IEEE 802.3(Ethernet)

IEEE 802.5(Token Ring)

IEEE 802.3
Ethernet

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
Deemed to be University u/s 3 of UGC Act, 1956

Introduction

- Local Area Network (LAN)
  - ***Network connecting devices in a limited geographic area,***
  - ***usually privately owned and limited to a single office, building, or campus***

- Three typical architectures used:
  - ***Ethernet, Token Bus and Token Ring.***

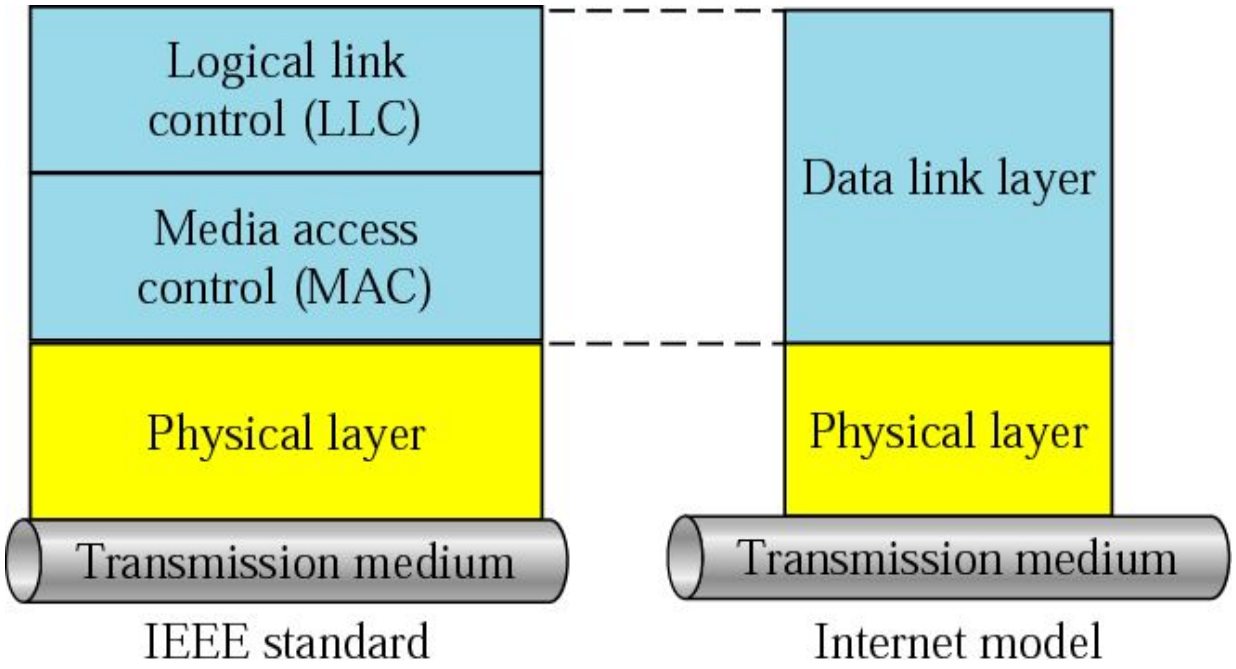
- ***Ethernet most dominant***

- ***Each protocol is based on HDLC***

Introduction

- Data link layer is further subdivided into two sub layers:
  - ***Logical Link Control (LLC)***
  - ***Medium Access Control (MAC)***

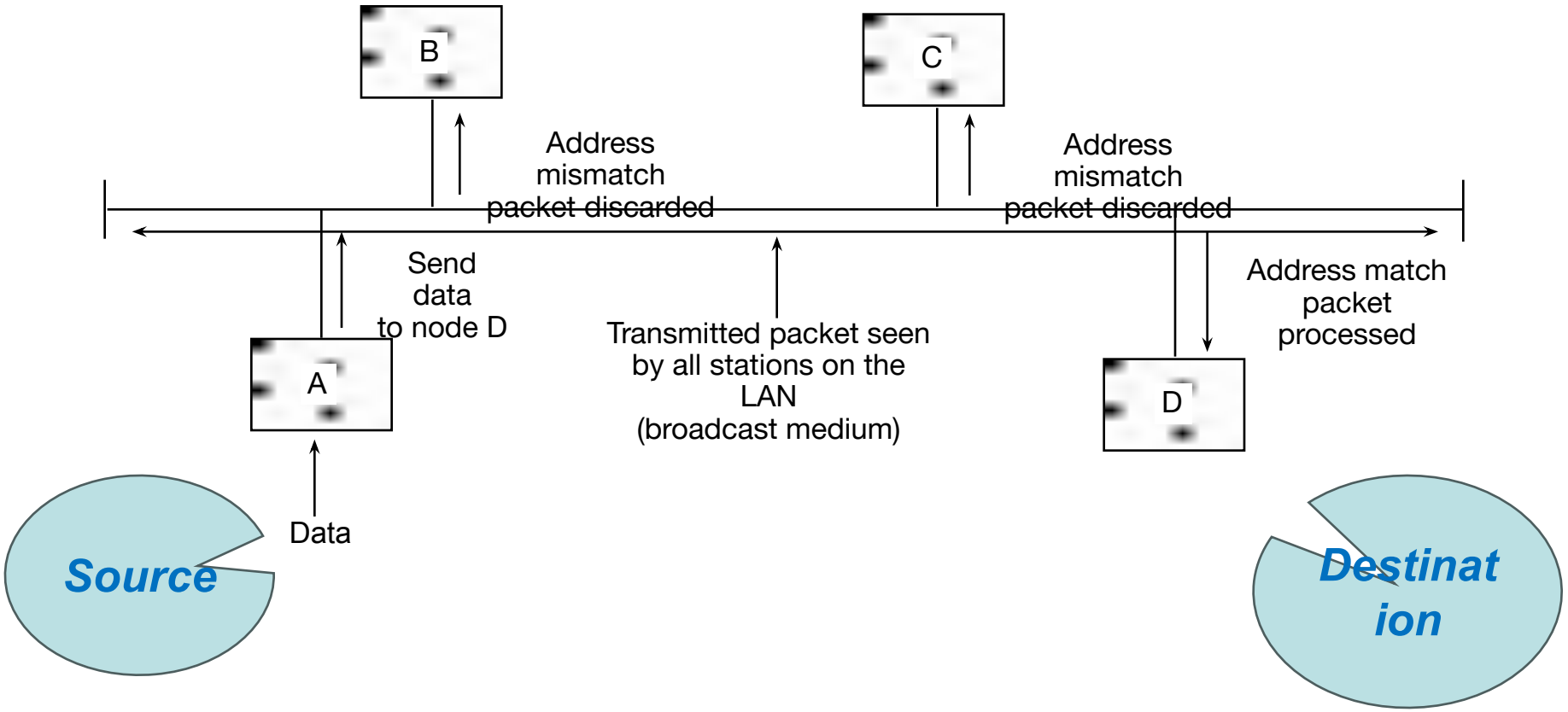
Project 802 and OSI Model



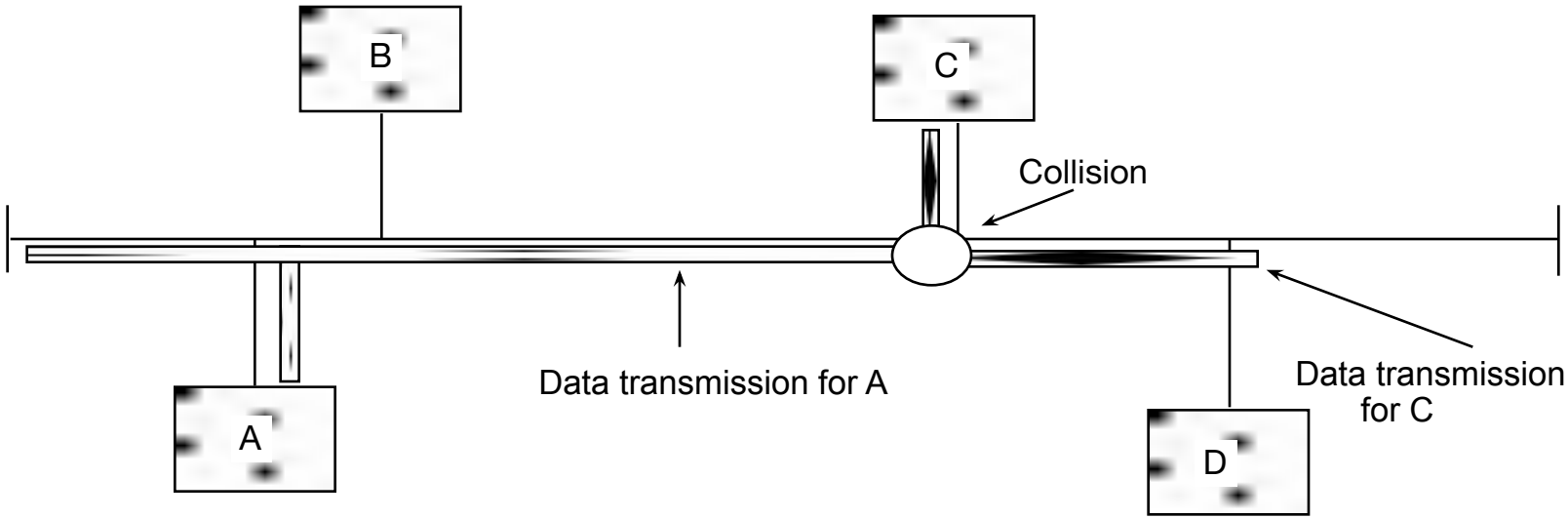
Data Link Layer Sub layers

- **Logical Link Control (LLC)** – upper layer
  - *Handles logical addressing, control information and data*
- **Medium Access Control (MAC)** – lower layer
  - *Proprietary to specific LAN product (e.g. Ethernet, Token Ring, Token Bus, etc.)*
  - *Resolves contention for the medium,*
  - *Provides synchronization, flow control, physical addressing, and error control specifications*

Normal Ethernet Operation



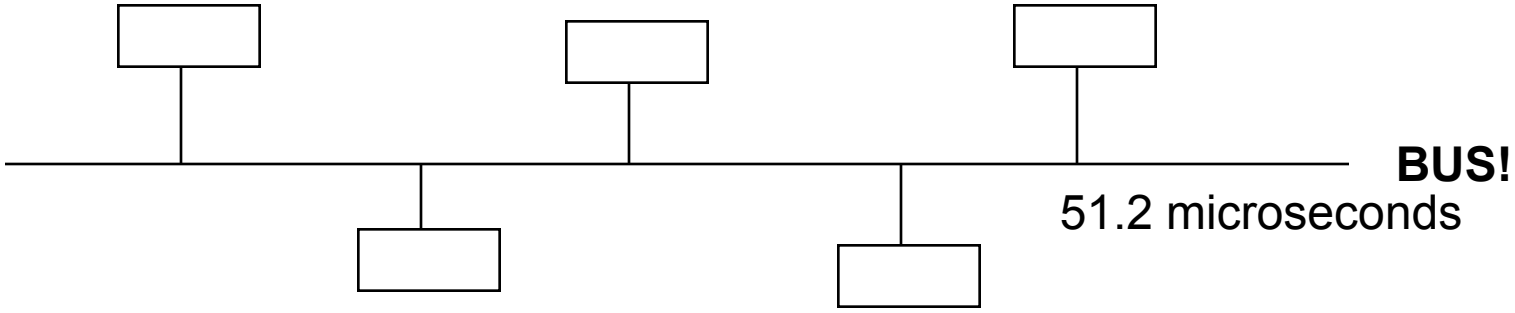
Ethernet Collisions



CSMA/CD

"Carrier Sense/Multiple Access with Collision Detection"

"Driving in Boston"



"Many stations; Listen before talking; listen while talking; if a collision, backoff and try again"

CSMA/CD - A Simple Definition

- A network station wishing to transmit will first check the cable plant to ensure that no other station is currently transmitting (*CARRIER SENSE*).

- The communications medium is one cable, therefore, it does allow multiple stations access to it with all being able to transmit and receive on the same cable (*MULTIPLE ACCESS*).

- Error detection is implemented throughout, ***the use of a station "listening" while it is transmitting its data.***

  - ***A jam signal is transmitted to network by the transmitting stations*** that detected the collision, to ensure that all stations know of the collision. All stations will "backoff" for a random time.

  - Detection and retransmission is accomplished in microseconds.

  - Two or more stations transmitting causes a collision (*COLLISION DETECTION*)

Traditional Ethernet (802.3)

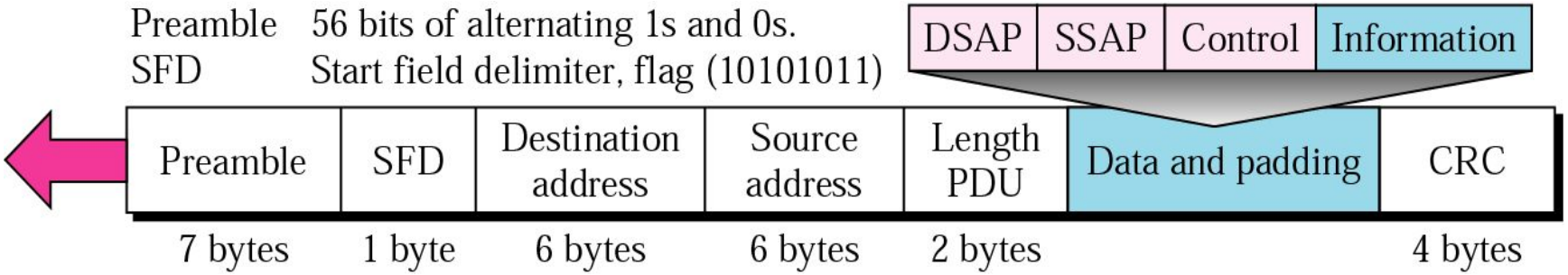
- Overlapping signals are referred to as **collisions**
  - Increased stations Increased traffic more collisions

- Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
  - ***used to coordinate traffic, minimize collisions, and maximize number of frames delivered successfully***

Ethernet Frame Format

- Consists of seven fields

- No mechanism for acknowledging received frames; considered an unreliable medium



Ethernet Frame Fields

- **Preamble** –
  - *seven bytes of alternating 0s and 1s*
  - *To notify receiver of incoming frames and to provide synchronization*
- **Start frame delimiter (SFD)** – one byte signaling the beginning of the frame
- **Destination address (DA)** –
  - *Six bytes*
  - *containing the physical address of the next destination;*
  - *if packet must reach another LAN, this field contains the physical address of the router;*
  - *upon reaching the target network, this field contains the physical address of the destination device*

Ethernet Frame Fields (cont)

- **Source address (SA)**
  - ***Six byte field***
  - ***containing physical address of last station to forward packet, sending station or most recent router***

- **Length/type** – two bytes indicating number of bytes in coming PDU; if fixed length, can indicate type

- **Data** – 46 to 1500 bytes

- **CRC** – CRC-32 error detection information

Ethernet Addressing

- Each station on the network must have a unique physical address
- Provided by a **six-byte physical address** encoded on the network interface card (NIC)
- Normally written in hexadecimal notation

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Categories of traditional Ethernet

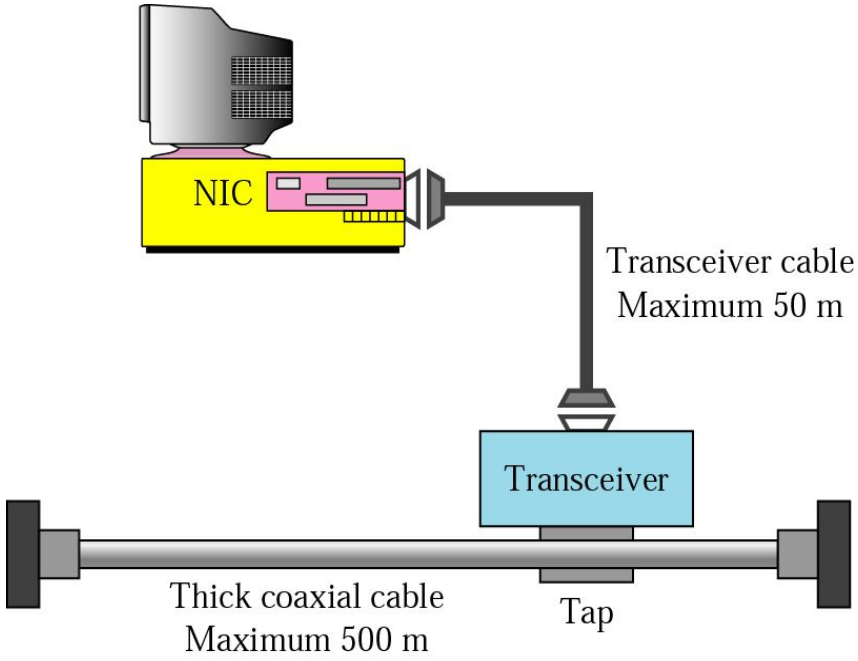
- **Baseband** – digital signals using Manchester encoding
  - **10Base5, 10Base2, 10-Base-T, 10Base-FL**
  - ***First number indicates data rate in Mbps***
  - ***Last number indicates maximum cable length or type***
- **Broadband** – analog signals using digital/analog conversion (differential PSK)
  - Only specification: 10Broad36

10Base5 - Thicknet

- **referred to as thicknet**

- Uses ***thick coaxial cable for connecting stations*** to form a network.

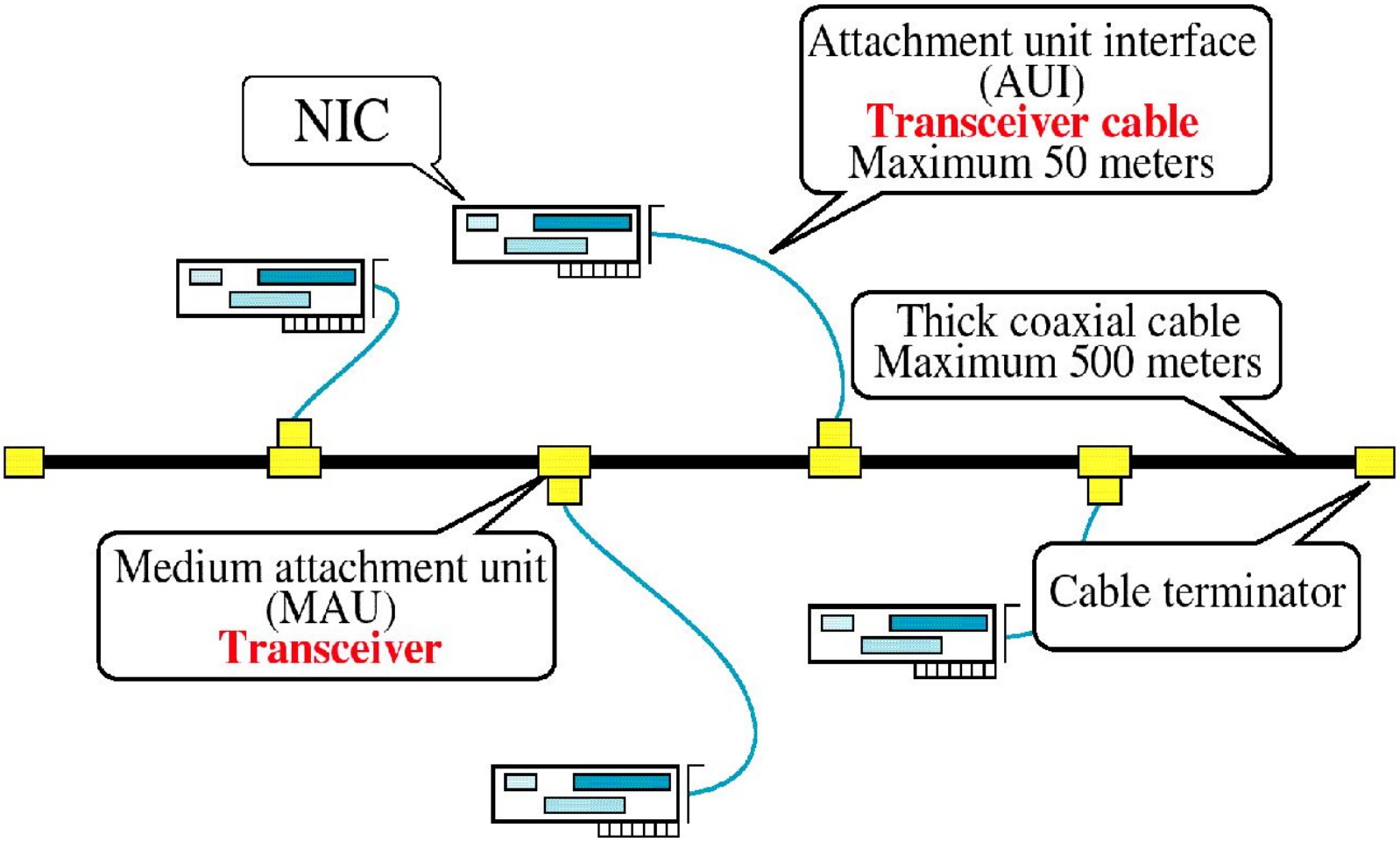
- Another name for 10Base5 is Standard Ethernet



Thicknet Characteristics

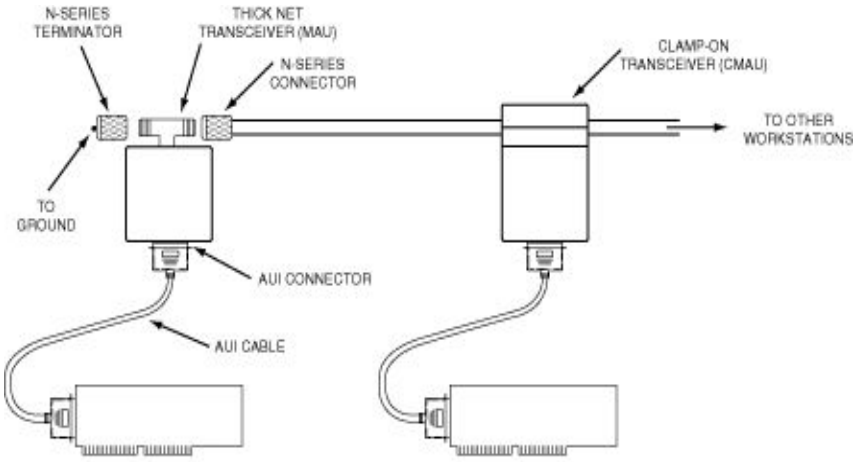
- Supports ***transmission rates up to 10 Mbps*** in Baseband mode
- ***Less expensive than fiber-optic cable***, **but more expensive than other types of coax**
- ***Wide diameter and excellent shielding*** **make it more resistant to noise than other types of wiring**
- In actual networks, the presence of collisions reduces this to more like 4 to 6 Mbps.

10Base5 Topology



10Base5 Connectors

AUI Cable/Transceiver Cable



10Base5 network configuration

10Base2 - Thinnet

- ***Referred to as thinnet (or "thin coax")***
- ***Uses thin coaxial cabling for connecting stations*** to form a network.
- **Supports a maximum bandwidth of 10 Mbps**
- In actual networks, the presence of collisions reduces this to more like 4 to 6 Mbps.
- **The maximum length** of any particular segment of a ***10Base2 network is 185 meters***

10Base2 - Thinnet

- A 10Base2 segment should have *no more than 30 stations wired to it.*

- **The minimum distance between these stations *must be 0.5 meters.***

10Base-T: Twisted Pair Ethernet

- Most popular standard; easiest to install and reconfigure
- Star topology LAN using UTP cable; no need for AUI
- ***Supports data rage of 10 Mbps with a max hub to station length of 100 meters***
- Transceiver operations are carried out in an intelligent hub
- NIC reads destination address of frame and only opens if it matches that address
- 10BaseT networks are wired together in a star topology to a central hub.

10Base-T: Twisted Pair Ethernet

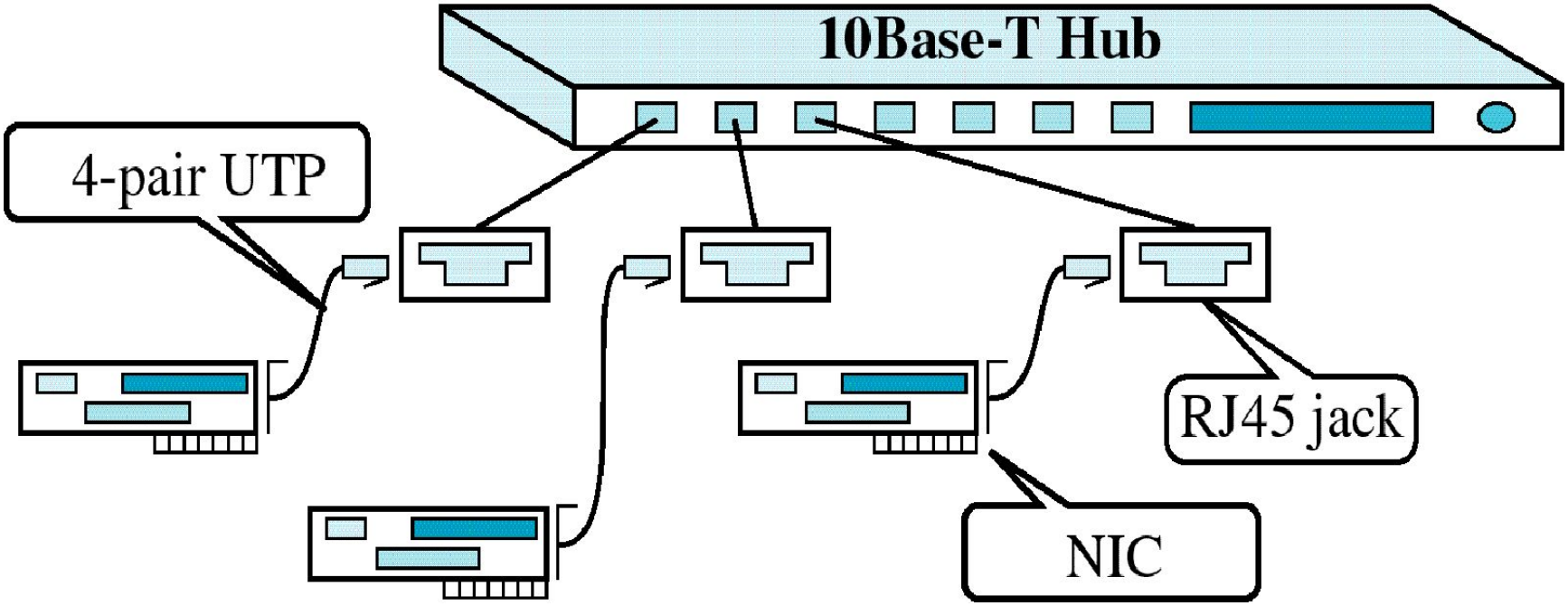
- The UTP cabling used for wiring should be category 3 cabling, category 4 cabling, or category 5 cabling, terminated with RJ-45 connectors.
- **The maximum length** of any particular segment of a ***10BaseT network is 100 meters.***
- **If distances longer than this are required,** ***two or more segments must be connected using repeaters.***
- **The minimum length of a segment** ***should be 2.5 meters.***

10Base-T: Twisted Pair Ethernet

- By using stackable hubs or by cascading regular hubs into a cascaded star topology, you can network large numbers of computers using 10BaseT cable.

- Although they support up to 1024 nodes, collision domains supporting no more than 200 or 300 nodes will yield the best performance

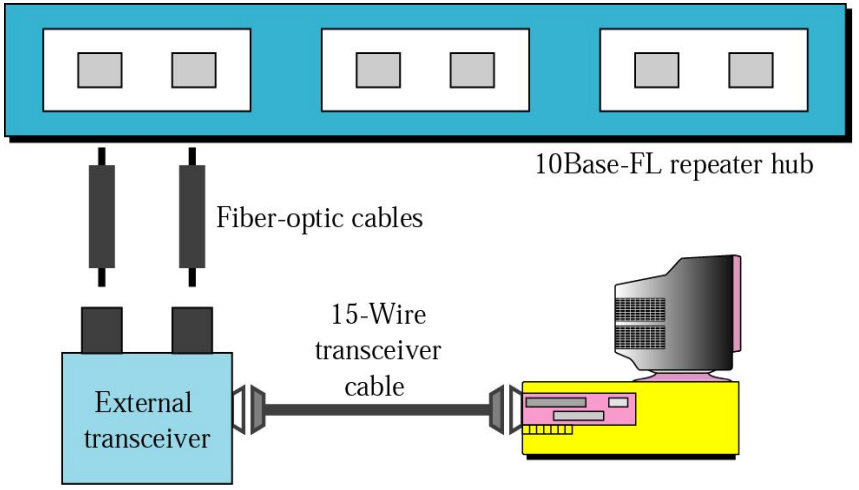
10Base-T



10Base-FL: Fiber Link Ethernet

- Uses star topology to connect stations to a hub

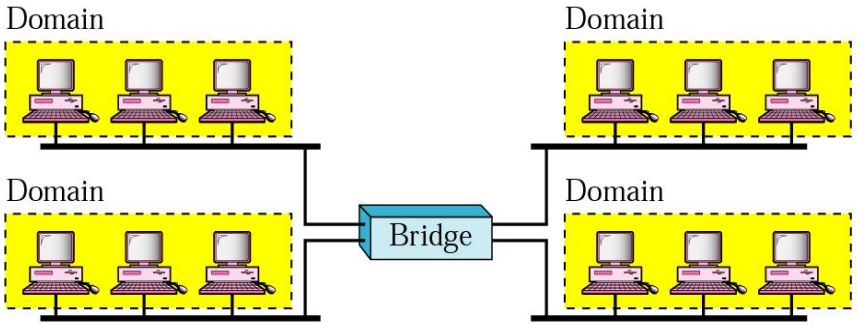
- External transceiver called a fiber-optic MAU connects processing device to fiber-optic cables via a 15-wire transceiver



Bridged Ethernet

- Increases bandwidth by dividing the network into smaller networks, allowing concurrent communications
- Separates collision domains since traffic is lower with segmentation

a. Without bridging



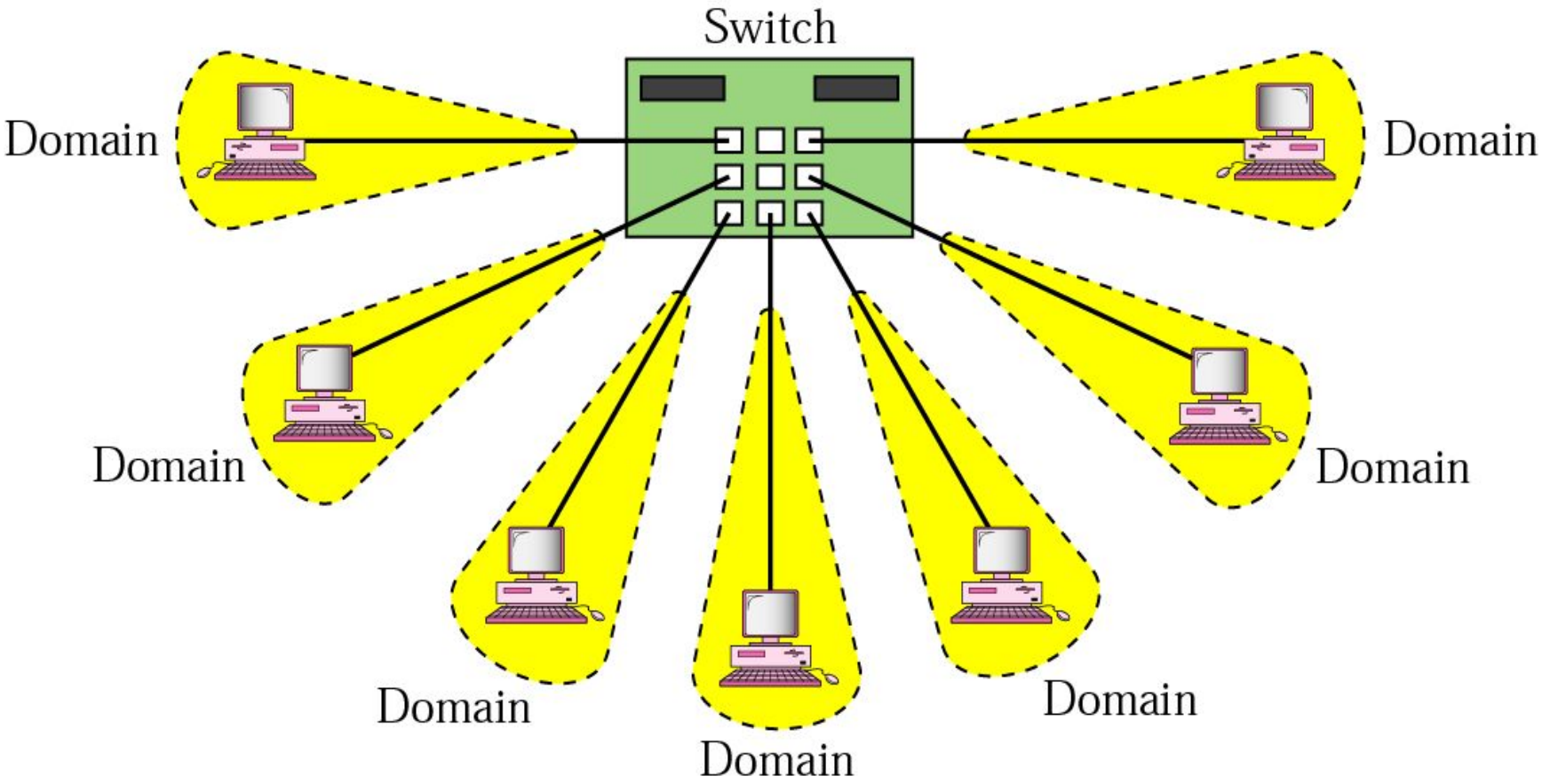
b. With bridging

Switched Ethernet

- A switch device recognizes the destination address and routes the frame to the specific port to which the destination station is connected (enables point-to-point connection; no collisions)

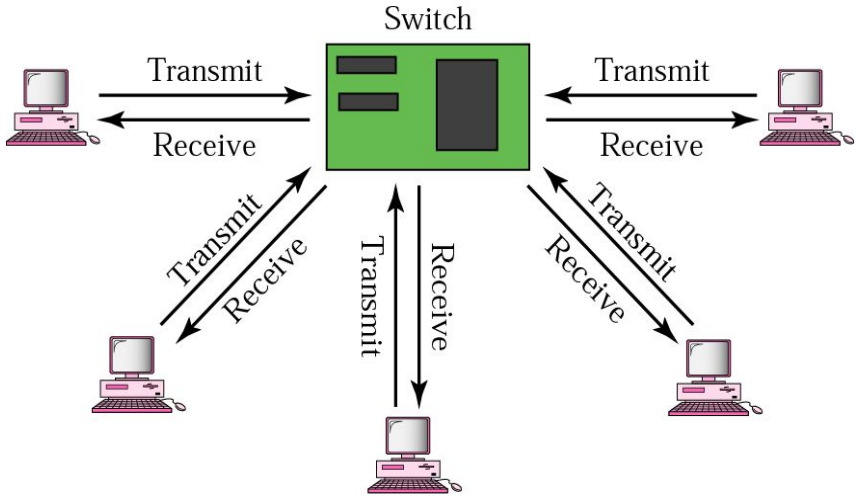
- Also helps to improve security

Switched Ethernet



Full-Duplex Ethernet

- 10Base5 and 10Base2 are half-duplex
- Full-duplex increases capacity of each domain
- No need for CSMA/CD



Fast Ethernet

- ***Operates at 100 Mbps;*** faster speeds needed for CAD, image processing, real-time audio and video.

- No change in frame format, addressing, or access method

- Data rate and collision domain are changed

- Physical implementation is star topology
  - 100Base-X (100Base-TX and 100Base-FX)
  - 100Base-T4

Gigabit Ethernet

- Data rate of 1000 Mbps or 1 Gbps
- Usually implemented as full-duplex with no CSMA/CD
- 1000Base-X uses shortwave optical fiber (1000Base-SX), long-wave optical fiber (1000Base-LX), or twisted-pair cables (1000Base-T)

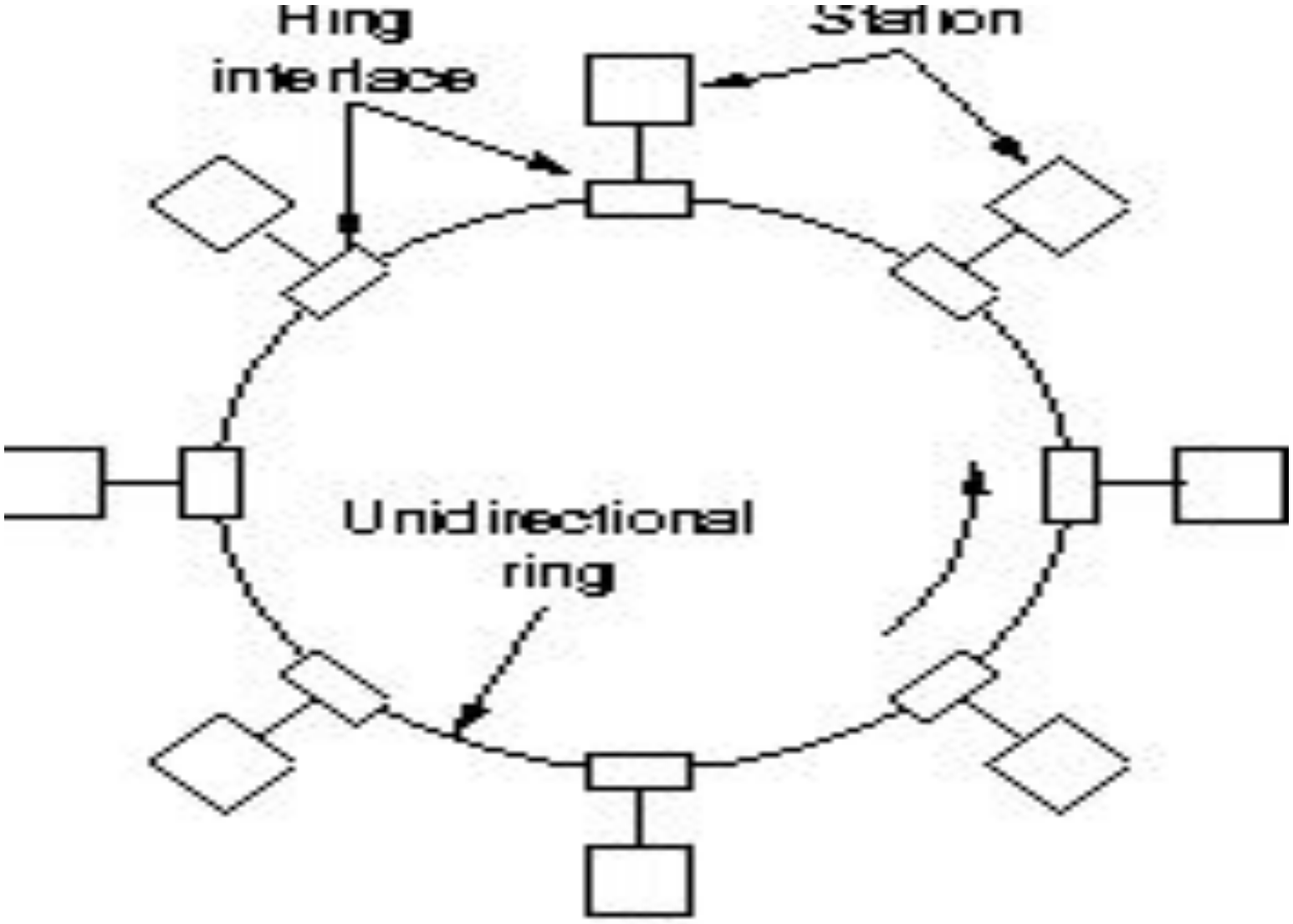
Summary

- Ethernet – most widely used LAN protocol
- Specific implementations discussed:
  - Traditional (10Mbps)
  - Fast Ethernet (100 Mbps)
  - Gigabit (1 Gbps)
  - Ten-Gigabit (10 Gbps)
- Bridging and switching techniques

IEEE 802.5

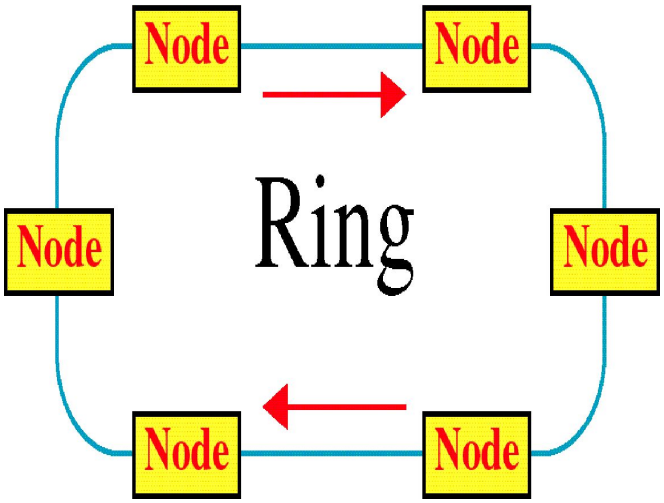
Token Ring

Token Ring



Token Ring Implementation

- Series of 150-ohm shielded twisted-pairs sections
- Output port on each station connected to input port on the next
- Frame is passed to each station in sequence
- Station functions as a repeater

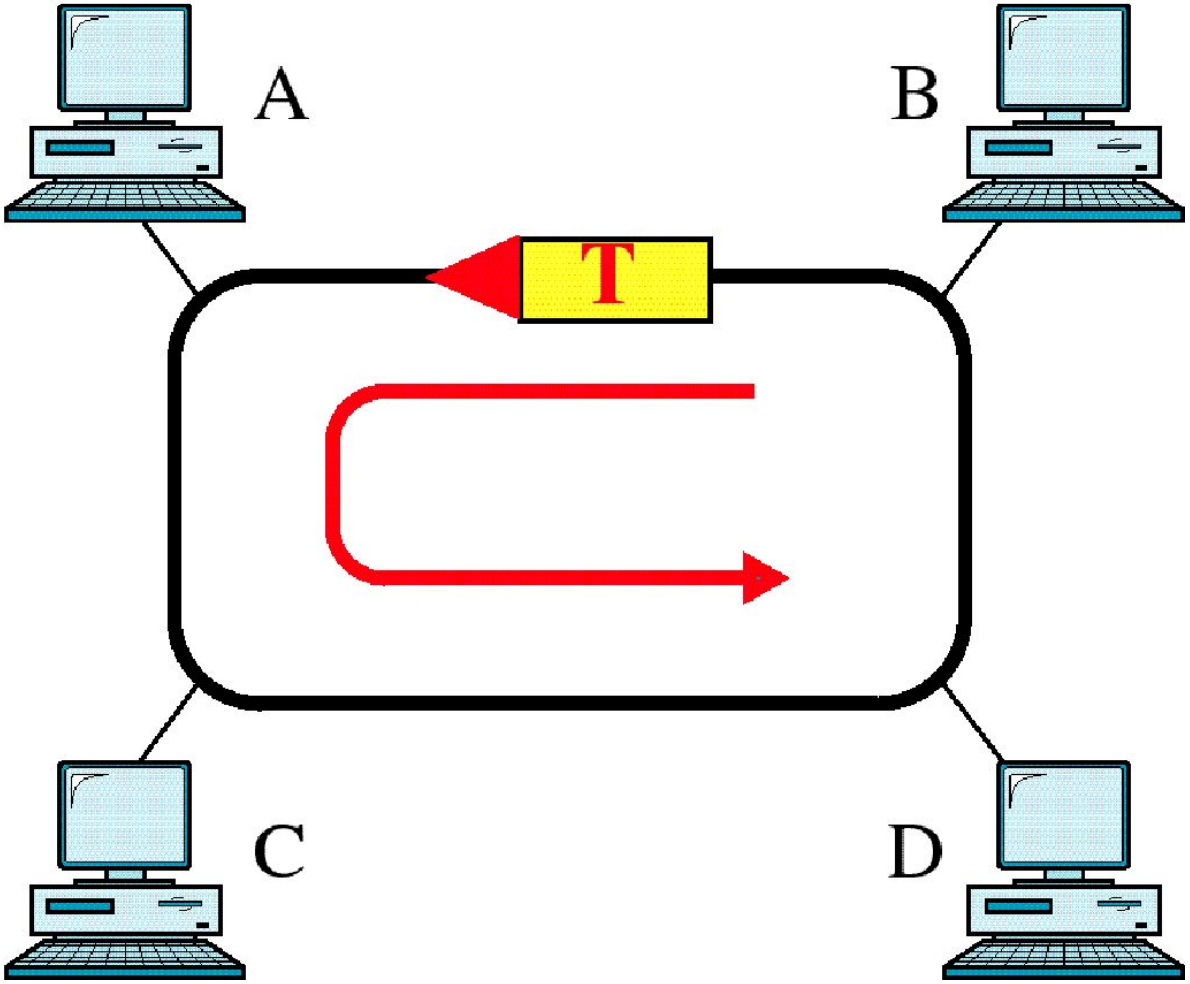


Token Passing

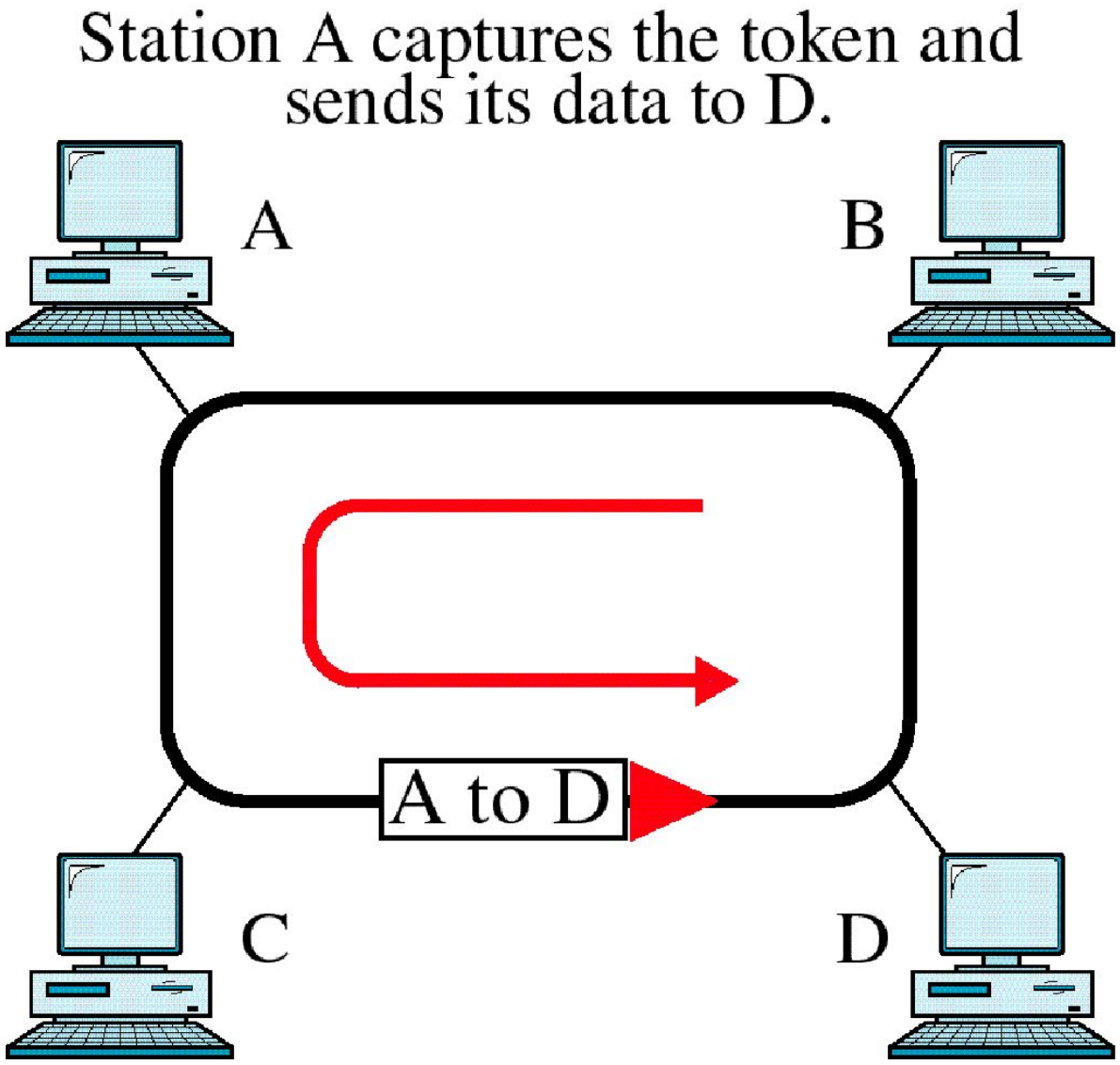
- Station can send only *when it receives a special frame called a token*
- Token circulates around the ring
- If station wishes to send, it captures the token and sends one or more frames
- Token is then released so next station can transmit

Token Passing

Token is traveling along the ring.

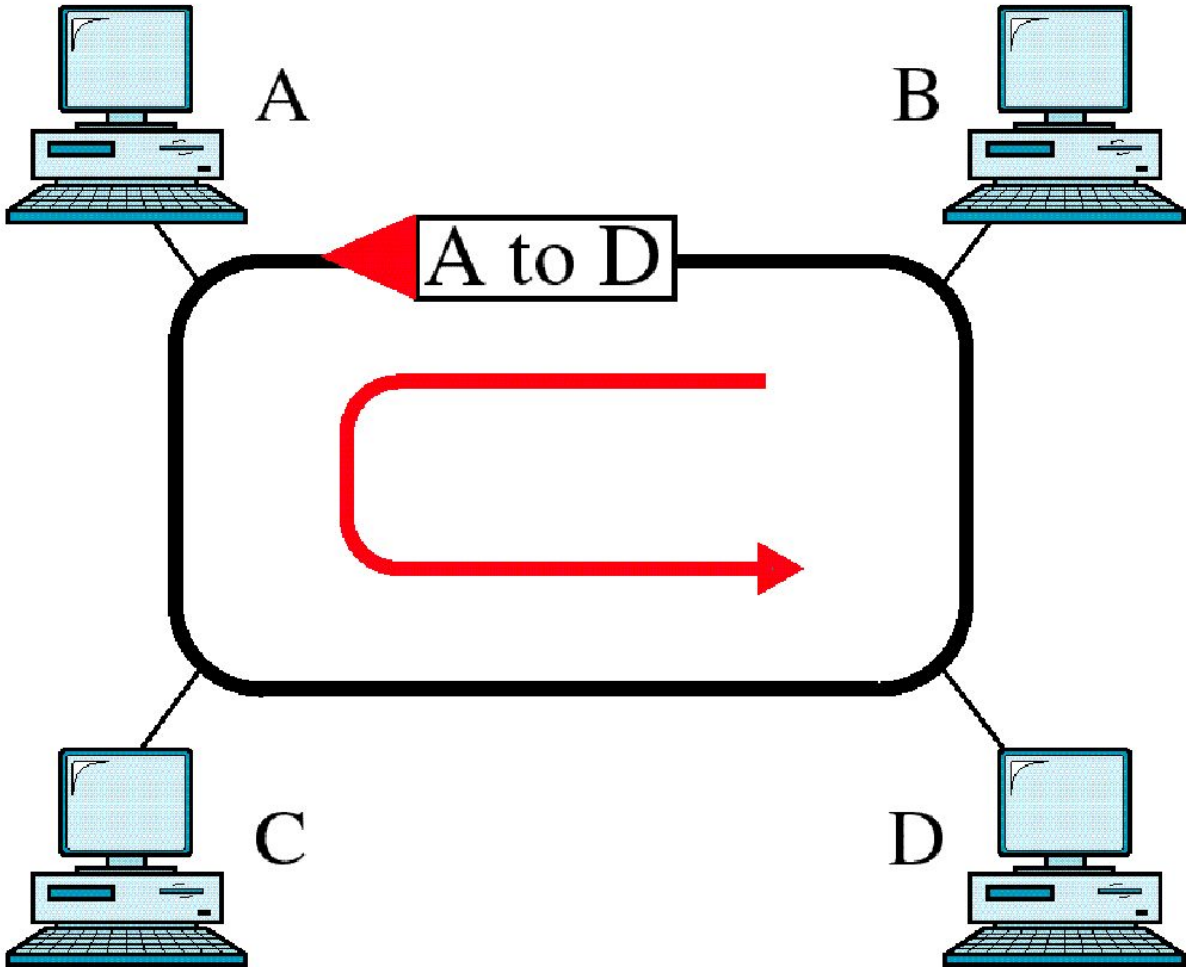


Token Passing

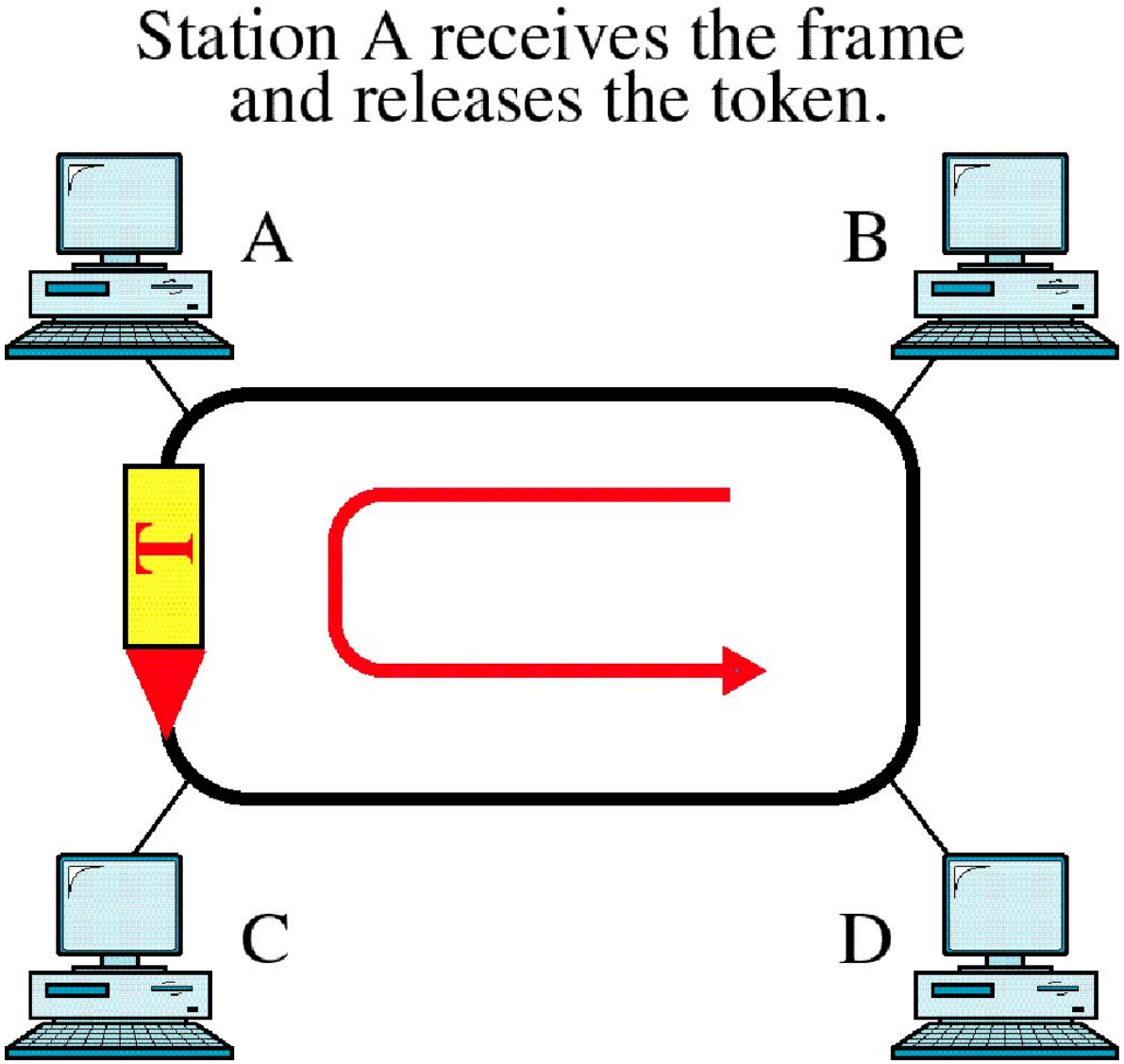


Token Passing

Station D copies the frame and sends the data back to the ring.



Token Passing



Token Passing – Token Ring (IEEE 802.5)

- Requires that stations take turns sending data
- Token passing coordinates process
- Token is a specially formatted three-byte frame that circulates; station wishing to transmit must first have possession
- Token passes from NIC to NIC in sequence;
  - ***if station has data to send, station takes token and sends data frame;***
  - ***if not, passes to neighbor***

Token Passing – Token Ring (IEEE 802.5)

- Each station receives the frame one by one and examines the destination address
- If it matches, frame is copied; station checks the frame for errors; changes bits to indicate the frame was received and copied
- Packet continues around the ring and is passed back to originating station

Token Passing – Token Ring (IEEE 802.5)

- Once the sender receives the frame and recognizes its address in the sender field, it examines the address-recognized bits.
- If they are set, it knows the frame was received and copied.
- Sender then discards the frame and releases the token back to the ring

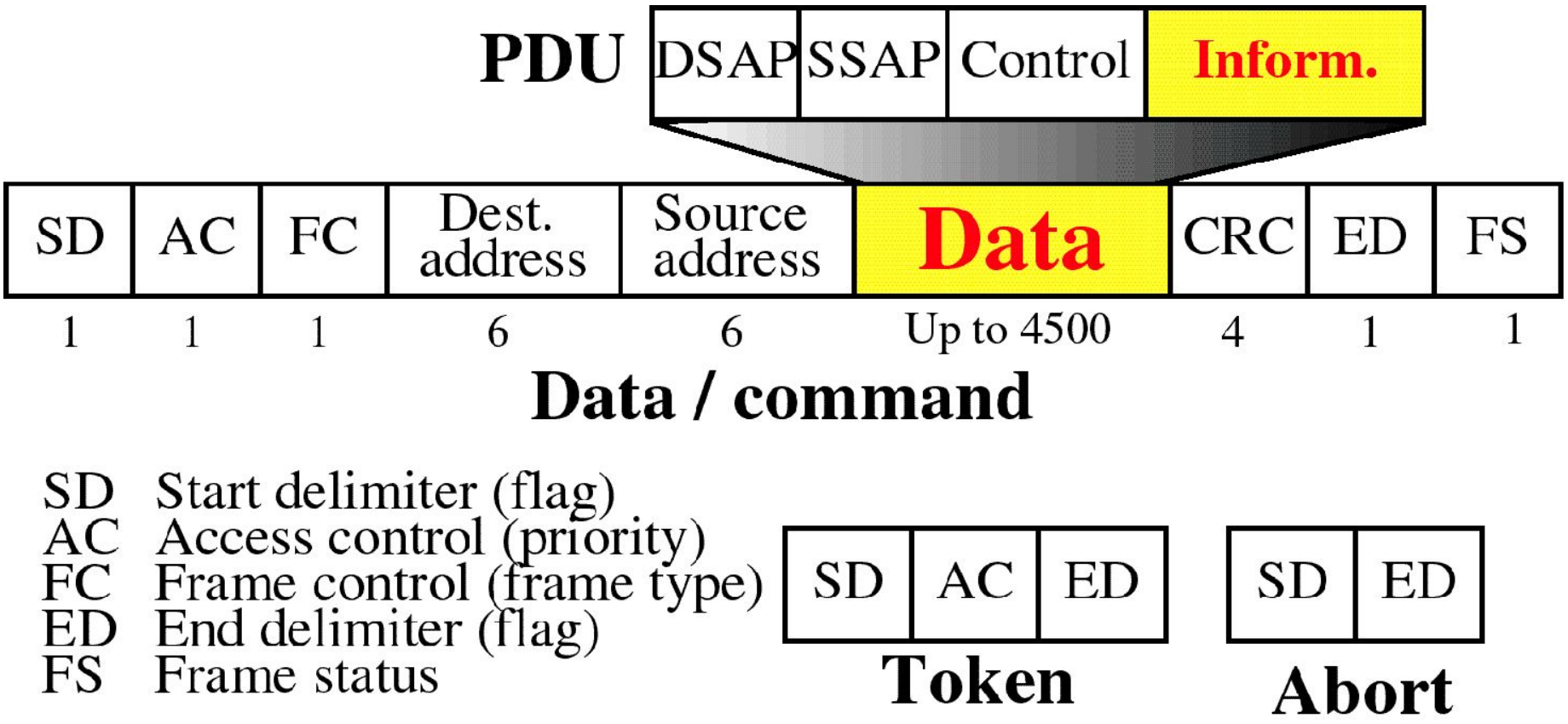
Priority and Reservation

- Higher priority stations may access the token sooner,
- Every station has a priority code
- As token passes, station waiting to transmit can place its priority code in the access control (AC) field of the token or data frame
- Higher priority stations may remove a lower priority reservation
- If stations have equal priority, it's first-come, first-served

Monitor Stations

- **Lost tokens** - timer is issued each time a frame or token is generated
- If no frame is received within time period, new token is generated by a **monitor station**
- **Orphan frames** result if a sending station neglects to remove a used data frame from the ring
- Monitor sets a bit in the AC field in each frame; as frame passes, bit is set; if the frame passes again, the monitor discards, will remove it, and generate a new token

Token Ring Frame



Thanking You