

Link layer, LANs: outline

5.1 introduction, services

5.2 error detection,
correction

5.3 multiple access
protocols

5.4 LANs

- addressing, ARP
- Ethernet
- switches
- VLANs

5.5 link virtualization:
MPLS

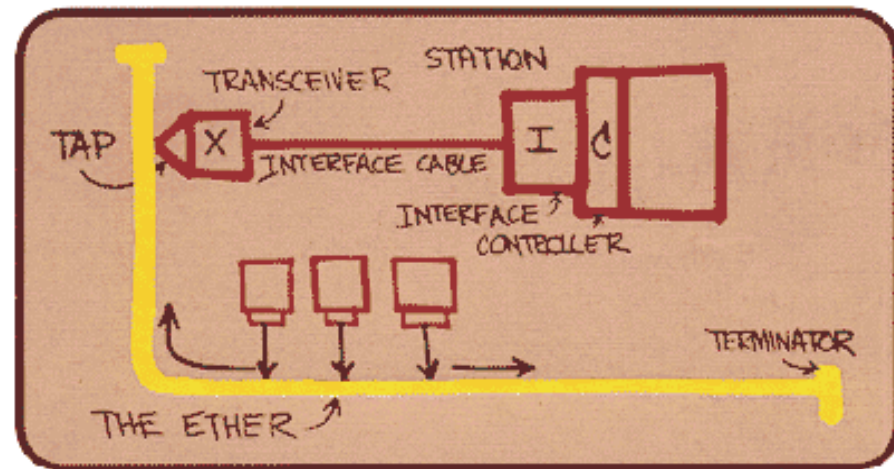
5.6 data center
networking

5.7 a day in the life of a
web request

Ethernet

“dominant” wired LAN technology:

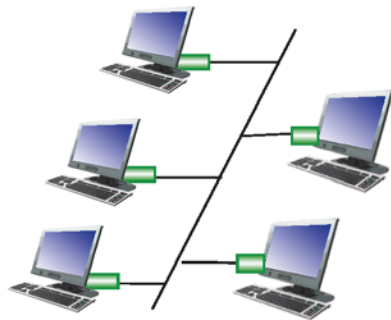
- ❖ cheap \$20 for NIC
- ❖ first widely used LAN technology
- ❖ simpler, cheaper than token LANs and ATM
- ❖ kept up with speed race: 10 Mbps – 10 Gbps



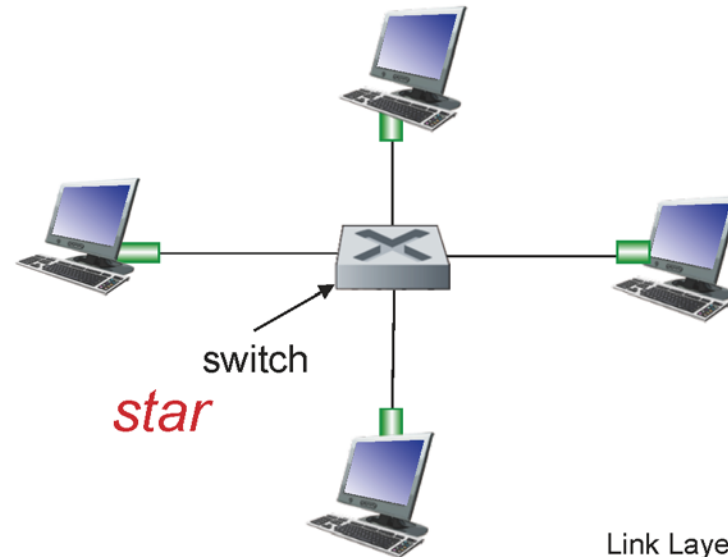
Metcalfe's Ethernet sketch

Ethernet: physical topology

- ❖ *bus*: popular through mid 90s
 - all nodes in same collision domain (can collide with each other)
- ❖ *star*: prevails today
 - active *switch* in center
 - each “spoke” runs a (separate) Ethernet protocol (nodes do not collide with each other)



bus: coaxial cable



star

Ethernet frame structure

sending adapter encapsulates IP datagram (or other network layer protocol packet) in **Ethernet frame**



preamble:

- ❖ 7 bytes with pattern 10101010 followed by one byte with pattern 10101011
- ❖ used to synchronize receiver, sender clock rates

Ethernet uses CSMA/CD

- ❖ No slots
- ❖ adapter doesn't transmit if it senses that some other adapter is transmitting, that is, **carrier sense**
- ❖ transmitting adapter aborts when it senses that another adapter is transmitting, that is, **collision detection**
- ❖ Before attempting a retransmission, adapter waits a random time, that is, **random access**

Ethernet CSMA/CD algorithm

1. Adaptor receives datagram from net layer & creates frame
2. If adapter senses channel idle, it starts to transmit frame. If it senses channel busy, waits until channel idle and then transmits
3. If adapter transmits entire frame without detecting another transmission, the adapter is done with frame !
4. If adapter detects another transmission while transmitting, aborts and sends jam signal
5. After aborting, adapter enters **exponential backoff**: after the m th collision, adapter chooses a K at random from $\{0,1,2,\dots,2^m-1\}$. Adapter waits $K \cdot 512$ bit times and returns to Step 2

Question

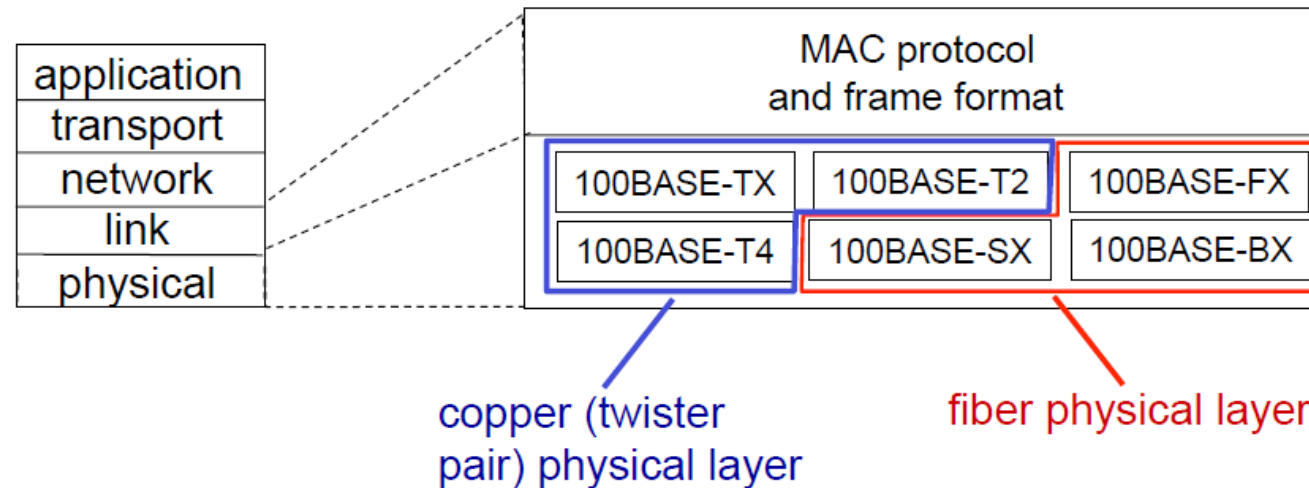
❖ Is it possible that:

A collision happens in Ethernet
But is not detected at the *MAC* layer

Remember: *CSMA/CD* does not use *MAC* layer *ACKs*

802.3 Ethernet standards: link & physical layers

- ❖ *many* different Ethernet standards
 - common MAC protocol and frame format
 - different speeds: 2 Mbps, 10 Mbps, 100 Mbps, 1 Gbps, 10G bps
 - different physical layer media: fiber, cable



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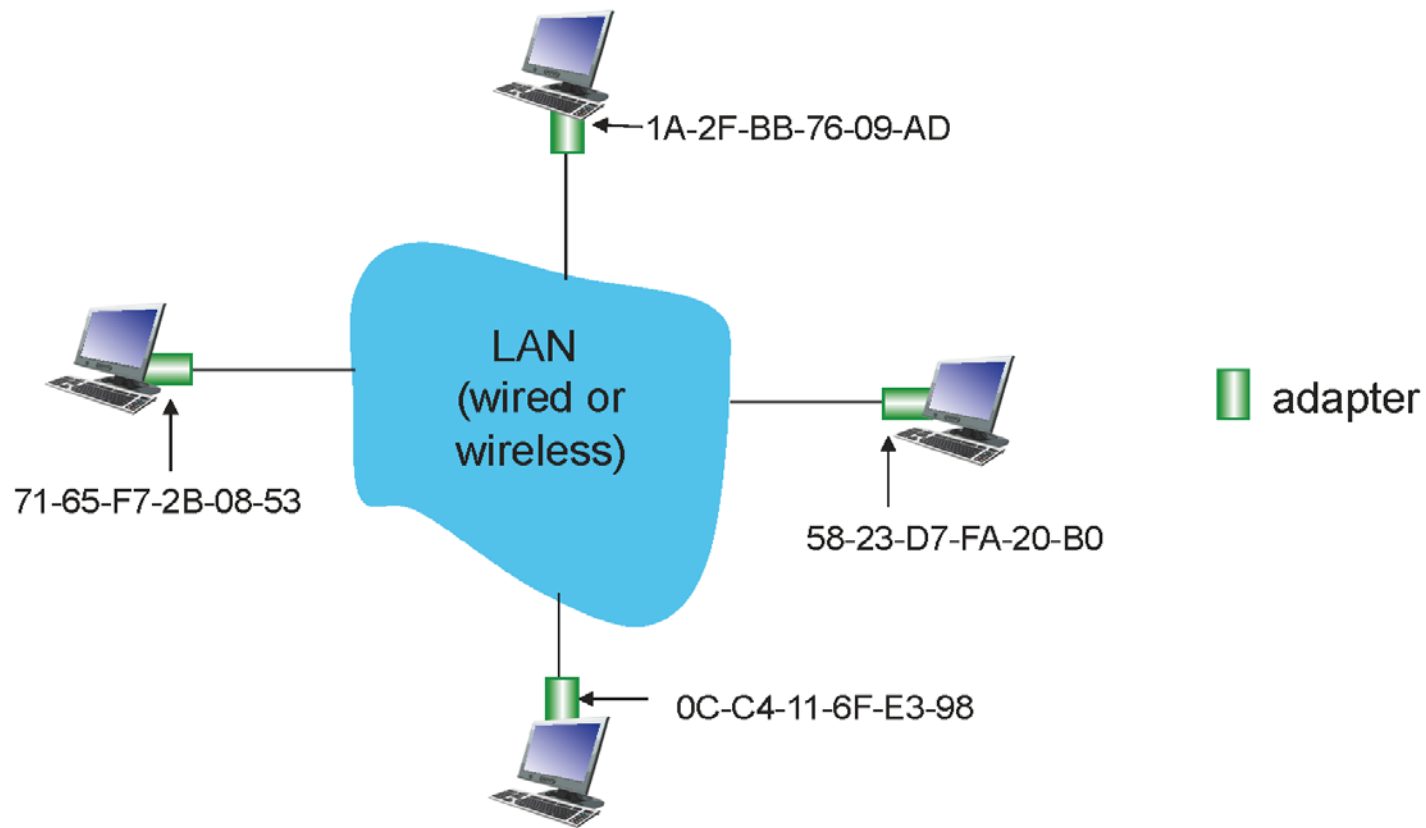
MAC addresses and ARP

- ❖ 32-bit IP address:
 - *network-layer* address for interface
 - used for layer 3 (network layer) forwarding
- ❖ MAC (or LAN or physical or Ethernet) address:
 - function: *used ‘locally’ to get frame from one interface to another physically-connected interface (same network, in IP-addressing sense)*
 - 48 bit MAC address (for most LANs) burned in NIC ROM, also sometimes software settable
 - e.g.: 1A-2F-BB-76-09-AD

hexadecimal (base 16) notation
(each “number” represents 4 bits)

LAN addresses and ARP

each adapter on LAN has unique *LAN* address



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