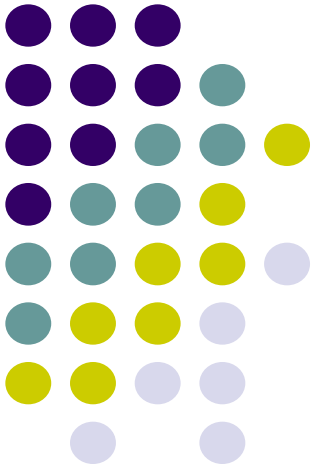
CME 3004 Computer Networks

LAN Technologies
and
Network Topologies



Direct Point-to-Point Communication

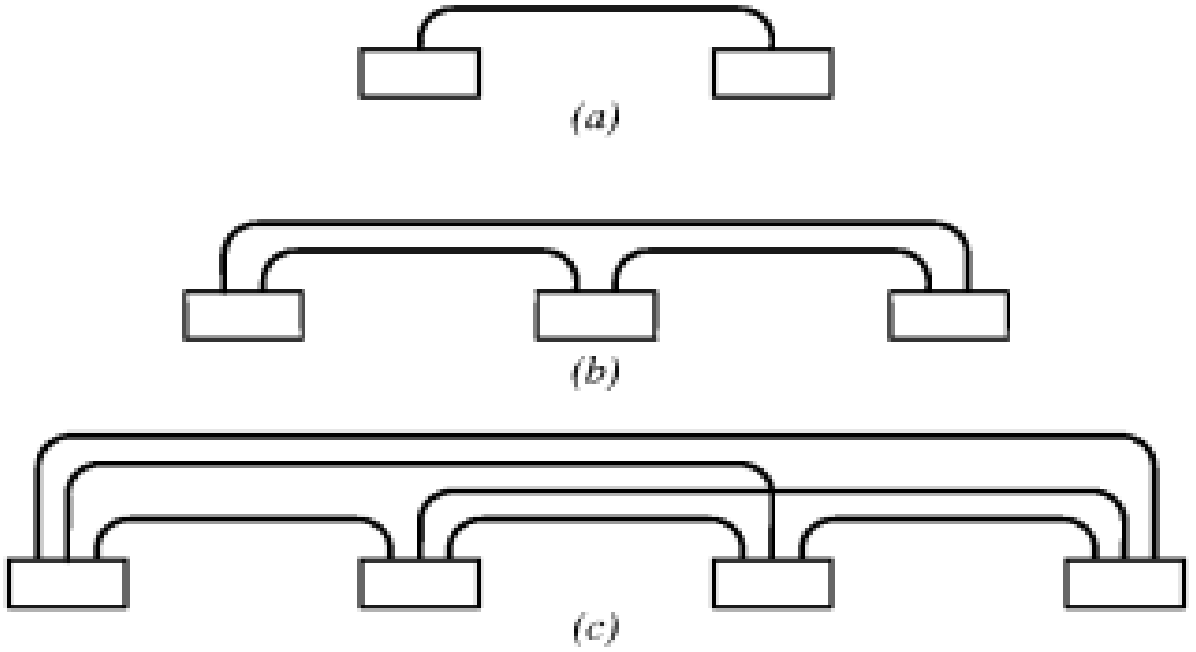
- Computers connected by communication channels that each connect exactly ***two*** computers

- Forms

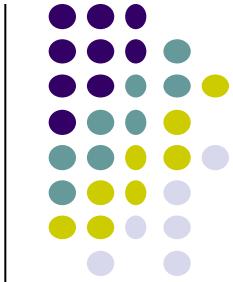
  mesh or

  point-to-point

  network



Advantages of Point-to-Point Network

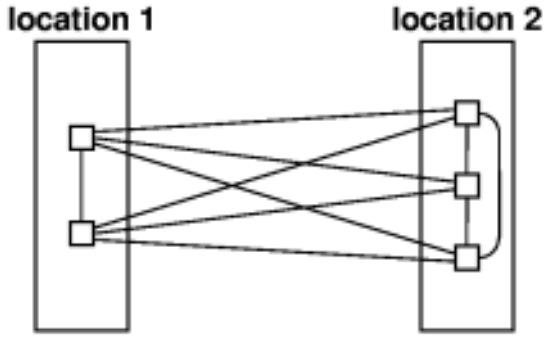


- Allows flexibility in communication hardware, packet formats, etc.
- The connected computers can decide exactly how to send data across the connection.
- Provides security and privacy because communication channel is not shared.

Disadvantages of Point-to-Point Network

- Number of wires grows as square of number of computers
  - For N computers:

    Direct Connections = $\frac{(N^2 - N)}{2}$

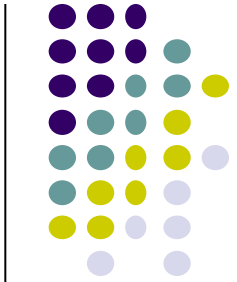


- Adding a new computer

requires *N - 1* new connections

- Connections between buildings can be prohibitive

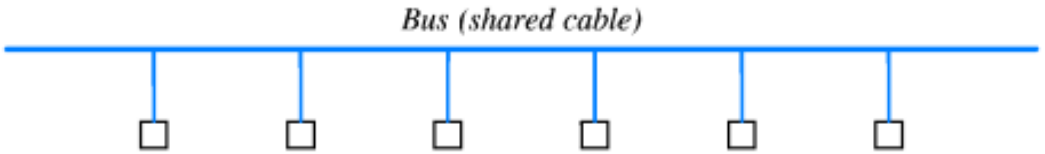
Local Area Networks

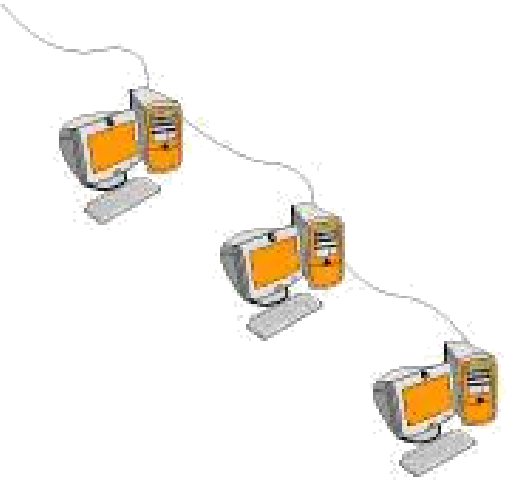


- LANs developed in late 1960s and early 1970s
- Alternative to expensive, dedicated point-to-point connections, etc.
- Locality reference principle
- Networks may be classified by its general shape or topology. Three most popular:
  - Star , Ring, Bus

Bus Topology

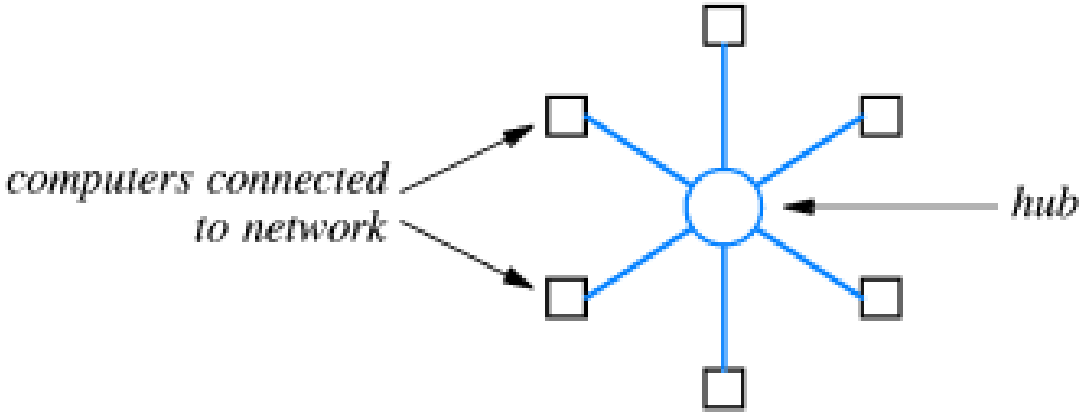
- Single cable connects all computers
- Each computer has connected to shared cable
- Computers must synchronize and allow only one computer to transmit at a time

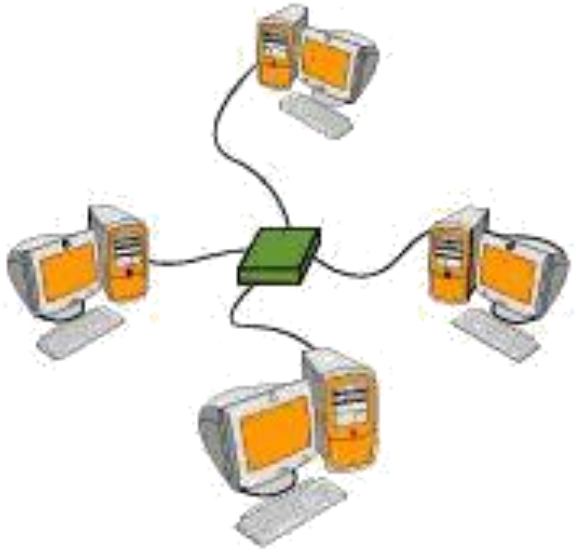




Star Topology

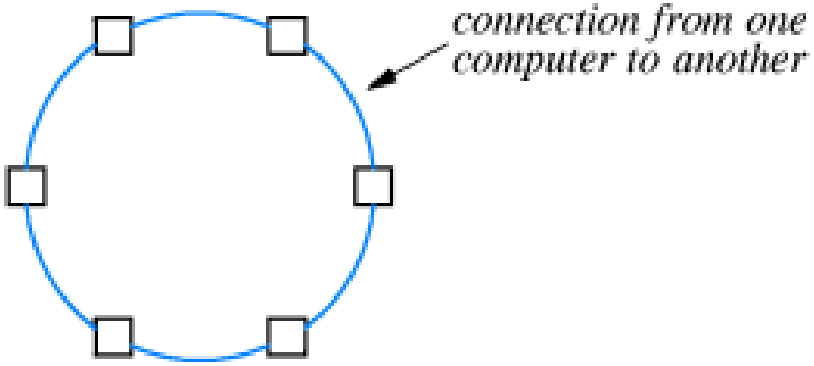
- All computers attach to a central point
- Center of star is sometimes called a *hub*

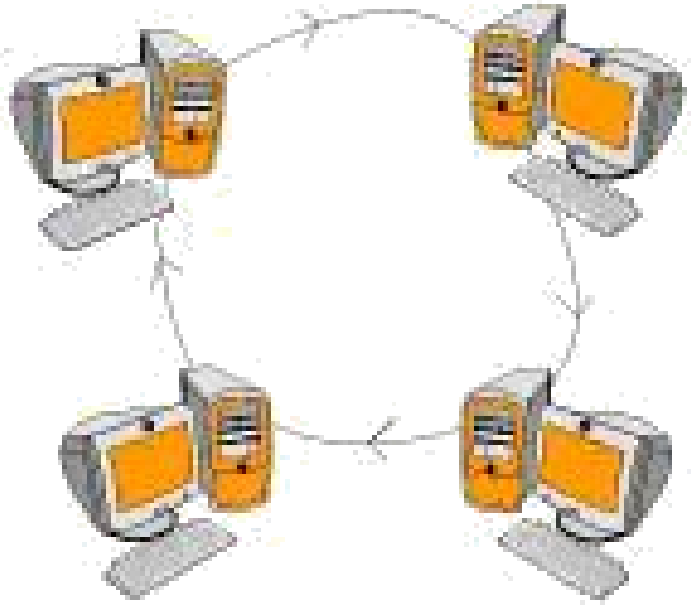




Ring Topology

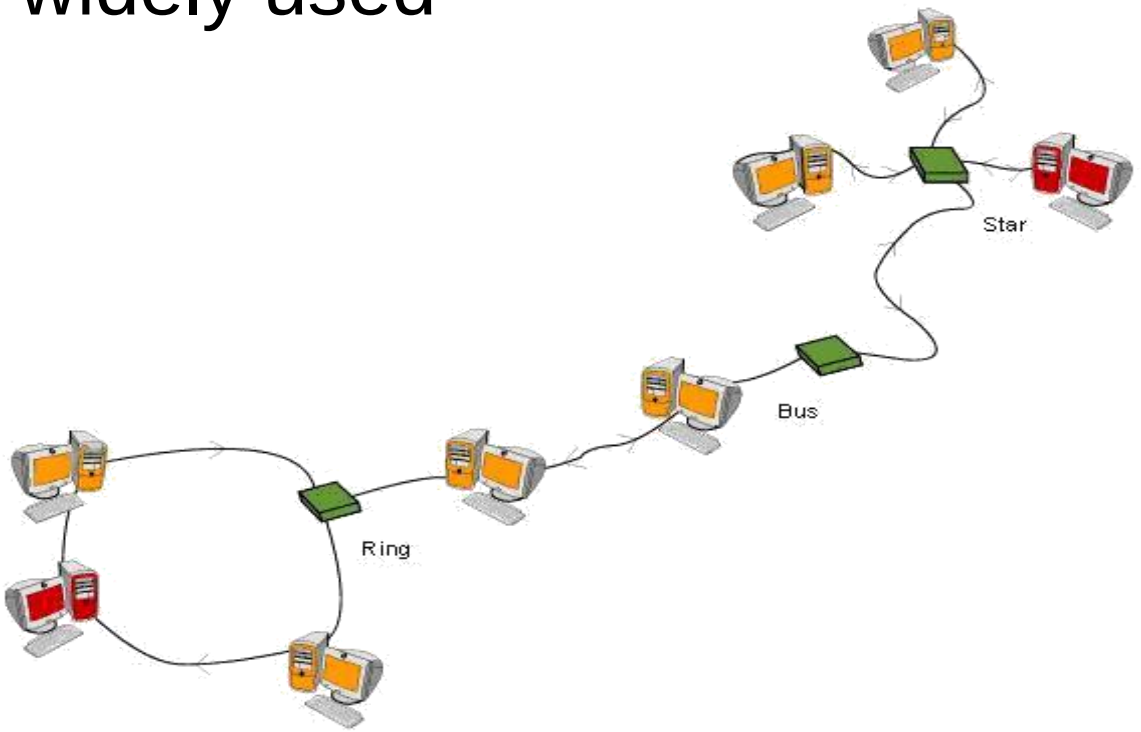
- Computers connected in a closed loop
- First passes data to second, second passes data to third, and so on



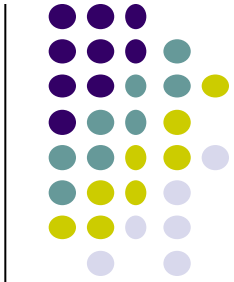


Why Multiple Topologies?

- Each has advantages and disadvantages
- Industry is settling on star topology as most widely used



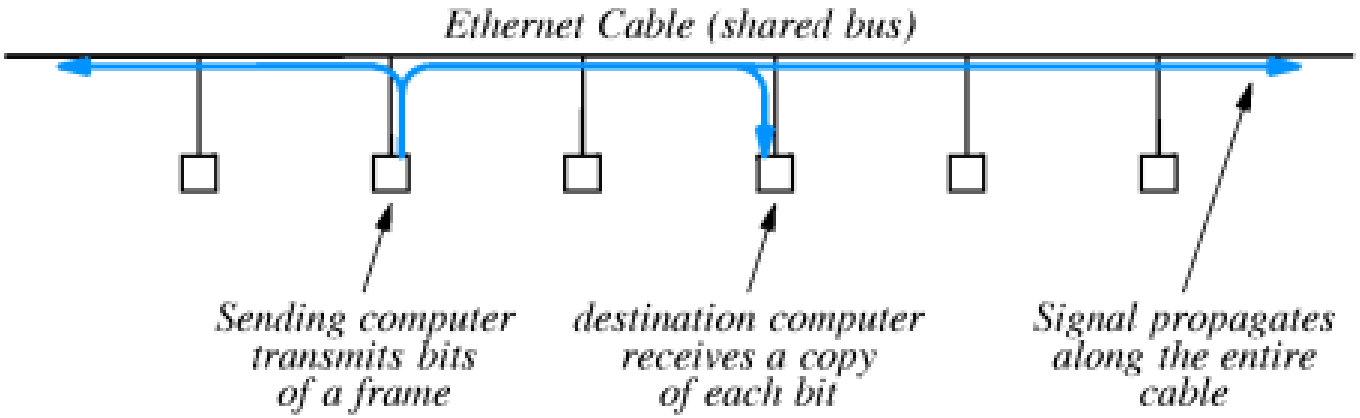
Example Bus Network: Ethernet



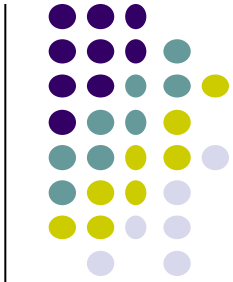
- Widely used LAN technology
- Uses bus topology
  - Single coax cable - the *ether*
  - Multiple computers connect
- One Ethernet cable is sometimes called a *segment*
  - Limited to 500 meters in length
  - Minimum separation between connections is 3 meters

Ethernet speeds

- Originally 3Mbps
- Current standard is 10Mbps
- *Fast Ethernet* operates at 100Mbps

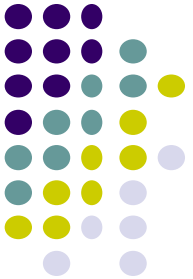


Carrier Sense Multiple Access (CSMA)



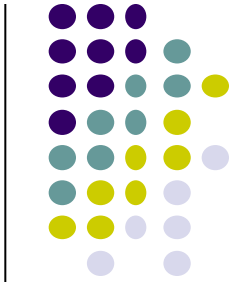
- Ethernet network does not have a centralized controller to coordinate transmission.
- CSMA is a distributed coordination scheme that uses electrical activity on the cable to determine status, it is the idea of using the presence of signal to determine when to transmit.
- If no computer sends frame, ether does not contain electrical signals.
- To determine whether the cable is currently being used, a carrier can be checked. This carrier wave is usually of much higher frequency than the input signal.
- "**Carrier Sense**", checking for a carrier wave, describes the fact that a transmitter listens for a carrier wave before trying to send.
- "**Multiple Access**" describes the fact that multiple stations send and receive on the medium.

Carrier Sense Multiple Access with Collision Detect (CSMA-CD)



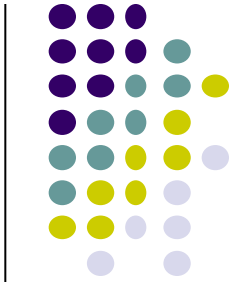
- The interference between two signals is called **collision**.
- CSMA can not prevent all possible conflicts.
- When a collison is detected, sending station stops transmitting.
- **Collision Detect (CD)** is monitoring cable during transmission.
- CSMA-CD is Ethernet mechanism used to detect collisions.
- CSMA-CD is a network control protocol in which:
  - a carrier sensing scheme is used.
  - a transmitting data station that detects another signal while transmitting a frame, stops transmitting that frame, transmits a jam signal, and then waits for a random time interval (known as "backoff delay" and determined using the truncated binary exponential backoff algorithm) before trying to send that frame again.

Carrier Sense Multiple Access with Collision Avoidance (CSMA-CA)



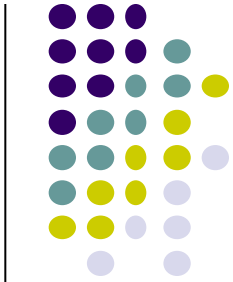
- In CSMA/CA, once the channel is clear, a station sends a signal telling all other stations not to transmit, and then sends its packet.
- In Ethernet 802.3, the station continues to wait for a time, and checks to see if the channel is still free. If it is free, the station transmits, and waits for an acknowledgment signal that the packet was received.
- Because control messages are much shorter than data frames, the probability of a second collision is much lower than conventional Ethernet.

Example Bus Network: LocalTalk



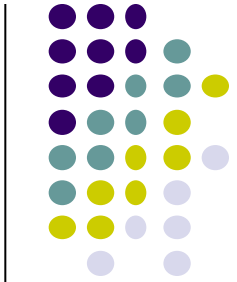
- LAN technology that uses bus topology
- Interface included with all Macintosh computers
- Relatively low speed, has lower throughput
- Low cost (``free'' with a Macintosh); easy to install and connect
- Uses CSMA/CA (instead of CSMA/CD)

Example Ring Network: Token Ring



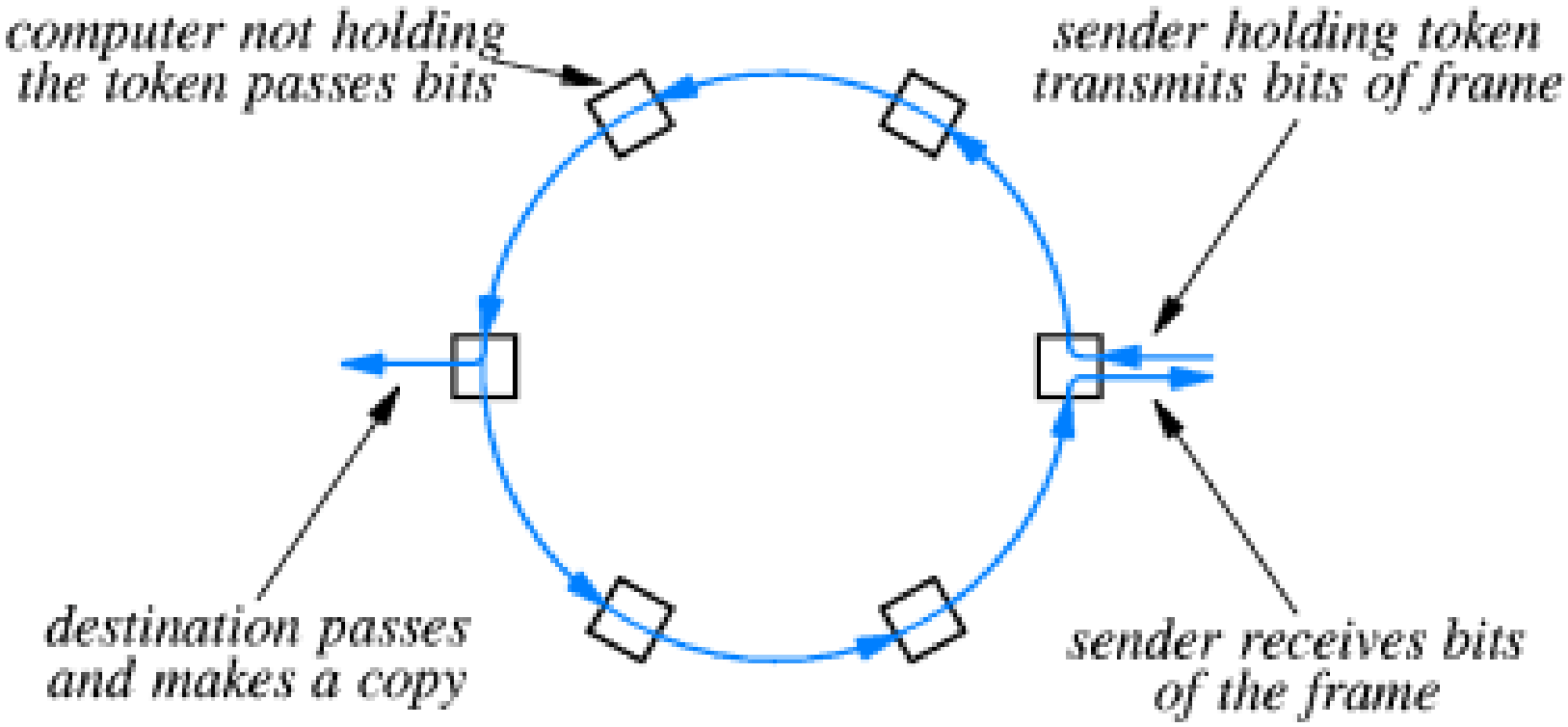
- Many LAN technologies that use ring topology use *token passing* for synchronized access to the ring
- Ring itself is treated as a single, shared communication medium
- Bits pass from transmitter, past other computers and are copied by destination
- Hardware must be designed to pass token even if attached computer is powered down

Using the Token

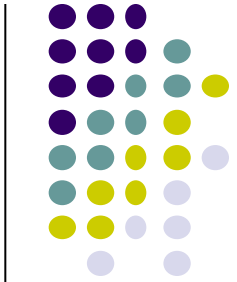


- When a computer wants to transmit, it waits for the *token*
- After transmitting one frame, computer transmits token on ring
- Next computer ready to transmit receives token and then transmits
- Famous example: IBM Token Ring

Using the Token

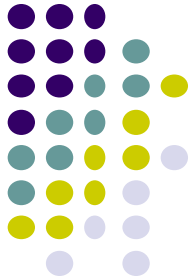


Example Ring Network: FDDI



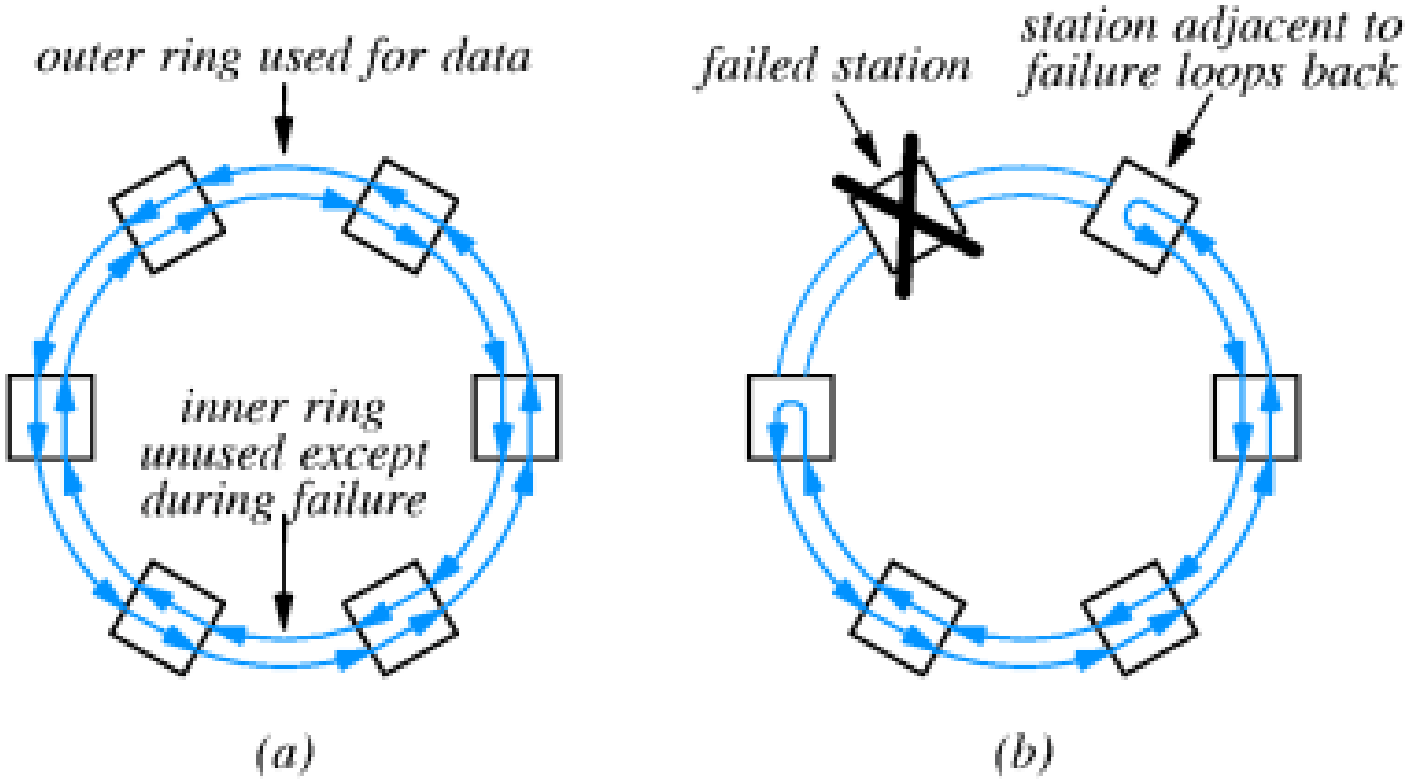
- ***Fiber Distributed Data Interconnect*** **(FDDI)** is a LAN technology that uses ring topology
  - Uses fiber optics between stations
  - Transmits data at 100Mbps
- Uses pairs of fibers to form two concentric rings.
- ***CDDI (Copper Distributed Data Interconnection)*** works like FDDI, but uses copper wires instead of optical fibers.

Fiber Distributed Data Interconnect

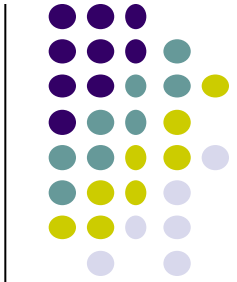


- FDDI uses *counter-rotating* rings
- In case of fiber or station failure, remaining stations *loop back* and reroute data through spare ring
- All stations automatically configure loop back by monitoring data ring
- Self-healing network

Fiber Distributed Data Interconnect

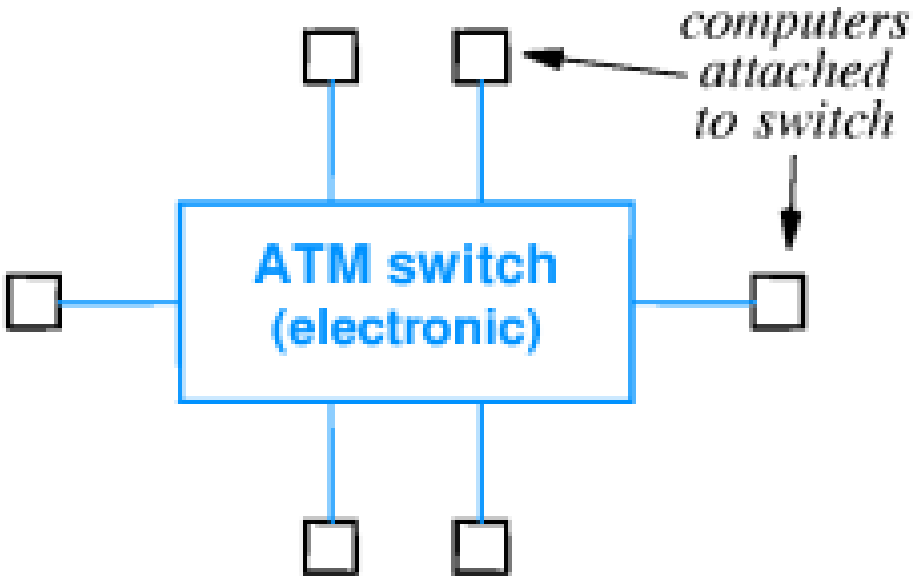


Example Star Network: ATM



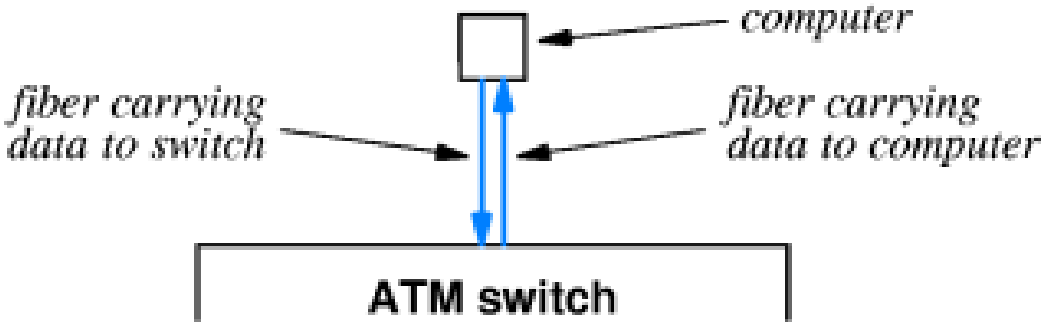
- Asynchronous Transfer Mode technology is a LAN technology that uses star topology which consists of electronic packet switches to which computers can connect
- ATM switches form *hub* into which computers connect
- Computers get point-to-point connections
  - data from transmitter is routed directly through hub switches to destination

Asynchronous Transfer Mode

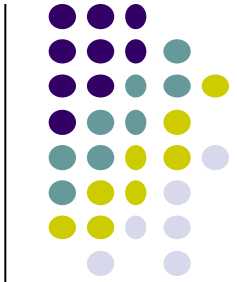


Asynchronous Transfer Mode

- *Transmits data at over 155Mbps*
- *Uses fiber optics to connect computer to switch*
- *Each connection includes two fibers*



LAN Technologies



- *LAN technologies use shared communication media to interconnect multiple computers over short distances*
- *Transmitting computer has exclusive use of communication medium*
- *Computers must synchronize transmission and share available capacity*