NETWORK TRANSMISSION MEDIA

A physical media is needed to transport a stream of bits from one device to another. The various medias can be characterized in terms of -

① bandwidth
② propagation delay
③ cost
④ ease of installation and maintenance.

Such physical media are called Network Transmission Media. They can be classified as guided (eg. coaxial cable) and unguided (eg. wireless) media.

Wired Transmission Media

① Twisted pair copper cables, are widely used due to low cost and ease of installation. A cable can have 4, 5 or 6 pairs of twisted wires. Each category differs in the supported data rate. Category 6 cable will support gigabit-Ethernet. Twisted pair cables can be unshielded (UTP) or shielded (STP).

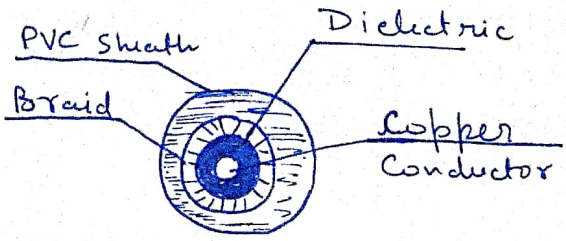
UTP: very low cost and easy to use.

disadvantages - high attenuation, susceptibility to electromagnetic interference. Hence cannot be used for more than 100m without repeater.

STP: introduced in 1980s by IBM, each twisted pair is foil shielded, also includes a braided wire that is earthed at one end.

disadvantages - high cost, difficult installation, ground loops can occur due to improper installation, limitation of usage restricted to 100m.

② Coaxial cable :



Cross section of a coaxial cable.

Copper conductor carries the bits, and is surrounded by an insulating material. The braid is braided metal shield that protects the digital signal travelling along the core by absorbing external noise.

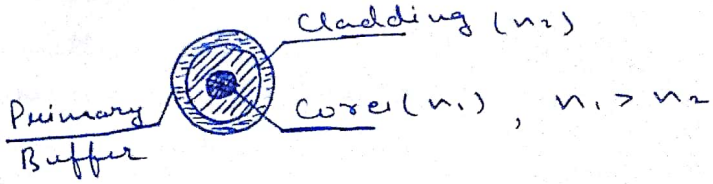
Benefits - ⓐ high immunity to noise
ⓑ can be used over large distances.

Coaxial cables are widely used in network backbone.

(2.i) Thicknet cables (10Base5) support 10 Mbps maximum data rate, base band signalling and 500m max. signalling statement. Thicknet was the original transmission medium used in Ethernet networks and supported over 100 nodes per segment.

(2.ii) Thinnet cables (10Base2) support 10 Mbps maximum data rate, base band signalling and 185 m maximum segment length. It can support upto 30 nodes per network segment.

③ Optical fibre :



Optical fibre carries information (i.e. bits) in form of light. The digital information is first converted into light beam by an LED or laser emitting diode. The beam ~~suffe~~ undergoes multiple Total Internal Reflection from source end to destination end, hence suffering very less loss. Optical fibres can carry data along a few kilometers before needing a repeater.

Wireless transmission media employ electro-magnetic waves to transport a stream of bits between two or more nodes, without establishing any physical link. Example

Radio transmission : frequency range b/w 3 Hz to 300 GHz.

Low frequency waves can penetrate large obstacles such as buildings and high frequency radio waves can travel in straight line and bounce back.

Microwave transmission : frequency range b/w 300 MHz to 300 GHz.

The transmitter and receiver must be aligned strictly in line of sight. Microwaves cannot penetrate walls and transmission depends heavily on the weather.

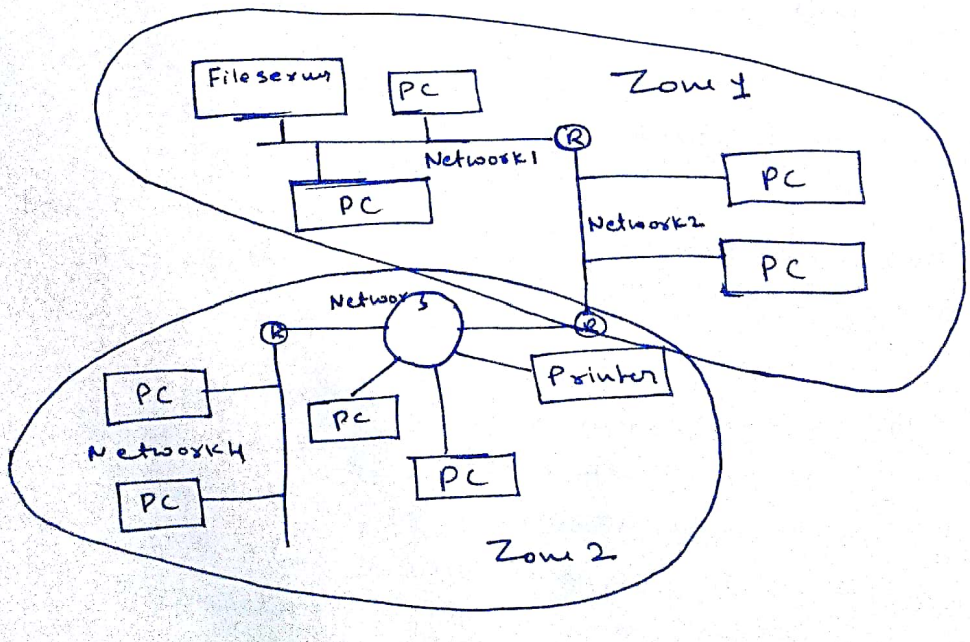
Infrared transmission : frequency range b/w 300 GHz to 430 THz.

Infrared is directional in nature and can be used for very short distances like a TV remote.

Light transmission : it is the highest electromagnetic spectrum frequency. It requires the use of lasers. At both ends there is a laser and a photodetector. The laser at one end and the photodetector at the other end must be perfectly aligned.

APPLE TALK

AppleTalk is a protocol suit developed by apple computers in the early 1980s to allow multiple users to share resources such as files and printers, and is one of the earliest implementations of a distributed client/server networking system. Phase 1 was designed for use with workgroups only, but Phase 2 was designed to support both client-server LANs and internetworking. Upto 253 hosts or servers can be accomodated on a single AppleTalk network segment. AppleTalk network segments are arranged hierarchically and consists of nodes, ports, zones, and sockets.



A typical AppleTalk network

A node is any device (eg. a computer, router, printer etc.) connected to an AppleTalk network. Each node belongs to a single network and a specific zone. Software processes running on a client node, or any node for that matter are identified by sockets, and are known as socket clients. An AppleTalk node can contain upto 254 socket numbers.

AppleTalk networks can be extended or non-extended. A non-extended network is a physical network segment that is assigned a single network number between 1 and 1024. Each node number in the network must be unique. An extended network is a physical network segment that can be assigned multiple network numbers. Extended networks can have multiple zones configured on a single network segment. A zone is a logical group of nodes on networks defined by the network administrator. Nodes on networks need not be physically contiguous to belong to the same zone.

AppleTalk uses addresses to identify devices on a network. Each address is composed of a 16 bit network number that identifies a specific network, and an 8 bit node number that identifies a node attached to the specified network. A socket number identifies a specific process running on a network node. Addresses are usually written as decimal values seperated by a period. For example 12.3.51 means network 12, node 1 and socket 51.

NETWARE

NetWare is a discontinued computer network operating system developed by Novell, Inc. It initially used cooperative multitasking to run various services on a personal computer, using the IPX network protocol.

The original NetWare product in 1983, supported clients running CP/M as well as MS-DOS operating system, ran over a properietary star network topology and was based on a Novell based file server using the Motorola 68000 processor, but the company soon moved away from building its own hardware, and NetWare became hardware-independent, running on any suitable Intel-based IBM PC compatible system, and a wide range of network cards. From the beggining NetWare implemented a number of features inspired by mainframe and minicomputer systems.

The final update release was version 6.5 SP8 of May 2009. The replacement is Open Enterprise Server.

Netware dominated the Network Operating System (NOS) market from the mid 1980-s through the mid-to-late 1990s due to its extremly high performance relative to other NOS technologies. The reason for NetWare's performance advantages were :

(1) Files service instead of disk service.

Earlier nearly all LAN storage was based on the disk server model. This meant that if a client computer wanted to read a particular block from a particular file it would have to issue the following requests across the relatively slow LAN

(i) Read first block of directory.
(ii) Continue reading subsequent directory blocks until the directory block containing the information on the desired file was found.
(iii) Read through multiple file entry blocks until the block containing the location of the desired file block was found.
(iv) Read the desired data block.

On the other hand NetWare was based on file service model i.e. it interacted with the client at file API model. Thus where the desired data is stored physically was figured out locally within the server itself. So all the instructions that were exchanged over the network were

(i) send a file open request.
(ii) send a request for the desired data from the file.

(2) Aggressive Caching

Netware design focused on servers with large amount of RAM. When a volume was mounted, entire file allocation table (FAT) was read into the RAM; adding a disk to a server would often require a RAM upgrade as well. Netware automatically used all otherwise unused RAM for caching active files and employed delayed write backs to facilitate reordering of disk requests. An unexpected shutdown could therefore corrupt data making an uninterruptible power supply practically mandatory for a server.

(3) Efficiency of Netware Core Protocol (NCP)

Most network protocols at the time, when Netware was developed, didn't trust the network to deliver message. So a normal client file read involved

(i) Client sends read request to server
(ii) Server acknowledges the request
(iii) Client acknowledges the acknowledgment
(iv) Server sends requested data.
(v) Client acknowledges data
(vi) Server acknowledges acknowledgment.

NCP on the other hand believed that the network would work perfectly most of the time, thus a file request by a client would look like

(i) Client sends a read request to server.
(ii) Server sends requested data to the client.

All requests contained a sequence number. If the client did not receive ~~an acknowd~~ response, it would resend the request with the same sequence number. If the server had already processed the request it would reply with the cached response, if it had not yet had the time to process the request it would send a positive acknowledgment. The bottom line was to trust the network and this approach brought a 2/3 reduction in network transactions and associated latency.

(4) Non-preemptive OS designed for network services

Netware was a special purpose OS, not a time sharing one. It was written from the ground up as a platform for client-server processing services. Initially it focused on file and print services but later demonstrated its flexibility by running data bases, emails and web and other services as well. A drawback of allowing the processes to manage themselves was that a misbehaving process could bring down the entire server.

IBM SYSTEM NETWORK ARCHITECTURE (SNA)

SNA is IBM's proprietary networking architecture, created in 1974. It is a complete protocol stack for interconnecting computers and their resources. SNA describes formats and protocols and is, in itself, not a piece of software. The implementation of SNA takes the form of various communication packages, most notably Virtual Telecommunications Access Method (VTAM) the mainframe software package for SNA.

SNA's objective was to reduce the costs of operating large numbers of terminals and thus induce customers to develop or expand interactive terminal based systems as opposed to batch systems.

The most important elements of SNA include

① IBM Network Control Program (NCP) is a communications program running on the 3705 and subsequent 37XX communication processors that, among other things, implement the package switching protocol defined by SNA.

② Synchronous Data Link Control (SDLC) is a protocol that greatly improved the efficiency of data transfer over a single link.

- ⓐ SDLC included powerful error detection and correction codes. So the network controller could take care of minor errors without requesting for the data again.
- ⓑ It enabled 3705 communications processor to send frames of data one after the other without waiting for an acknowledgment of the previous frame.
- ⓒ These frames all had the same type of envelop which contained enough information for data packages from different types of terminals to be sent along the same communication lines.

(3) VTAM, a software package to provide log-in, session keeping and routing services within the mainframe.

SNA removed link control from the application programs and placed it in NCP (a system program(s))

It had the following

(I) Advantages -

(i) Localization of problems in network as only a few programs (software pieces) dealt with communication links.

(ii) Adding communication capabilities to an application program became easier as the complex parts were dealt by system programs.

(iii) With the advent of Advanced Peer to Peer Networking (APPN) routing became the functionality of the computer as opposed to the router. Each computer maintained a list of nodes that defined the forwarding mechanism. A centralized node type known as Network Node maintained global table of all other node types. APPN stopped the need to maintain Advanced Program to Program Communication routing table that explicitly defined endpoint to endpoint connectivity.

(II) Disadvantages -

(i) Connection to non-SNA networks was difficult.

(ii) A list of alternate pathways between every pair of nodes in a network had to be predesigned and stored.

(iii) SNA network installation and maintenance are complicated and SNA network products are (were) expensive

(iv) Back then the concept of layer communication was not fully adopted.

(v) SNA's architecture invoked huge state machine logic to keep track of everything