NETWORK TOPOLOGY

How To Chose Between The Different Network Topologies

- To chose between these topologies, you have to consider the relative transmission status between the devices to be linked together
- These relative transmission status between devices include:
  - *Peer-to-peer* transmission:
    - The devices equally share the control on the link
  - *Primary-secondary* transmission:
    - One device controls the traffic, whereas the others must transmit through it
- Ring and mesh topologies are more convenient for peer-to-peer transmission
- Star topology is more convenient for primary-secondary transmission
- Bus topology is equally convenient for either

A Star Network Example: ATM

- Asynchronous Transfer Mode (ATM)
- ATM has nothing to do with the Automated Teller Machines, which many banks provide; although an ATM machine may use an ATM network to talk to its bank
- The basic element of an ATM network is an electronic switch to which several computers can be connected

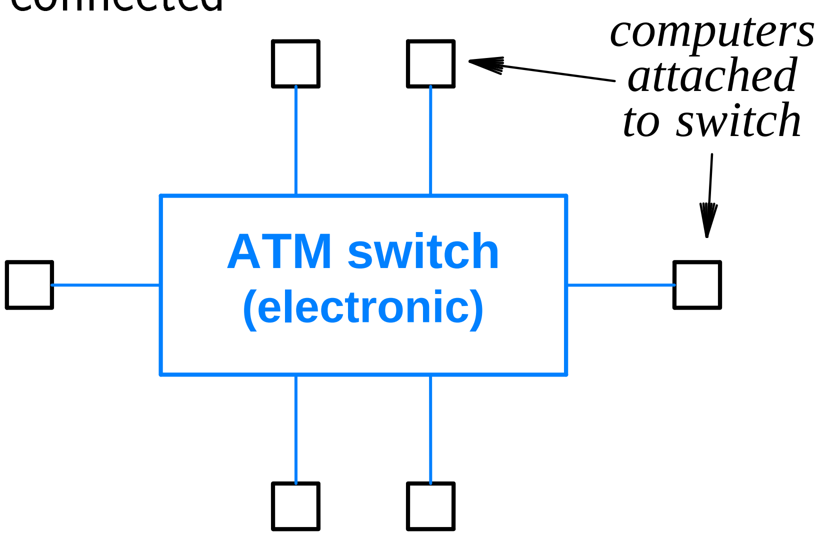


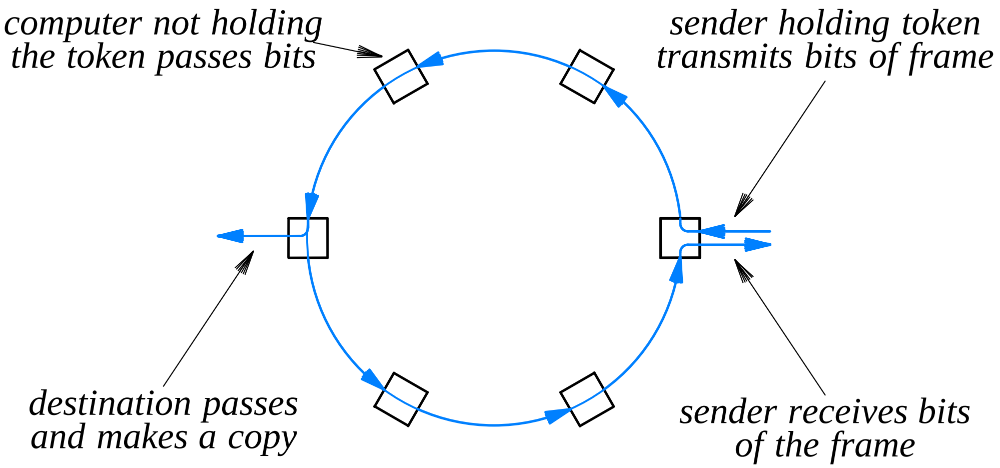
Illustration of an ATM switch with six computers attached

- Before transferring any data between two computers
  - A request must be sent from one computer to the ATM switch asking for establishing a connection with another computer
  - If the request is granted by the switch, the connection between these two computers is established and the data transfer can be started
- Although data delivery is not 100% guaranteed, but their order is
- Unlike bus or ring topologies, a star network does not propagate data to any computers other than the communicating pair
- If the connection between a computer and the switch breaks, only that computer is affected
- A typical connection between a computer and an ATM switch operates at a speed of 155 Mbps, or faster
- To carry such high data rates, the connection between a computer and an ATM switch usually is a optical fiber, not a copper cable

A Ring Network Example: IBM Token-Ring

- A "*token*" is a special reserved message (bit pattern) which is not included within any data frame
- Bit stuffing is applied to assure that the token pattern is not included within any data frames
- If the network is idle, i.e., there is no data passing around the ring, the token is passed around the ring
- The token-ring hardware ensures that exactly one token exists on a token-ring network
- When a computer needs to send data, it must wait for permission before it can access the network
  - A computer must wait for the token to arrive
  - When a token arrives, the computer temporarily removes the token from the ring and consider itself gets the acquired permission

- Once it obtains permission, the sending computer has a complete control of the ring; i.e., no other computer is allowed to send
- As the sending computer transmits a frame, and only one frame, the bits pass from the sender to the next computer, then to the next computer and so on
- If a frame is destined for a given computer, that computer makes a copy of the frame as the bits pass around the ring
- After a full trip around the ring, bits arrive back at the sender
- The sender then transmits the token again

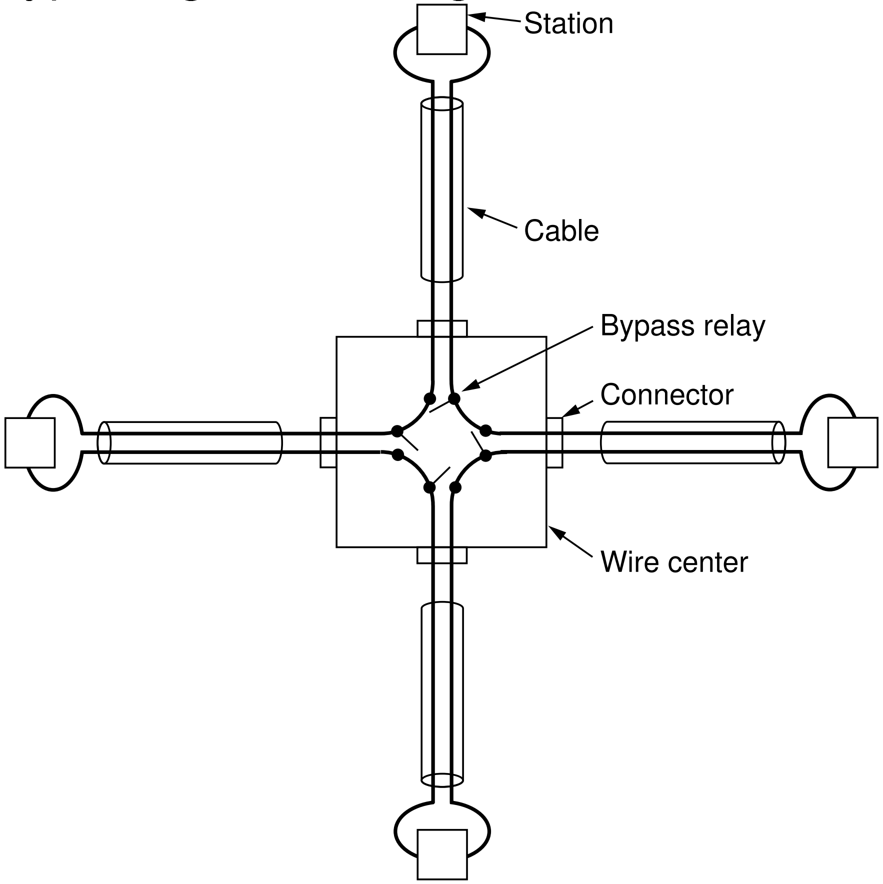


The conceptual flow of bits during a transmission on a token-ring

- The sender can compare the data being received to the data being sent to make sure that no transmission errors occurred
- The token passing scheme guarantees fair access: as token passes around the ring, each computer will have an opportunity to use the network
- If a particular computer does not have any data to send when it receives the token, the interface hardware merely passes the token on without delay
- IBM token-Ring has become so popular that many professionals use the term Token-Ring to denote IBM's technology
- IBM's Token-Ring operates at 16 Mbps

Another Ring Network Example: Star-Shaped Ring

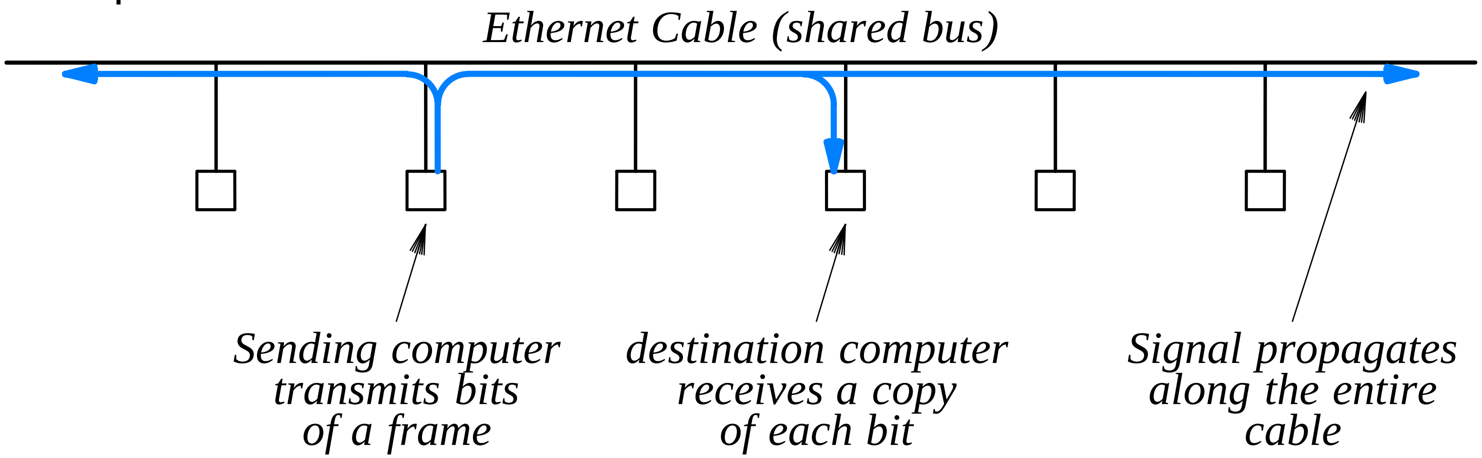
- Star-shaped ring network is a ring network
- It provides a way of preventing the whole network from being disabled if a cable is cut, by bypassing the bad segment



A star-shaped ring network

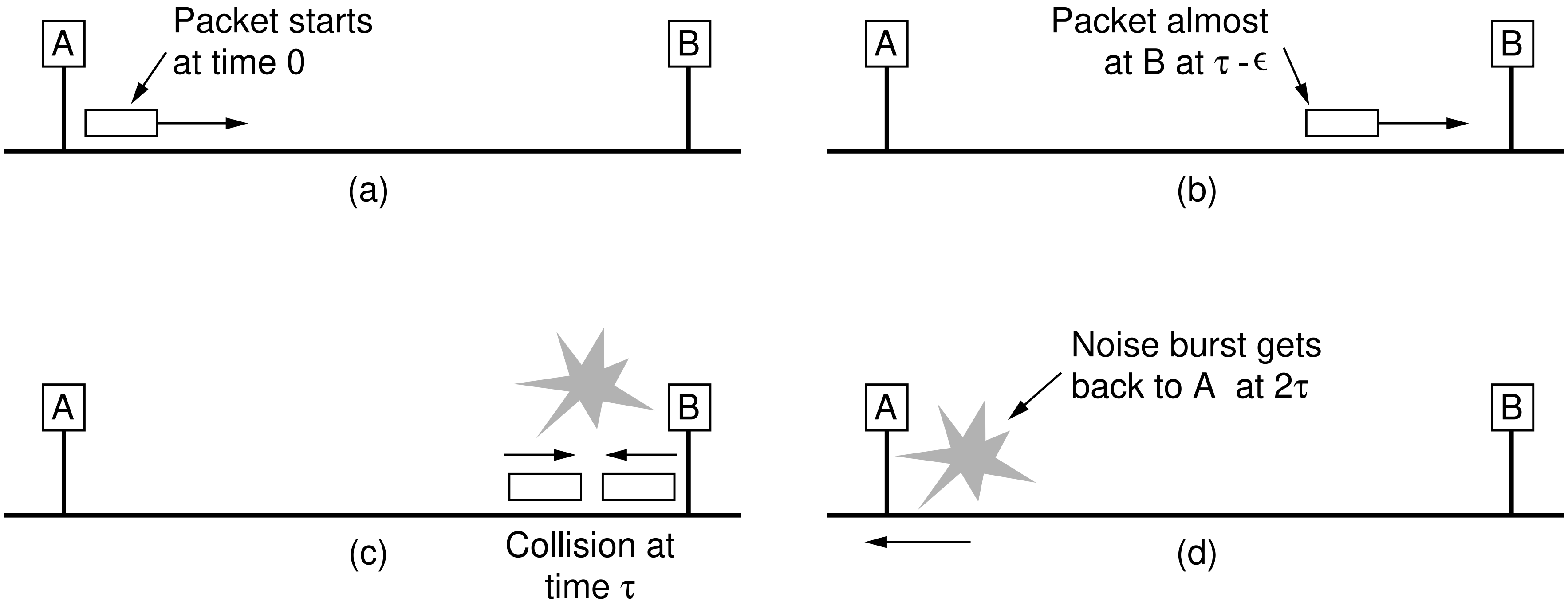
A Bus Network Example: Ethernet

- An Ethernet LAN consists of a single coaxial cable (called segment) to which multiple computers is connected
- A given Ethernet segment is limited in length
- A minimum separation between each pair of connections is required
- Only one computer transmits at any time
- A signal propagates across the entire cable
- All computers receive transmission



Conceptual flow of bits across an Ethernet

- An Ethernet network does not have a centralized controller that tells each computer how to take turn using the shared cable; instead, all computers attached to an Ethernet participate in a distributed coordination scheme called Carrier Sense Multiple Access (CSMA)
  - When a computer wants to transmit, it listens to the cable (Carrier Sense)
  - If the cable is busy, the computer waits until the cable becomes idle; otherwise it transmits immediately
- Although CSMA tries to prevent collisions between data from different computers, it can not prevent all possible conflicts



The sender must monitor signals on the cable for $2 \times \tau$ seconds

- Since a collision might happen, the sender must monitor signals on the cable for $2 \times \tau$ seconds (Collision Detection, or simply CD), where τ is the maximum propagation delay
- If the signal on the cable differs from the signal that the computer is sending, it means that a collision has occurred

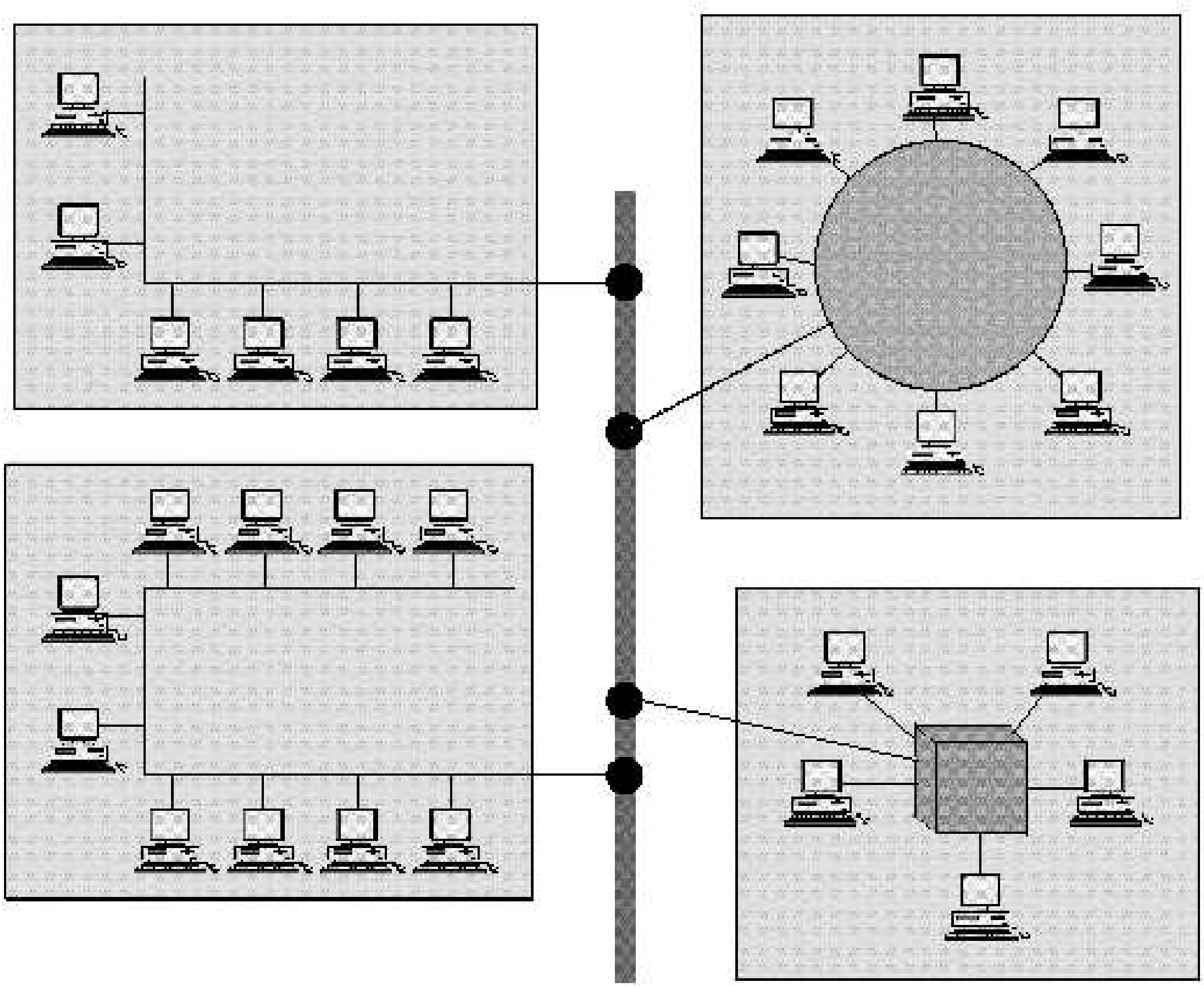
- All Colliding computers must
  - Terminate their transmission
  - Wait a random time, which is less than d seconds
  - Repeat the whole process all over again
- To avoid a sequence of collisions, Ethernet requires each computer to double the maximum waiting time before repeating the whole process after each same-frame collision
- This Ethernet mechanism is known as Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- *Is it a good idea to use CSMA/CD in a satellite network? Why?*
- The original Ethernet hardware operated at a bandwidth of 10 Mbps
- A later version, known as fast Ethernet, operates at 100 Mbps
- The most recent version, known as Gigabit Ethernet, operates at 1024 Mbps, i.e., 1 Gbps
- Ethernet is the most popular LAN

Networks Categories

- Networks are classified into one of three primary categories
  - Local Area Network (LAN)
  - Metropolitan Area Network (MAN)
  - Wide Area Network (WAN)

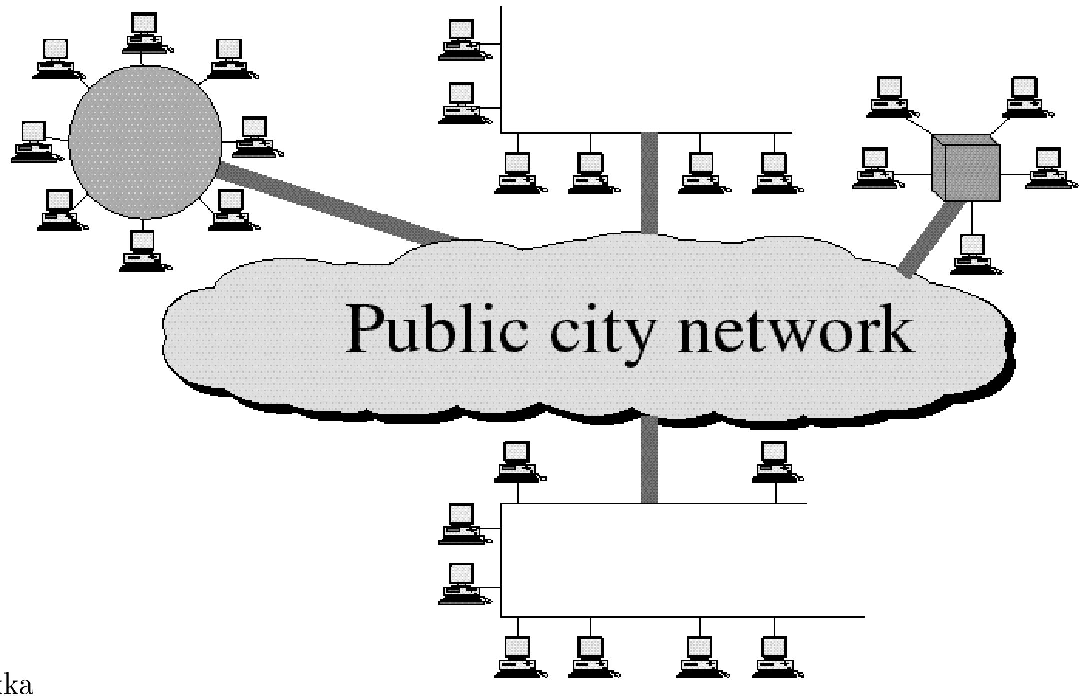
Local Area Network (LAN)

- Privately owned
- Can span a single building or campus (distance limitation)
- Can not handle an arbitrary number of computers (size limitation)
- Although a LAN can be extend (using bridges for example) over an arbitrary distance, it is not considered a WAN; this is due to its limitation to serve arbitrarily number of computers at arbitrarily sites
- Why LAN?
  - A computer is most likely to communicate with:
    * Computers that are physically located nearby, than with computers which are far away from it
    * The same set of computers repeatedly
  - Example: Human communications
- The most common LAN topologies are bus, ring, star, or a combination of them



Metropolitan Area Network (MAN)

- Designed to extend over an entire city
- May be a single network, e.g., a cable TV network, or it may be number of connected LANs
- May be wholly owned and operated by a private company, or it may be a service provided by a public company, such as a local telephone company
- Example: a company can use a MAN to connect the LANs in all of its offices throughout a city



Wide Area Network (WAN)

- Can span sites in multiple cities, countries, or continents
- Can handle an arbitrary number of computers
- May utilize public, leased, or private communication devices
- A WAN not only connects many computers at many sites, but also it must provide sufficient capacity to permit these computers to communicate simultaneously