THOMSON COURSE TECHNOLOGY

Network+ Guide to Networks, Fourth Edition

Chapter 6

Topologies and Access Methods

Objectives

- Describe the basic and hybrid LAN physical topologies, and their uses, advantages and disadvantages
- Describe the backbone structures that form the foundation for most LANs
- Compare the different types of switching used in data transmission

Objectives (continued)

- Understand the transmission methods underlying Ethernet, Token Ring, FDDI, and ATM networks
- Describe the characteristics of different wireless network technologies, including Bluetooth and the three IEEE 802.11 standards

Simple Physical Topologies

- Physical topology: physical layout of nodes on a network
- Three fundamental shapes:
  - Bus
  - Ring
  - Star
- May create hybrid topologies
- Topology integral to type of network, cabling infrastructure, and transmission media used

Bus

- Single cable connects all network nodes without intervening connectivity devices
- Devices share responsibility for getting data from one point to another
- Terminators stop signals after reaching end of wire
  - Prevent signal bounce
- Inexpensive, not very scalable
- Difficult to troubleshoot, not fault-tolerant

Bus (continued)

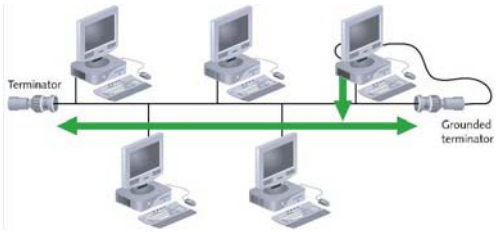

Figure 6-1: A terminated bus topology network

Ring

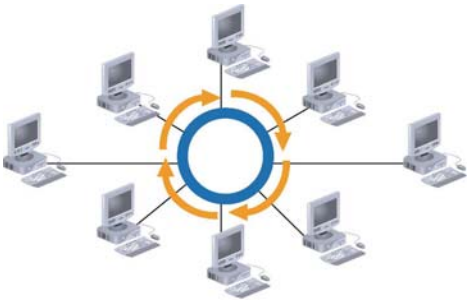

Figure 6-2: A typical ring topology network

Star

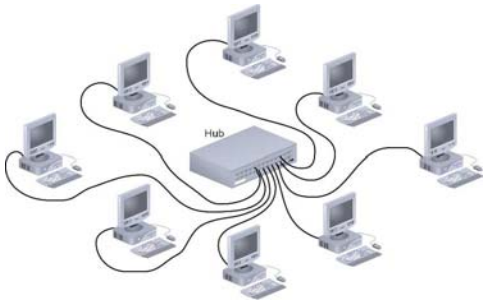

Figure 6-3: A typical star topology network

Star (continued)

- Any single cable connects only two devices
  - Cabling problems affect two nodes at most
- Requires more cabling than ring or bus networks
  - More fault-tolerant
- Easily moved, isolated, or interconnected with other networks
  - Scalable
- Supports max of 1024 addressable nodes on logical network

Hybrid Physical Topologies: Star-Wired Ring

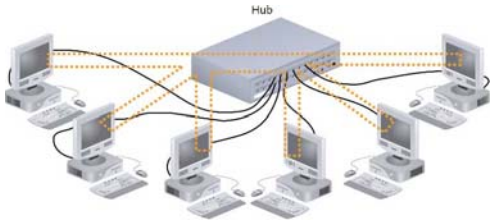

Figure 6-4: A star-wired ring topology network

Star-Wired Bus

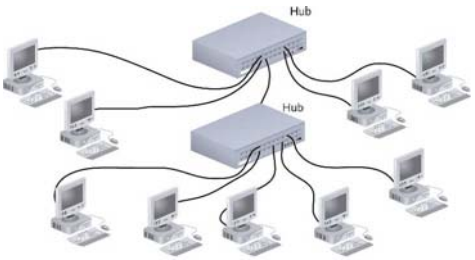

Figure 6-5: A star-wired bus topology network

Backbone Networks: Serial Backbone

- Daisy chain: linked series of devices
  - Hubs and switches often connected in daisy chain to extend a network
- Hubs, gateways, routers, switches, and bridges can form part of backbone
- Extent to which hubs can be connected is limited

Backbone Networks: Serial Backbone (continued)

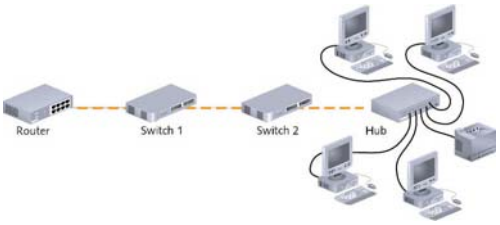

Figure 6-6: A serial backbone

Distributed Backbone

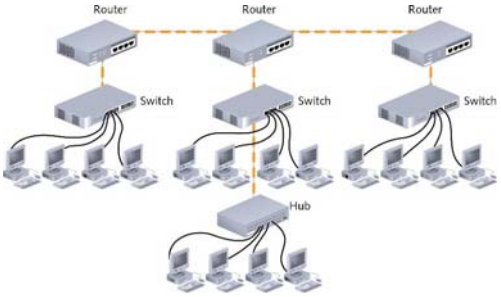

Figure 6-8: A distributed backbone connecting multiple LANs

Collapsed Backbone

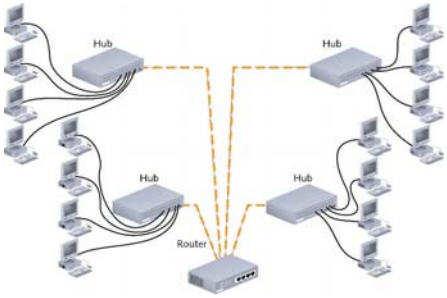

Figure 6-9: A collapsed backbone

Parallel Backbone

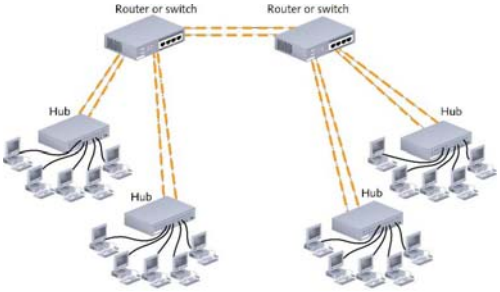

Figure 6-10: A parallel backbone

Logical Topologies

- Logical topology: how data is transmitted between nodes
  - May not match physical topology
- Bus logical topology: signals travel from one network device to all other devices on network
  - Required by bus, star, star-wired physical topologies
- Ring logical topology: signals follow circular path between sender and receiver
  - Required by ring, star-wired ring topologies

Switching: Circuit Switching

- Switching: component of network's logical topology that determines how connections are created between nodes
- Circuit switching: connection established between two network nodes before transmission
  - Bandwidth dedicated to connection
    - Remains available until communication terminated
  - While connected, all data follows same path initially selected by switch
  - Can result in waste of available resources

Message Switching

- Establishes connection between two devices, transfers information, then breaks connection
  - Information then stored and forwarded from second device to third device on path
  - "Store and forward" routine continues until message reaches destination
  - All information follows same physical path
  - Requires that each device in data's path have sufficient memory and processing power to accept and store information

Packet Switching

- Breaks data into packets before transmission
  - Packets can travel any network path
    - Contain destination address and sequencing information
    - Can attempt to find fastest circuit available
- When packets reach destination node, they are reassembled
  - Based on control information
  - Not optimal for live audio or video transmission
- Efficient use of bandwidth

Ethernet: CSMA/CD (Carrier Sense Multiple Access with Collision Detection)

- Access method: method of controlling how network nodes access communications channels
- CSMA/CD: Ethernet's access method
  - Ethernet NICs listen on network
    - Wait until no nodes transmitting data over the signal on the communications channel before transmission
    - Several Ethernet nodes can be connected to a network and can monitor traffic simultaneously

Ethernet: CSMA/CD (continued)

- Collision: two transmissions interfere with each other
  - Common on heavy-traffic networks
    - Can corrupt data or truncate data frames
- Jamming: NIC indicates to network nodes that previous transmission was faulty
- Collision domain: network portion in which collisions occur
- Data propagation delay: length of time data takes to travel between segment points

Ethernet: CSMA/CD (continued)

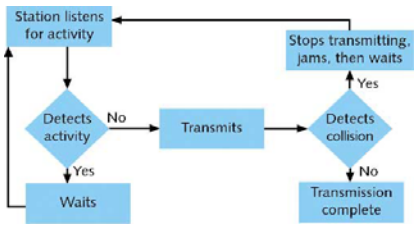

Figure 6-11: CSMA/CD process

Switched Ethernet

- Shared Ethernet: fixed amount of bandwidth
  - Shared by all devices on a segment
  - All nodes on segment belong to same collision domain
- Switched Ethernet: enables multiple nodes to simultaneously transmit and receive data over different logical network segments
  - Increases effective bandwidth of network segment

Switched Ethernet (continued)

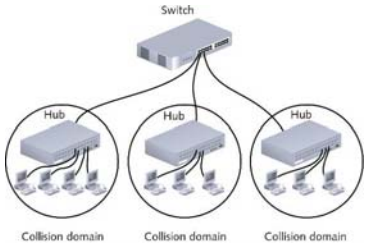

Figure 6-12: A switched Ethernet network

Ethernet Frames

- Ethernet networks may use one (or a combination) of four kinds of data frames:
  - Ethernet_802.2 (“Raw”)
  - Ethernet_802.3 (“Novell proprietary”)
  - Ethernet_II (“DIX”)
  - Ethernet_SNAP
- Frame types differ in way they code and decode packets of data
- Ethernet frame types have no relation to network’s topology or cabling characteristics

Using and Configuring Frames

- Cannot expect interoperability between frame types
- Node’s Data Link layer services must be properly configured for types of frames it might receive
  - LAN administrators must ensure all devices use same, correct frame type
  - Most networks use Ethernet_II
- Frame types typically specified through device’s NIC configuration software
  - Most NICs automatically sense frame types running on network and adjust

Frame Fields

- Ethernet frame types share many common fields
- Every frame contains:
  - 7-byte preamble and 1-byte start-of-frame delimiter (SFD)
  - 14-byte header
    - Destination address
    - Source address
    - Additional field that varies in function and size
  - 4-byte FCS field
  - Data portion
    - 46 to 1500 bytes of information

Ethernet_II (“DIX”)

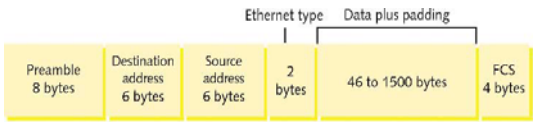

Figure 6-13: Ethernet_II (“DIX”) frame

PoE (Power over Ethernet)

- IEEE 802.3af standard specifies method for supplying electrical power over Ethernet connections
  - Useful for nodes far from power receptacles or needing constant, reliable power source
- Power sourcing equipment (PSE): device that supplies power
- Powered devices (PDs): receive power from PSE
- Requires CAT 5 or better copper cabling

Token Ring

- Token Ring networks can run at 4, 16, or 100 Mbps
  - High-Speed Token Ring (HSTR)
- Use token-passing routine and star-ring hybrid physical topology
- Token passing: 3-byte packet (token) transmitted between nodes in circular fashion around ring
  - When station has something to send, picks up token, changes it to a frame, adds header, information, and trailer fields
  - All nodes read frame as it traverses ring

Token Ring (continued)

- Token-passing control scheme avoids possibility for collisions
  - More reliable and efficient than Ethernet
- Active monitor: maintains timing for ring passing, monitors token and frame transmission, detects lost tokens, corrects errors
- Token Ring connections rely on NIC that taps into network through a MAU
- Self-shorting feature of Token Ring MAU ports makes Token Ring highly fault tolerant

Token Ring (continued)

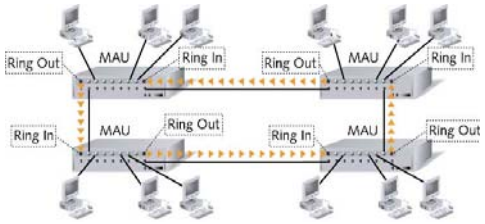

Figure 6-14: Interconnected Token Ring MAUs

FDDI (Fiber Distributed Data Interface)

- Uses double ring of MMF or SMF to transmit data at speeds of 100 Mbps
  - First network technology to reach 100 Mbps
  - Frequently found supporting network backbones installed in late 1980s and early 1990s
  - Used on MANs and WANs
  - Links can span distances up to 62 miles
  - Reliable and secure
  - Expensive

FDDI (continued)

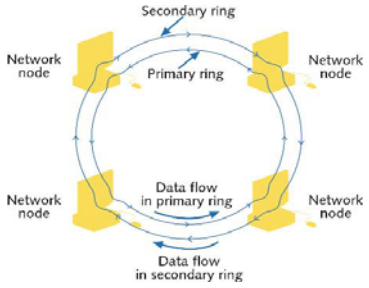

Figure 6-16: A FDDI network

ATM (Asynchronous Transfer Mode)

- ITU standard describing Data Link layer protocols for network access and signal multiplexing
- Packet called a cell
  - Always has 48 bytes of data plus 5-byte header
  - Fixed size provides predictable network performance
- Virtual circuits: connections between nodes that logically appear to be direct, dedicated links
  - Switches determine optimal path
    - Establish path before transmission
  - Configurable use of limited bandwidth

ATM (continued)

- Typically considered a packet-switching technology
- Establishing reliable connection allows ATM to guarantee specific quality of service (QoS) for certain transmissions
  - Standard specifying data will be delivered within certain period of time
- Compatible with other network technologies
- LAN Emulation (LANE) allows integration with Ethernet or Token Ring networks

Wireless Networks: 802.11

- Notable standards: 802.11b, 802.11a, 802.11g
  - Share many characteristics
    - e.g., Half-duplex signaling
- Access Method:
  - MAC services append 48-bit physical addresses to frames to identify source and destination
  - Use Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) to access shared medium
    - Minimizes potential for collisions
    - ACK packets used to verify every transmission

Wireless Networks: 802.11 (continued)

- Access Method (continued):
  - Request to Send/Clear to Send (RTS/CTS) protocol enables source node to issue RTS signal to an access point
    - Request exclusive opportunity to transmit
- Association:
  - Communication between station and access point enabling station to connect to network
  - Scanning: station surveys surroundings for access point(s)

Wireless Networks: 802.11 (continued)

- Association (continued):
  - Active scanning: station transmits a probe on all available channels within frequency range
  - Passive scanning: station listens on all channels within frequency range for beacon frame issued from an access point
    - Contains info required to associate node with access point [e.g., Service Set Identifier (SSID)]
  - WLANs can have multiple access points
    - Reassociation: station changes access points

Wireless Networks: 802.11 (continued)

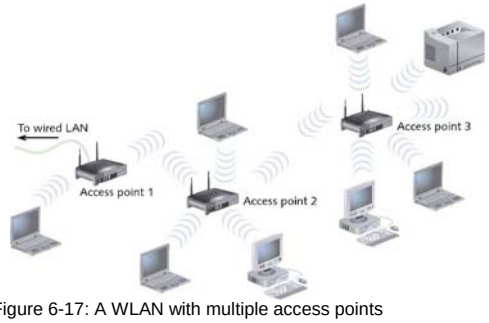

Figure 6-17: A WLAN with multiple access points

Wireless Networks: 802.11 (continued)

- Frames:
  - For each function, 802.11 specifies frame type at MAC sublayer
  - Management frames involved in association and reassociation
  - Control frames related to medium access and data delivery
  - Data frames carry data sent between stations

Wireless Networks: 802.11 (continued)

Frame Control (2 bytes)	Duration (2 bytes)	Address 1 (6 bytes)	Address 2 (6 bytes)	Address 3 (6 bytes)	Sequence Control (2 bytes)	Address 4 (6 bytes)	Data (0 - 2312 bytes)	Frame Check Sequence (6 bytes)

Figure 6-18: Basic 802.11 MAC frame format

Bluetooth

- Mobile wireless networking standard that uses FHSS RF signaling in 2.4-GHz band
- Relatively low throughput and short range
- Designed for use on small networks composed of personal area networks (PANs)
  - Piconets
    - Piconets consisting of two devices requires no setup
    - Master and slaves
    - Multiple Bluetooth piconets can be combined to form a scatternet

Bluetooth (continued)

Figure 6-19: A wireless personal area network (WPAN)

Bluetooth (continued)

Figure 6-21: A scatternet with two piconets

Infrared (IR)

Figure 6-22: Infrared transmission

Infrared (IR) (continued)

Standard	Frequency Range	Theoretical Maximum Throughput	Effective Throughput (Approximate)	Average Geographic Range
802.11b ("Wi-Fi")	2.4 GHz	11 Mbps	5 Mbps	100 meters (or approximately 330 feet)
802.11a	5 GHz	54 Mbps	11–18 Mbps	20 meters (or approximately 66 feet)
802.11g	2.4 GHz	54 Mbps	20–25 Mbps	100 meters (or approximately 330 feet)
Bluetooth ver. 1.x	2.4 GHz	1 Mbps	723 Kbps	10 meters (or approximately 33 feet)
Bluetooth ver. 2.0	2.4 GHz	2.1 Mbps	1.5 Mbps	30 meters (or approximately 100 feet)
IrDA	300–300,000 GHz	4 Mbps	3.5 Mbps	1 meter (or approximately 3.3 feet)

Table 6-1: Wireless standards

Summary

- A physical topology is the basic physical layout of a network; it does not specify devices, connectivity methods, or addresses on the network
- A bus topology consists of a single cable connecting all nodes on a network without intervening connectivity devices
- In a ring topology, each node is connected to the two nearest nodes so that the entire network forms a circle
- In a star topology, every node on the network is connected through a central device, such as a hub

Summary (continued)

- LANs often employ a hybrid of more than one simple physical topology
- Network backbones may follow serial, distributed, collapsed, or parallel topologies
- Switching manages the filtering and forwarding of packets between nodes on a network
- Ethernet employs a network access method called CSMA/CD
- Networks may use one (or a combination) of four kinds of Ethernet data frames

Summary (continued)

- Token Ring networks use the token-passing routine and a star-ring hybrid physical topology
- FDDI's fiber-optic cable and dual fiber rings offer greater reliability and security than twisted-pair copper wire
- ATM is a Data Link layer standard that relies on fixed packets, called cells, consisting of 48 bytes of data plus a 5-byte header
- Wireless standards vary by frequency, methods of signal, and geographic range