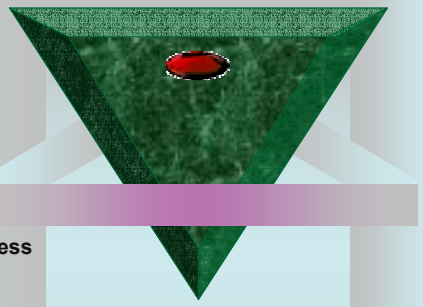
Introduction To Computer Networks



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Bibliography

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LAN's & WAN's

Any system that requires computers to communicate with each other will need specialized hardware and software such as:

- Modems (and/or other connection devices);
- Communication programs: contain standard protocols ensure that systems can signal to each other the start and finish of transmission and reception and any other problems experienced with data;
- Network circuits and software.

A network is composed from a hardware part (servers, workstations, cables, printers and so on) and a software part (operating systems and applications).

LAN's & WAN's

All networks, even the most complex ones, include the same three fundamental blocks:
- devices that supplies services to the network (e.g. servers);
- devices that uses that offered services (e.g. workstations);
-"something" that allow to communicate that devices.

Network components consist of files, print or communication server, Workstations, Network Interface Cards, connectors, cables, wiring boxes and any other required hardware for the chosen topology.

All Workstations are connected to a File Server by intermediate of a network card and a transmission media (channel). All computer networks may consist of one or more File Servers. Data communication capabilities are available to allow you to connect to a remote PC, to another LAN or to a mainframe (figure 1)

LAN's & WAN's

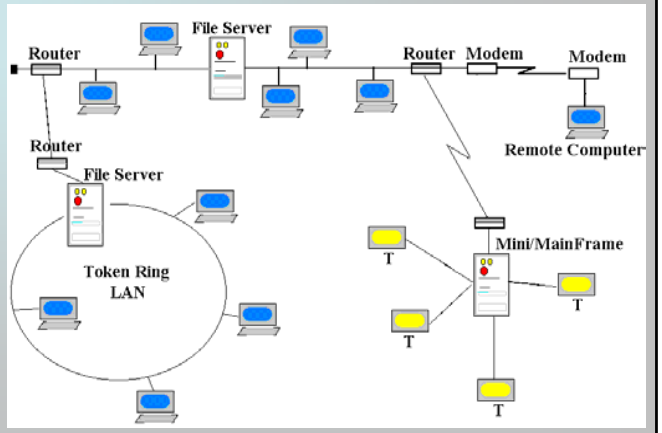


Figure 1 A network example

LAN's & WAN's

The networks runs under an operating system called Network Operating System (NOS), who must offer at least the following services:

- electronic mail (e-mail);
- sharing application software packages;
- central backup of files and application software;
- security;
- communication to remote Workstations (e.g. data can be transferred between networks; files can be created at a corporate national office and transferred electronically to each location and printing out), LAN's, and mini/mainframe connectivity.

LAN's & WAN's

A Local Area Network (LAN) links personal computers (Workstations) together so they can communicate an share resource, such as hard drives, printers, application software and data files.

Definition of LANs:

LANs are networks of computers and peripherals linked together on a single geographical site. They located generally in one single building or in a group of buildings positioned on an array whose surface is up to some square kilometers.

LAN's & WAN's

Advantages of networks:
- **data can be shared by all users;**
- **the network can gradually extended as organization grows;**
- **users can share expensive resources such high quality printers;**
- **if one machine breaks down, the others can continue working;**
- **cost effective for large numbers of users;**
- **members of the network can send electronic mail to one another reducing the amount of paperwork.**

LAN's & WAN's

Definition of WANs

A series of LANs joined together is often referred as WAN. WAN is a collection of LANs joined together over a large geographical area. Devices on each LAN communicate over the WAN using direct network connections or modems where direct connections are not available.

Some network and internetwork components

File Server. Every network starts with a server, usually a high performance PC; can be installed dedicated or nondedicated; runs under NOS (network OS).

In order to increase the quality of offered services in a network can be included specialized servers such as:
- mail servers – that allow the exchange of electronic messages;
-modem servers – that allow to the user to share many modems at a time for calls in or out to the network;
- print servers – that allow share printers;
- fax servers – that allow to users to receive and send fax in the network environment.

Workstation. All microcomputers that are connected to network (can be diskless or not).

Client. Any component of a network that uses services offered by a server is called generally client. The clients uses operating systems for workstations.

Some network and internetwork components

Topologies and Protocol. The communication between servers and clients is realized in the network environment (or medium), and is represented by topology and protocol:
- Topology - is the cabling schematic which includes components which make up the design of the LAN;
- Protocols - are the languages that allows computers to talk each other.

Some network and internetwork components

TOPOLOGY. Network topologies fall more or less naturally into two categories based on which communication strategy is fallowed when transfer messages between parties:
Broadcast. Broadcasting mean to sent a message to every other computer in the network; if a message arrives to a computer for which it was not intended, then it will simply discarded. This strategy is generally applied in local area network (LAN).
Unicast. Unicasting mean that the messages are sent specifically to a single receiver. Unicasting is typically adopted in WANs where the geographical distances prohibit the use of efficient transmission media that are used to exploit broadcast mechanisms effectively.

Some network and internetwork components

PROTOCOL. The protocol is the method in which the network interface cards (NIC) communicate over the topology. Protocols are essentially electronic rules of behavior that allow the network interface cards to initiate and maintain communication. These rules are controlled by the protocol engine:

- accepts raw data from the sending source;
- assembles and addresses packets;
- attaches any necessary information such as internet routing;
- places the packets onto the communication channel.

Some network and internetwork components

Hubs/Switches. A hub/switch is simply a box with circuitry inside and a bunch of jacks for RJ-45 plugs on the back.

Repeaters. A repeater provide a simple signal-regeneration services (protects against attenuation); links identical LANs;

Bridges. Between the sites of a network and between LAN's we can realize the communications by intermediate of bridges; a bridge effectively segment the network, keeping local traffic off the extended network while forwarding traffic intended for a remote device.

Some network and internetwork components

Routers. Manage the exchange of data packets between network cabling systems, and they still to be "intelligent.". they create a network of networks. The Internet routers serve as intermediate "store-and-forward" devices which relay messages from source to destination.

Gateways. Provide translation services between different computer protocols. They allow devices on a network to communicate, and not merely connect, with devices on a different network.

The communication process

Shared data. If two or more processes access same data, in the same time, we call that data shared data.

Communication. The communication take place between two processes: *souce process* (sender) and *destination process* (receiver).

The message based communication, suppose that the two involved processes can play one of the roles: of a sender or of a receiver. From the moment that a message has been sent and until the moment it is received the message is said to be *in transmission*.

The communication process

We can distinguish between two kinds of communication:

- **asynchronous communication** in which any data that is being communicating between source process and target process may be in "transit" without either of two processes waiting until that transmission is completed (it still in queue, for example); the transmitter and receiver use separate clocks
- **synchronous communication** require the sending and receiving system to synchronize their actions; they share a common time base, a serial *clock.*

The communication process

In the scheme from figure 2 each sending process uses a communication buffer and has an associated ***output queue*** in which the messages are first appended before being transmitted to the receiver. After transmission a message is appended to the receiving process ***input queue***, from which it will be removed later. When a message is removed from the receiver's queue, the message is said to be ***delivered*** to the receiving process

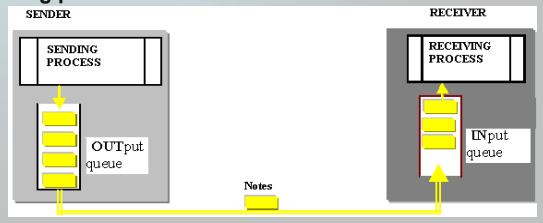


Figure 2. Buffered based message communication (message queues)

Communication media

Bandwidth - refers the transmission rate and whose unit of measurement is bits per second (bps or baud) and the highest units of this (KHZ; MHz; GHz etc)

A network medium can use the bandwidth in two modes:
- **baseband**, when the entire bandwidth is allowed to a single signal;
- **broadband**, when the bandwidth is used to transport simultaneously two or more independent signals (similarly with the TV transmission).

Communication media

Channel - a general communication medium between a set of senders and a set of receivers

The media used for transmission can be one or a combination of the following:

-**copper-based** media (such as those in which a copper wire is coated with an insulating material, coaxial cables (up to 10Mbps) as used for TV sets, or so called twisted pair connection that are used in most LANs (UTP- unshielded twisted pair with a speed up to 100Mbps; STP – shielded twisted pair up to 100Mbps) and 10 GB with the new 10GB Ethernet; 100GB);

-**fiber-optic** media (by which information is transported in the form of light, with a transmission rate > 1,000 GBps);

- **satellite** media (use radio wave to transmit data at distances over 30,000 Km);

- **terrestrial microwave** media, (radio waves are sent from one dish - antenna, aerial - to another);

- **infrared waves**.

Communication media

Depending on how the transmission take place and how many actors are implied the channel have a specific name as:

- **mailboxes** (a channel that allow multiple senders and receivers and that are provided with message queue);

- **ports** (the channel that have only one receiver);

-**link** (is a special type of channel with only a single sender and a single receiver; the link refers to physical medium).

A bidirectional link between a pair of processes which preserves the order of message transmission is called **connection**.

Topologies

Linear (bus) topology (Ethernet, Arcnet, G-net)

This topology (Figure 3) consists of several Workstations (nodes, sites) and a file server, which are attached to a common cable (like a TV cable). This cable is referred to as a bus or trunk. The nodes are attached to the cable using either T-connectors or taps and drop cables. The cable ends cannot be left open, they must be terminated with a terminating resistor device matching the impedance of the cable. This terminator absorbs the signal preventing it from echoing back on the line which will cause serious signal scrambling and bring the network down.

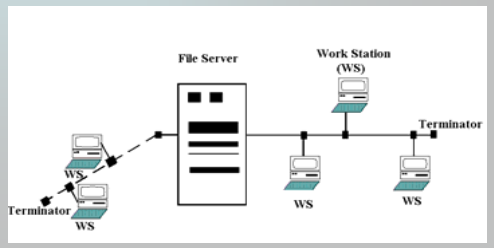


Figure 3. Linear (bus) topology

Topologies

Distributed Star Topology (S-Net, Ethernet, Arcnet...).

In the most popular network systems based on the star topology, each cable has two distinct connections, one for sending data from the hub to an individual PC and one for the PC to send data back to the hub. These paired connections are typically packaged into a single cable (figure 4). Star-style networks have become popular because their topology matches that of other office wiring.

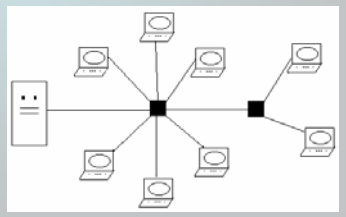


Figure 4. Distributed star topology

Topologies

Logical Ring Topology.

The ring topology looks like a linear network that's biting its own tail. The backbone is a continuous loop, a ring, with no end. But the ring is not a single, continuous wire. Instead it is made of short segments daisy chained from one PC to the next, the last connected, in turn, to the first. Each PC thus has two connections: one wire connects a PC to the PC before it in the ring, and a second wire leads to the next PC in the ring. Signals must traverse through one PC to get to the next, and the signals typically are listened to and analyzed along the way.

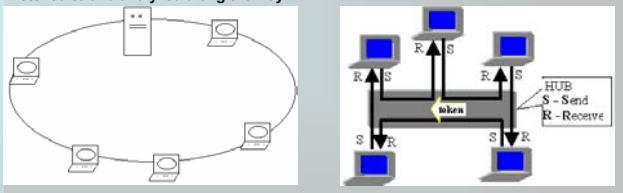


Figure 5. Logical ring topology

Topologies

FDDI networks.

FDDI – Fiber Distributed Data Interface - works as a token ring network at 100Mbps. A FDDI network can include two rings configured to transmit data in opposite directions (figure 6)

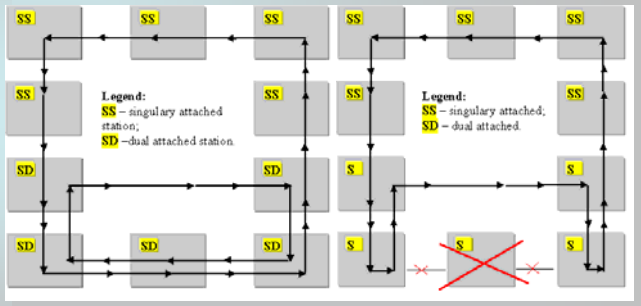
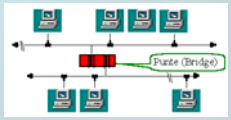


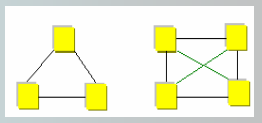
Figure 6. FDDI networks

Topologies

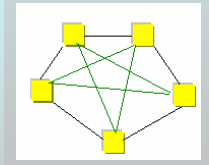
Complex LANs



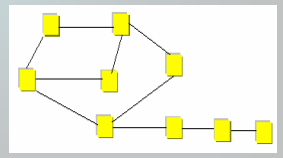
Extending bus



Extending P-P



Mesh



Hybrid Mesh

Figure 7. Complex networks

Topologies

Wide Area Network (WAN) topologies.

WAN's are organized completely differently from local area network, in a shape of a graph (figure 8) in which point-to-point connections are now taken as they are: messages are forwarded according to some routing message and routing is based on a technology referred as switching technology (circuit-switched or packet-switched). In the figure are shown two alternative routes, labeled with r1 and r2, for getting message from node S (sender) to node R (receiver) in a WAN.

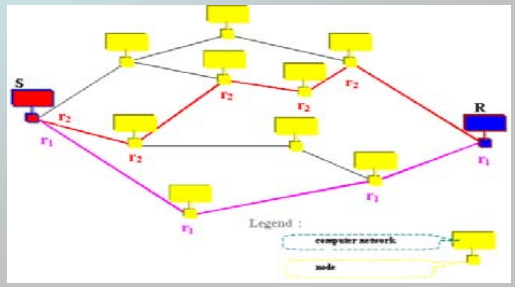


Figure 8. WAN topology

Topologies

An essential part of the WAN is represented by the routers, which acts as true switches in a circuit-switched network. A limitation of that kind of WAN is that as long as neither the sender nor the receiver has indicated that communication has ended, the connection should be maintained.

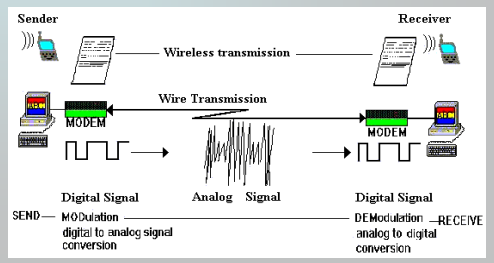
Alternatively to that technology the packet-switched technology can be employed: a message is disassembled into a number of packets (and then decomposed into a number of frames formed by series of bits) which subsequently sent across the network (no full connection between sender and receiver is required). Each packet carries the address of the destination and nodes in the WAN will forward a packet in the right direction.

Learn about (reference [AvDg03]):

- Communication Models: OSI (Open System Interconection) and IEEE (Institute of Electrical and Electronics Engineers)
- Protocols: TCP/IP
- Standards:
  - Ethernet
  - Token Ring
  - Asynchronous Transfer Mode (ATM)
  - FDDI
  - AppleTalk
  - Arcnet
  - Zero-Slot LANs

MoDem

Modems are a vital piece of hardware allowing your computer to talk with another computer over telephone lines. The computer's binary patterns are translated by the modem to analog signals on ones of differing frequency which can be transmitted over phone lines. This is known as signal MODulation. At the receiving end, the process is reversed, with the tone being converted back to computer digital code. This is known as signal DEModulation, hence the term MODEM.



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