Recent Advances in 100 Mbps LAN Technologies

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Why This Seminar Series?

- Technology is moving too fast
- Throughout 1980's everyone believed Ethernet was not scalable
- September 1992: First time 100 Mbps Ethernet was discussed publicly and products appeared 13 months later
- Middle 1995: No one imagined Ethernet at Gigabit. Middle 1996: Gigabit Ethernet products announced
- Network engineer, managers and users need to keep track of the latest

ATM vs Legacy LANs

- Last year, every one planned for ATM.
  This year, many are not so sure.
- One network for all.
  Which network that is? ATM or Ethernet?
- Switching is better than routing.
  What should be switched? Cells or Frames?
- Multimedia needs quality of service. Do we really need reservations or is priority enough?
- Need a technology that is scalable in speed from Mbps to Gbps. Is that ATM or Ethernet?

More About This Series

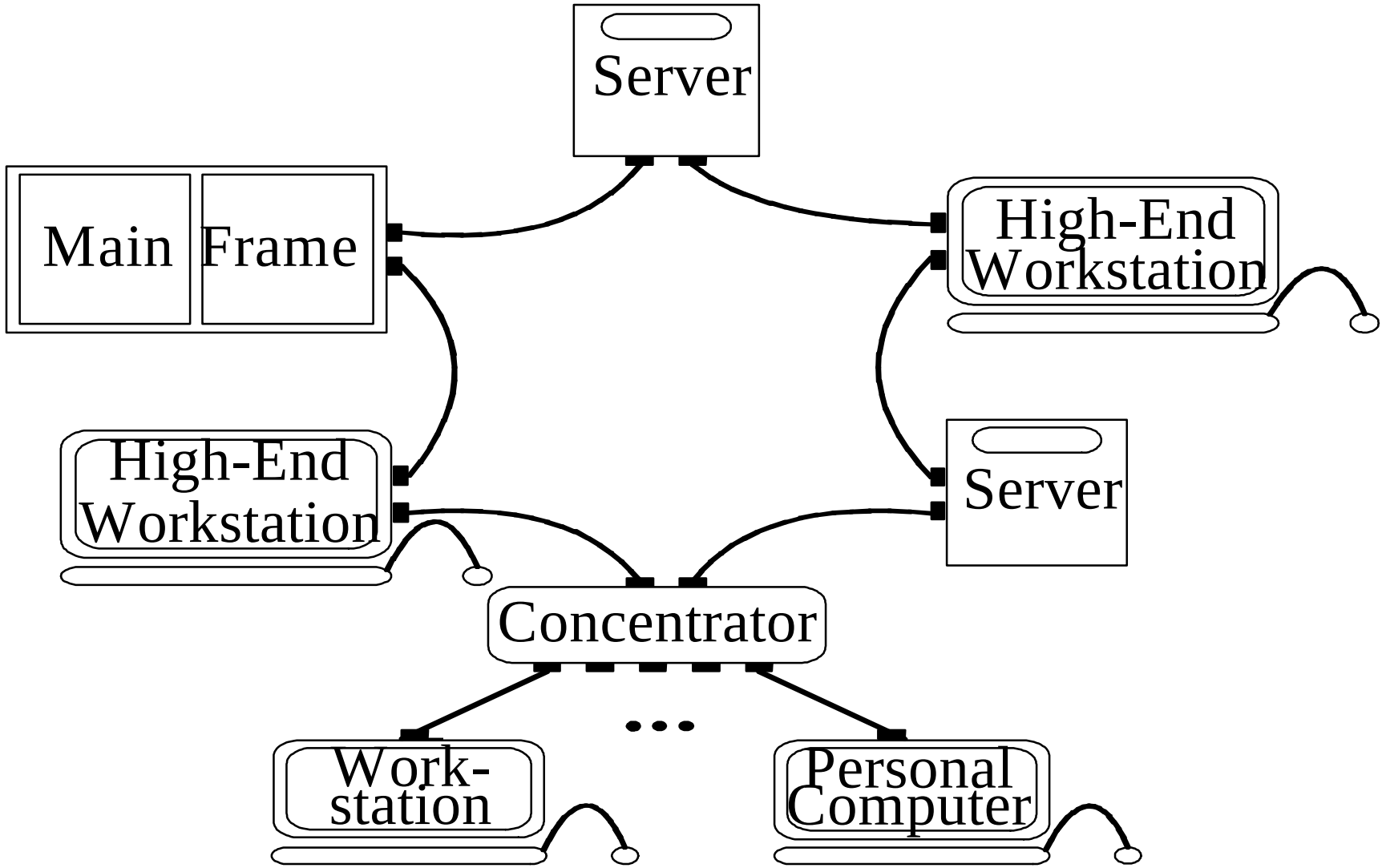
- Designed for Industry
  ⇒ Covers both research and developments
- Tutorials on latest developments
  - LAN Switching
  - QoS on LANs
  - Multimegabit Access to Home
  - QoS on Internet
  - Virtual LANs
  - Gigabit Ethernet
  - Multimedia on Internet
  - Wireless and Mobility on Internet
- Please fill out the participant information/survey on the last page.

- FDDI, Copper FDDI
- Ethernet: History, Access Method
- IEEE 802.3 Notation: 10BASE5
- Repeater, hub, bridge, router
- 100 Mbps Ethernet
- 100VG-AnyLAN

FDDI

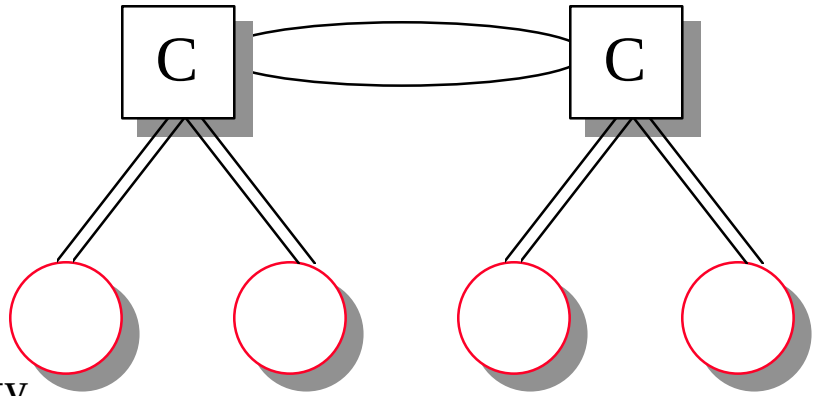
- Fiber Distributed Data Interface
- ANSI Standard for 100 Mbps timed token access
- Up to 500 stations on a single FDDI network
- Inter-node links of up to 2 km on multimode fiber, 60+ km on single mode fiber, Longer SONET links, 100 m on UTP.
- Round-trip path limited to 200 km$\Rightarrow$100 km cable.
- Maximum frame size is 4500 bytes.
- Eight priority levels
- Arranged as single- or dual-ring logical topology

Dual-Ring of Trees Topology



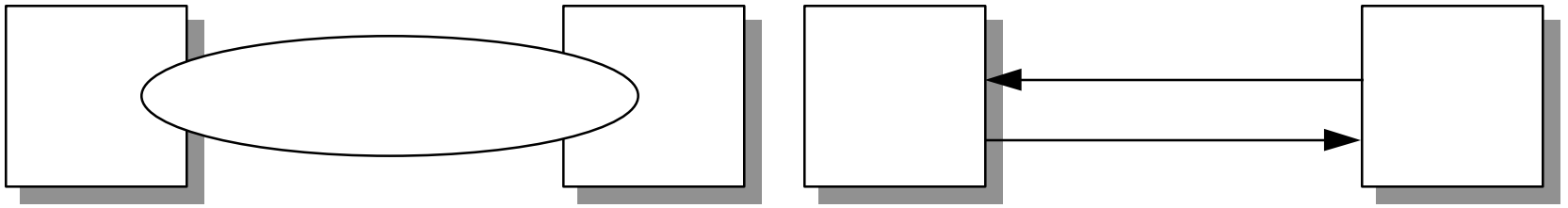
TP-PMD

- Twisted-Pair Physical Media Dependent
  = Copper FDDI or CDDI
- Allows 100 m over Cat-5 unshielded twisted pair (UTP)
  - **Cat-3**: 15 MHz Voice grade
  - **Cat-4**: 20 MHz
  - **Cat-5**: 100 MHz data grade



Full Duplex FDDI

- The stations transmit and receive simultaneously.
- Works only on a 2-station ring.
- 200 Mbps.
- Network starts in ring mode.
- After detecting a two node ring using management frames, stations negotiate & enter full duplex mode
- On error, stations enter the ring mode.



CSMA/CD

- Aloha at University of Hawaii:
  Transmit whenever you like
  Worst case utilization = 1/(2e) =18%
- Slotted Aloha: Fixed size transmission slots
  Worst case utilization = 1/e = 37%

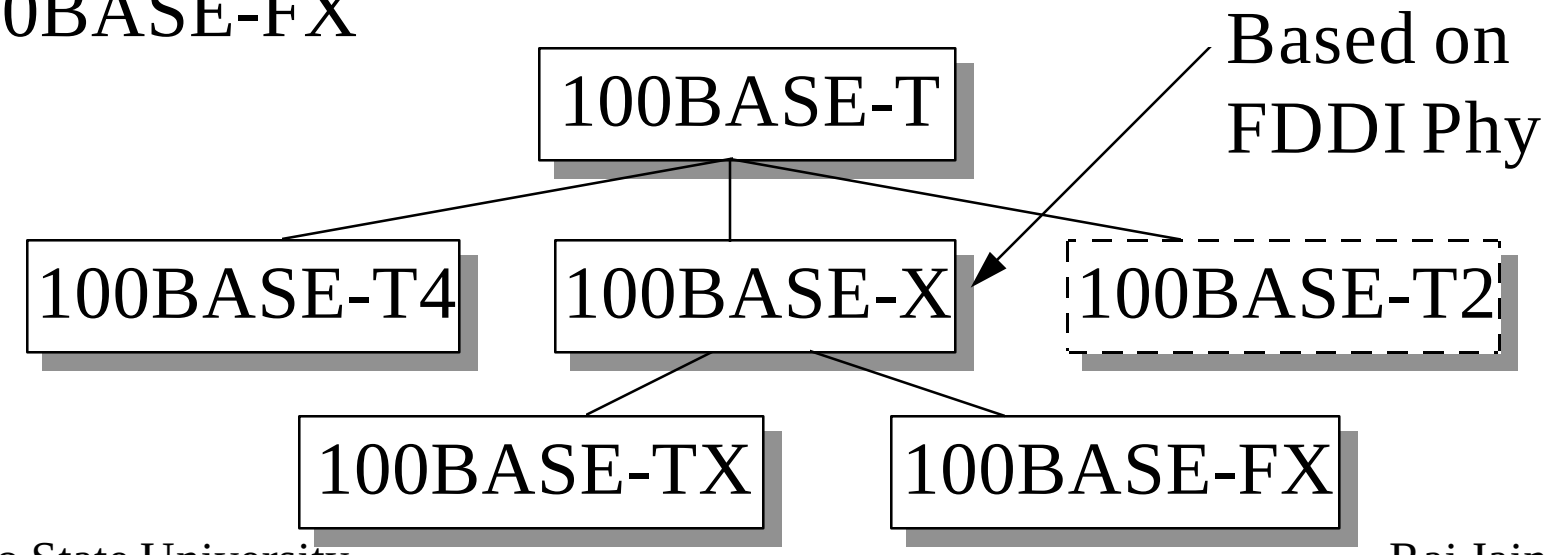
- CSMA: Carrier Sense Multiple Access
  Listen before you transmit
- CSMA/CD: CSMA with Collision Detection
  Listen while transmitting. Stop if you hear someone

CSMA/CD PHY Standards

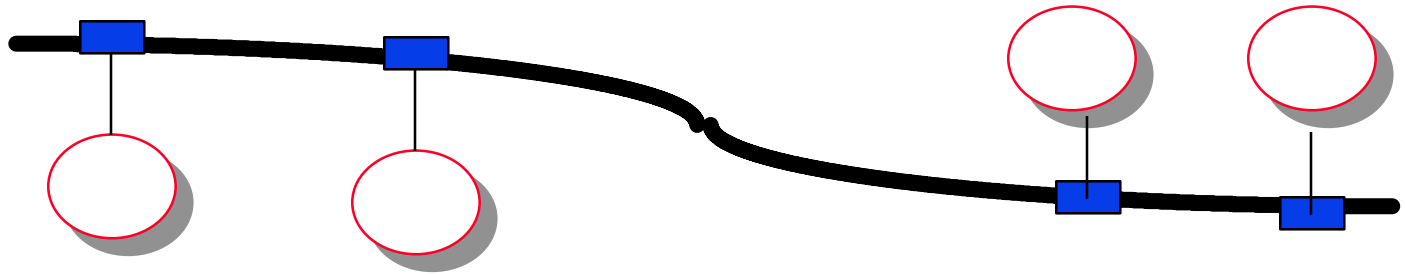
- **10BASE5:** 10 Mb/s over coaxial cable (ThickWire)
- **10BROAD36:** 10 Mb/s over broadband cable, 3600 m max segments
- **10BASE2:** 10 Mb/s over thin RG58 coaxial cable (ThinWire), 185 m max segments
- **1BASE5:** 1 Mb/s over 2 pairs of UTP
- **10BASE-T:** 10 Mb/s over 2 pairs of UTP
- **10BASE-F:** Fiber Optic inter-repeater link (FOIRL), 10BASE-FL (link), 10BASE-FB (backbone), or 10BASE-FP (Passive)

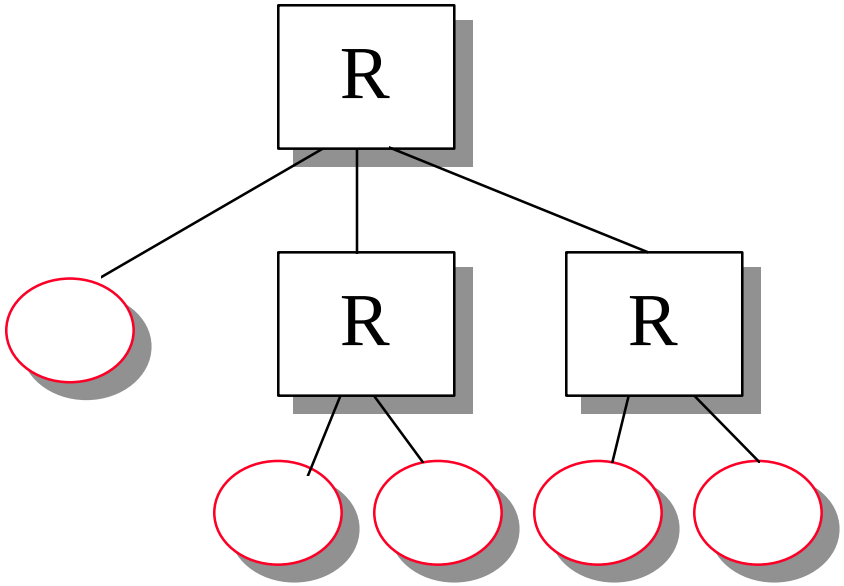
Fast Ethernet Standards

- **100BASE-T4:** 100 Mb/s over 4 pairs of CAT-3, 4, 5
- **100BASE-TX:** 100 Mb/s over 2 pairs of CAT-5, STP
- **100BASE-FX:** 100 Mbps CSMA/CD over 2 fibers
- **100BASE-X:** 100BASE-TX or 100BASE-FX
- **100BASE-T:** 100BASE-T4, 100BASE-TX, or 100BASE-FX



10BASE5 vs 10BASE-T



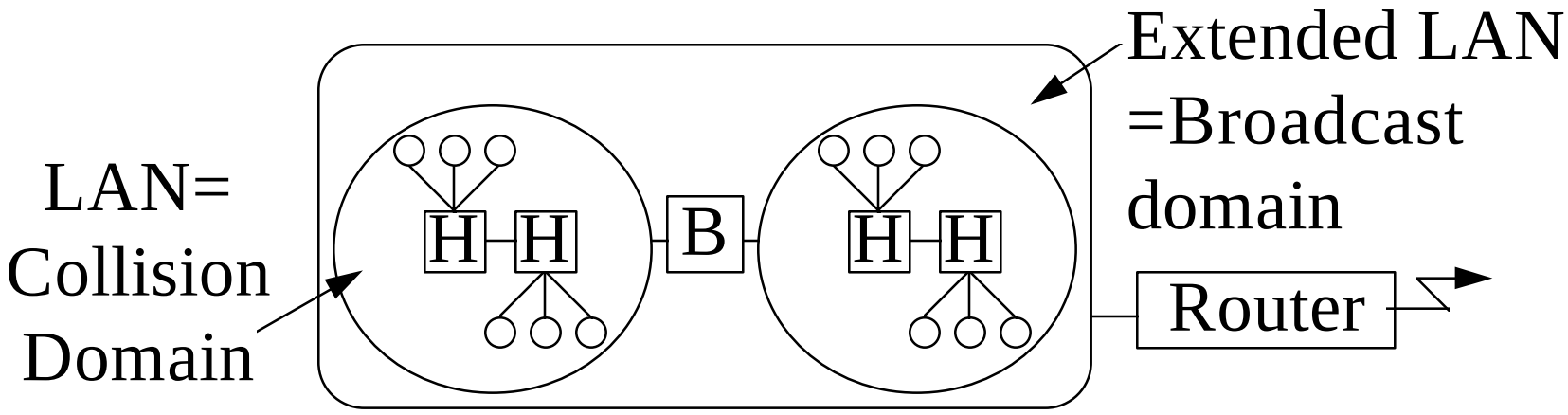


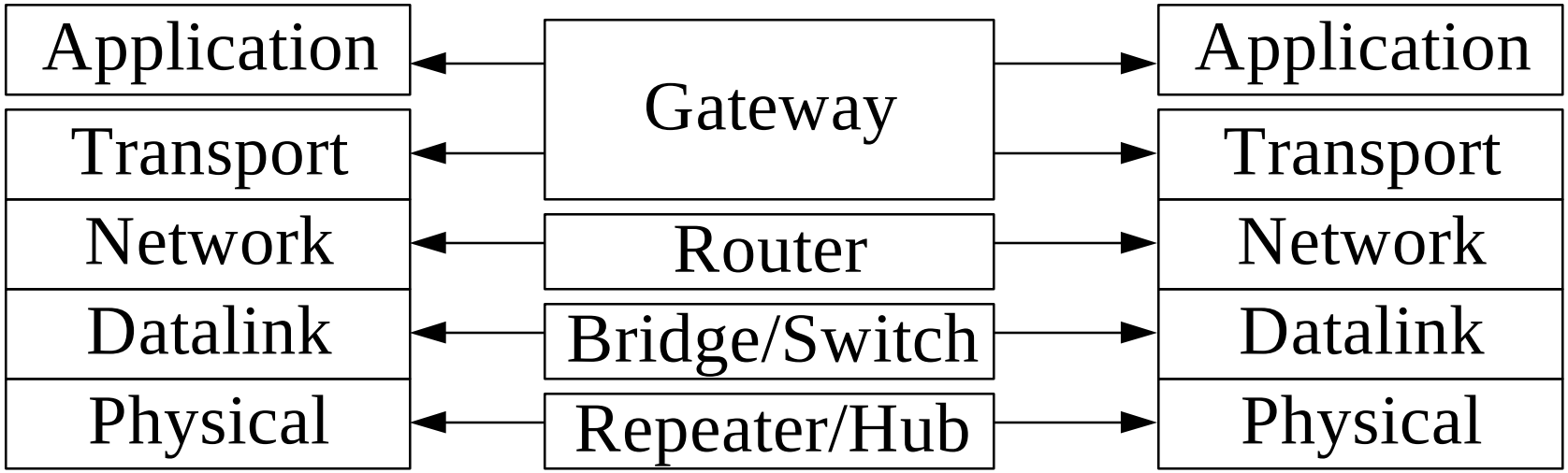
Interconnection Devices

- **Repeater**: PHY device that restores data and collision signals
- **Hub:** Multiport repeater + fault detection and recovery
- **Bridge:** Datalink layer device connecting two or more collision domains. MAC multicasts are propagated throughout "extended LAN."
- **Router:** Network layer device. IP, IPX, AppleTalk. Does not propagate MAC multicasts.
- **Switch**: Multiport bridge with parallel paths

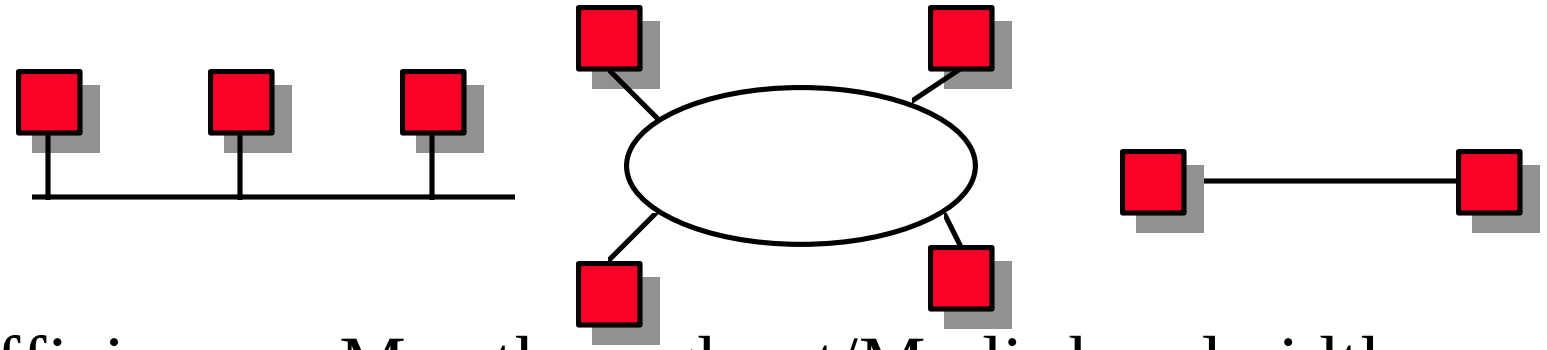
These are functions. Packaging varies.

Interconnection Devices





Distance-Bandwidth Tradeoff



- Efficiency = Max throughput/Media bandwidth
- Efficiency is a decreasing function of α

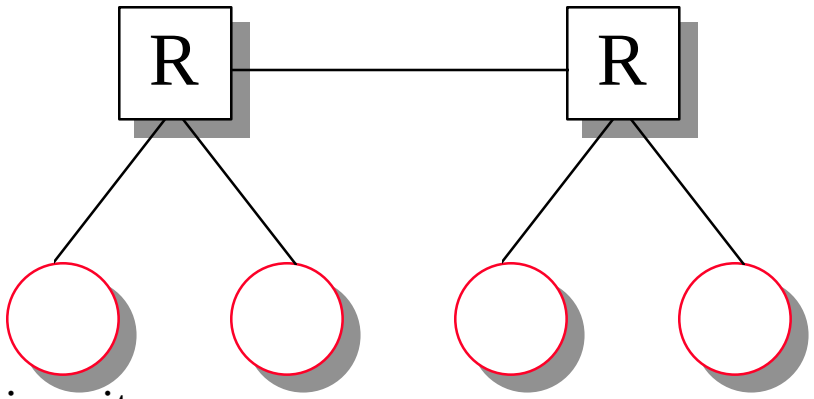
  α = Propagation delay /Transmission time

  = (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

Fast Ethernet

- Same access method (CSMA/CD) as in Ethernet
- Same frame sizes (64 B to 1518 B) as in Ethernet
- Ten times faster. Ten times shorter.
- Extent = 2.5 km (10 Mbps) 205 m (100 Mbps)
- 10/100 adapters⇒ Autonegotiate the speed



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[1], UTP, Fiber	UTP[2], Fiber
Standard	802.3	802.3u
Cost	X	2X

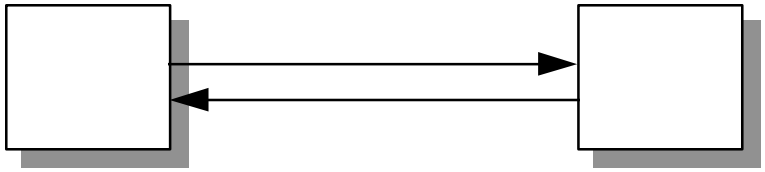
[1] Coax users may need to rewire to upgrade

[2] 100 BASE-T4 does not allow full duplex

100BASE-T Options

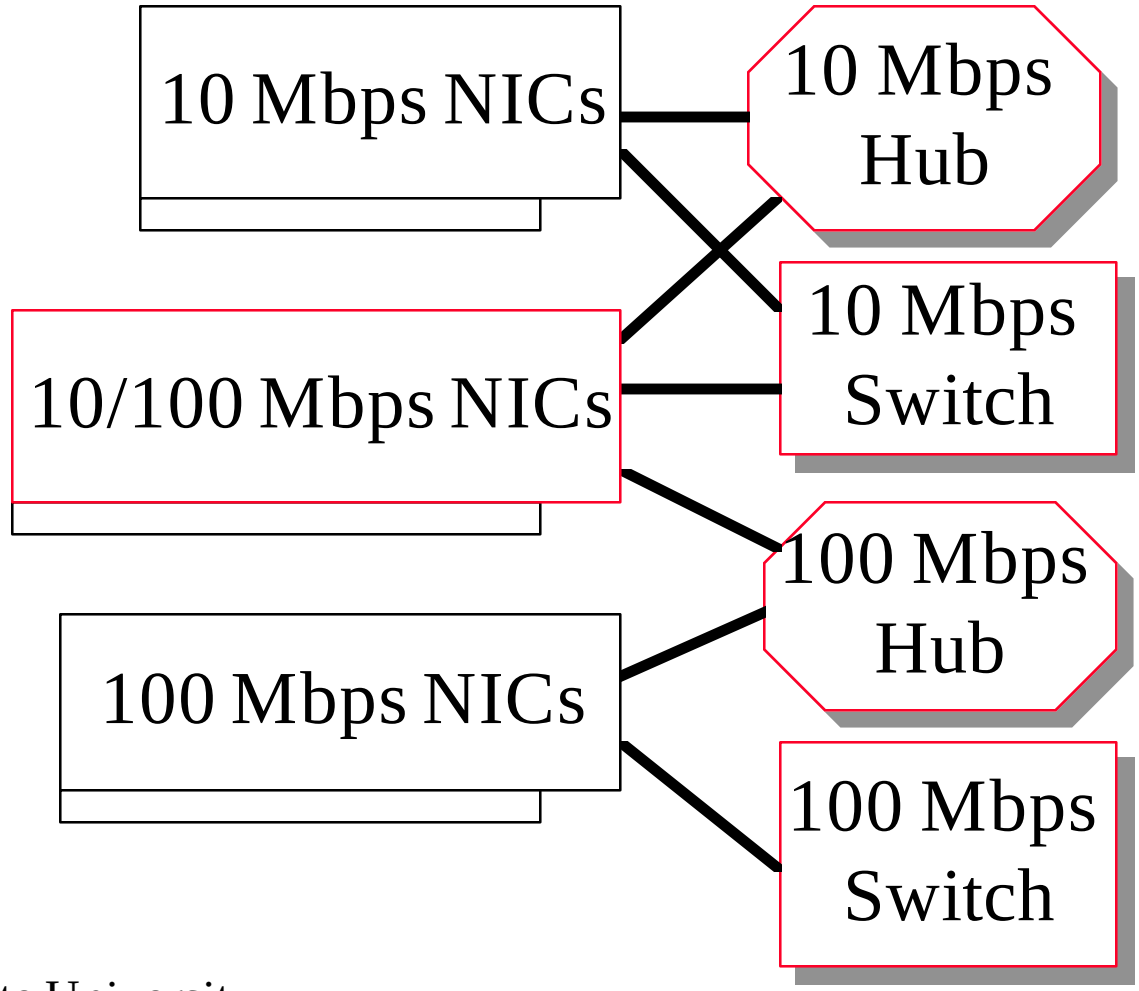
- Autonegotiation: Automatically select 10 or 100 Mbps
  Priority Order: 100BASE-TX Full Duplex, 100BASE-T4, 100BASE-TX, 10BASE-T Full Duplex, 10BASE-T
  (T4 connected to phone line⇒ Burnout on ringing)
- Exposed Medium Independent Interface
  Some place the transceivers on the adapter
- Far-end Fault Indication: Link failure in one direction.
  End not receiving the signal sends an indication to other
- Cross-over correction: swapping the transmit and receive pairs
- Polarity Reversal: Swapping the two wires in a pair

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

Planning for Growth

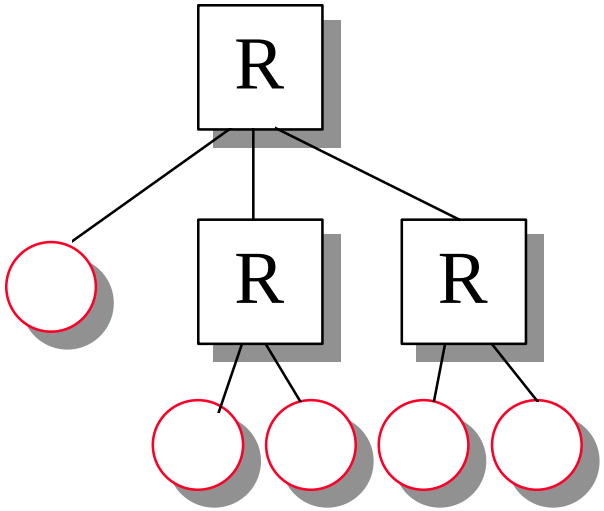


Prices

- 10BASE-T NICs: $29-$100
- 10/100 100BASE-T NICs: $89-$259
- 10BASE-T Hubs: $39-$150 (8 ports)
- 100BASE-T Hubs: $2375 (12 ports)
- 100BASE-FX Hubs: $600/port
- Hybrid 10/100 Switches: $4995 (24×10+1×100)
- 100BASE-T Switches: $1000/port
- 100BASE-FX Switches: $1700/port

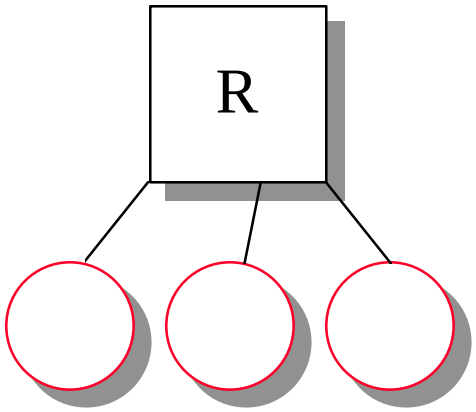
100VG-AnyLAN: Key Features

- IEEE 802.12 standard. Also known as 100BASE-VG.
- **AnyLAN**:
  ⇒ Supports both Ethernet and token ring frame formats
  - Only one format in any LAN
  - Allows 10BASE-T and Token ring wiring infrastructure.
  - 2.5 km network diameter
- Priorities: Normal and High⇒ Multimedia
  But, need new software for new features
- Multi-level Configuration.



- Many current products recommend limiting to 3 repeaters/path. 10BASE-T allows 4 repeaters.
- Store-and-forwarding repeaters.
  Repeaters monitor destination address.
- **Privacy**: Unicast packets not delivered to other end-nodes.
- All repeaters and promiscuous nodes hear all traffic.

Demand Priority Protocol

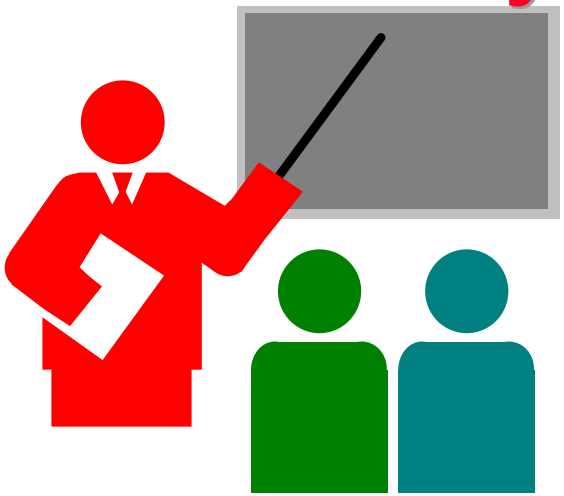


- Round-robin in physical port order. One packet per grant
- Two Priorities: Normal and High
  - Higher priority requests preempt normal priority *round*
  - Higher priority requests served after current normal priority packet*finishes*. No preemption.

LANs: Comparison

	100VG-AnyLAN	100BASE-T4	100BASE-TX	TP-PMD	10BASE-T
Cat5 Links	200	100	100	190	100+
Network Diameter	2,000m	250m	250m	N/A	2,500m
Cat3 Links	100m	100m	No	No	100m
# of pairs	4 (2 on STP)	4	2	2	2,4
10/100	Yes	Yes	Yes	N/A	N/A
Cost	1.5X	1.5X	1.5X	5X	X
Standard	802.12	802.3u	802.3u	TP-PMD	802.3i

Summary



- FDDI is designed for campus backbone
- Fast Ethernet: 100BASE-T4, 100BASE-TX, 100BASE-FX, 100BASE-T2
- Shared Ethernet is limited in distance.
  Can use switched and full duplex links for campus.
- 10/100 NICs are preferable over 10 Mbps.

Acronyms

- AUI Attachment Unit Interface
- Cat-3 Category 3 Cable
- Cat-4 Category 4 Cable
- Cat-5 Category 5 Cable
- CRC Cyclic Redundancy Check
- DTE Data Terminal Equipment
- FCS Frame Check Sequence
- FDDI Fiber Distributed Data Interface
- FEXT Far-end Crosstalk

- FOIRL Fiber Optic Inter-Repeater Link
- FLP Fast Link Pulse
- FOMAU Fiber Optic Medium Attachment Unit
- FOMDI Fiber Optic Media Dependent Interface
- FOPMA Fiber Optic Physical Medium Attachment
- HH Header Hub
- IH Intermediate Hub
- IPG Inter-packet Gap
- IRL Inter-Repeater Link

- LAN Local Area Network
- LLC Logical Link Control
- MAC Medium Access Control
- MAU Medium Attachment Unit
- MDI Medium Dependent Interface
- MIB Management Interface Base
- MII Media independent interface
- NEXT Near-end Crosstalk
- NLP Normal Link Pulse
- NRZI N
- PCS Physical Coding sublayer

- PHY Physical Layer Device Sublayer
- PLS Physical signaling sublayer
- PMA Physical Medium Attachment
- PMD Physical Medium Dependent
- PMI Physical Medium Independent
- SSD Start of Stream Delimiter
- SFD Start of Frame Delimiter
- STP Shielded Twisted Pair
- UTP Unshielded Twisted Pair

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Name: _____

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Comments/Suggestions for Today's Seminar:

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Participant Survey

Future Topics of Interest: Please indicate your interest level 0=None, 1=Some, 2=OK, 3=High

[ ] Virtual LANs

[ ] Quality of Service on LANs

[ ] Gigabit Ethernet

[ ] ATM Networks

[ ] Multimedia networking

[ ] Wireless Networking

[ ] Others (specify) _____

Seminar Time Preference:

[ ] 10AM-11:30AM [ ] 3:00PM-4:30PM