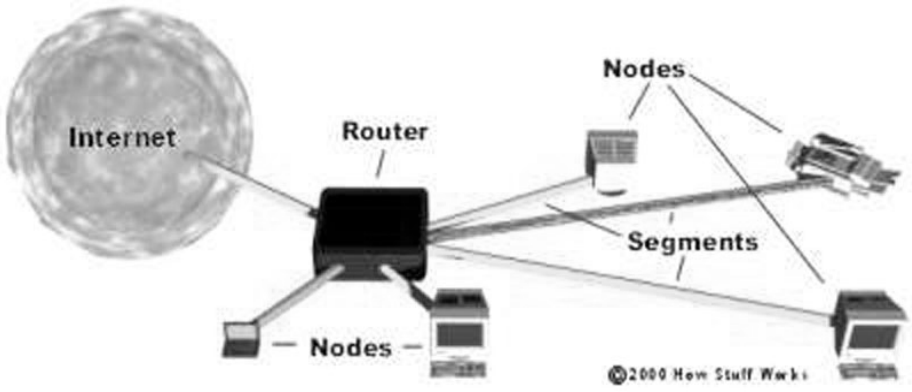
Lecture notes for SSY150: Multimedia and video communications

Networks: Basics and Terminologies

(Extra reading material for lecture 7)

Irene Y.H. Gu, Dept. of Signals and Systems,
Chalmers Univ. of Technology, Sweden
April, 2009



Network Terminology

Node: anything connected to the network, e.g. computers, printers.

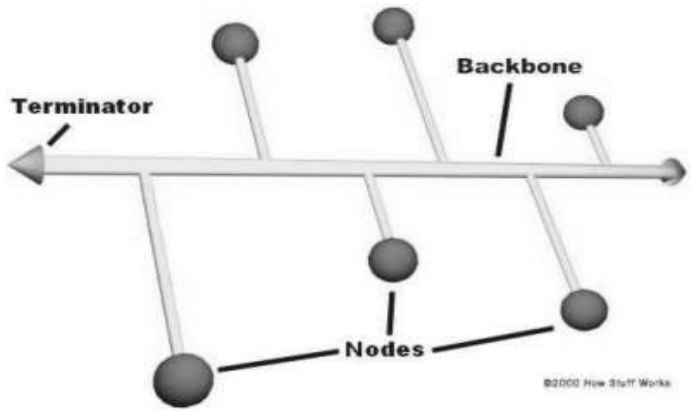
Segment: any portion of a network that is separated by a switch, bridge or a router from another part of a network.

Backbone: the main network cables that all segments connect to. A backbone is usually capable of carrying more information than the individual segments.

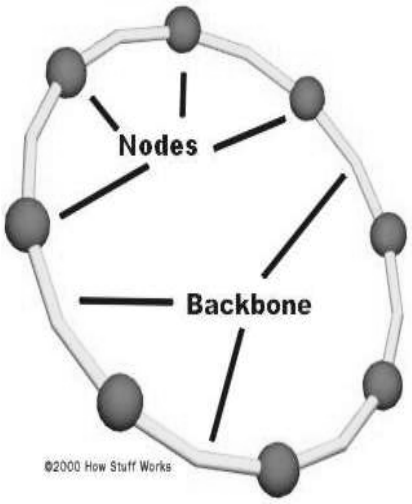
Topology: The way nodes are physically connected to the network

Network topology: Bus

each node is connected along the same backbone. Information sent from a node travels along the backbone until it reaches its destination node. A bus network is terminated with a resistor.



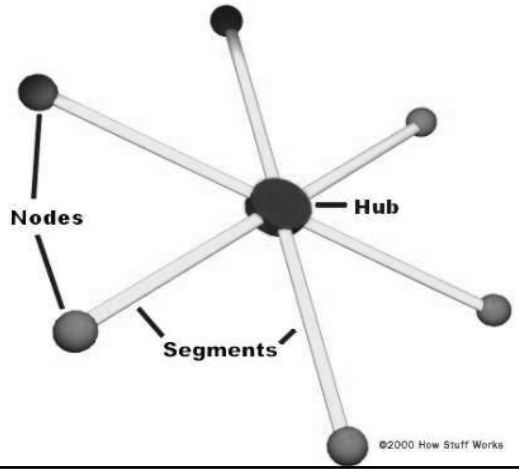
Network topology: Ring



- Each node takes a turn sending and receiving information through the use of a token.
- The token + data: The token is passed sequentially to the nodes in the ring.
- For a node who has the token, the node extracts the data addressed to it,
  - adds new data it wishes to send, and pass the token to the next node.
- Only the node with the token is allowed to send data. All other nodes must wait for the token to come.

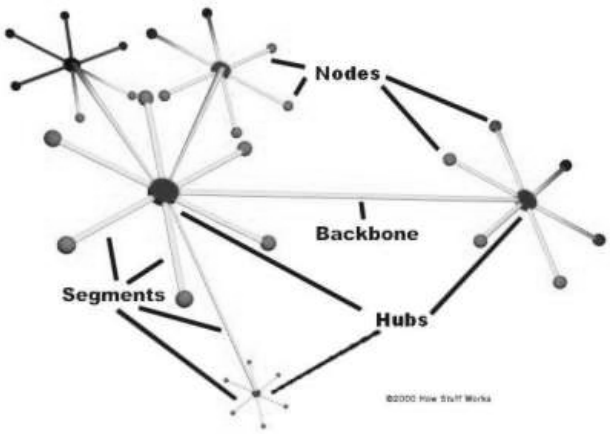
Network topology: Star

Each node is connected to a central device called a hub. The hub takes a signal from any node and passes it to all other nodes in the network.



Network topology: Star Bus

+ Combines star and bus topologies to create a versatile network.
+ Nodes maybe connected to hubs (in star topology), and hubs are connected to the network backbone (in bus topology).



Other network topologies

- One-to-one
- Hierarchical
- Hybrid
- Client-server
- Multiple nodes

Switches

- Allow different nodes of a network to communicate directly with each other.
- Allow several users to send information over a network at the same time without slowing each other down.

Hubs

A hub is the place where data converges from one or more directions, and is forwarded to one or more directions.

Gateways

A gateway is a network point acting as an entrance to another network.

Routers

- A router determines the next network point where a packet should be sent to.
- A router creates/maintain a table of available routes and their conditions. Using this along with distance and cost algorithms to determine the best route for a packet.
- A packet usually travels through a number of network points with routers before arriving its destination.

Bridge

- Connects between LANs that uses the same protocol (e.g. Ethernet, token ring).
- Examines each message on a LAN:

  "passing" those within the same LAN, forwarding those on the other interconnected LANs.

Difference: bridge, router, gateway

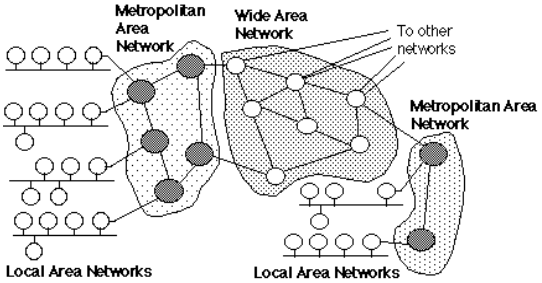
- Bridge: device that interconnects two LANs that use the SAME logical link control protocol but may use different medium access control protocols.
- Router: device that interconnects *similar* networks, e.g. similar protocols, workstations, servers
- Gateway: device that interconnects *dissimilar* protocols and servers

Wide area networks (WANs)
and
local area networks (LANs)

Categories of Networks

- Personal Area Networks (PANs)- close to one person, typically 3-10m
- Local Area Networks (LANs) - diameter up to 10km
- Metropolitan Area Networks (MANs) - diameter 5 - 50kms
- Wide Area Networks (WANs)

They differ in size!

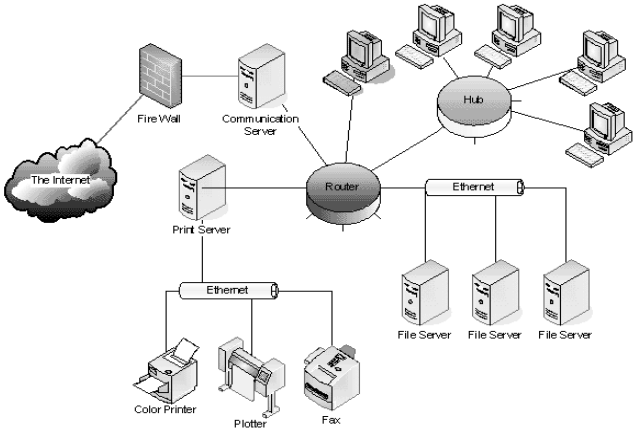


Local Area Networks (LANs)

- Interconnecting PCs, workstations and printers within a building or a small area up to 10 Km.
- Small group of persons sharing common programs and communication needs.
- LAN is capable of high transmission rates (100 Mb/s to Gb/s).
- LAN equipment is usually owned by organizations.
- PCs and workstations are interconnected to servers through twisted pair, fiber optics, etc.
- LAN is interconnected with other networks through switches and router/gateways.

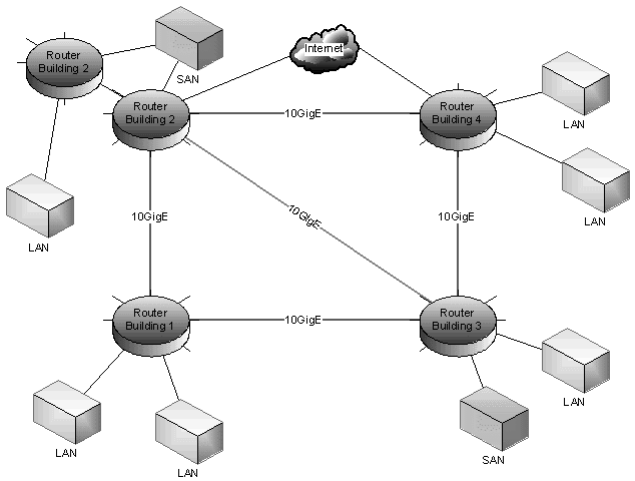
Local Area Networks (LANs)

A network of computers that are in the same general physical location, within a building or a campus.



Example: an office LAN

Metropolitan Area Networks (MANs)



Example of a MAN network

Wide Area Networks (WANs)

- WANs communicate over a large geographical area (e.g. lab-to lab; city-to-city; east coast-to-west coast; North America-to-South America etc)
- WANs Rely on infrastructures established by telephone companies or public switched telephone network (PSTN).
- WAN consists of interconnected switching nodes (typically, computers). These nodes are used to route messages through switching facilities, and to move data to its destination. Signals are routed across the network to the specified destination through software control.
- Initially, “circuit switching” and “packet switching” were implemented in WANs.
  Lately, “frame relay” and “asynchronous transfer mode” (ATM) networks were implemented for high transmission rate.

N-ISDN and B-ISDN

- ISDN (Integrated services digital network) was intended to be a world wide public telecommunication network
- ISDN has standardized user interfaces, implemented a set of digital switches and paths supporting a broad range of traffic types and providing a value added processing service
- ISDN is multiple networks, but integrated to provide user with single, uniform accessibility and world wide interconnection.
- 1st generation is N-ISBN (*narrowband ISDN*), supports 144kb/s, consists of 2B channels (data) of 64 kb/s each and 1D channel of 16kb/s (control signal), has a circuit switching orientation.
- 2nd generation is B-ISBN (*broadband ISDN*), supports data rates of 100 Mb/s, has a packet switching orientation.

Circuit Switching

- Using dedicated communication path to establish between two stations or multiple end points through the nodes of a WAN
- A transmission path is a connected sequence of physical link between the nodes.
- On each link, a logical channel is dedicated to the connection. Data generated by the source station are transmitted along dedicated path as rapidly as possible.
- In each node, incoming data are routed / switched to an appropriate outgoing channel.
- Typical example of circuit switching: telephone networks.

Packet Switching

- No dedicate transmission link is required. A message/data is sent in a sequence of packets.
- Packets in a same sequence may pass through different set of nodes to reach the same destination
- When a packet is received in a node, it is stored briefly in a buffer, and then transmitted to a next node.
- At destination, packets are put together accordingly to form the complete message from the source.
- Packet switching is commonly used for terminal-to-computer, computer-to-computer communications.
- For packet switch networks, packets require a large overhead for error detection and control. Each node then performs additional processing to insure reliable transmission.
- If packet errors occur, the packet is retransmitted.
- Packet switching networks are designed to operate at data rate of 64kb/s to the end user.

Frame Relay

- Frame relay removes large overhead involved in error protection, enabling high capacity of transmission (assuming low error rates in networks).
- Size of packets can vary.
- Frame relay networks operate at a data rate of 2 Mb/s.

Asynchronous Transfer Mode (ATM)

- also referred to as “Cell Relay”
- Evolved from frame relay and circuit switching.
- Major differences: Frame relay uses variable length packets called “frames”. ATM uses fixed length packets called “cells” (53 Bytes).
- small overhead for error control as frame relay. It depends on inherent reliability of a transmission system and on higher layers in the systems to identify and correct errors.
- operates at a rate up to 100 Mb/s
- allows dynamically using virtual channels with higher data rates as the transmission paths.

Media Access Control (MAC) Address

- is the physical address of a device, e.g. a NIC (network interface card) of a computer in the network.
- A MAC address has two parts, each has 3 bytes. The first 3 bytes specify the company that made the NIC, the 2nd 3 bytes are the serial number of the NIC.

Network Interface Card (NIC)

- Every computer and most devices (e.g. a network printer) is connected to a network through a NIC.
- In most desktop computers, this is an Ethernet card (10 or 100 Mbps) plugged in a slot on the computer motherboard.

Ethernet

- A group of standards for defining a LAN, including standards in cabling, structure of data, hardware connecting these cables.
- Independent of network topology
- IEEE 802.3 Ethernet Specification
  - Great detail specifying cable types, data formats, and procedures for transferring that data through those cables
- IEEE 802.5 Token Ring Specification
- Using MAC addresses to distinguish between machines, Ethernet transmits frames of data across baseband cables using CSMA *(*Carrier Sense Multiple Access*)* / CD *(*Collision Detection*)* (IEEE 802.3)