.S. network hardware company, developed and introduced the first network switch in 1990.

1996 IPv6 was introduced in 1996 as an improvement over IPv4, including a wider range of IP addresses, improved routing, and embedded encryption.

1997 The first version of the 802.11 standard for Wi-Fi is introduced in June 1997, providing transmission speeds up to 2 Mbps.

1999 The 802.11a standard for Wi-Fi was made official in 1999, designed to use the 5 GHz band and provide transmission speeds up to 25 Mbps.

1999 802.11b devices were available to the public starting mid-1999, providing transmission speeds up to 11 Mbps.

1999 The WEP encryption protocol for Wi-Fi is introduced in September 1999, for use with 802.11b.

2003 802.11g devices were available to the public starting in January 2003, providing transmission speeds up to 20 Mbps.

2003 The WPA encryption protocol for Wi-Fi is introduced in 2003, for use with 802.11g.

2003 The WPA2 encryption protocol is introduced in 2004, as an improvement over and replacement for WPA. All Wi-Fi devices are required to be WPA2 certified by 2006.

2009 The 802.11n standard for Wi-Fi was made official in 2009. It provides higher transfer speeds over 802.11a and 802.11g, and it can operate on the 2.4 GHz and 5 GHz bandwidths.

2018 The Wi-Fi Alliance introduced WPA3 encryption for Wi-Fi in January 2018, which includes security enhancements over WPA2.