

# **Data Link Layer: Ethernet -- Overview**

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# Background

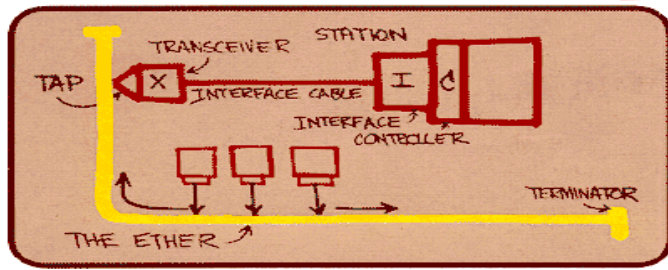
- Very successful and widely used technology (as of 2010, market of \$16 billion per year)
- Cheap: Only 5\$ (300Rs) for 100Mbps
- Kept up with speed race: 10Mbps to 100Gbps  
10,000 304 lanes
- IEEE 802.3 working group
  - Many standards (different speeds, different physical media)

# History

- 1970's: Metcalfe conceived the idea
- Up to early 1990's: Bus topology based on co-axial cable
  - Thicknet (10Base5)  
Mbps → Baseband → 500 m
  - Thinnet (10Base2) → 200 m
- Media Access Control: CSMA/CD




Bus



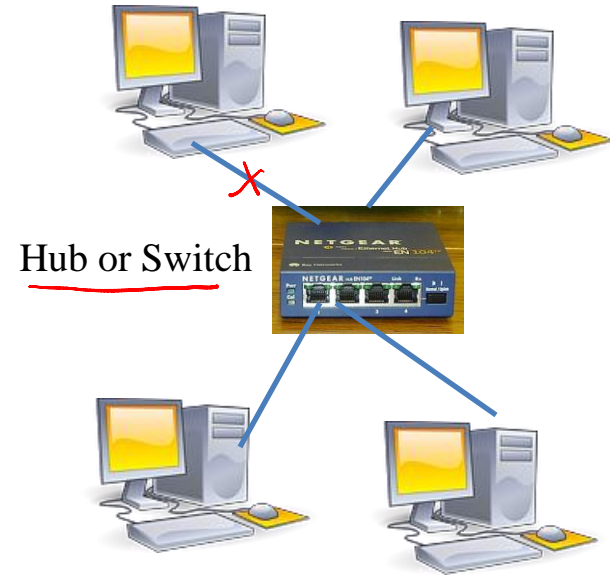
Metcalfe's Ethernet sketch

# Problems with Bus Topology

- Co-axial cables were expensive A diagram of a bus topology. A horizontal red line represents the bus. Three vertical red lines connect nodes to the bus. The first two nodes are labeled 'D' in red. The third node is labeled 'D' in red, but the connection point on the bus is marked with a red 'X', indicating a break or fault.
- 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)
  - ↗ 10Mbps ↖
- Based on twisted pair cables
- Low cost, reliable, easy management/troubleshooting

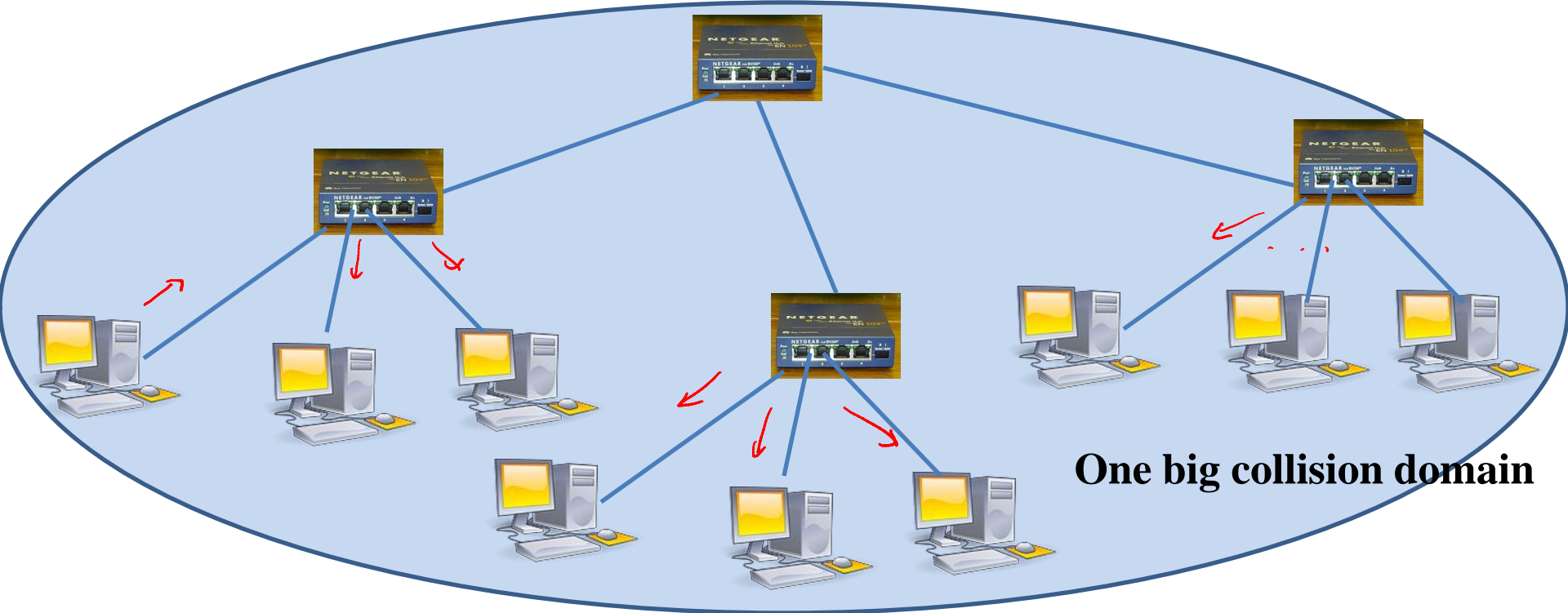


# Hub

- 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 increase reach
- Cannot connect 10BaseT with 100BaseT



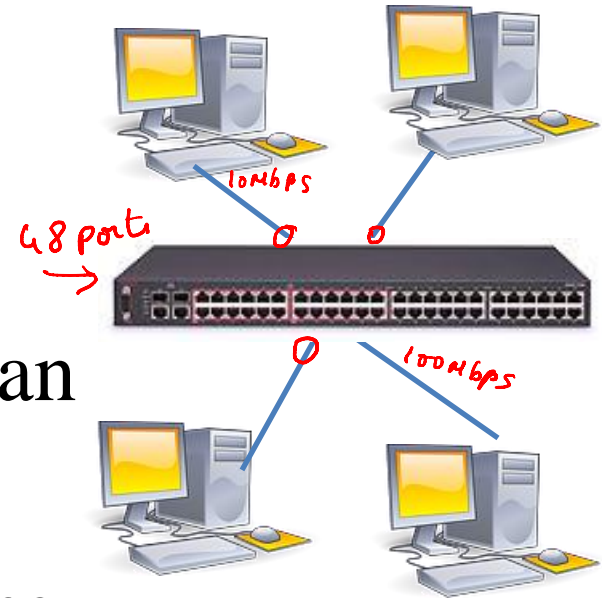
# Restrictions

- 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 *max distance two hosts*
  - 100BaseT: terminal to hub <sup>100m</sup>~~200m~~; at most 2 repeaters; network diameter 200m
  - Maximum number of hosts: 1024

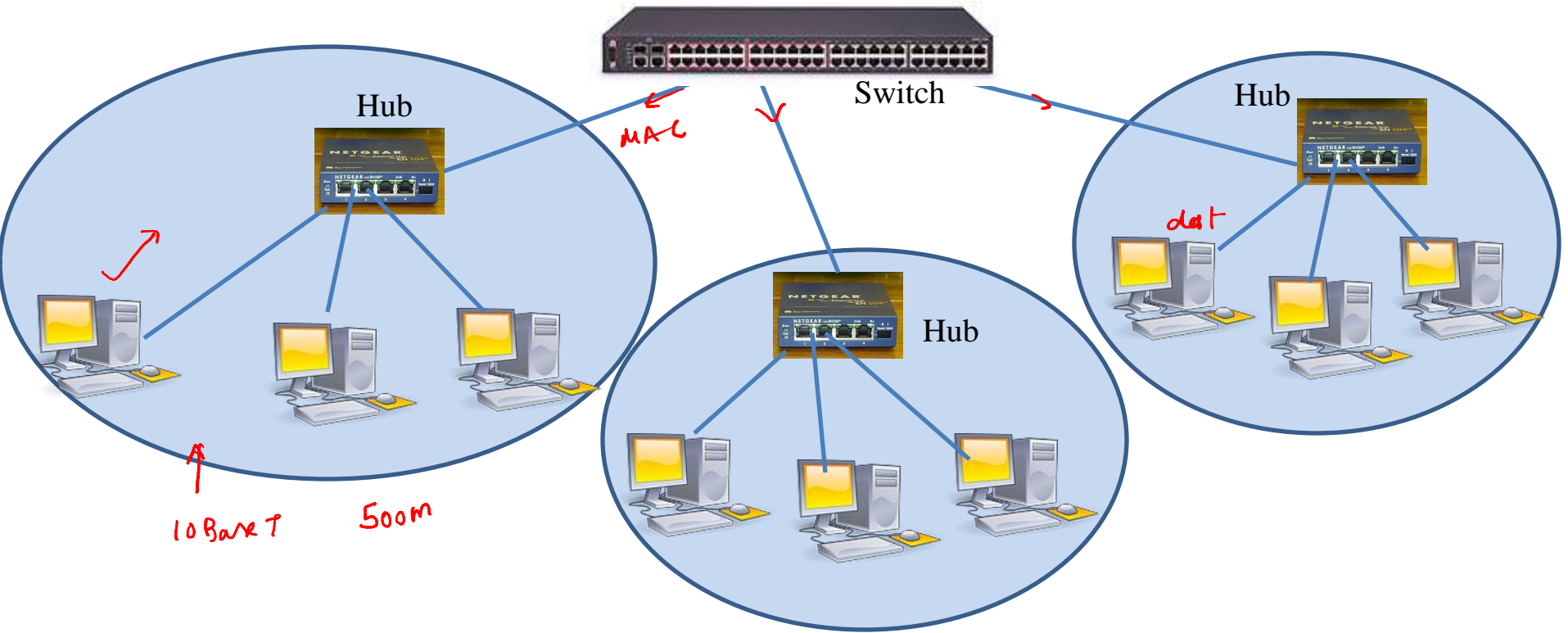


# Layer-2 Switch

- Also called Ethernet Bridge
- Most used configuration
- Transfers frames from an input to an output link
  - Runs MAC protocol on each interface
  - Buffer packets
  - Break up collision domains
  - Can switch speeds (10Mbps, 100Mbps)

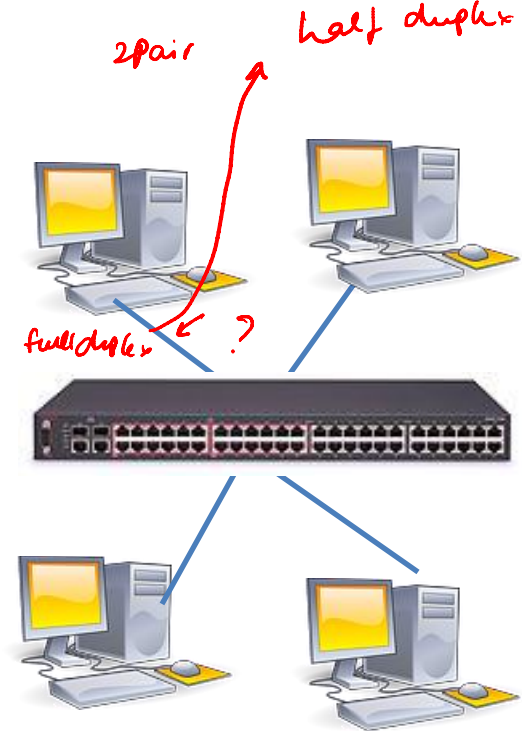


# Interconnection with Switch



# Modes of operation

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

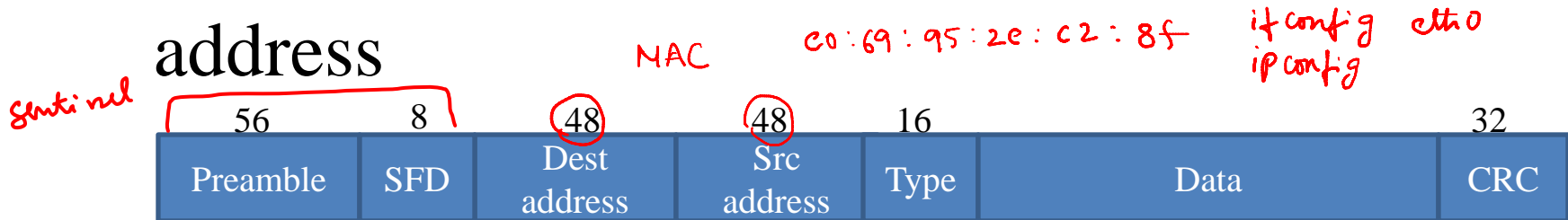


# Ethernet Service

- Connectionless: No handshaking between sender and receiver
- Unreliable: Does not provide any means for recovering lost frames
  - If application needs reliability, it needs to employ TCP

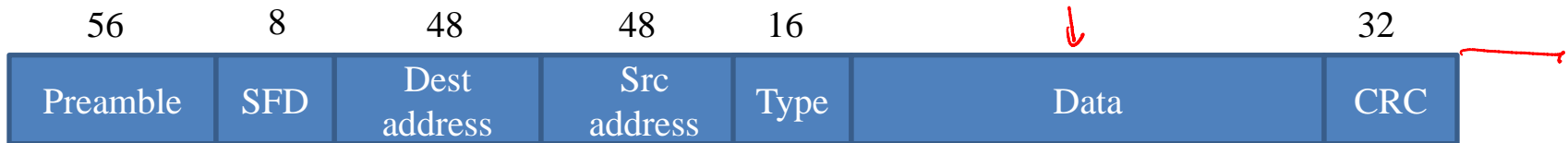
# Ethernet Frame Structure

- 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)



# 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) ff:ff:ff:ff:ff:ff
  - Multicast address (first bit is 1) if it belongs to the group and adaptor appropriately configured

# Summary

- Ethernet underwent significant evolution over the years
  - 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
  - Only constant: frame format
- Going Forward: CSMA/CD MAC

10 Mbps, 100 Gbps

802.3i 10BaseT, 802.3u Fast Ethernet

802.3ab Gigabit ethernet, 802.3x full duplex

→ Shared mode / half-duplex