Computer Communications Networks Course

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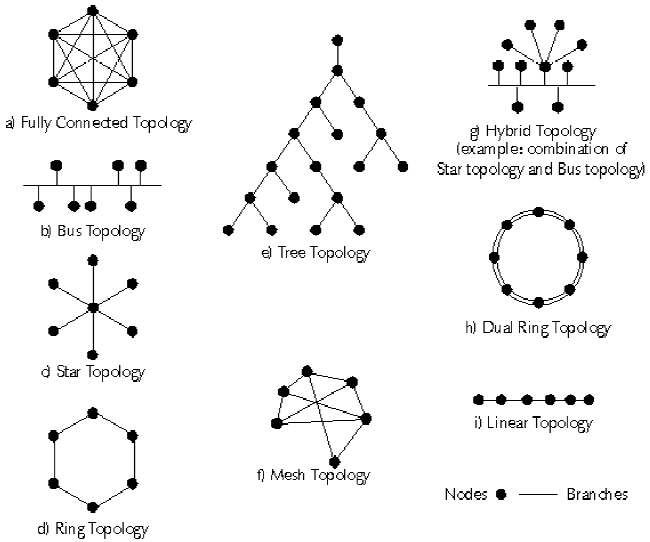
Introduction

- In the real world, data/computer networks are implemented by following a predefined physical and logical layout.
- The physical layout (topology) of a network refers to how communication media, such as cables, computers, and other peripherals are physically connected and arranged.
- Logical topology is the method used to pass the information between workstations.

Network Topologies

Common network physical topologies may be summarized as shown in the Figure.



BUS Topology

- The bus topology is very common for local area networks.
- Network stations are attached to a transmission medium, called a bus.
- When a station transmits a frame on the bus all other stations attached to the bus receive the frame.
- Frames are said to be broadcast on the medium.
- A popular protocol used with this LAN topology is the Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol.
- There is no controlling station on a broadcast bus topology LAN. Control functions are distributed to all LAN stations.
- Each station must also be capable of detecting faults.

STAR Topology

- In a network that has a star topology, each station is connected to a central controlling device (also called a hub/switch) via point-to-point lines. The central device acts as a high speed signal copier/multiplexer between connections.
- The structure of a star network is very simple and has many advantages over the single cable-bus topology such as .
- To overcome the disadvantage of having a single point of failure, the central switch must use very reliable components and usually provides some form of redundancy.

Mesh and Tree Topologies

- **Mesh Topology:** This topology involves some wiring overhead since every network station is directly connected to all the other stations.
- It also means that each station has to have (N-1) I/O ports, where N is the number of stations in the network.
- However, a mesh network topology has excellent fault tolerance, since, when a link fails, message traffic can be routed through an intermediate node.
- **Tree topology:** is a variation of the bus topology. A CSMA/CD protocol can be applied to both topologies, and in both cases transmitted frames are broadcast to all stations active on the shared medium. As with the bus topology, there is no controlling station on the LAN.

Ring Topologies

- In a network that has a ring topology, each station is attached to its adjacent station by point-to-point links thus forming a physical ring. Each station's adapter regenerates the signal as it retransmits a data packet that is circulating on the ring.
- A popular protocol used with ring topology is token passing, in which access to the medium is controlled by possession of a circulating token.
- Different token passing access protocols are defined for ring topology LANs.
- The major disadvantage of a physical ring topology is its sensitivity to single link failure. If one connection between two stations fails the ring traffic is down.

Communication Media and Network Access

- In a network, information (data) traverses a communications medium (typically a wire) as electrical signals that originate and terminate in computing devices like computers and printers.
- Three basic elements of a network:
  - **The communication medium**: (typically a cable, but radio frequency and infrared transmissions can also serve as a data communications medium);
  - **The data (information)**: its data (which flows in its most elementary binary form -essentially zeros and ones);
  - **The Access Points**: which contact between network wires and the computing devices to which they are connected. These latter are called network interface cards (**NICs**).

Examples of Communication Media (1)

- Network cables are typically coaxial, twisted-pair, or fiber optic. Some are shielded while others are not. These different types of cable vary in cost and transmission capacity, and each typically serves a specific network role.
- Fiber optic cable has the added advantage of being non-conductive, which is advantageous for external cables.
- Coaxial cables is rapidly losing favor on modern networks because it is difficult to work with and integrates poorly with switched networks.

Examples of Communication Media (2)

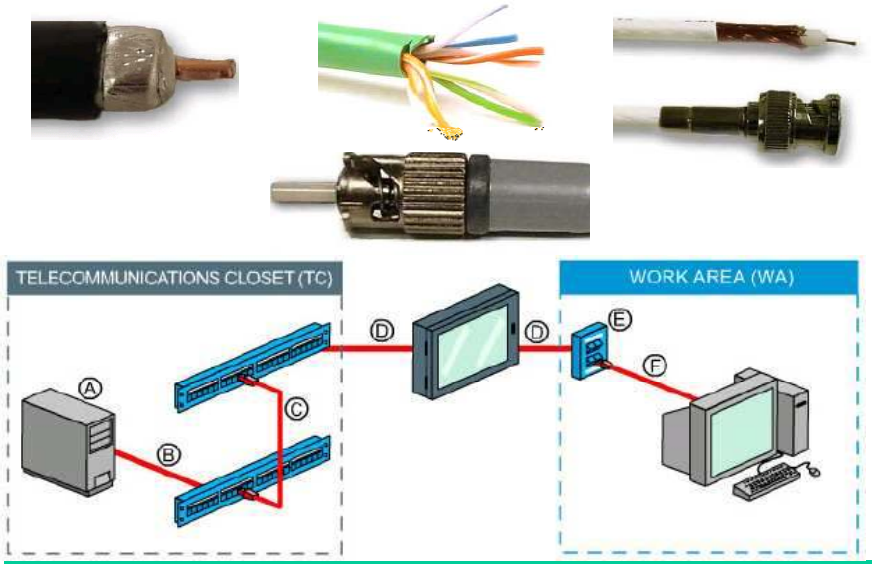
- In summary, we have
  - **Coax:** Two conductors share the same axis. Commonly used for thick Ethernet, thin Ethernet, cable TV and ARCnet, coaxial cabling that uses BNC connectors; heavy shielding protects data, but expensive and hard to make connectors. Bandwidth is between 2.5 Mbps and 10 Mbps.
  - **UTP**: Unshielded Twisted Pair uses RJ-45, RJ-11, RS-232, and RS-449 connectors. Max length is 100 meters, speed is up to 100Mps. Cheap, easy to install, length becomes a problem. It is most sensitive to electromagnetic interference. Can be CAT 2,3,4,5 or 6 quality grades.

Examples of Communication Media (3)

- **STP**: Shielded Twisted Pair. One or more twisted pairs of wire in foil or wire woven-copper shielding. Uses RJ-45, RJ-11, RS-232, and RS-449 connectors, max length is 100 meters, speed is up to 500Mps. Not as inexpensive as UTP, easy to install.

- **Fiber Optic**: (IEEE 802.8) Cable in which the center core, a glass cladding composed of varying layers of reflective glass, refracts light back into the core. Max length is 25 kilometers, speed is up to 2Gbps but very expensive. Best used for a backbone due to cost.

Examples of Communication Media (4)



Overview of Network Devices (1)

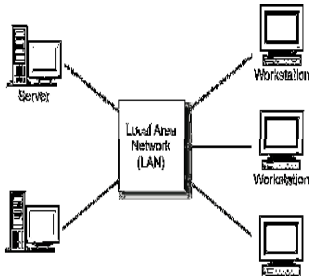
- LANs are the basic building blocks of a computer network.
- Large-scale networks join LANs together with cables (or other communications medium).
- Linking stations and LANs together introduces complexity, particularly if the network has a great many stations and LANs, or if they are separated geographically.
- Without network devices, large-scale networks would be impossible to build.

Overview of Network Devices (2)

- The technology of central connection points, such as hubs, bridges, routers, and switches allow networks to be segmented, and they also add "address-intelligence" at the level of the physical wire.
- They solve the problem of line-length constraints by acting as repeaters.
- The main used network devices are:
  - **Hub:** it is the point of central connection for all of the LAN's shared devices. a hub serves the same function as the shared cable in the bus model -it connects devices on the LAN.

Overview of Network Devices (3)

- On a hubbed LAN, devices exchange data by first sending it to the hub. The hub, in turn, repeats the "message" back out to all of its connected devices.



- As with the bus LAN, only the device to which the message is addressed will copy the message, while the others ignore it.
- When a LAN reaches its maximum effective size, it is necessary to install another LAN and then connect the two.

Overview of Network Devices (4)

- **Router:** is a device that, like a hub, has ports through which data passes.
  - With a router, data passes only from one LAN to another.
  - Unlike hubs, routers do not blindly repeat the data they receive. Instead, routers are "intelligent" devices.
  - As data packets flow into a router, it inspects the packet's header (which contains the packet's destination address) and based on this information it makes a routing decision.
  - Because routers understand communications protocols (like IP, which governs Internet addressing), routers can make configurable routing decisions.
  - Routers are typically more expensive than other inter-network connection devices, and they are also more complicated to set up.

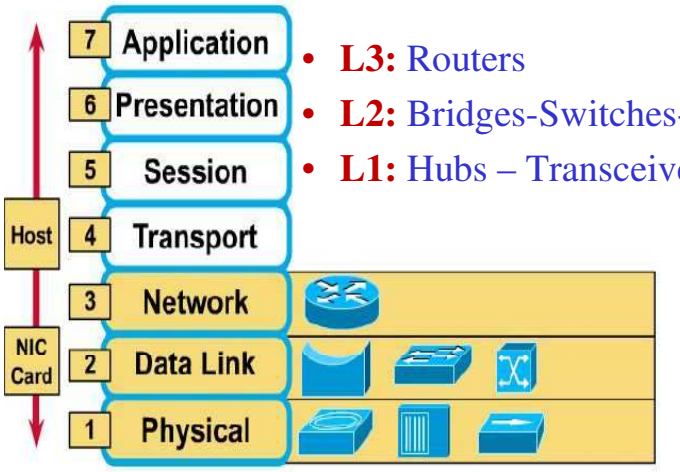
Overview of Network Devices (5)

- **Bridge:**
  - Bridges are simpler and less expensive than routers, but offer similar inter-network capability.
  - Typically, bridges have ports connected to two or more separate LAN segments.
  - Rather than complicated routing decisions, bridges make straightforward yes/no decisions about forwarding the data packets they receive.
  - Bridges base their decisions on the packet's destination address (H/W), which it compares to a stored table of known network addresses.
  - Although, bridges are not sophisticated as routers, they do possess some filtering capabilities.

Overview of Network Devices (6)

- **Switches:** are the most recent and most sophisticated of inter-networking devices.
  - Like routers and bridges, switches also link LANs.
  - Their strength comes in their ability to link many LANs.
  - They are like multi-port bridges, so they can manage complex switching among multiple LANs. This makes them useful tools for segmenting network traffic.
  - Switches provide the same kind of address-intelligence (filtering and forwarding) that routers provide.
  - But rather than working with the IP address, as routers do, a switch uses H/W address that works at a low level, where the network devices interface with the medium.

Network devices Function at Layers



- **L3:** Routers
- **L2:** Bridges-Switches- Concentrators
- **L1:** Hubs – Transceivers - Repeaters

Limiting Collisions in LANs

- **Reducing traffic in networks makes it more efficient**
- **This can be done using Bridges, Switches and/or Routers.**
- **Each shared link is called collision domain.**
- **We can improve the performance of a Large network by dividing it into multiple collision domains (subnets).**