# 04 - LAN

## LAN

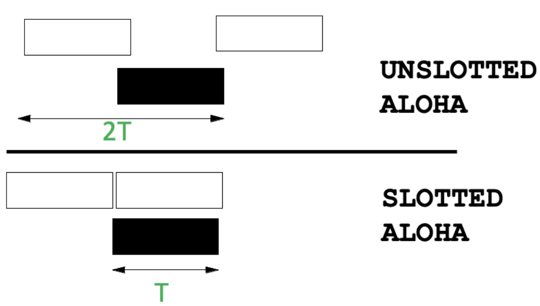
- fiber unidirectional 1 to 1
- Ethernet is many to many link
- however bc its a single link, we need to be able to demux the signal to the correct receiver → Media Access Control Adress (MAC addr.)
- LAN is also known as
  - Multi access link - multiple nodes on the same link
  - broadcast links - every transmission can be heard by all nodes
  - LAN - geographically serviced by a local region 1-10 km(s)
- Pros
  - cost - connect all devices on a campus on a single link
  - bandwidth - ethernet i high bandwidth distributed computing
  - statistical multiplexing - time division multiplexing (TDM) is not good when user traffic is busy → many collisions
    - each user splits the bandwidth, high bandwidth when low traffic

### Statistical vs Strict Mux

- strict - TDM/FDM where user given fix allocation regardless of whether user want to send → bad
- bursty - traffic has aa high and average peak
- therefore, strict gives each user $B/N$ bandwidth
- stat mux gives $B/x$ where $x$ is number of busy users, $x << N$

## ALOHA

- ethernet predecessor - multiple ground stations across Hawaii
- problem - no collision detection when traffic was high → similar problems in wireless 802.11
- sol - slotted aloha, allocate bandwidth and reduce collision period by half but require




shared clock

## CSMA/CD & Ethernet

Bob Metcalfe - inventor of Ethernet at Xerox PARC and CSMA/CD for Harvard PhD thesis

### CSMA/CD

- to be better than aloha
- CS - carrier sense → nodes listen before sending

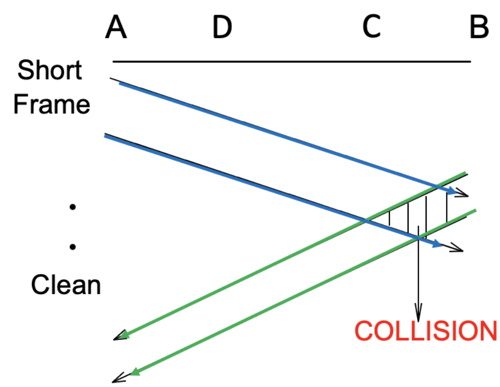
- MA - Multiple access - many to many
- CD - w/ Collision detection → only handles collision errors

## Ethernet

- aborts transmission after 64 bytes if a collision is detected while aloha sends full 1500 byte datagram
- only handles collision detection (frequent) but not frame corruption recovery
- senders cannot detect collisions, only nodes at the intersection of 2 signals can detect collisions at their node
- note that collision are between waves in ethernet and 802.11 not mass-based particles

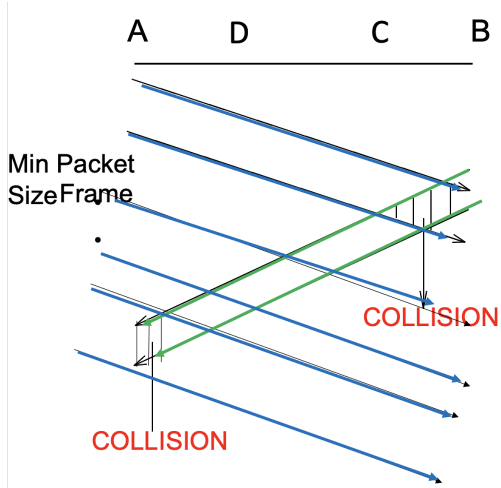
## Packet Size dependence

- ethernet enforces minimum packet size of 64 bytes for CD




A transmits to C and B transmits to D, if A sends a short frame *C will detect a collision and A will not.* So A won't retransmit

- without min packet size - no retransmission

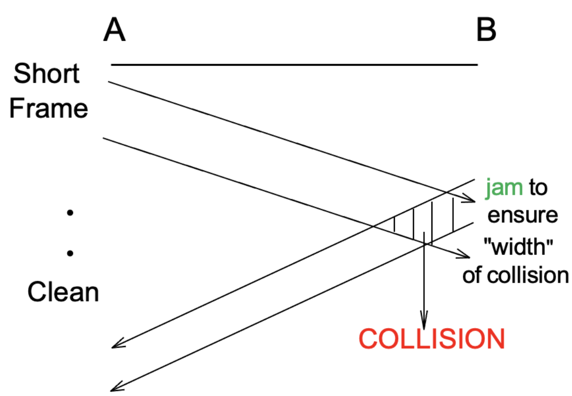



A transmits to C and B transmits to D, if A sends a "long enough" frame, *C will detect a collision and A will too.* So A will retransmit

- with limited packet size
- the min-size of the packet depends on the pipe size = transmission rate × round trip prop delay
  - e.g., if R = 10Mbit/s, One way PD = 25.6$\mu$s; then pipe size = 512 bits = 64 bytes

- pipe size (bandwidth-delay product, B) = transmission rate (B/s) $\times$ round-trip propagation delay (s)

## Collision Detection

- consider 2 colliders, one should wait 1 slot and the other 0 slots, mux collision or time with coin toss → just pick 1 signal to pass through the detecting node, e.g. if C detects colision of A→B and B→A and order is A→C→B then C just muxes one of the signals
- consider 16 colliders - ethernet does **Binary Exponential Backoff**
  - after attempt A, each station randomly picks a number of slots between 0 and $2^A - 1$. A slot is 51.2$\mu s$ (because of prev question pipe). after 1 collision pick 0 or 1 slot, after 2 collisions pick up to 4 sots, after 3 up to 8 slots (slots 0 ... 7)
- ethernet's 3 mechanisms
  - CS - don't transmit when someone else is (imagine the detecting node wants to transmit)
  - CD - stop frame if CD before 64 bytes of frame
  - Exponential backoff - collisions are frequent so must retransmit, random backoff avoids synchronized colllissions, dynamically adjut number of colliders with backoff
- terms
  - slot time - 2T, where T is 1-way prop delay, limited to 51.2$\mu s$ to allow 64 byte pipe size
  - min packet size - 64 bytes to avoid transmision end before CD
  - jam - transmit smal number of bits after CD to ensure other tranmitterss also detect collision
- 

  - CD - one option is use Manchester encoding averge voltage, e.g. 0 (0V) or 1 (1.5V) has avg 0.75V, collision ⇒ average 1.5V

# Ethernet Details

## Terms

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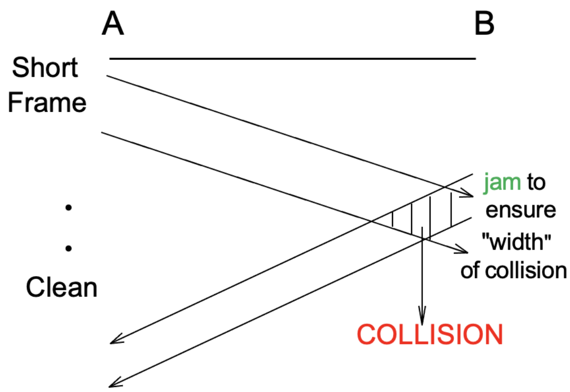


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## Header

- dest for mux, source for mux ack, length in case frame is smaller than min packet size, CRC - error detection hash

| 01010111 preamble | Dest (6) | Source (6) | Length (2) | Data | Pad | CRC |
|---|---|---|---|---|---|---|

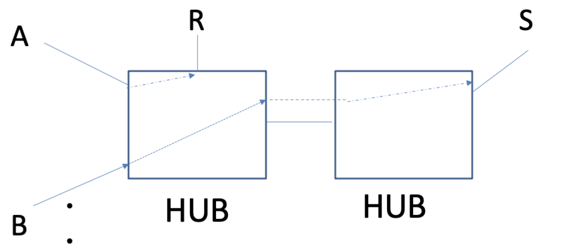
**Total Frame length**
**64<=L<=1500**

## Hardware

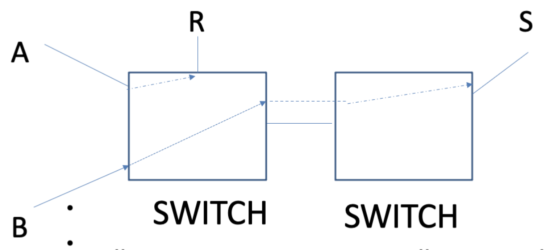
- limited distance of 2.5 km with 500m wires and 4 repeaters
- thin wire or thick wire
- physical topology of star (all nodes connected to hub) or tree (bus with main line and branches)

## Limitations

- Bandwidth and distance, if speed increased, distance must be shorter, e.g. 100 Mbps ether hass 200m extent
- Gigabit ether has 2m extent → switches, hubs, point to point
- therefore, cost of stat mux is why ethernet is limited to LAN
- so modern day shift from mainline ethernet to series of point to point switches but keep ethernet header




If A talks to R at same time as B talks to S there is a collision. True for 10 and 100 M Ethernet.




A can talk to R at same time as B talks to S with no collision. Switch buffers and allows parallel connections. True for Gigabit Ethernet



- CSMA/CD to Switches