CISC 7332X T6

Ethernet

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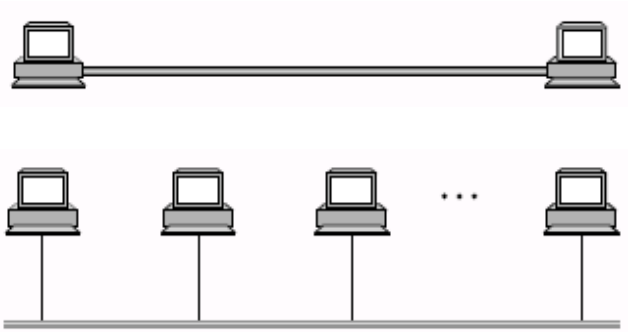
Outline

- CSMA/CD
- Ethernet

Medium Access Control

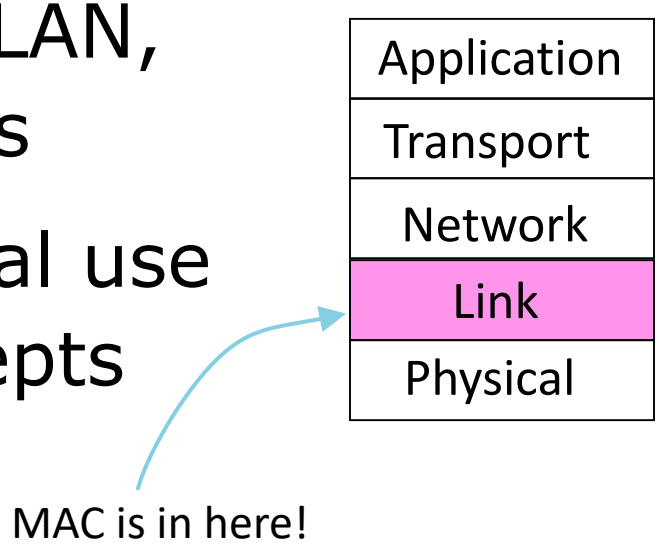
- Two types of network links
  - Point-to-point
  - Multiple access (broadcast)



- Key issue
  - Who gets to use the channel when there is a competition to it?
  - Multiaccess channel/random access channel
  - Medium Access Control (MAC)

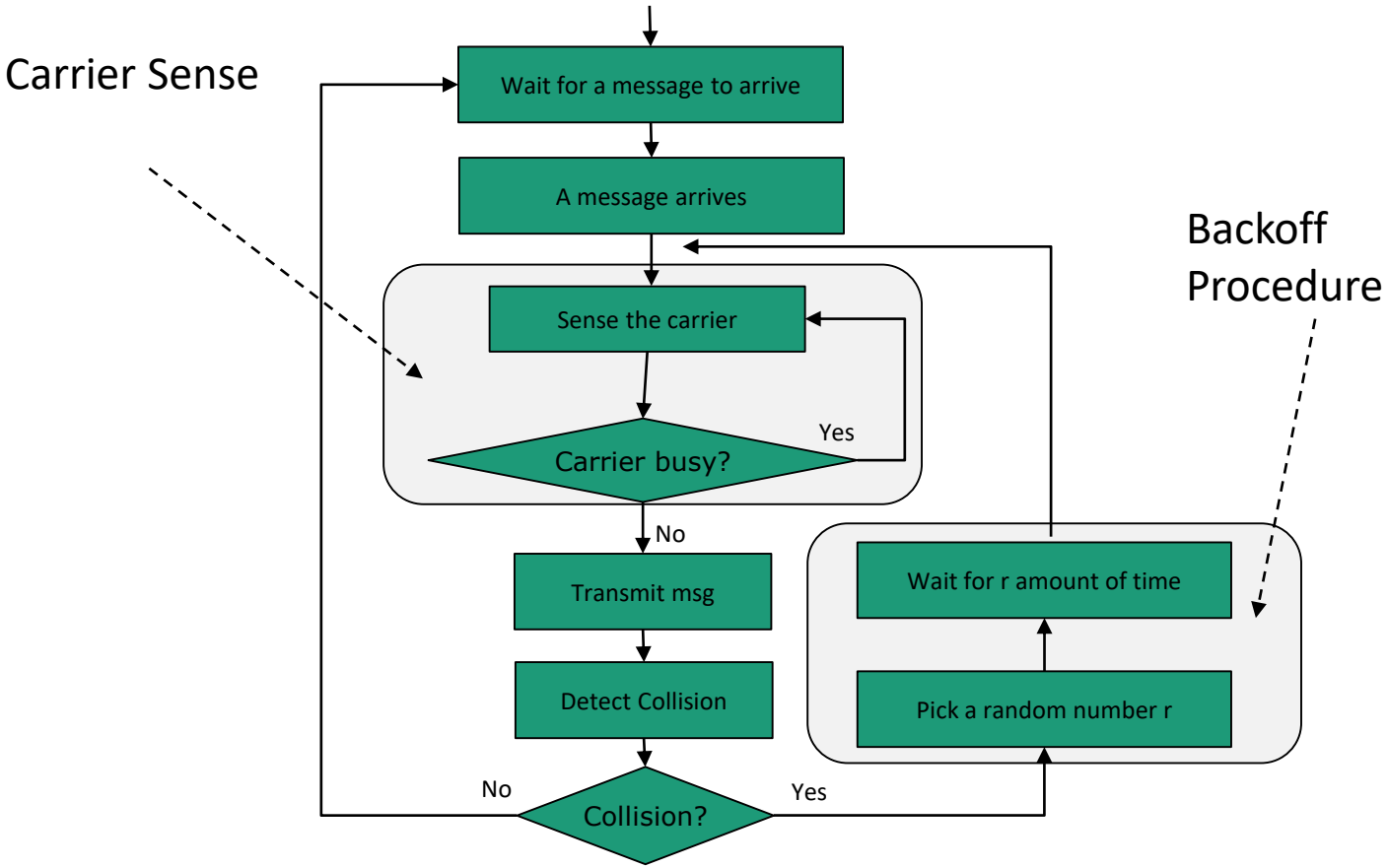
The MAC Sublayer

- The protocols used to determine who goes next on a multiaccess channel
- Especially important for LAN, particularly wireless LANs
- In contrast, WANs general use point-to-point links, excepts for satellite networks

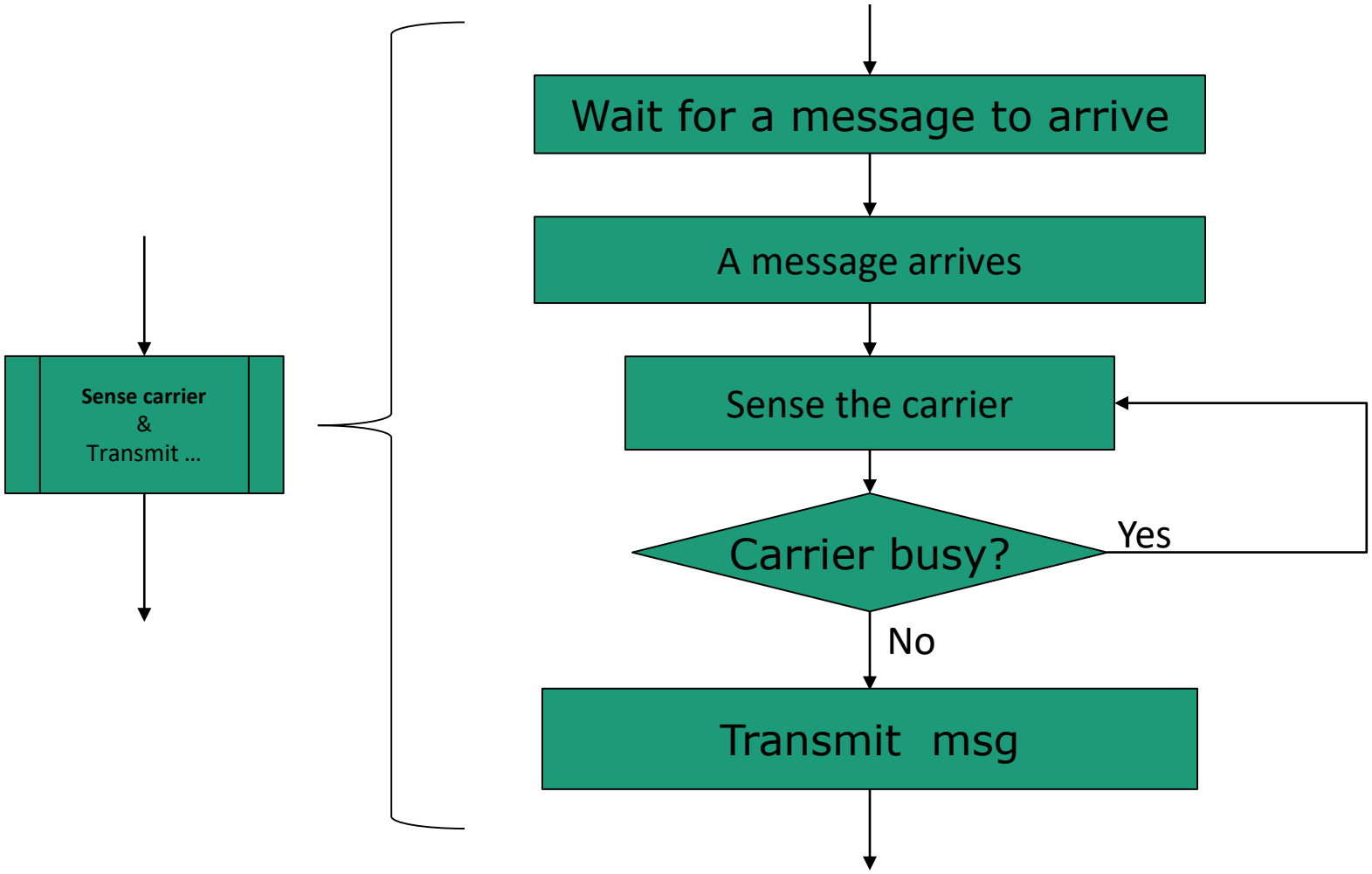


CSMA/CD

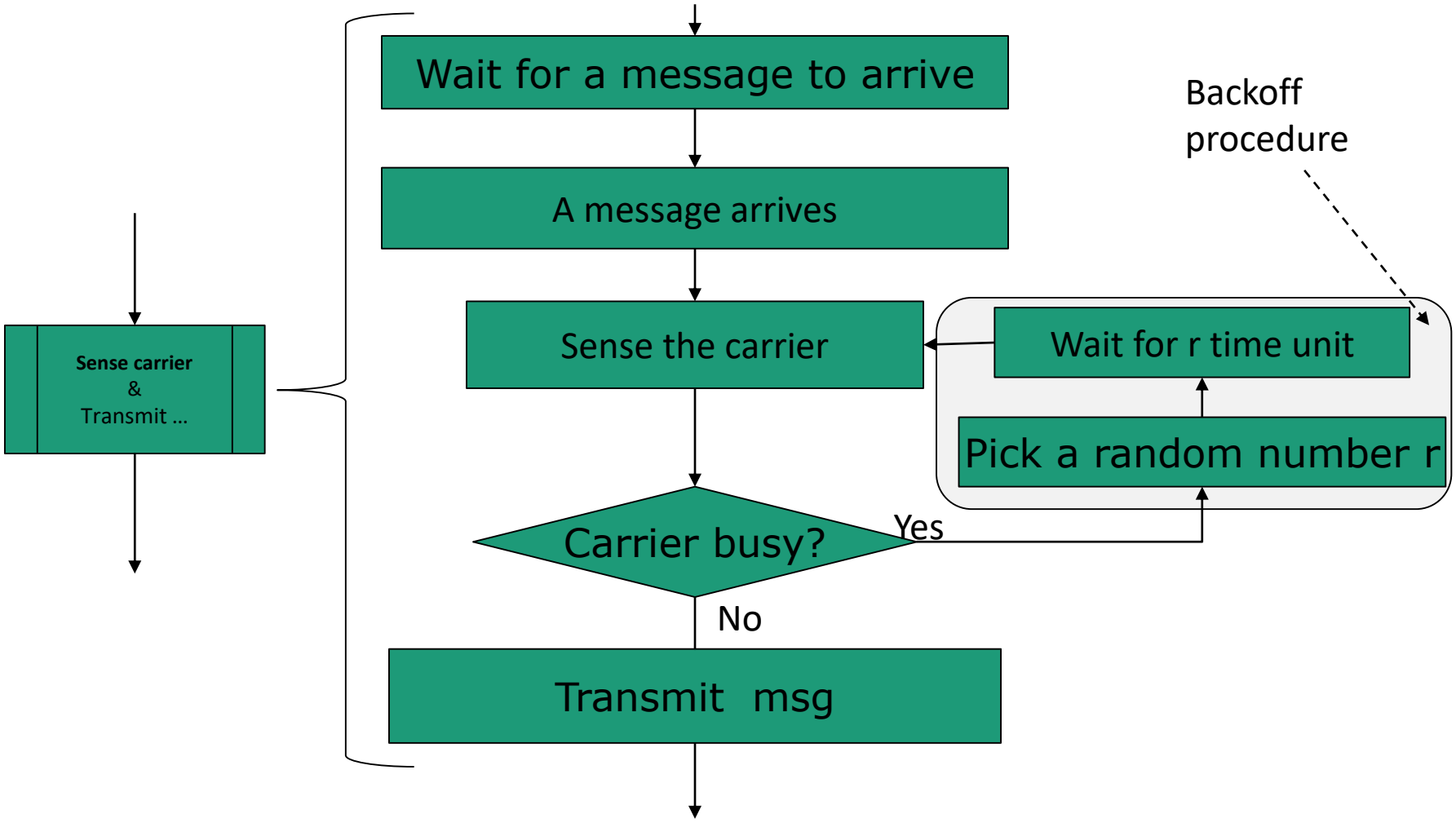
- 1-Persistent CSMA and CD



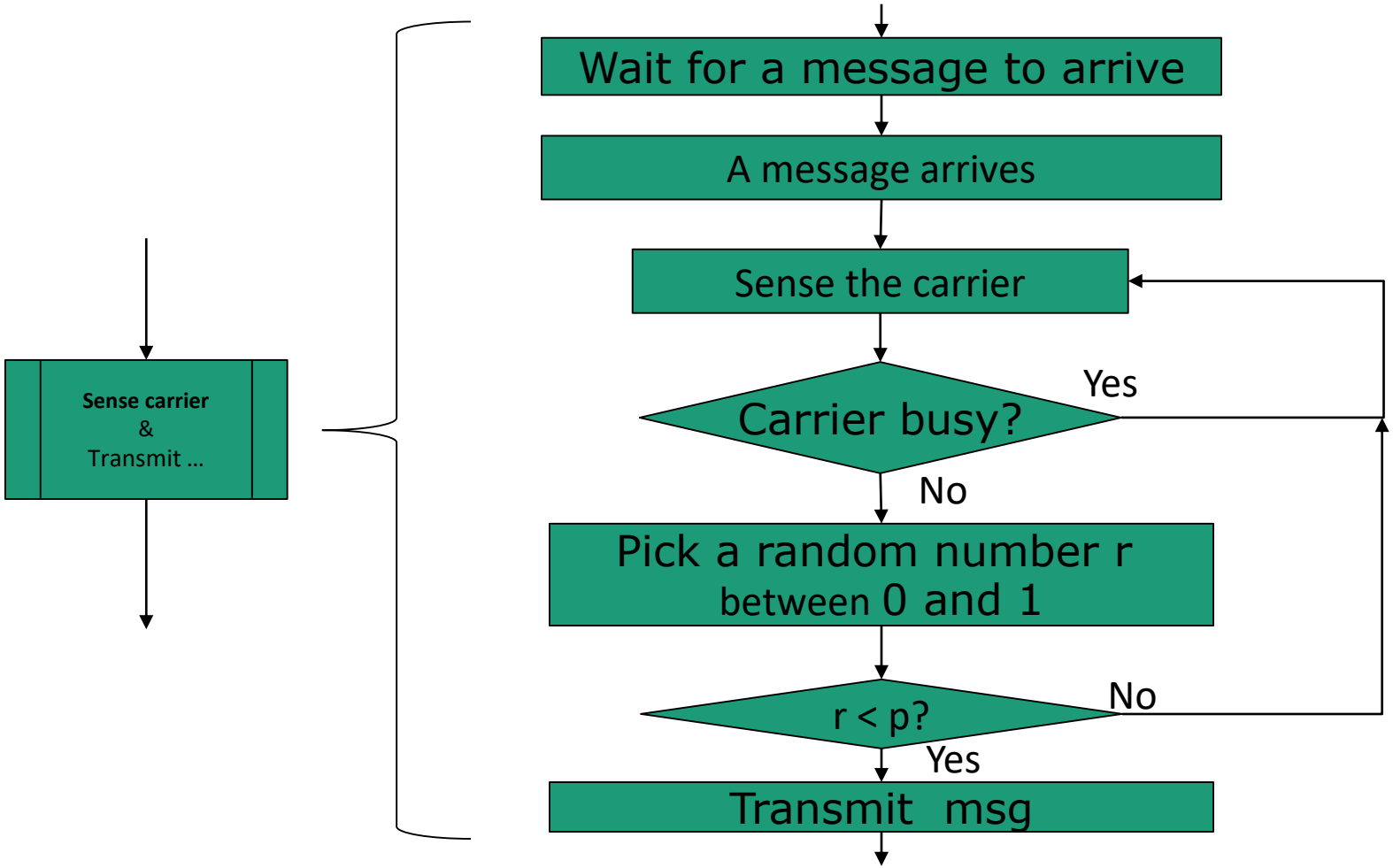
1-persistent CSMA with CD



Non-persistent CSMA with CD

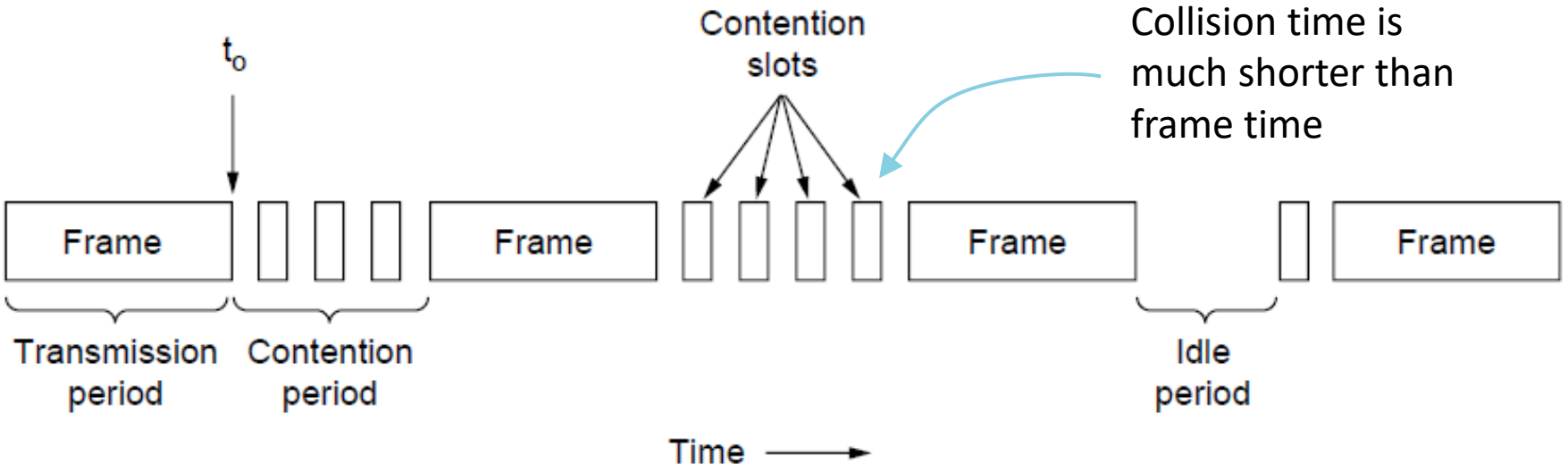


p-persistent CSMA with CD



Collision Detection

- CSMA/CD improvement is to detect/abort collisions
  - Reduced contention times improve performance



Questions?

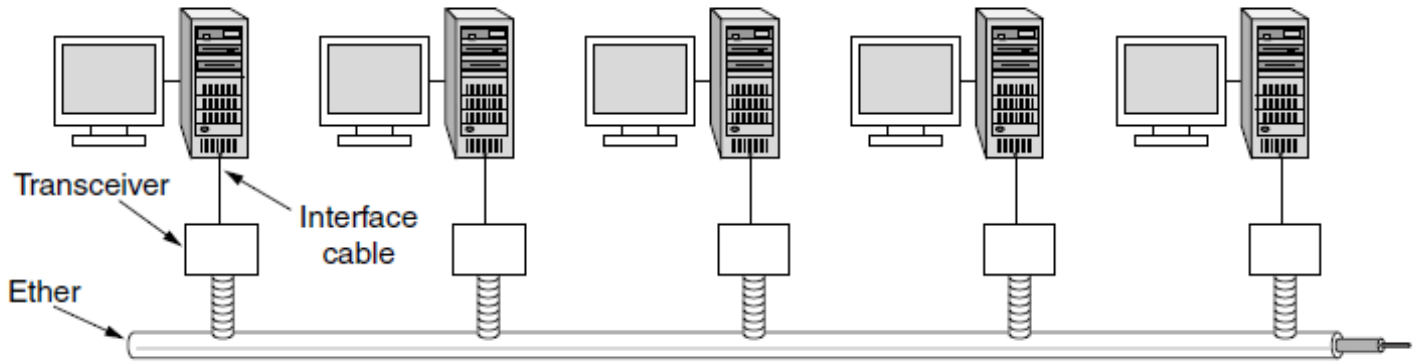
- CSMA/CD

Ethernet

- Classic Ethernet
- Switching/Fast Ethernet
- Gigabit/10 Gigabit Ethernet

Classic Ethernet: Physical Layer

- One shared coaxial cable to which all hosts attached
  - Up to 10 Mbps, with Manchester encoding
  - Hosts ran the classic Ethernet protocol for access

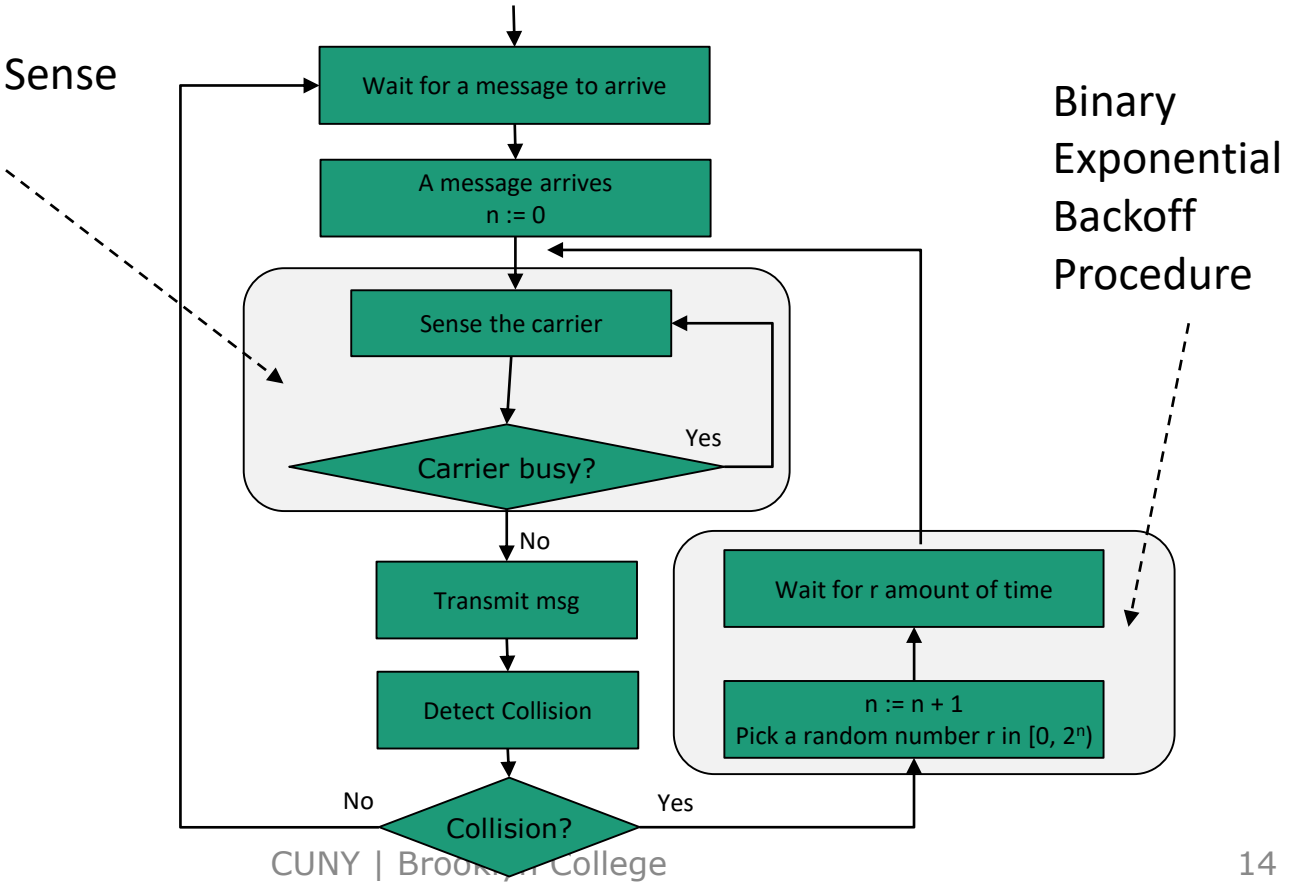


Classic Ethernet: MAC

- MAC protocol is 1-persistent CSMA/CD with BEB
  - Random delay (backoff) after collision is computed with BEB (Binary Exponential Backoff)

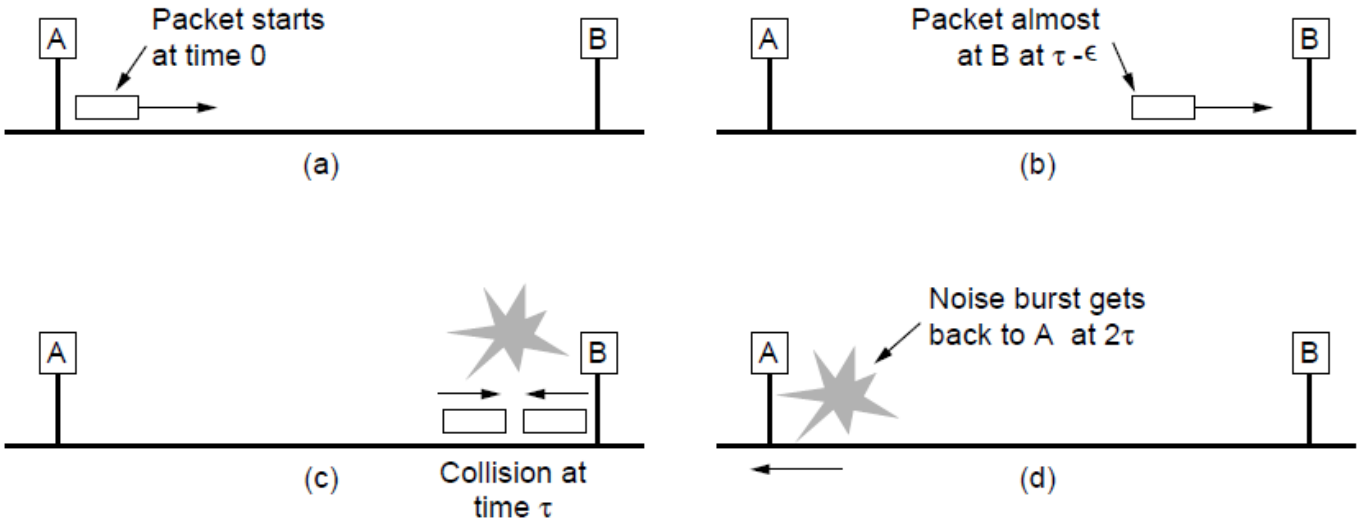
1-Persistent CSMA and CD with BEB

- Time is slotted; when n >= 10, timeout occurs



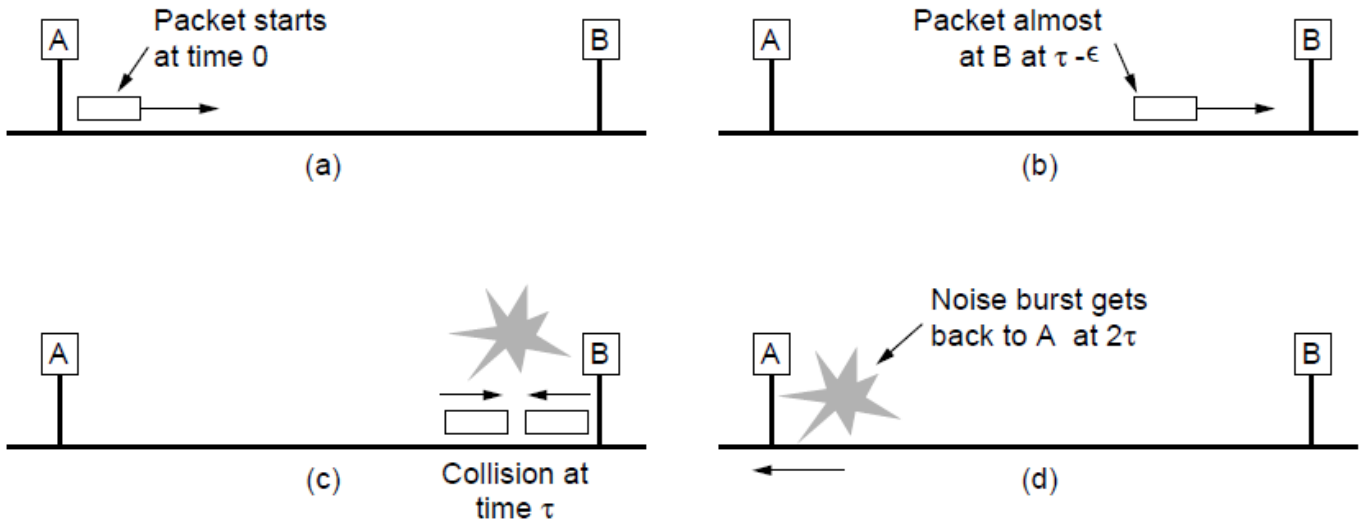
Classic Ethernet: CD Mechanism

- Collisions can occur and take as long as 2τ to detect
  - When it detects a collision, the receiver transmits a short jamming signal



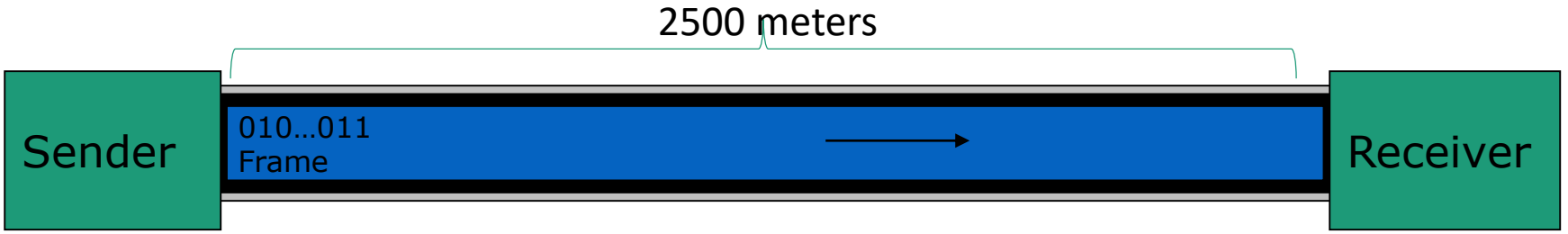
Classic Ethernet: Minim Frame Length

- τ is the time it takes to propagate over the Ethernet
- Leads to minimum packet size/frame length for reliable detection



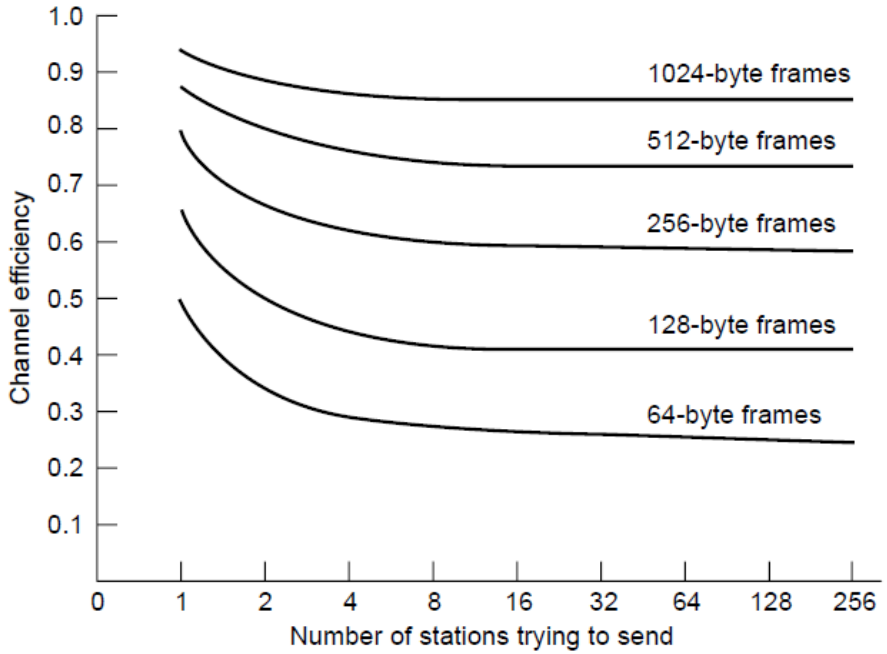
CD and Minimum Frame Length

- To make CD effective, we want a sending station not to complete transmission (last bit leaving the station) before the first bit reaches the receiving station.
  - At 10 Mbps, 1RTT ≈ 50 μs, add a margin of safety, the shortest frame is 512 bits or 64 bytes



Classic Ethernet: Performance

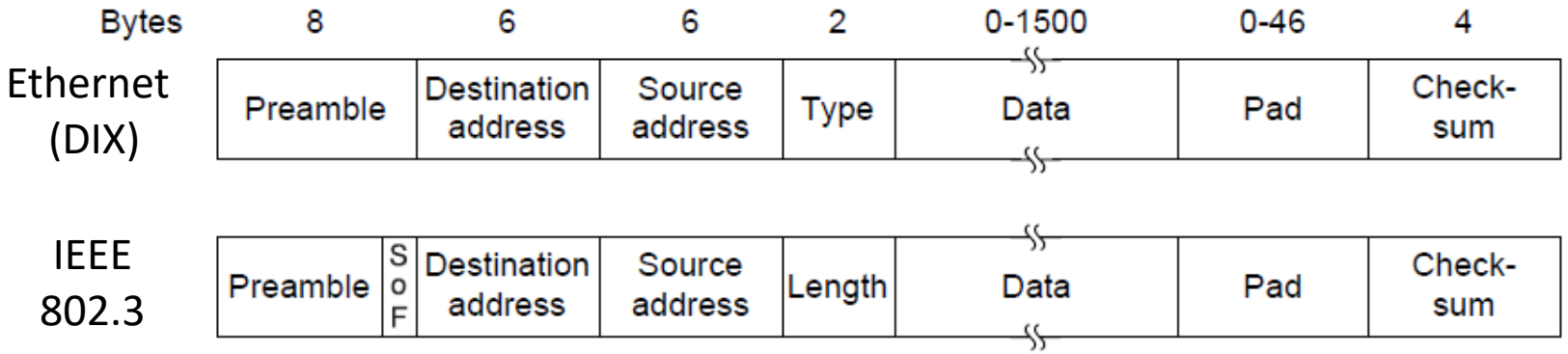
- Efficient for large frames, even with many senders; degrades for small frames (and long LANs)



10 Mbps Ethernet,
64 byte min. frame

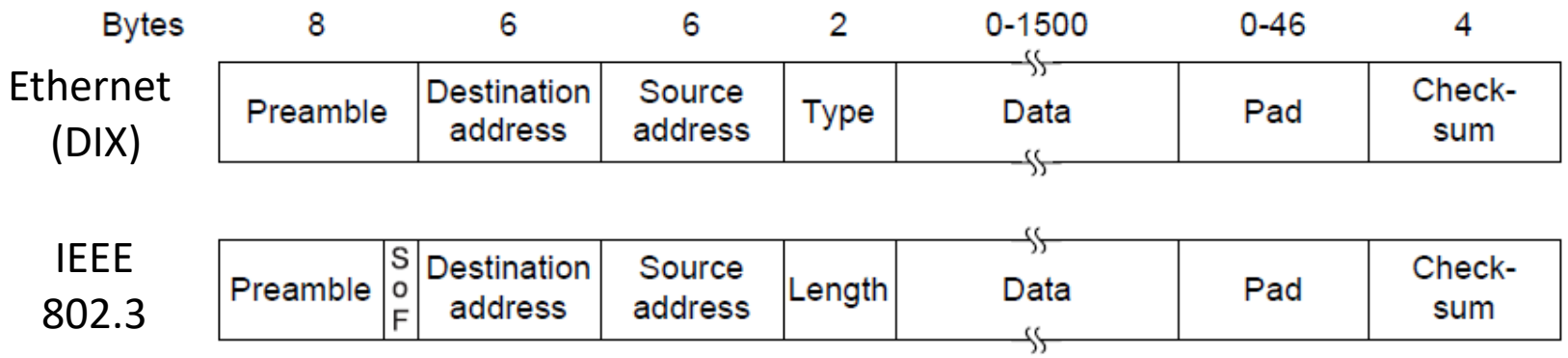
Classic Ethernet: Frame Format

- Frame format is still used with modern Ethernet



Frame Format: Minimum Frame Length

- Minimum 46 bytes of data or padding



Questions?

- Channel allocation algorithms for Ethernet
- Frame format
- Minimum length requirement

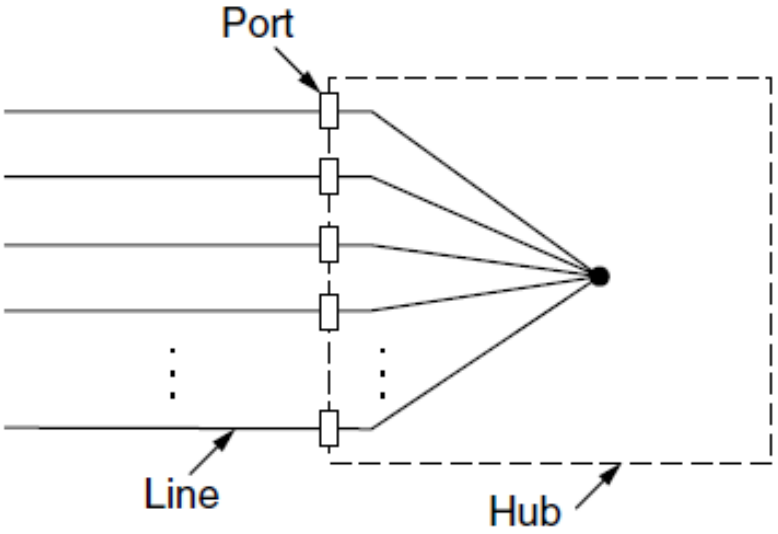
LAN Switching

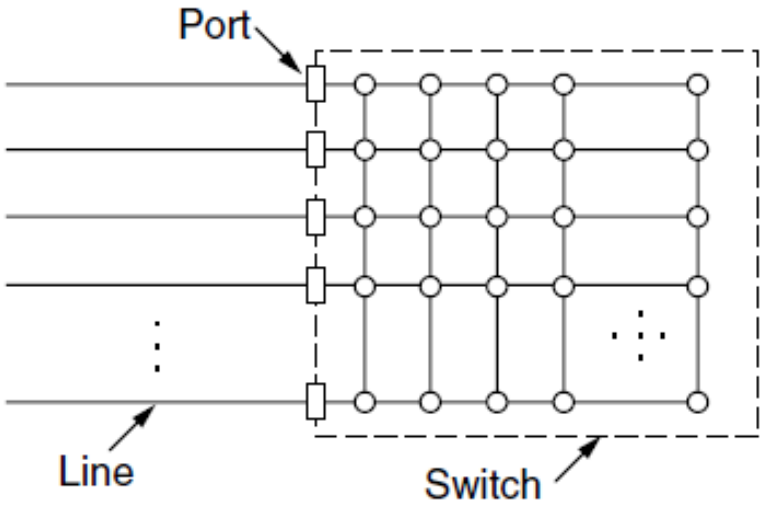
- LAN switching will be discussed next week in detail
- LAN switching → Switched/Fast Ethernet

Hub and Switch

- Hubs wire all lines into a single CSMA/CD domain
- Switches isolate each port to a separate domain
  - Much greater throughput for multiple ports
  - No need for CSMA/CD with full-duplex lines

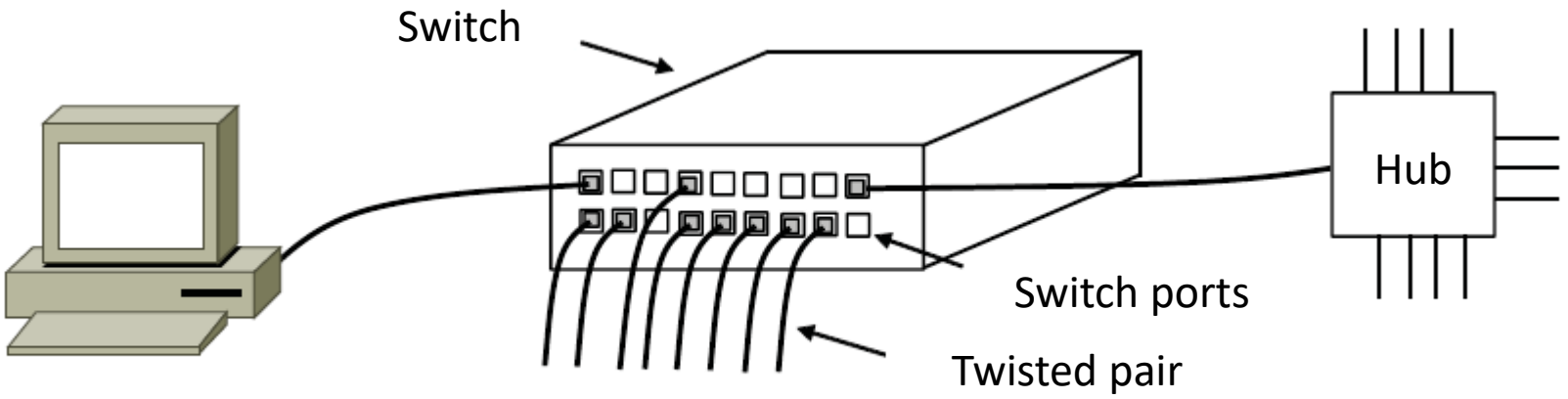
Hub and Switch





Switched/Fast Ethernet

- Switches can be wired to computers, hubs and switches
  - Hubs concentrate traffic from computers
  - More on how to switch frames the in next



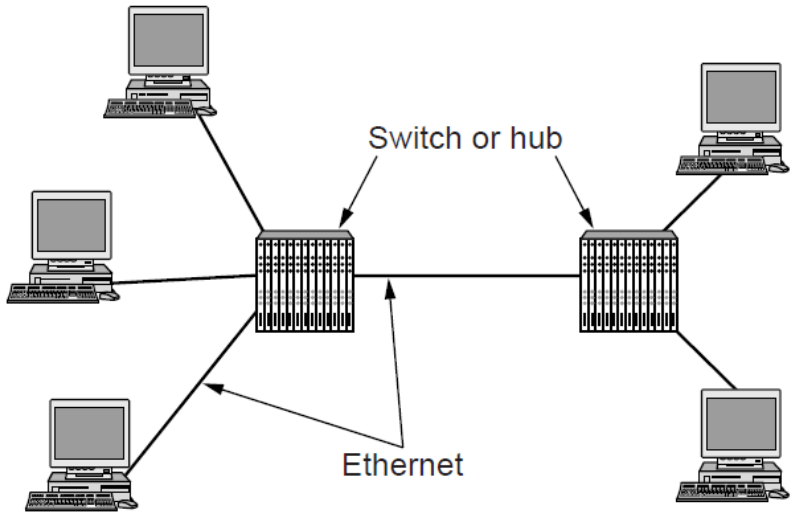
Switched/Fast Ethernet

- Fast Ethernet extended Ethernet from 10 to 100 Mbps
  - Twisted pair (with Cat 5) dominated the market

Name	Cable	Max. segment	Advantages
100Base-T4	Twisted pair	100 m	Uses category 3 UTP
100Base-TX	Twisted pair	100 m	Full duplex at 100 Mbps (Cat 5 UTP)
100Base-FX	Fiber optics	2000 m	Full duplex at 100 Mbps; long runs

Gigabit/10 Gigabit Ethernet

- Switched Gigabit Ethernet has many varieties with full-duplex lines between computers/switches



Gigabit / 10 Gigabit Ethernet: Varieties

- Gigabit Ethernet
- 10 Gigabit Ethernet
- 40/100 Gigabit Ethernet

Gigabit Ethernet

- 1000Base-T is popular

Name	Cable	Max. segment	Advantages
1000Base-SX	Fiber optics	550 m	Multimode fiber (50, 62.5 microns)
1000Base-LX	Fiber optics	5000 m	Single (10 μ) or multimode (50, 62.5 μ)
1000Base-CX	2 Pairs of STP	25 m	Shielded twisted pair
1000Base-T	4 Pairs of UTP	100 m	Standard category 5 UTP

10 Gigabit Ethernet

Name	Cable	Max. segment	Advantages
10GBase-SR	Fiber optics	Up to 300 m	Multimode fiber (0.85μ)
10GBase-LR	Fiber optics	10 km	Single-mode fiber (1.3μ)
10GBase-ER	Fiber optics	40 km	Single-mode fiber (1.5μ)
10GBase-CX4	4 Pairs of twinax	15 m	Twinaxial copper
10GBase-T	4 Pairs of UTP	100 m	Category 6a UTP

Questions?

- Switched Ethernet
  - Fast Ethernet
  - Gigabit Ethernet
  - 10 Gigabit Ethernet
  - 40/100 Gigabit Ethernet

Accessing Ethernet Service on Host

- Using socket API
  - raw socket
- Example Programs
  - https://github.com/huichen-cs/ethernet