

Hi-Speed LANs

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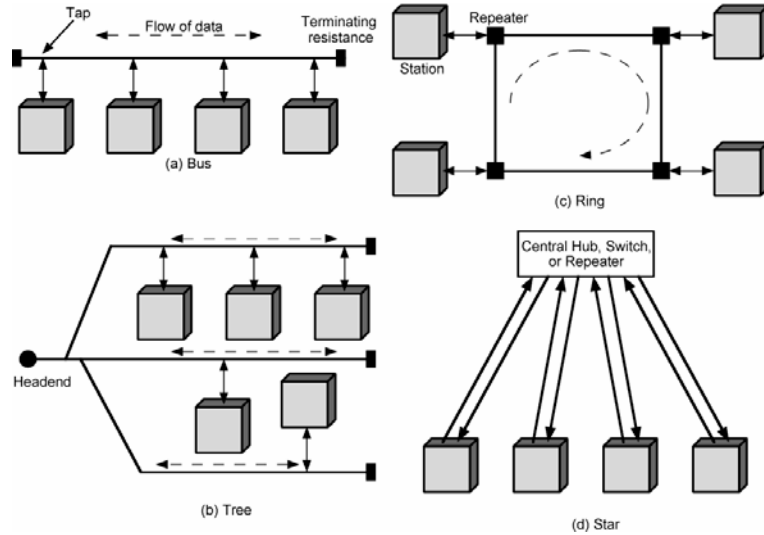
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- q LAN Topologies
- q Media Access Control (MAC), CSMA/CD
- q Ethernet Standards
- q CSMA/CD Performance
- q Ethernet vs Fast Ethernet
- q Full-Duplex Ethernet
- q IEEE 802 Address Format

LAN Topologies



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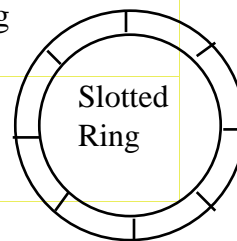
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Media Access Control (MAC)

	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	



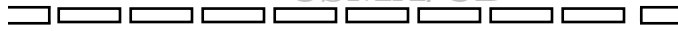
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CSMA/CD



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

IEEE 802.3 CSMA/CD

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

CSMA/CD Operation

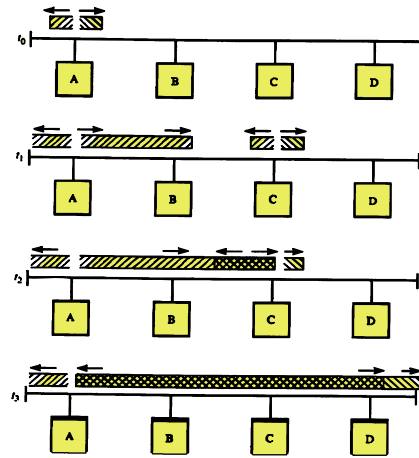


Fig 13.1

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

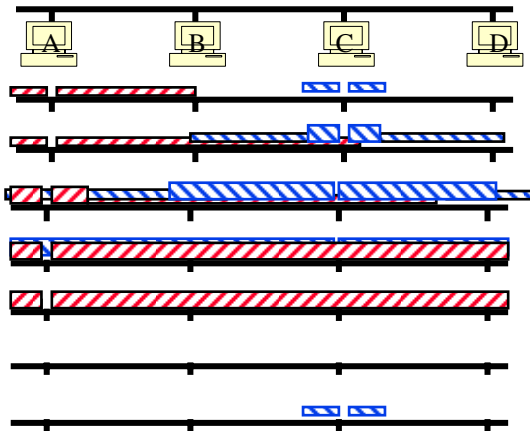
Both A and C sense idle

t=3+51.2+9.6μs: A and C

draw random numbers

A gets 1 and C gets 0

C starts transmitting



q Collision window = $2 \times \text{One-way Propagation delay} = 51.2 \mu\text{s}$

q One way delay = $25.6 \mu\text{s} \Rightarrow \text{Max Distance} < 2.5 \text{ km}$

Original Ethernet Configuration

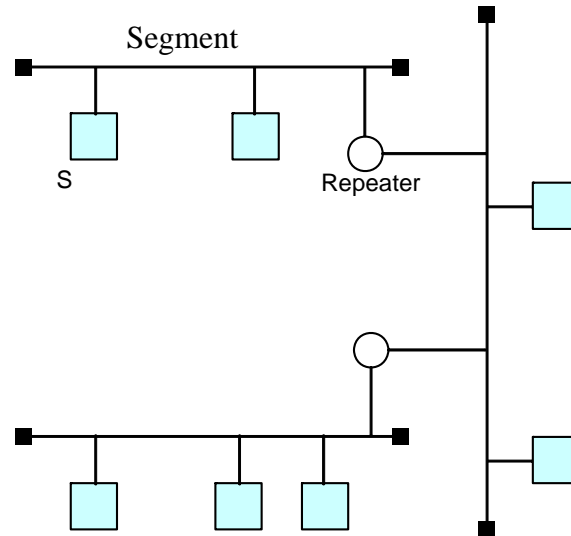
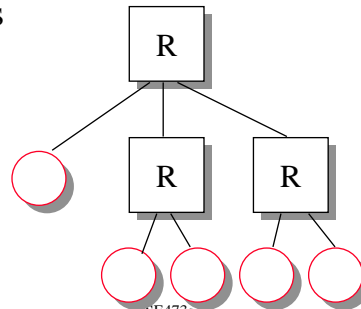


Fig.12.9

10BASE-T

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



Ethernet Standards

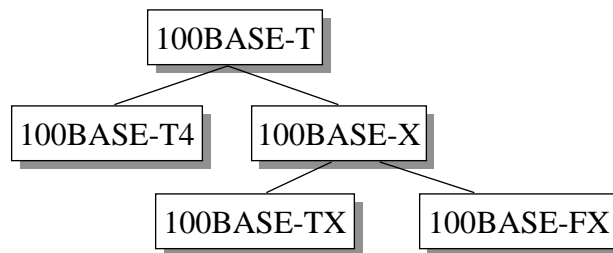
- q 10BASE5: 10 Mb/s over coaxial cable (ThickWire)
- q 10BROAD36: 10 Mb/s over broadband cable, 3600 m max segments
- q 1BASE5: 1 Mb/s over 2 pairs of UTP
- q 10BASE2: 10 Mb/s over thin RG58 coaxial cable (ThinWire), 185 m max segments
- q 10BASE-T: 10 Mb/s over 2 pairs of UTP
- q 10BASE-FL: 10 Mb/s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

Ethernet Standards (Cont)

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

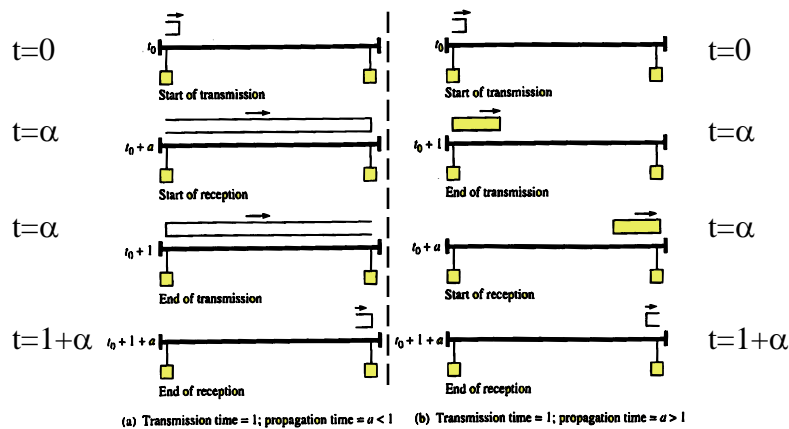
Ethernet Standards (Cont)

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



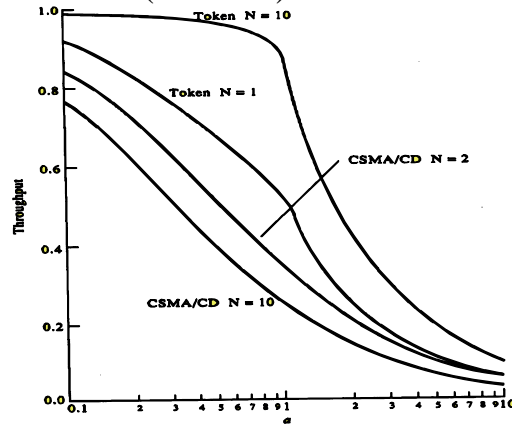
CSMA/CD Performance

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

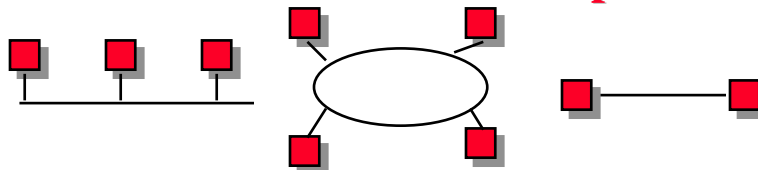


CSMA/CD Performance (Cont)

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



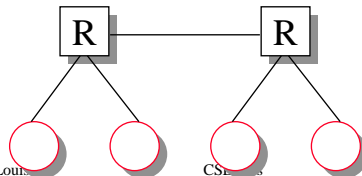
Distance-B/W Principle



- q Efficiency = Max throughput/Media bandwidth
- q Efficiency is a non-increasing function of α
 - $\alpha = \text{Propagation delay} / \text{Transmission time}$
 - $= (\text{Distance} / \text{Speed of light}) / (\text{Transmission size} / \text{Bits/sec})$
 - $= \text{Distance} \times \text{Bits/sec} / (\text{Speed of light}) (\text{Transmission size})$
- q Bit rate-distance-transmission size tradeoff.
- q 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



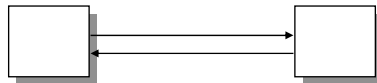
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Full-Duplex Ethernet



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

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IEEE 802 Address Format

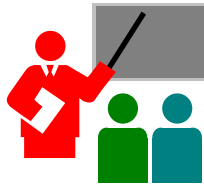
q 48-bit: 1000 0000 : 0000 0001 : 0100 0011
: 0000 0000 : 1000 0000 : 0000 1100
= 80:01:43:00:80:0C

Organizationally Unique Identifier (OUI)		24 bits assigned by OUI Owner
Individual/Group	Universal/Local	
1	1	22
		24

q Multicast = “To all bridges on this LAN”

q Broadcast = “To all stations”
= 111111...111 = FF:FF:FF:FF:FF:FF

Summary



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

Reading Assignment

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