Hi-Speed LANs

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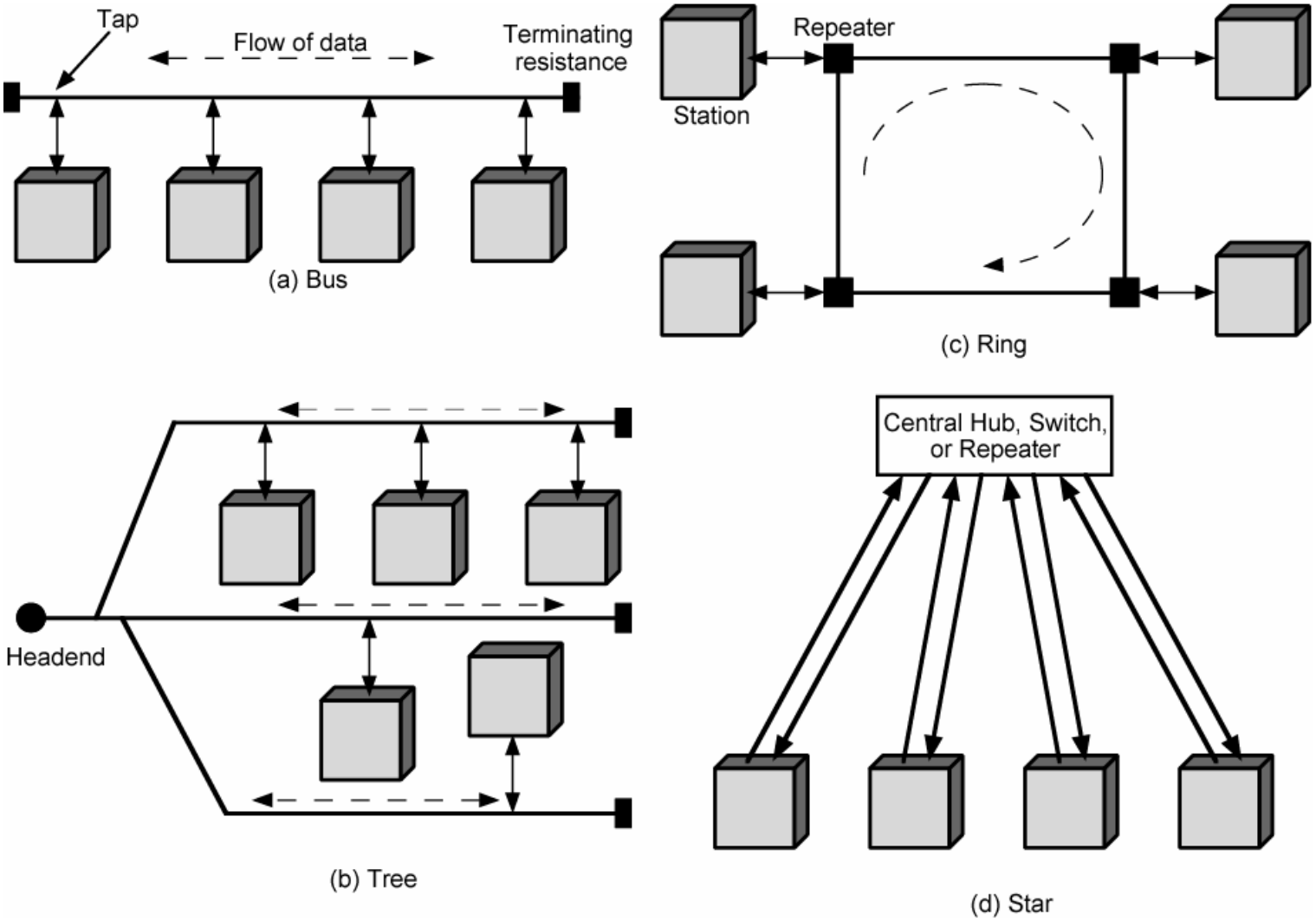
These slides are available on-line at:

http://www.cse.wustl.edu/~jain/cse473-05/

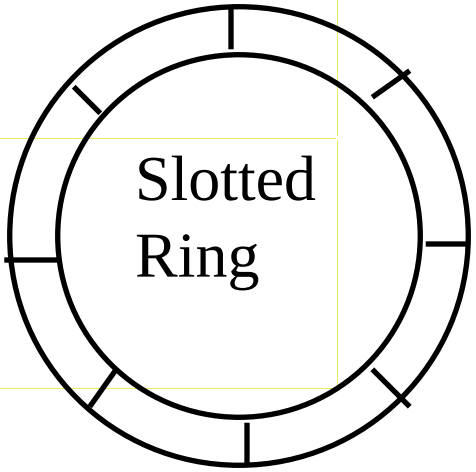
- LAN Topologies
- Media Access Control (MAC), CSMA/CD
- Ethernet Standards
- CSMA/CD Performance
- Ethernet vs Fast Ethernet
- Full-Duplex Ethernet
- IEEE 802 Address Format

LAN Topologies



Media Access Control (MAC)

	Bus Topology	Ring Topology
Token Passing	IEEE 802.4 Token bus	IEEE 802.5 Token Ring
Slotted Access	IEEE 802.6 DQDB	Cambridge Ring
Contention	IEEE 802.3 CSMACD	



CSMA/CD

- Aloha at Univ of Hawaii:
  Transmit whenever you like
  Worst case utilization = 1/(2e) =18%
- Slotted Aloha: Fixed size transmission slots
  Worst case utilization = 1/e = 37%
- CSMA: Carrier Sense Multiple Access
  Listen before you transmit
- p-Persistent CSMA: If idle, transmit with probability p. Delay by one time unit with probability 1-p
- CSMA/CD: CSMA with Collision Detection
  Listen while transmitting. Stop if you hear someone else

IEEE 802.3 CSMA/CD

- If the medium is idle, transmit (1-persistent).
- If the medium is busy, wait until idle and then transmit immediately.
- If a collision is detected while transmitting,
  - Transmit a jam signal for one slot (= 51.2 μs = 64 byte times)
  - Wait for a random time and reattempt (up to 16 times)
  - Random time = Uniform[0,$2^{\min(k,10)}$-1] slots
- Collision detected by monitoring the voltage
  High voltage ⇒ two or more transmitters ⇒ Collision
  ⇒ Length of the cable is limited to 2 km

CSMA/CD Operation

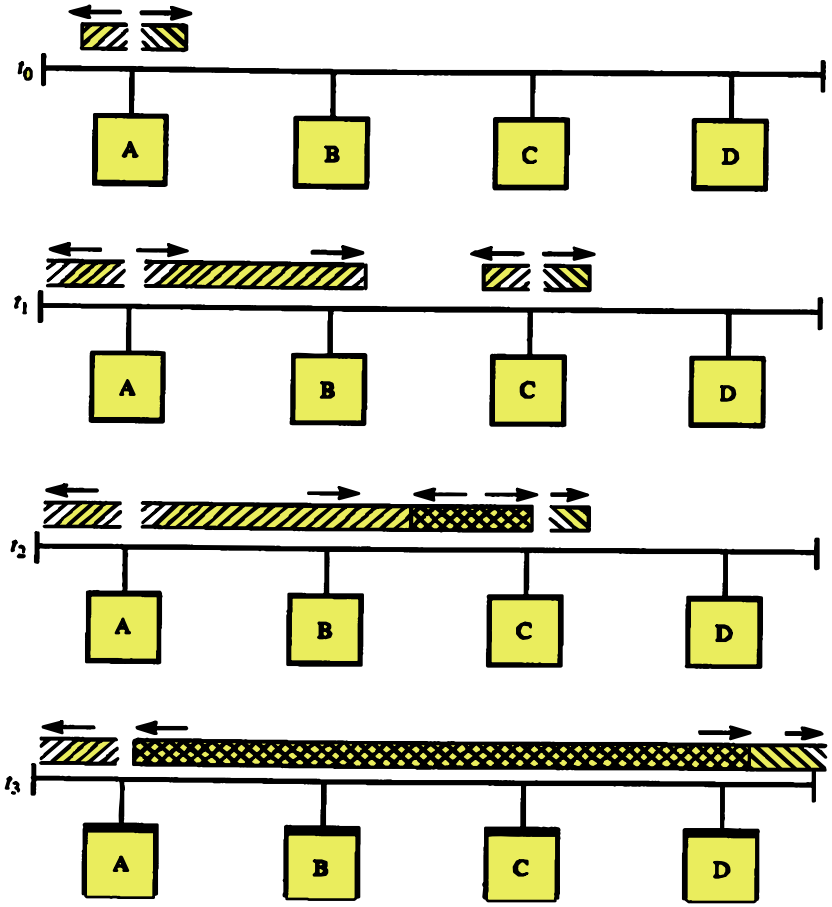


Fig 13.1

CSMA/CD Operation

t=0: A starts transmitting

t=1: C starts transmitting

t=2: C detects collision and sends jam

t=3: A detects collision and sends jam

t=2+51.2μs: C stops jam

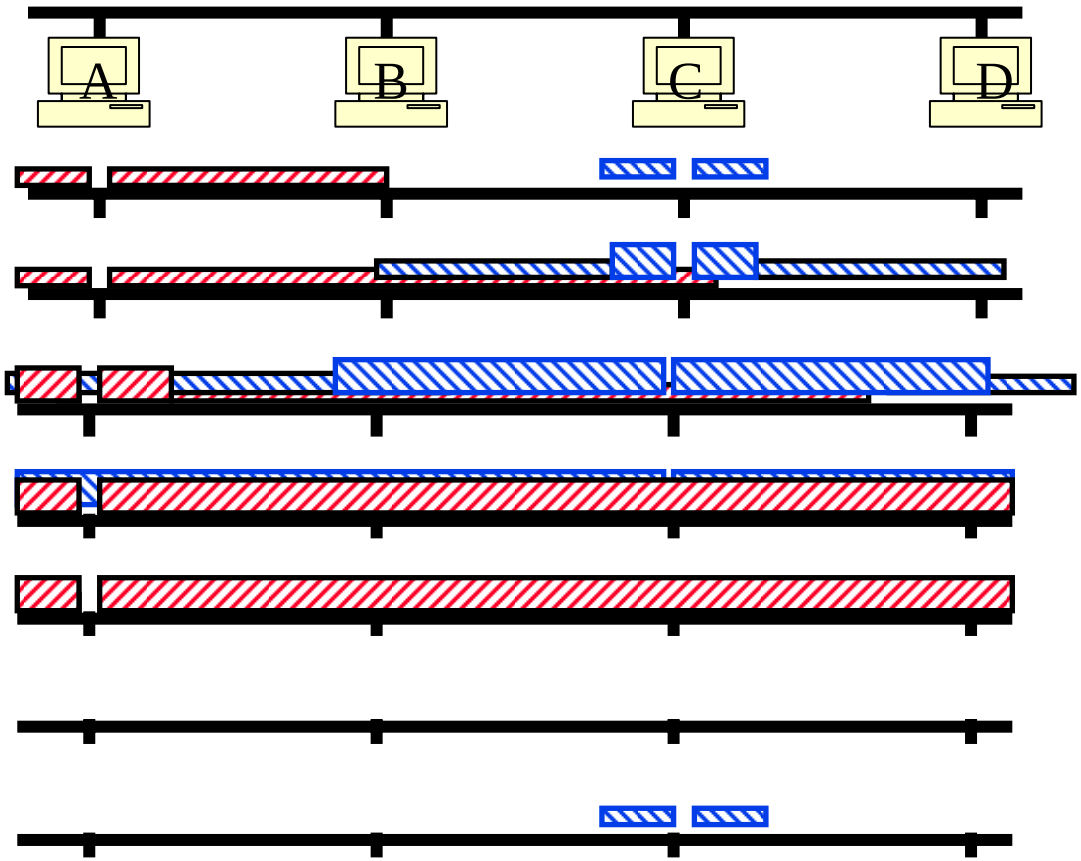
t=3+51.2μs:A stops jam

Both A and C sense idle

t=3+51.2+9.6μs: A and C draw random numbers

A gets 1 and C gets 0

C starts transmitting



- Collision window = 2 × One-way Propagation delay = 51.2 μs
- One way delay = 25.6 μs ⇒ Max Distance <2.5 km

Original Ethernet Configuration

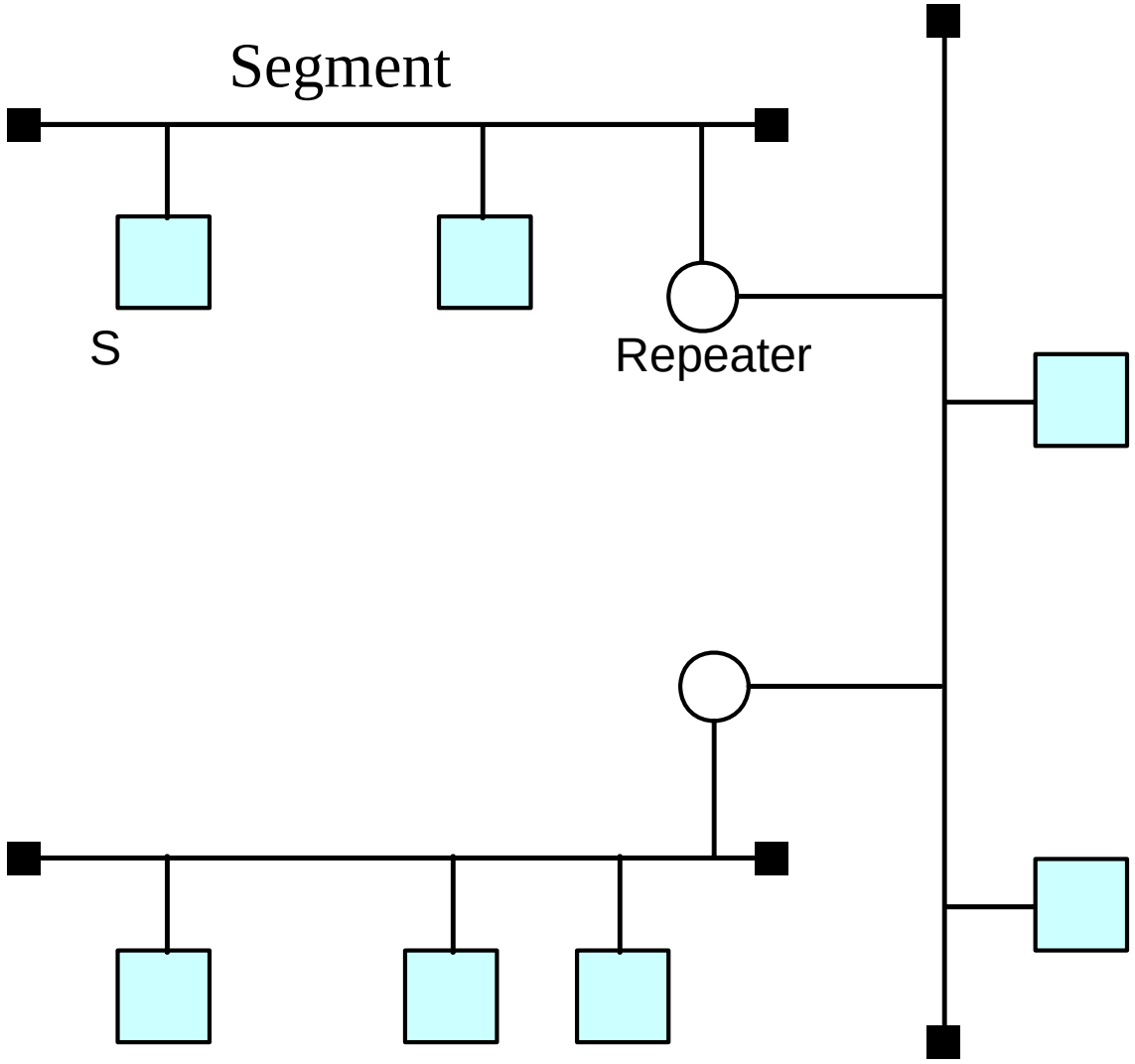
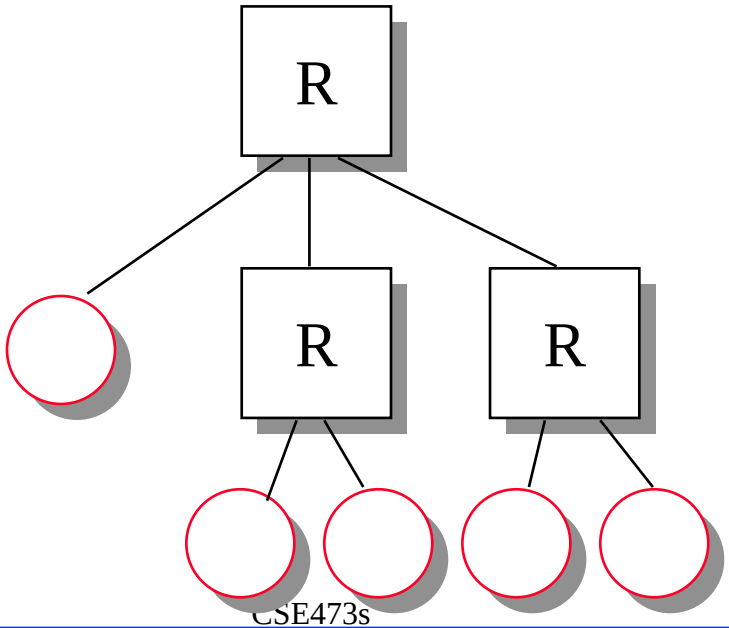


Fig 12.9

10BASE-T

- Hub repeats the signal on all ports
- Activity on two or more channels ⇒ Collision
  Collision presence (CP) transmitted by hub to all stations
  Collision window = 2× One-way delay between farthest stations



Ethernet Standards

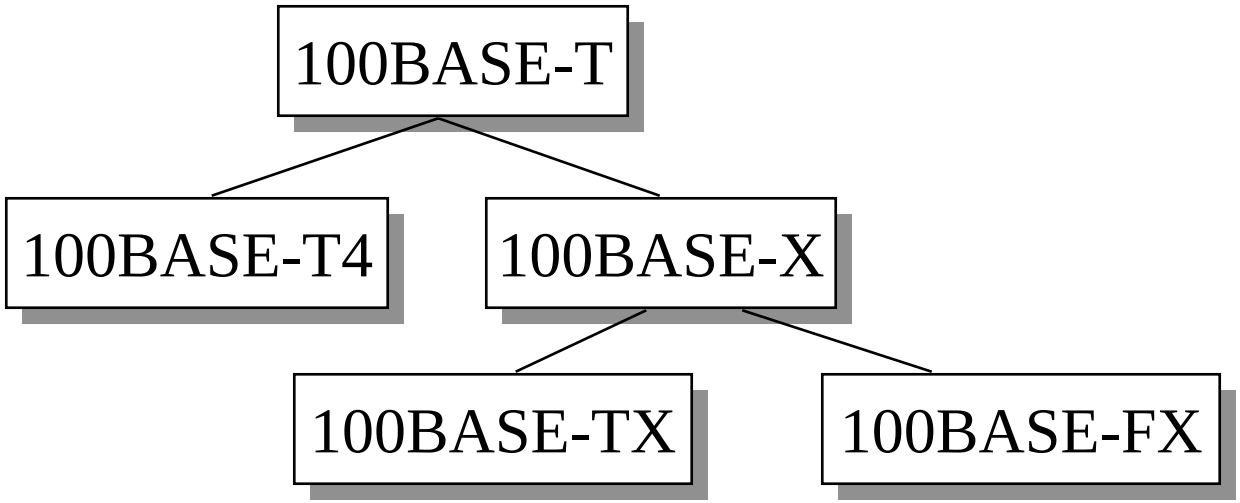
- 10BASE5: 10 Mb/s over coaxial cable (ThickWire)
- 10BROAD36: 10 Mb/s over broadband cable, 3600 m max segments
- 1BASE5: 1 Mb/s over 2 pairs of UTP
- 10BASE2: 10 Mb/s over thin RG58 coaxial cable (ThinWire), 185 m max segments
- 10BASE-T: 10 Mb/s over 2 pairs of UTP
- 10BASE-FL: 10 Mb/s fiber optic point-to-point link
- 10BASE-FB: 10 Mb/s fiber optic backbone (between repeaters). Also, known as synchronous Ethernet.

Ethernet Standards (Cont)

- 10BASE-FP: 10 Mb/s fiber optic passive star + segments
- 10BASE-F: 10BASE-FL, 10BASE-FB, or 10BASE-FP
- 100BASE-T4: 100 Mb/s over 4 pairs of CAT-3, 4, 5 UTP
- 100BASE-TX: 100 Mb/s over 2 pairs of CAT-5 UTP or STP
- 100BASE-FX: 100 Mbps CSMA/CD over 2 optical fiber

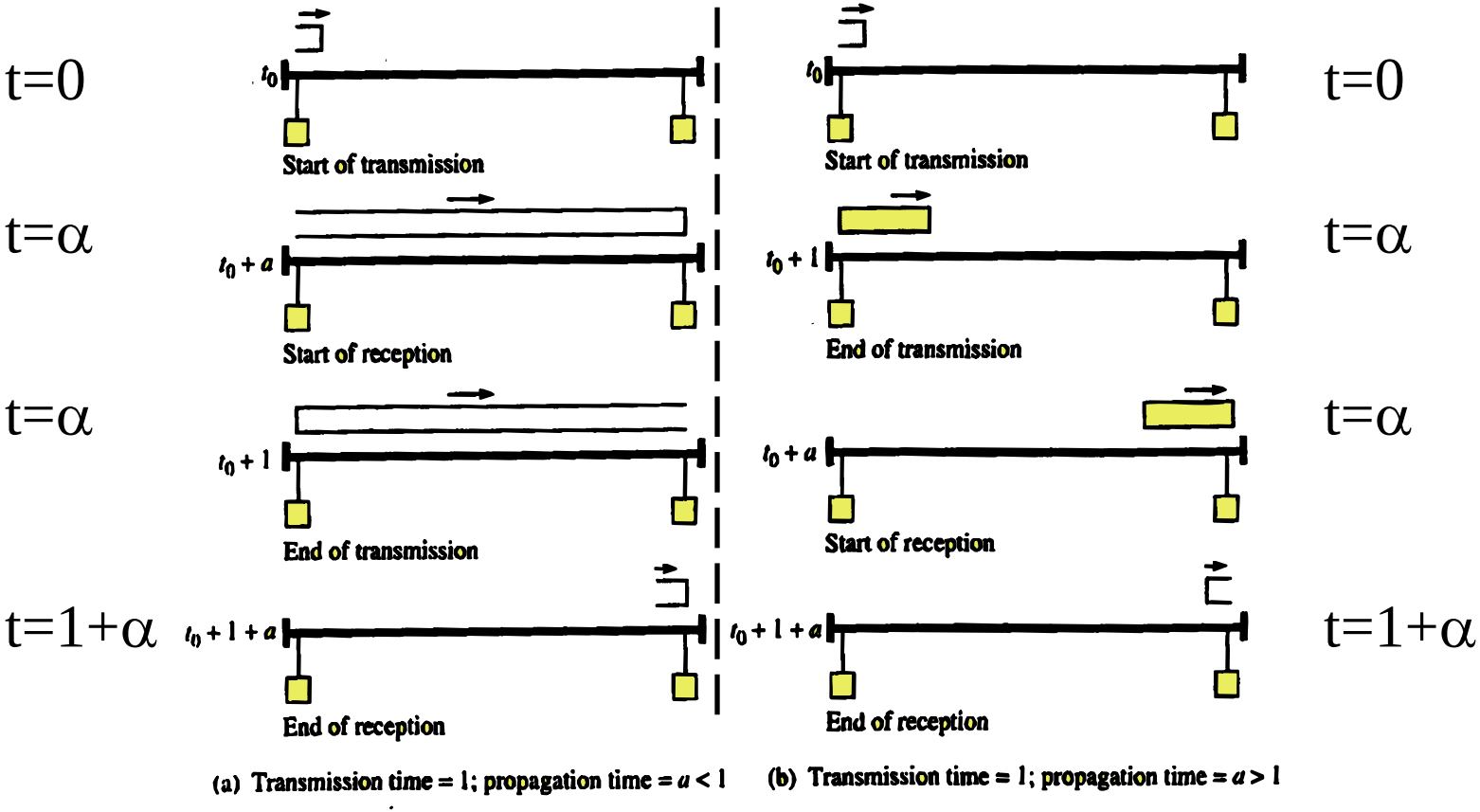
Ethernet Standards (Cont)

- 100BASE-X: 100BASE-TX or 100BASE-FX
- 100BASE-T: 100BASE-T4, 100BASE-TX, or 100BASE-FX
- 1000BASE-T: 1 Gbps (Gigabit Ethernet)
- 10GBASE-T: 10 Gbps Ethernet



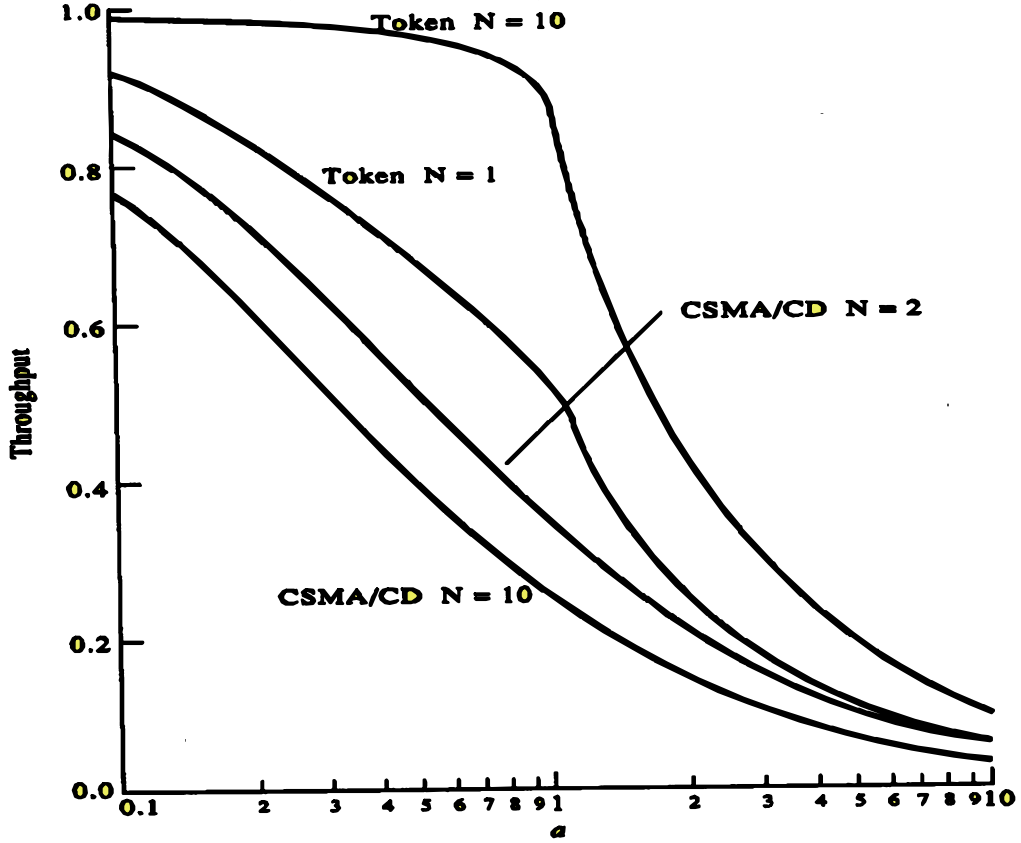
CSMA/CD Performance

- α = Propagation delay/Frame time
- U = Frame Time/(Propagation delay+Frame Time) = $1/(1+\alpha)$

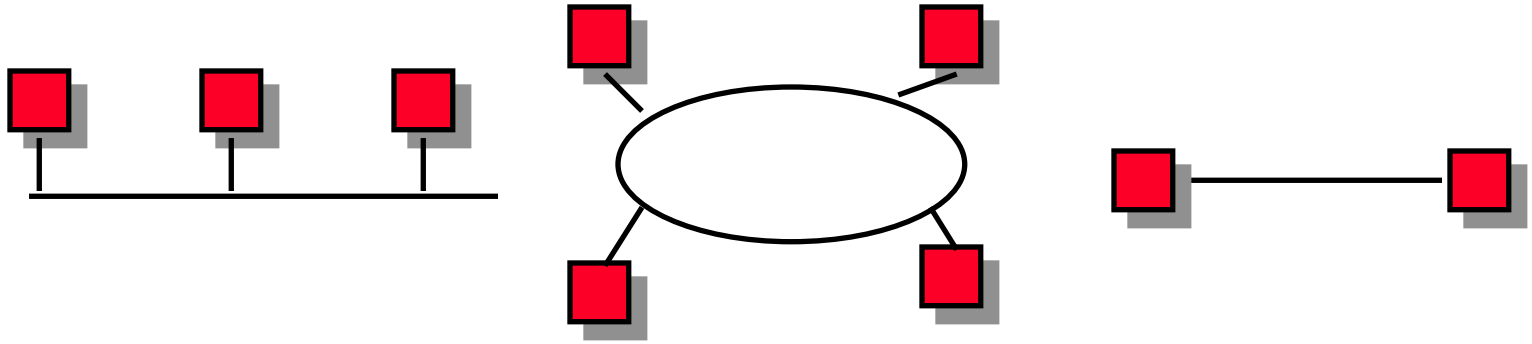


CSMA/CD Performance (Cont)

- $U=1/[1+2\alpha(1-A)/A]$, where $A = (1-1/N)^{N-1} \rightarrow e^{-1}$
- Worst case $U = 1/(1+3.44a)$ with $N= \infty$



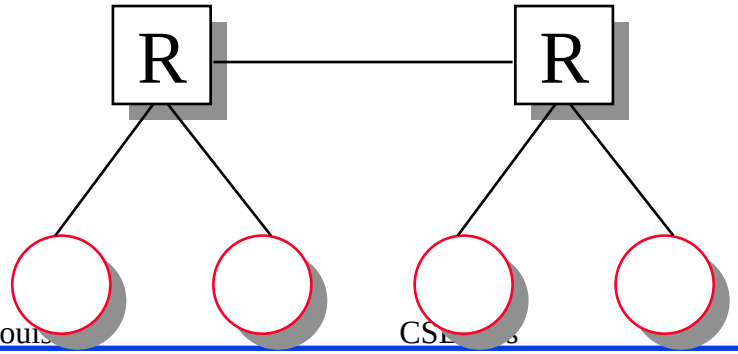
Distance-B/W Principle



- Efficiency = Max throughput/Media bandwidth
- Efficiency is a non-increasing function of α
  α = Propagation delay /Transmission time
  = (Distance/Speed of light)/(Transmission size/Bits/sec)
  = Distance×Bits/sec/(Speed of light)(Transmission size)
- Bit rate-distance-transmission size tradeoff.
- 100 Mb/s $\Rightarrow$ Change distance or frame size

Ethernet vs Fast Ethernet

	Ethernet	Fast Ethernet
Speed	10 Mbps	100 Mbps
MAC	CSMA/CD	CSMA/CD
Network diameter	2.5 km	205 m
Topology	Bus, star	Star
Cable	Coax, UTP, Fiber	UTP, Fiber
Standard	802.3	802.3u
Cost	X	2X



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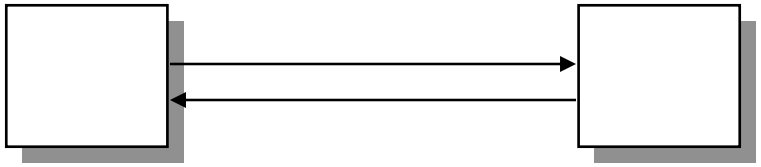
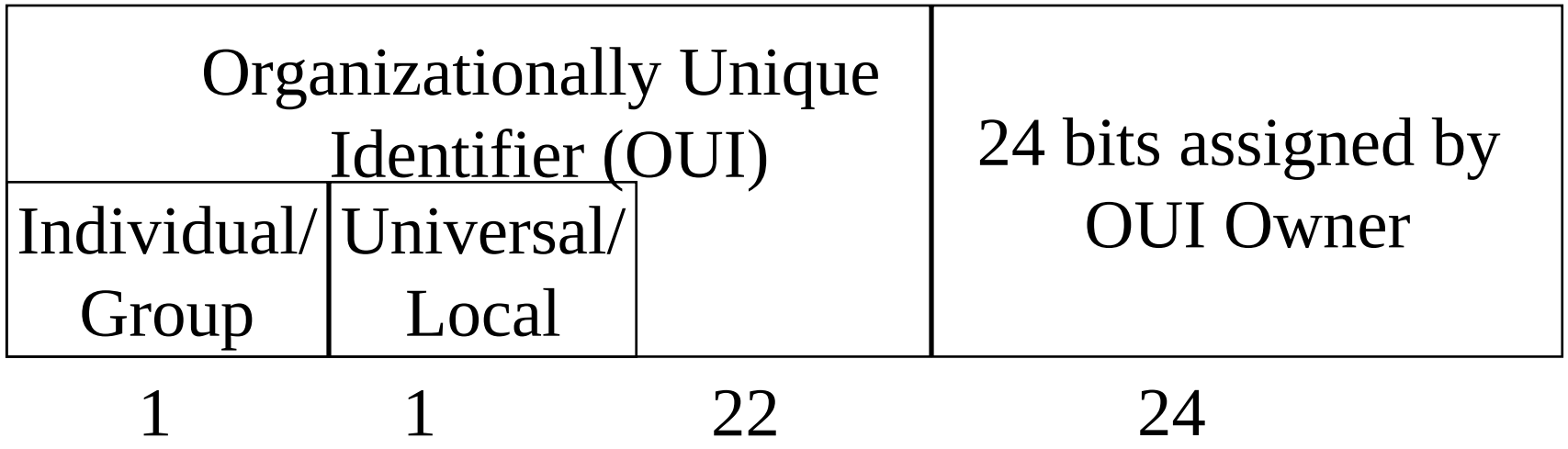
Full-Duplex Ethernet



- Uses point-to-point links between TWO nodes
- Full-duplex bi-directional transmission
- Transmit any time
- Not yet standardized in IEEE 802
- Many vendors are shipping switch/bridge/NICs with full duplex
- No collisions $\Rightarrow$ 50+ Km on fiber.
- Between servers and switches or between switches

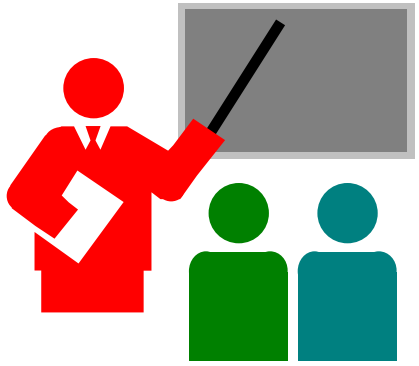
IEEE 802 Address Format

- 48-bit:1000 0000 : 0000 0001 : 0100 0011 : 0000 0000 : 1000 0000 : 0000 1100
  = 80:01:43:00:80:0C



- Multicast = "To all bridges on this LAN"
- Broadcast = "To all stations"
  = 111111....111 = FF:FF:FF:FF:FF:FF

Summary



- Ring, Bus, Tree, Star topologies
- CSMA, CD, and *p*-persistence
- Binary exponential backoff
- 10BASE-T vs 100BASE-T
- Full-duplex Ethernet
- Multicast and unicast Ethernet frames

Reading Assignment

- Read sections 15.2, 16.1 and 16.2 16.5, 16.6, Appendix 16A, Appendix 16B of Stallings 7th Edition.