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Computer networks and data security: A survey

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Abstract
A computer network is not only connecting computers together for sharing physical resources, they are a system of interconnected computers for the purpose of sharing digital information. Major Networking types are LAN, MAN, WAN. Transport Control Protocol & Internet Protocol is the language of the Internet. Learning to declare IP with Subnet mask as network bit and host bit is a basic part of networking. LAN topographical is a design / strategies that are used to implement LAN Communication. Switching Techniques such as Circuit Switching, Massage Switching, Packet Switching. Data security refers to protective digital privacy measures that are applied to prevent un-authorized access to computers, databases and websites.

Keywords: Network's component, internet protocol, subnet mask, topology, communication switching techniques, data security technologies, hub

1. Introduction
A computer network consists of a collection of computers; printers and other equipment that is connect together so that they can communicate with each other. A network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. The old model of single computer serving all of the organizations computational needs has been replaced by one in which a large number of separate but interconnected computers do the job. These systems are called computer networks. With a network, user must explicitly log on to one machine, explicitly submit jobs remotely, explicitly move files around and generally handle all the network management personally. With the distributed system, nothing has to be done explicitly it is all automatically done by the system without the users knowledge.

2. Components of a Network
A computer network comprises the following components:
- A minimum of at least 2 computers
- Cables that connect the computers to each other, although wireless communication is becoming more common (see Advice Sheet 20 for more information)
- A network interface device on each computer (this is called a network interface card or NIC)
- A 'Switch' used to switch the data from one point to another. Hubs are outdated and are little used for new installations.
- Network operating system software

A. Structured Cabling
The two most popular types of structured network cabling are twisted-pair (also known as 10BaseT) and thin coax (also known as 10Base2). 10BaseT cabling looks like ordinary telephone wire, except that it has 8 wires inside instead of 4. Thin coax looks like the copper coaxial cabling that's often used to connect a Video Recorder to a TV.

B. Network Interface Card (NIC)
A NIC (pronounced 'nick') is also known as a network card. The following figure1 depicts the NIC. It connects the computer to the cabling, which in turn links all of the computers on

the network together. Each computer on a network must have a network card. Most modern network cards are 10/100 NICs and can operate at either 10Mbps or 100Mbps.

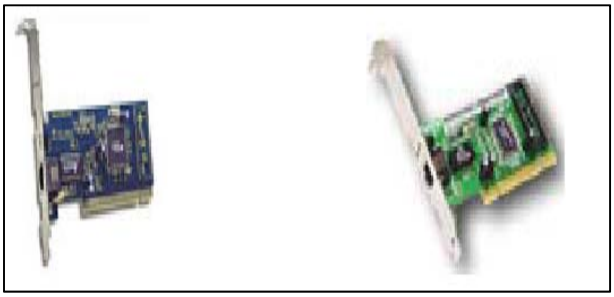

Fig 1: Network Interface Cards (NICs)

C. Hub and Switch

A hub is a device used to connect a PC to the network. The function of a hub is to direct information around the network, facilitating communication between all connected devices. However in new installations switches should be used instead of hubs as they are more effective and provide better performance. A switch, which is often, termed a 'smart hub' is shown in the following figure 2.

Switches and hubs are technologies or 'boxes' to which computers, printers, and other networking devices are connected. Switches are the more recent technology and the accepted way of building today's networks.

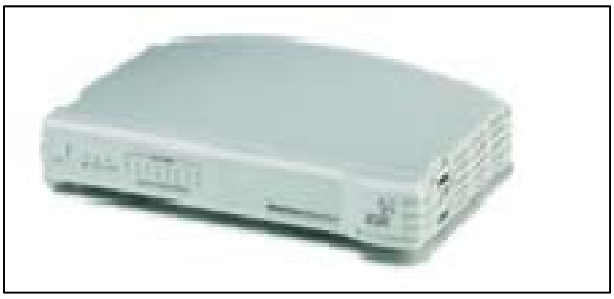

Fig 2: An 8 port Hub

D. Wireless Networks

The term 'wireless network' refers to two or more computers communicating using standard network rules or protocols, but without the use of cabling to connect the computers together. Instead, the computers use wireless radio signals to send information from one to the other. A wireless local area network (WLAN) consists of two key components: an access point (also called a base station is shown in figure3) and a wireless card is shown in the figure 4.

Fig 3: Wireless Access point or Wireless Basestation

Fig 4: Desktop PC Wireless LAN card Wireless LAN card

3. Types of Networks

- Local Area Networks (LAN)
- Metropolitan Area Networks (MAN)
- Wide Area Networks (WAN)
- Personal Area Network (PAN)
- Local Area Networks:

Local area networks, generally called LANs, are privately-owned networks within a single building or campus of up to a few kilometers in size. They are widely used to connect personal computers and workstations in company offices and factories to share resources (e.g., printers) and exchange information. If the network is contained within a relatively small area, such as a classroom, school, or single building, as shown in following Figure 5, it is commonly referred to as a local area network (LAN).

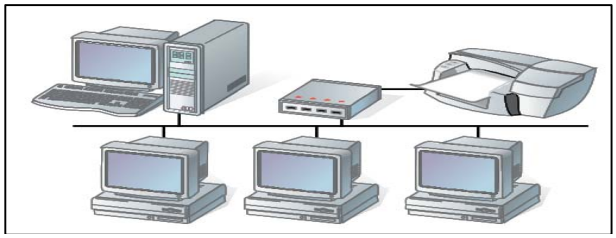

Fig 5: LAN covers a relatively small distance

LANs are distinguished from other kinds of networks by three characteristics:
(1) Their size,
(2) Their transmission technology, and
(3) Their topology.

LANs are restricted in size, which means that the worst-case transmission time is bounded and known in advance. Knowing this bound makes it possible to use certain kinds of designs that would not otherwise be possible. It also simplifies network management. LANs may use a transmission technology consisting of a cable to which all the machines are attached, like the telephone company party lines once used in rural areas. Traditional LANs run at speeds of 10 Mbps to 100 Mbps, have low delay (microseconds or nanoseconds), and make very few errors. Newer LANs operate at up to 10 Gbps various topologies are possible for broadcast LANs. Figure1 shows two of them. In a bus (i.e., a linear cable) network, at any instant at most one machine is the master and is allowed to transmit. All other machines are required to refrain from sending. An arbitration mechanism is needed to resolve conflicts when two or more machines want to transmit simultaneously. The arbitration mechanism may be centralized or distributed. IEEE 802.3, popularly called Ethernet, for example, is a bus-based broadcast network with decentralized control,

usually operating at 10 Mbps to 10 Gbps. Computers on an Ethernet can transmit whenever they want to; if two or more packets collide, each computer just waits a random time and tries again later.

LAN Topologies

A network topology refers to the physical layout of the network in which all the devices are connected. This includes all the hardware that makes up the network. The points of the connection to the network by the station are calls Nodes or Link stations.

There are several types of topographical design & strategies are used to implement LAN. The majority of these are based on three types of topologies.

- Star topology
- Bus topology
- Ring topology

Star topology

In this topology, a number of stations are connected directly to a central station or controller. Communication on the connecting links between the stations & the central station of the star topology can be bi- directional and are point to point. A station on this type of network passes an information frame to the central controller, which then forwards the information to the destination station. The central controller manages and controls all communication between stations on the network. Figure 6 represents star topology.

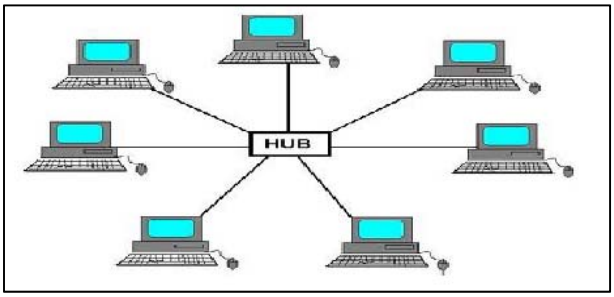

Fig 6: Star Topology

Bus topology

A bus topology is shown above all stations are connected to a single communication line. This single communication line is referred to a bus. Information frames originating at a station are propagated away from the station in both directions on the bus. Each station on the bus interrogates the information frame destination address failed for its on addresses. If the destination failed does not match the station address, the station discards the information frame back on to the bus. If the destination address matches the station addresses, it accepts the information frame & processes the frame. Figure 7 represents bus topology.

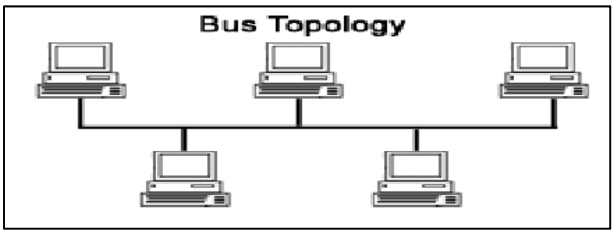

Fig 7: Bus Topology

Ring topology

Local area network that have each station attached to an adjacent station using point to point links from physical ring. Each station attached and active to the ring regenerate the information frame, then retransmits the information frame on the ring. The ring itself is logically circle and the information travels in one direction. Failure of a station in a ring topology disrupts the ring because the information frame is not regenerated. Additions or deletions of stations of the ring can be disruptive, if the changes are not managed properly. Figure 8 represents ring topology.

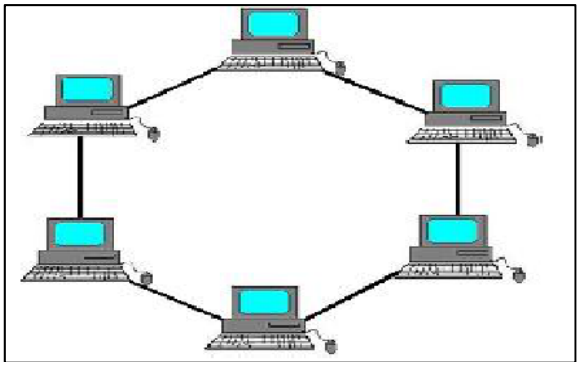

Fig 8: Ring Topology

B. Metropolitan Area Networks (MAN)

A metropolitan area network, or MAN, covers a city. The best-known example of a MAN is the cable television network available in many cities. This system grew from earlier community antenna systems used in areas with poor over-the-air television reception. In these early systems, a large antenna was placed on top of a nearby hill and signal was then piped to the subscribers' houses. At first, these were locally-designed, ad hoc systems. Then companies began jumping into the business, getting contracts from city governments to wire up an entire city. The next step was television programming and even entire channels designed for cable only. Often these channels were highly specialized, such as all news, all sports, all cooking, all gardening, and so on. But from their inception until the late 1990s, they were intended for television reception only. To a first approximation, a MAN might look something like the system shown in Figure 9. In this figure both television signals and Internet are fed into the centralized head end for subsequent distribution to people's homes. Cable television is not the only MAN. Recent developments in high-speed wireless Internet access resulted in another MAN, which has been standardized as IEEE 802.16.

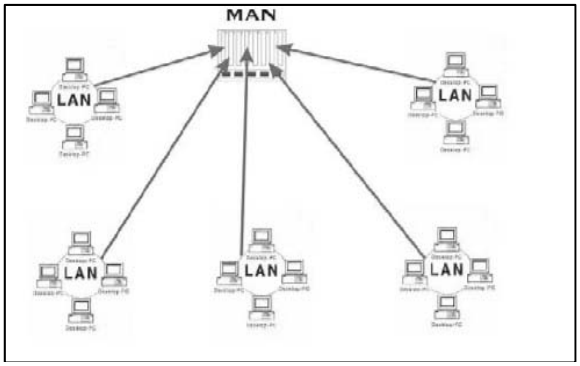

Fig 9: MAN

A MAN is implemented by a standard called DQDB (Distributed Queue Dual Bus) or IEEE 802.16. DQDB has two unidirectional buses (or cables) to which all the computers are attached.

C. Wide Area Networks (WAN)

A wide area network, or WAN, spans a large geographical area, often a country or continent. It contains a collection of machines intended for running user (i.e., application) programs. These machines are called as hosts. The hosts are connected by a communication subnet, or just subnet for short. The hosts are owned by the customers (e.g., people's personal computers), whereas the communication subnet is typically owned and operated by a telephone company or Internet service provider. The job of the subnet is to carry messages from host to host, just as the telephone system carries words from speaker to listener.

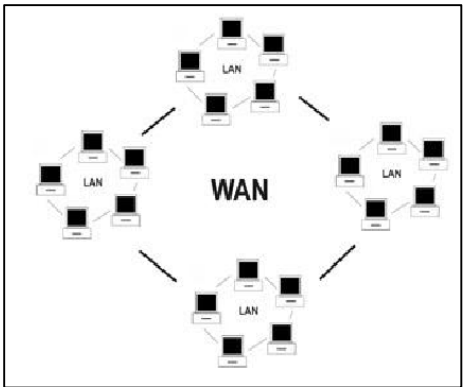

Fig 10: WAN

In wide area networks, the subnet consists of two distinct components: transmission lines & switching elements. Transmission lines (also called circuits, channels, or trunks) move bits between machines. The switching elements are specialized computers used to connect two or more transmission lines. When data arrive on an incoming line, the switching element must choose an outgoing line to forward them on. Figure 10 represents WAN.

D. Personal Area Network (PAN)

A PAN is a network that is used for communicating among computers and computer devices (including telephones) in close proximity of around a few meters within a room. It can be used for communicating between the devices themselves, or for connecting to a larger network such as the internet. PAN's can be wired or wireless. The Personal Area Network is shown in the following figure 11.

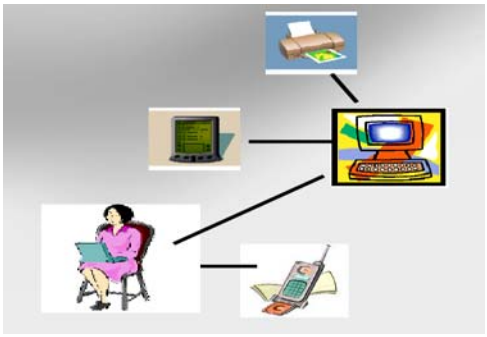

Fig 11: Personal Area Network (PAN)

4. Communication Switching Techniques

Switching

A network consists of many switching devices. In order to connect multiple devices, one solution could be to have a point to point connection in between pair of devices. But this increases the number of connection. The other solution could be to have a central device and connect every device to each other via the central device which is generally known as Star Topology. Both these methods are wasteful and impractical for very large network. The other topology also cannot be used at this stage. Hence a better solution for this situation is SWITCHING. A switched network is made up of a series of interconnected nodes called switches.

Types of Switching Techniques

There are basically three types of switching methods are made available. Out of three methods, circuit switching and packet switching are commonly used but the message switching has been opposed out in the general communication procedure but is still used in the networking application.

- Circuit Switching
- Packet Switching
- Message Switching

A. Circuit Switching

Circuit Switching is generally used in the public networks. It comes into existence for handling voice traffic in addition to digital data. However digital data handling by the use of circuit switching methods are proved to be inefficient.

Circuit Switching Network

Here the network connection allows the electrical current and the associated voice with it to flow in between the two respective users. The end to end communication was established during the duration of call. In circuit switching the routing decision is made when the path is set up across the given network. After the link has been sets in between the sender and the receiver then the information is forwarded continuously over the provided link. In Circuit Switching a dedicated link/path is established across the sender and the receiver which is maintained for the entire duration of conversation.

B. Packet Switching

In Packet Switching, messages are broken up into packets and each of which includes a header with source, destination and intermediate node address information. Individual Packets in packet switching technique take different routes to reach their respective destination. Independent routing of packets is done in this case for following reasons:

- Bandwidth is reduces by the splitting of data onto different routes for a busy circuit.
- For a certain link in the network, the link goes down during transmission the the remaining packet can be sent through the another route.

Packet Switching Network

The major advantage of Packet switching is that they are used for performing data rate conversion. When traversing the network switches, routers or the other network nodes then the packets are buffered in the queue, resulting in variable delay and throughput depending on the network's capacity and the traffic load on network. Packet switching

contrasts with another principal networking paradigm, circuit switching, a method which sets up a limited number of dedicated connections of constant bit rate and constant delay between nodes for exclusive use during the communication session. In cases where traffic fees are charged, for example in cellular communication, packet switching is characterized by a fee per unit of information transmitted.

C. Message Switching

In case of Message Switching it is not necessary to establish a dedicated path in between any two communication devices. Here each message is treated as an independent unit and includes its own destination source address by its own. Each complete message is then transmitted from one device to another through internetwork.

Message Switching Data Network

Each intermediate device receives the message and stores it until the nest device is ready to receive it and then this message is forwarded to the next device. For this reason a message switching network is sometimes called as Store and Forward Switching. Message switches can be programmed with the information about the most efficient route as well as information regarding to the near switches that can be used for forwarding the present message to their required destination. The storing and Forwarding introduces the concept of delay. For this reasons this switching is not recommended for real time applications like voice and video.

5. Type of Wide Area Network

- Public Networks
- Private Networks

A. Public Networks

Public networks are those networks which are installed and run by the telecommunication authorities and are made available to any organization or individual who subscribe.

- Public Switched Telephone Network (PSTN)
- Public Switched Data Network (PSDN)
- Value Added Services (VANs/ VADs)
- Integrated Services Digital Network (ISDN)

B. Private Networks

The basic technique used in all forms of private WAN is to use private (or more usually leased) circuits to link the locations to be served by the network. Between these fixed points the owner of the network has complete freedom to use the circuits in any way they want. They can use the circuit to carry large quantities of data or for high speed transmission

6. IP Address

Every host connected to an internet must have a unique IP address on that network. The address in IPv4 is a 32 bit number. It is usually represented as 4, 8 bit numbers separated by dots, for example: 147.197.205.211 In order to address different networks on an internet the address is structured into a network part and a host part. So the University of Hertfordshire network address is 147.197 and one host on it is 205.211. Not all networks have a 16 bit address. The NIC allocates network addresses to organizations which in turn are responsible for allocating their own host addresses. There are four types of address such as,

- Type A If the first bit is 0 (the first 8 bit field is less than 127) then that's the network address and the host address is 24 bits, there are only just over 100 of these and each can have over 16 million hosts on their nets.
- Type B If the first two bits are "10" then the network address is the next 14 bits that means there are about 16000 of these networks, each with upto 65000 hosts.
- Type C For smaller organisations if the first 2 bits are "110" than the network address is the following 22 bits and there is only an 8 bit host number.
- Type D and E If the first 3 bits are "111" then the remaining bits are used for special broadcast and multi-cast addressing.

7. Data Security

The idea behind data security is protecting data from corruption and unauthorized user. Data security means protecting data, such as a database, from destructive forces and from the unwanted actions of unauthorized users.

Data security mainly deals with client/server distributed system. There are four main security components such as security authentication, authorization, access control and encryption. Data security technologies

- Data encryption
- Backups
- Data masking
- Data erasure
- Digital inheritance

8. Conclusion

Computer communication, it seems, will become a much more useful networking tool when large numbers of people with similar interests acquire access to the technology. Computer network will become a much more useful tool for sharing information and resources, when large numbers of people with similar ideas and interest access to the technology or a network. Data security is most important and annoying things in any network, though data security technologies were developed some loop holes were found by the hackers. This problem should become increasingly minimized over the coming years as the technological innovations become more diffused throughout society.

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