Token Passing: IEEE802.5 standard

- 4 Mbps
- maximum token holding time: 10 ms, limiting packet length
- packet (token, data) format:

SD	AC	FC

SD	AC	FC	dest addr	src addr	data	checksum	ED	FS

- *SD, ED* mark start, end of packet

IEEE802.5 standard

SD	AC	FC

SD	AC	FC	dest addr	src addr	data	checksum	ED	FS

- ***AC access control byte:***
  - *token bit:* value 0 means token can be seized, value 1 means data follows FC
  - *priority bits:* priority of packet
  - *reservation bits:* station can write these bits to prevent stations with lower priority packet from seizing token after token becomes free
- *FC frame control:* used for monitoring and maintenance

IEEE802.5 standard

- *source, destination address:* 48 bit physical address, as in Ethernet
- *data:* packet from network layer
- *checksum*
- *frame status (FS):* set by destination, read by sender
  - set to indicate destination is up, pkt copied OK from ring
  - DLC-level ACKing

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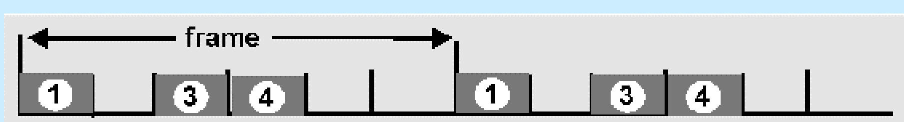
Time Division Multiple Access

- TDMA: time division multiple access
- access to channel in "rounds"
- each station gets fixed length slot (pkt trans time) in each round
- unused slots go idle
- example: 6-station LAN, 1,3,4 have pkt, 2,5,6 idle



Pros and cons:

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Reservation-based Protocols

- want to avoid wasted slots in TDMA
- access to channel in rounds (again). Each round:
- begins with N *short reservation slots*
  - reservation slot time equal to end-end propagation delay of channel
  - station with message to send posts reservation (1) in its reservation slot
  - reservation slots seen by all stations
- after reservation slots, message transmissions ordered by known priority

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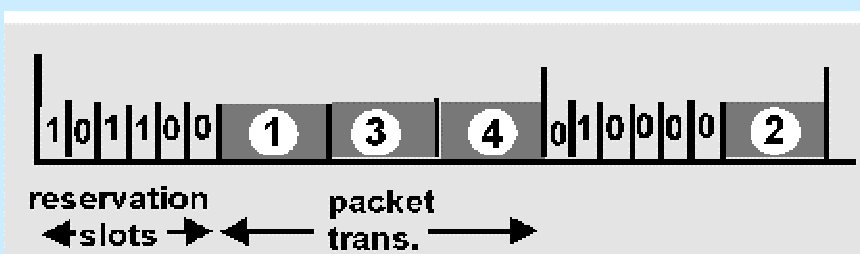

Pros and cons:

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Critical Assessment of Multiple Access Protocols

Random access: Alohas, CSMA, group

Controlled, predetermined: TDMA

Controlled demand adaptive: tokens, reservation

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ARP: Address Resolution Protocol

- IEEE802.* (Ethernet, token ring/bus) interface cards only recognize 48-bit IEEE 802. physical layer addresses on packets
- network layer uses IP address (32 bits)

Q: how to determine physical address of machine with given IP address?

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ARP : Address Resolution Protocol

- A knows B's IP address, wants to learn physical address of B
- A broadcasts ARP query pkt, containing B's IP address
- all machines on LAN receive ARP query
- B receives ARP packet, replies to A with its (B's) physical layer address
- A caches (saves) IP-to-physical address pairs until information becomes old (times out)

soft state: information that times out (goes away)

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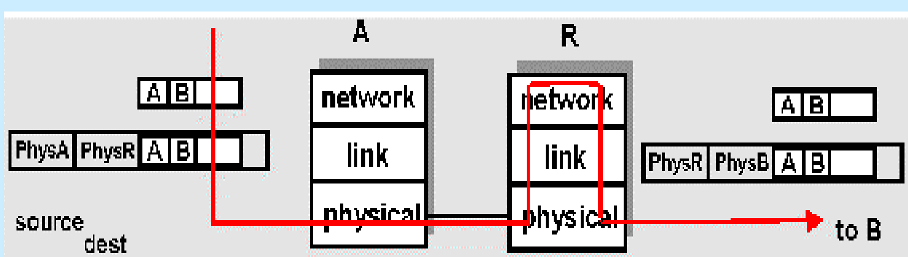

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Routing and Physical Layer Addresses: synthesis

- P Host A knows router R is next hop to IP destination B:
- A creates IP packet with source A, destination B
- A uses ARP to get physical layer address of R
- A creates Ethernet packet with R's physical address as dest, Ethernet packet contains A-to-B IP packet
- A sends Ethernet packet
- R receives Ethernet packet
- R removes IP datagram from Ethernet packet, sees it is destined to B
- R creates physical layer packet, containing A-to-B IP datagram and sends to next router on route to B

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Interconnecting LANs

Why not just one big LAN?

- limited amount of supportable traffic: on single LAN, all stations must share bandwidth
- limited length: 802.3 specifies maximum cable length
- limited number of stations: 802.4/5 have token passing delays at each station

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Bridges and Repeaters

Bridges versus Repeaters for interconnecting LANs

Repeater

- copies (amplifies, regenerates) bits between LAN segments
- no storage of packets
- physical-level (only) interconnection of LANs

Bridge

- receives, stores, forward (when appropriate) packets between LANs
- has two layers of protocol stack: physical and link-level (media access)

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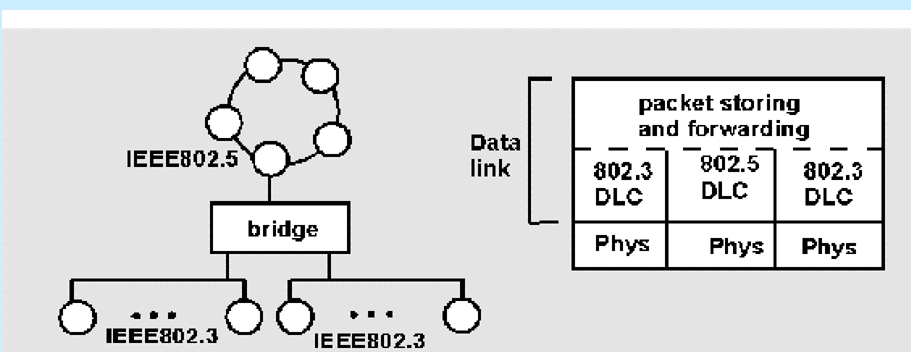
Bridges versus routers



Bridges are arguably routers

- know physical layer addresses of stations on each interconnected LAN
- receive and selectively forwards packets transmitted on LAN

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Bridges versus routers

Bridges are not routers

- no knowledge of "outside world", only stations on interconnected LAN
- bridges don't exchange routing tables
- deal only with physical layer addresses

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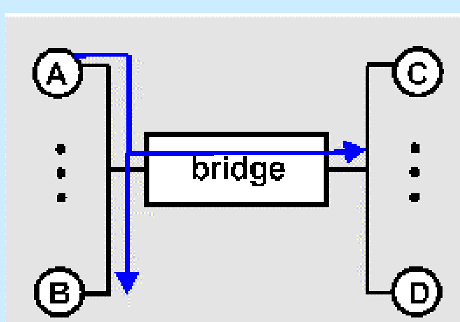
Bridges: Forward Packets

Bridges filter packets

- intra-LAN -segment pkts not forwarded onto other LAN segments
- inter-LAN-segment pkts must be forwarded, but where?



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Bridges: Forward Packets

Techniques for forwarding packets

- flood packets (obvious drawbacks)
- router-discovery-like protocol
  - allows bridge to identify hosts on LAN segment
  - drawbacks?
- bridge "observes" traffic and "learns" which stations are attached
  - transparent: just add bridge to LAN, all hosts behave as if bridge were not there

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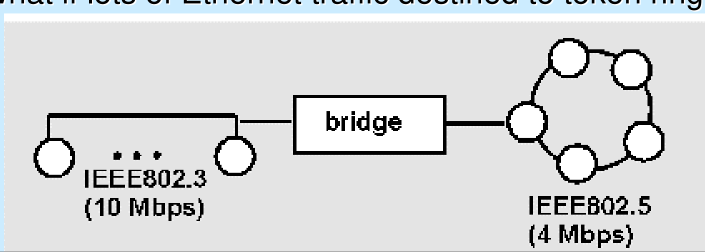
Bridges: the headaches of 3 LAN standards

Computation

- bridge may need to translate between 3 802 standards (each 802.* has different format)
- translated packet requires new checksum

Speed mismatch

- different 802.* LAN's operate at different speeds
- what if lots of Ethernet traffic destined to token ring?



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Bridges: the headaches of 3 LAN standards

Size mismatches

- has 1518 byte max packet size, 802.4 has 8191 byte max packet size
- what if 802.4 pkt forwarded onto 802.3 Ethernet?
  - fragmentation at physical layer?
  - drop packet (the IEEE standard)

Other mismatches

- 802.5 has priorities; 802.3 does not
- ...

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Switched 802.3 LAN's

- bridges interconnect general 802.* LANs
  - may require packet conversion

Switched Ethernet:

- central "hub" interconnects ethernet segments
- in practice, each segment often has only one computer
- simultaneous transmission to same destination
  - let first one through
  - possibly buffer other packets

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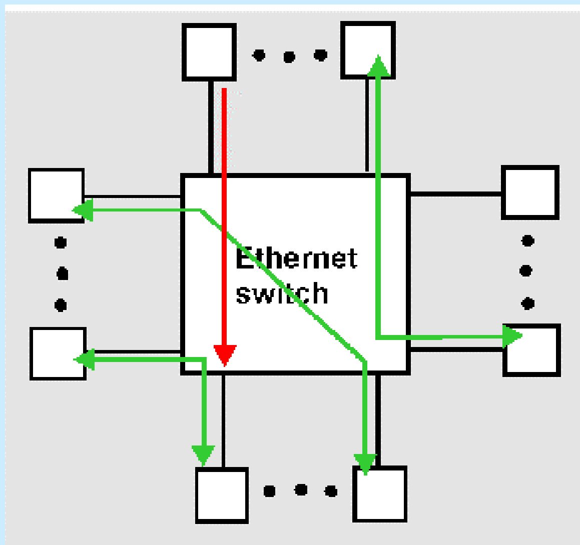
Switched 802.3 LAN's



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DLC Summary

- point-to-point DLC: "standard" reliable data transfer techniques
- the multiple access problem
  - random access protocols (collisions)
  - demand adaptive, controlled (collision) free protocols: token passing, mini-slotted reservations
  - TDMA
- IEEE 802.* standards: Ethernet, token bus and ring
- bridges, switches for interconnecting LANs

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