Data Link Layer: Ethernet -- Overview

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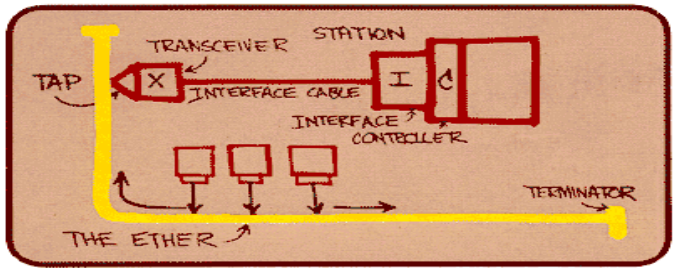
Background

- Very successful and widely used technology (as of 2010, market of $16 billion per year)
- Cheap: Only 5$ (300Rs) for 100Mbps
- Kept up with speed race: 10Mbps to 100Gbps
- IEEE 802.3 working group
  - Many standards (different speeds, different physical media)

History

- 1970's: Metcalfe conceived the idea
- Up to early 1990's: Bus topology based on co-axial cable
  - Thicknet (10Base5)
  - Thinnet (10Base2)
- Media Access Control: CSMA/CD



Metcalfe's Ethernet sketch

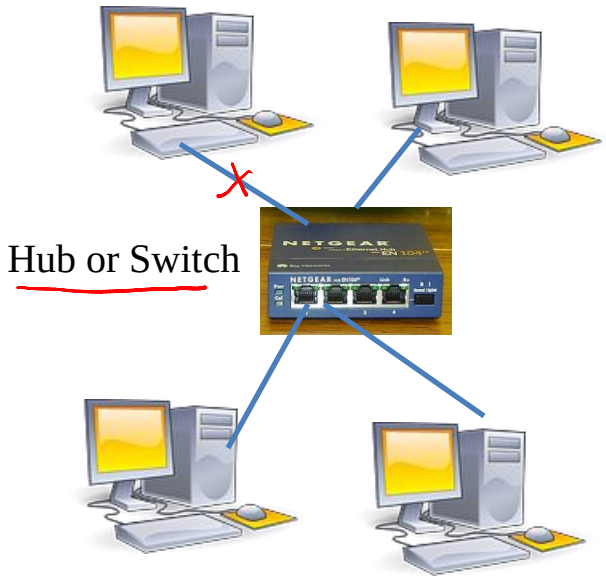
Problems with Bus Topology

- Co-axial cables were expensive

- Break/Fault in co-axial cable affects all nodes
- Adding/removing nodes disrupts the entire network
- Cabling Issues lead to star topology

Star Topology

- Connect via hub or switch
- 10BaseT, 100BaseT (Fast Ethernet), 1000BaseT (Gigabit Ethernet)
  - Based on twisted pair cables
  - Low cost, reliable, easy management/troubleshooting



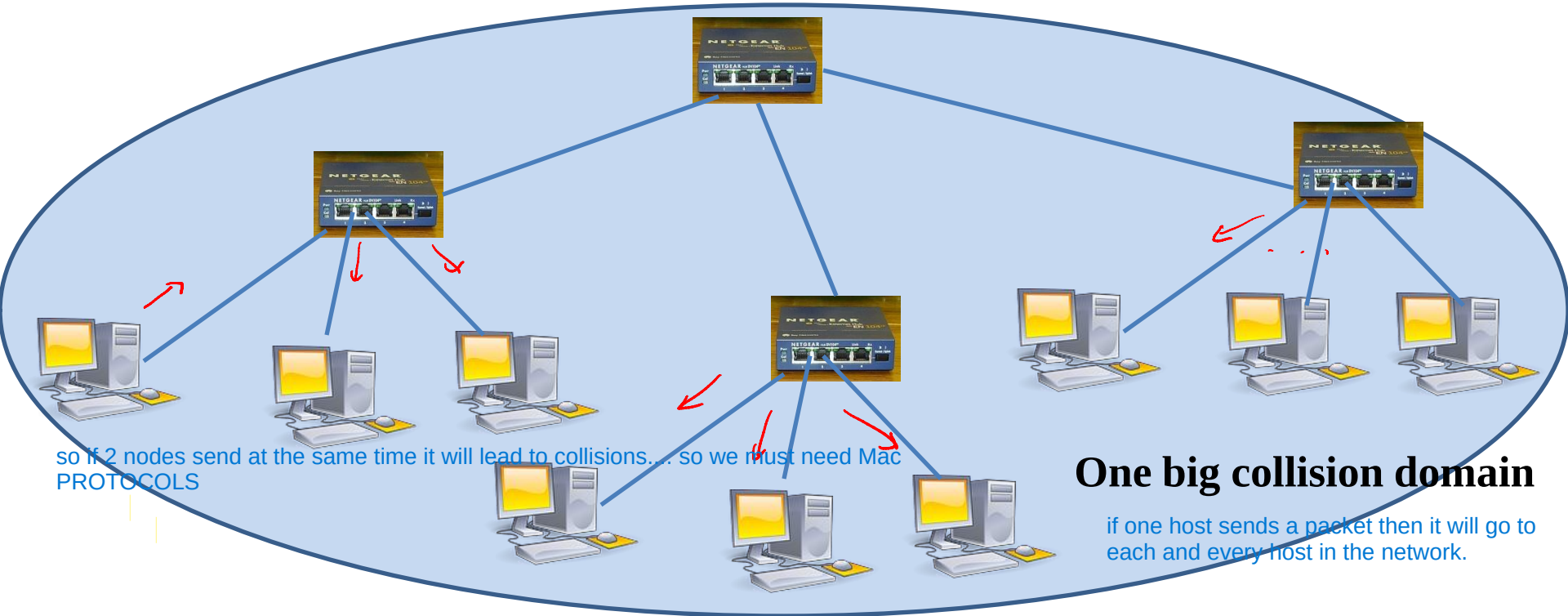
many buildings already had these twisted pairs, as they were the same wires as part of the telephone wires... so cost less

Hub

- Physical layer repeater: bits from one link sent out on all other links at same rate after boosting up the energy
  - No frame buffering
  - No MAC protocol (CSMA/CD) at hub

Interconnecting Hubs

- Can increases reach
- Cannot connect 10BaseT with 100BaseT



so if 2 nodes send at the same time it will lead to collisions... so we must need Mac PROTOCOLS

One big collision domain

if one host sends a packet then it will go to each and every host in the network.

Restrictions

- Can increase distance but many restrictions
  - 10BaseT: terminal to hub 100m; at most 4 repeaters; network diameter 500m
  - 10Base5: terminal to hub 500m; at most 4 repeaters; network diameter 2.5km
  - 100BaseT: terminal to hub 200m; at most 2 repeaters; network diameter 200m
  - Maximum number of hosts: 1024

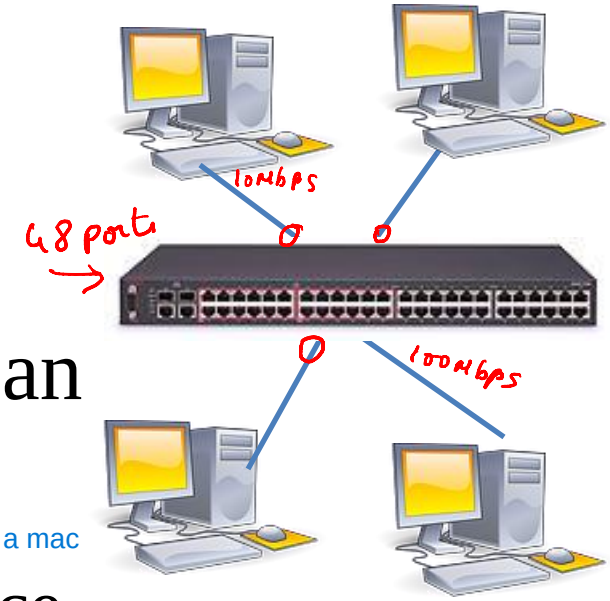
max distance two Hosts which are within the same collision domain

100 m

within a same collision domain

Layer-2 Switch

- Also called Ethernet Bridge
- Most used configuration than hubs
- Transfers frames from an input to an output link



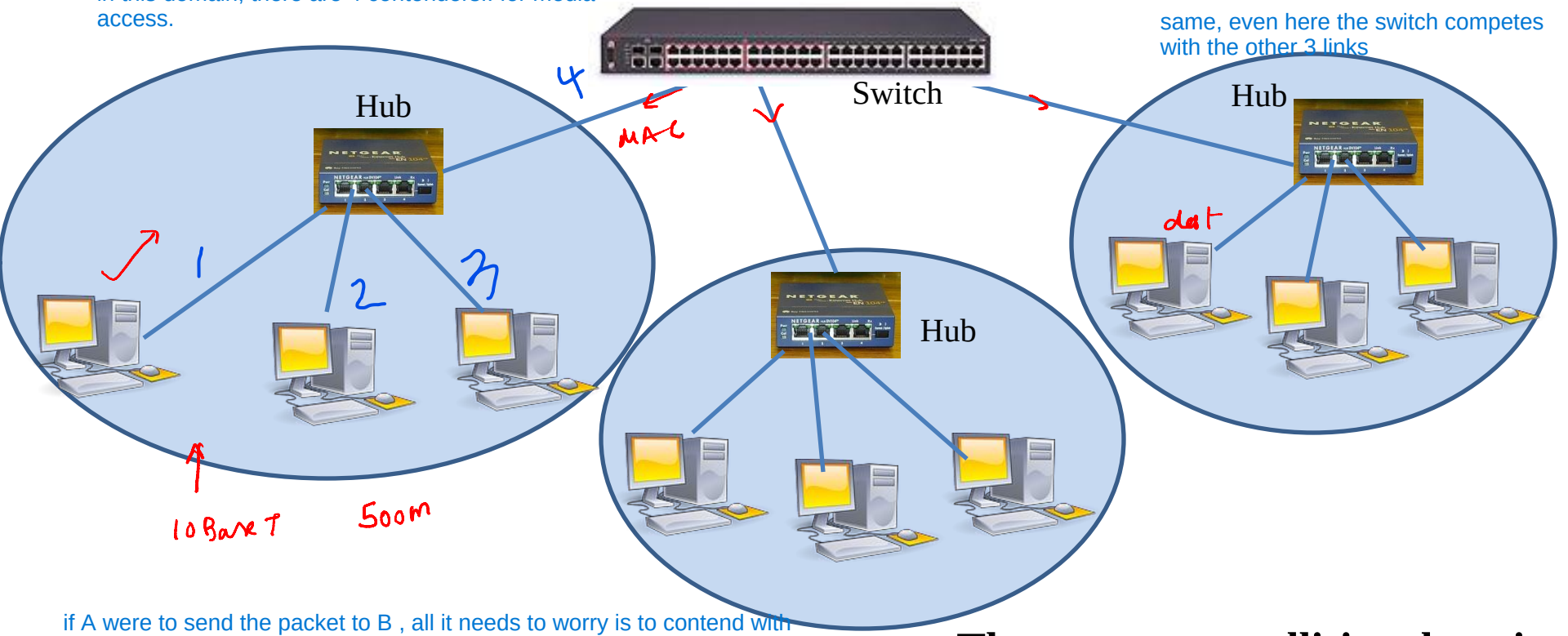
it connects to many ports (hosts). and on each of the interfaces, it runs a mac protocol

  - Runs MAC protocol on each interface
  - Buffer packets
  - Break up collision domains
  - Can switch speeds (10Mbps, 100Mbps)

Interconnection with Switch

in this domain, there are 4 contenders.. for media access.

same, even here the switch competes with the other 3 links



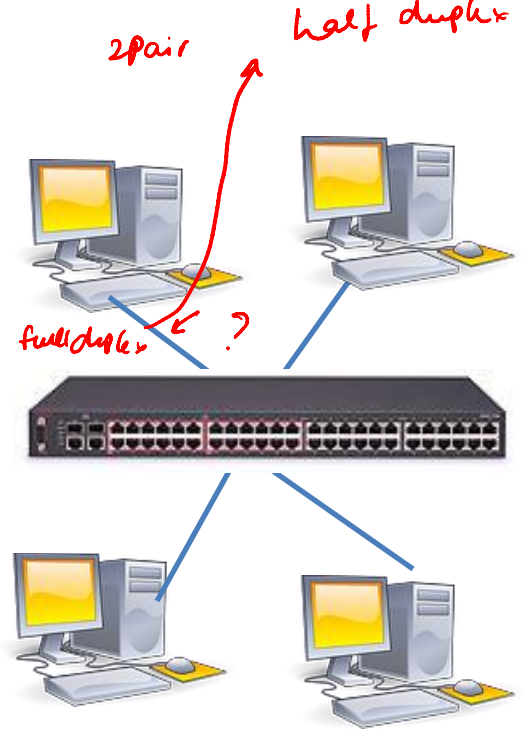
if A were to send the packet to B , all it needs to worry is to contend with the hosts within its own domain, and send to the switch. Then the switch buffers and sends it to domainof B, where again competing happens, and finally reaches B.

Three separate collision domains

Modes of operation

- Shared Mode (Half-duplex)
  - Employs MAC protocol csma/cd
- Full duplex mode
  - Separate wires for transmission and reception
  - No need for MAC
  - Works only on point-to-point links

if it was a half dup link, then there is a contention between host and switch... but in a full one, no clash



Ethernet Service

- Connectionless: No handshaking between sender and receiver

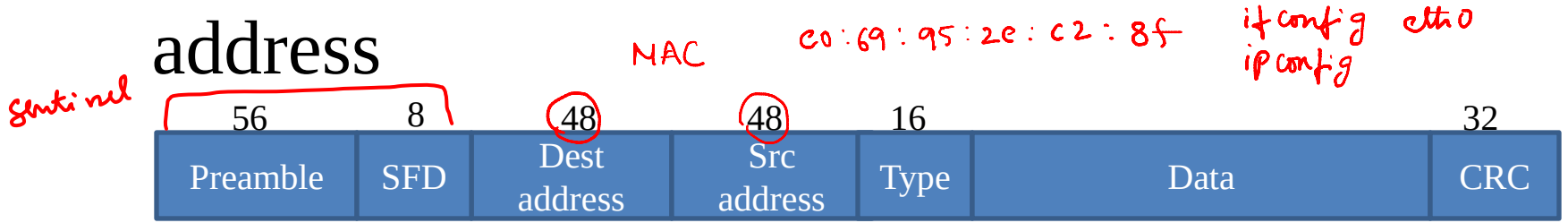
whether a receiver is alive or not, it just sends

- Unreliable: Does not provide any means for recovering lost frames
  - If application needs reliability, it needs to employ TCP

random acess protocols do retry when, there are collisions, but that is not the same as providing reliability

Ethernet Frame Structure

- Preamble: Sequence of alternating 1's and 0's for synchronization
  - 10BaseT: Manchester encoding
- SFD: 10101011 (start frame delimiter)
- Source and Destination addresses: 48 bit MAC address



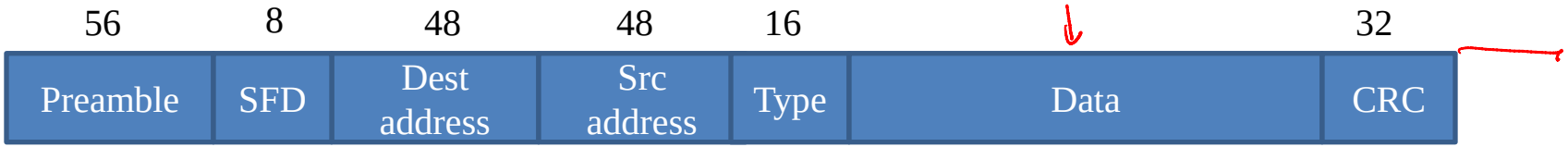
Ethernet Frame Structure

- Type: Demultiplexing key – specifies which higher layer protocol the packet is intended

IP, ICMP

- Data: IP payload
  - Minimum 46 bytes and up to 1500 bytes
- CRC: Error Detection
- Inter Frame Gap: 96 bits (12 bytes)

so that the receiver has enough time to process before the next frame



Ethernet Address

- Unique address belonging to the adaptor
  - Each manufacturer allocated different prefix
  - E.g. Intel: C4-85-08 (C4-85-08-30-33-48)
- In normal mode, an adaptor passes up frames if
  - Addressed to it (Unicast)
  - Broadcast address (all 1's)
  - Multicast address (first bit is 1) if it belongs to the group and adaptor appropriately configured

host can have multiple adaptors

ff:ff....

Summary

- Ethernet underwent significant evolution over the years

  10 Mbps, 100 Gbps

  - Speed increased by 10,000 times
  - Variety of media (coaxial, twisted pair, fiber optics)
  - Switching circumvented need for MAC
  - Many standards to cater to various versions

    802.3i 10BaseT, 802.3u Fast Ethernet

    802.3ab Gigabit ethernet, 802.3x full duplex
  - Only constant: frame format

    ↳ Shared mode / half-duplex
- Going Forward: CSMA/CD MAC

only applicable for the shared mode or the half duplex mode