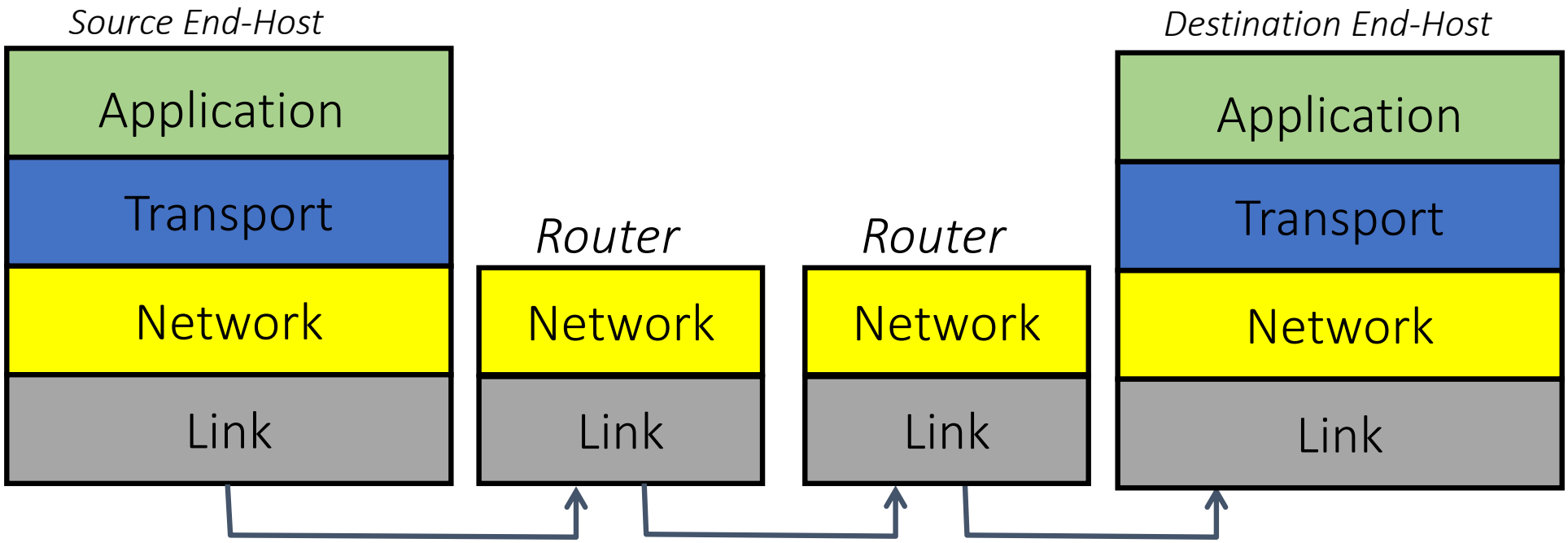
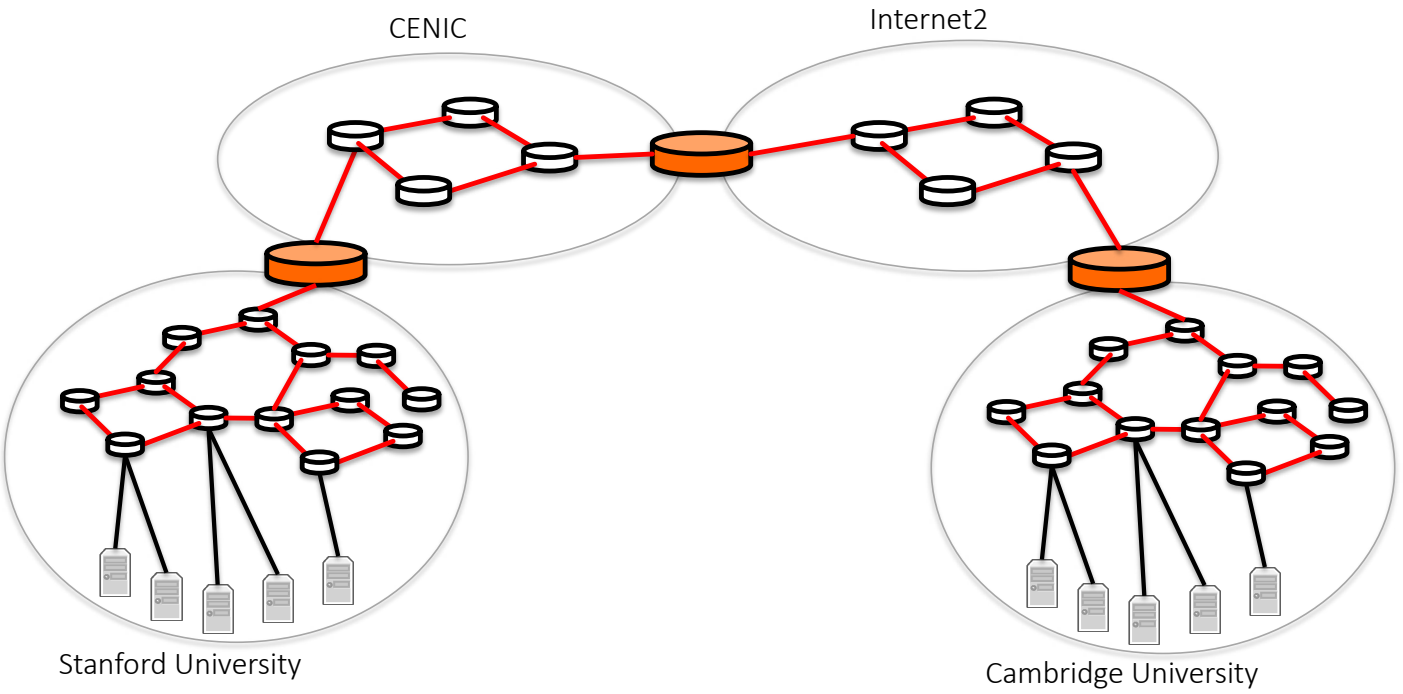
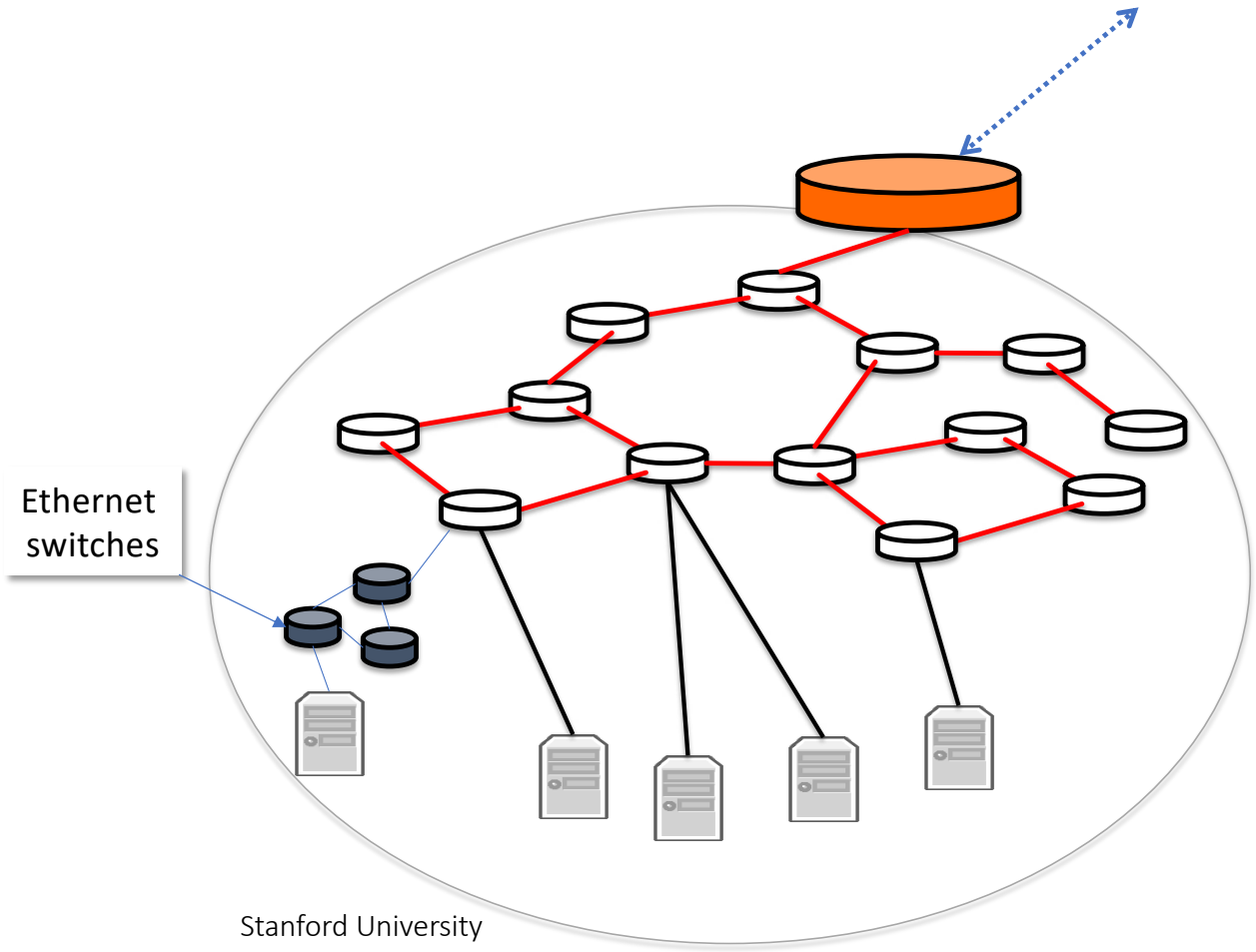
Ethernet and CSMA/CD

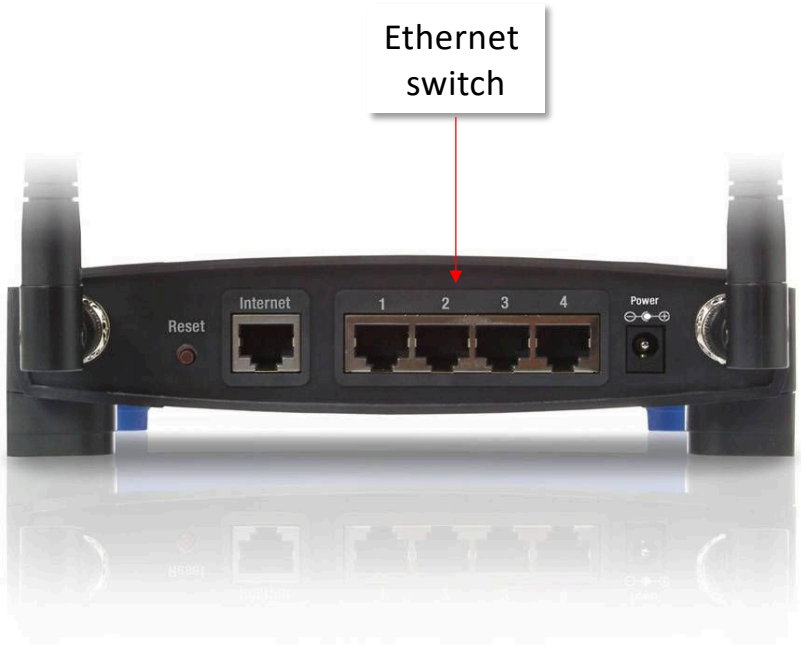
The 4 Layer Internet Model



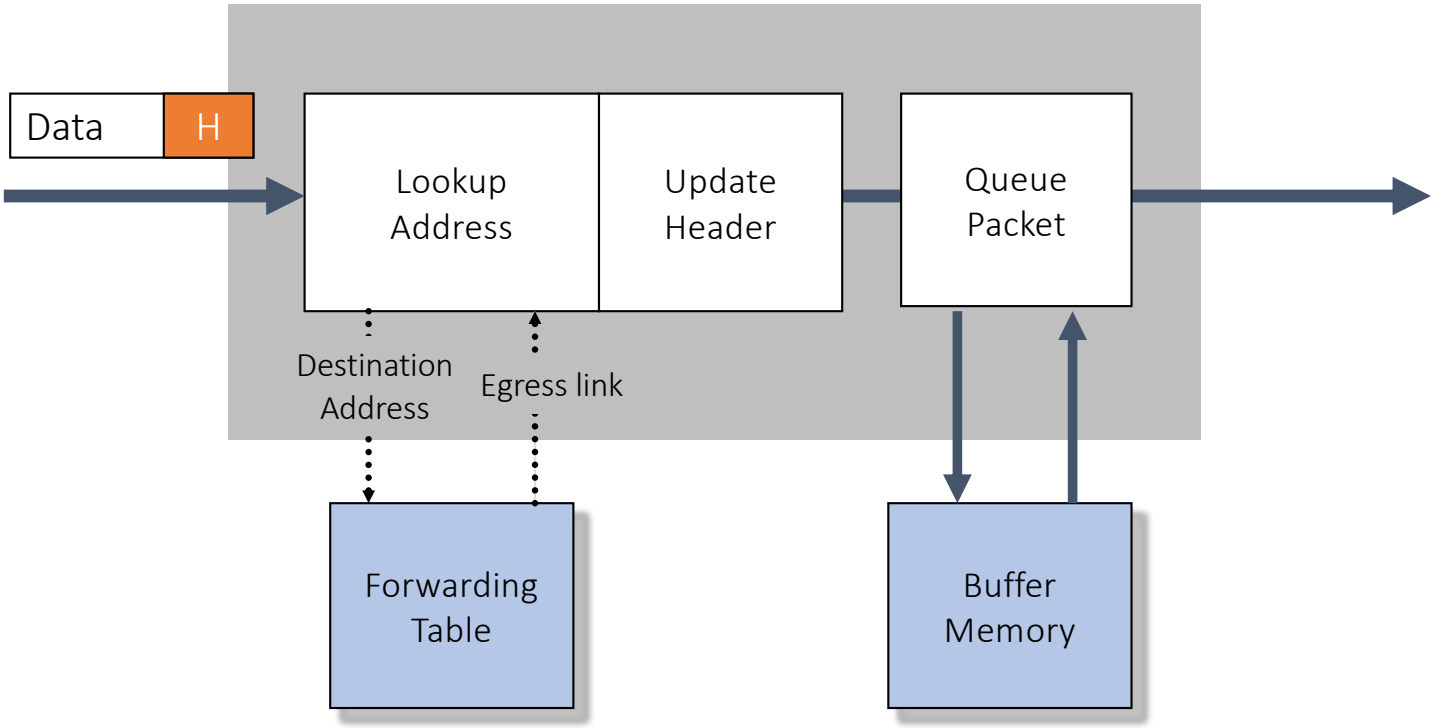

CENIC
Internet2
Stanford University
Cambridge University


Ethernet
switches
Stanford University

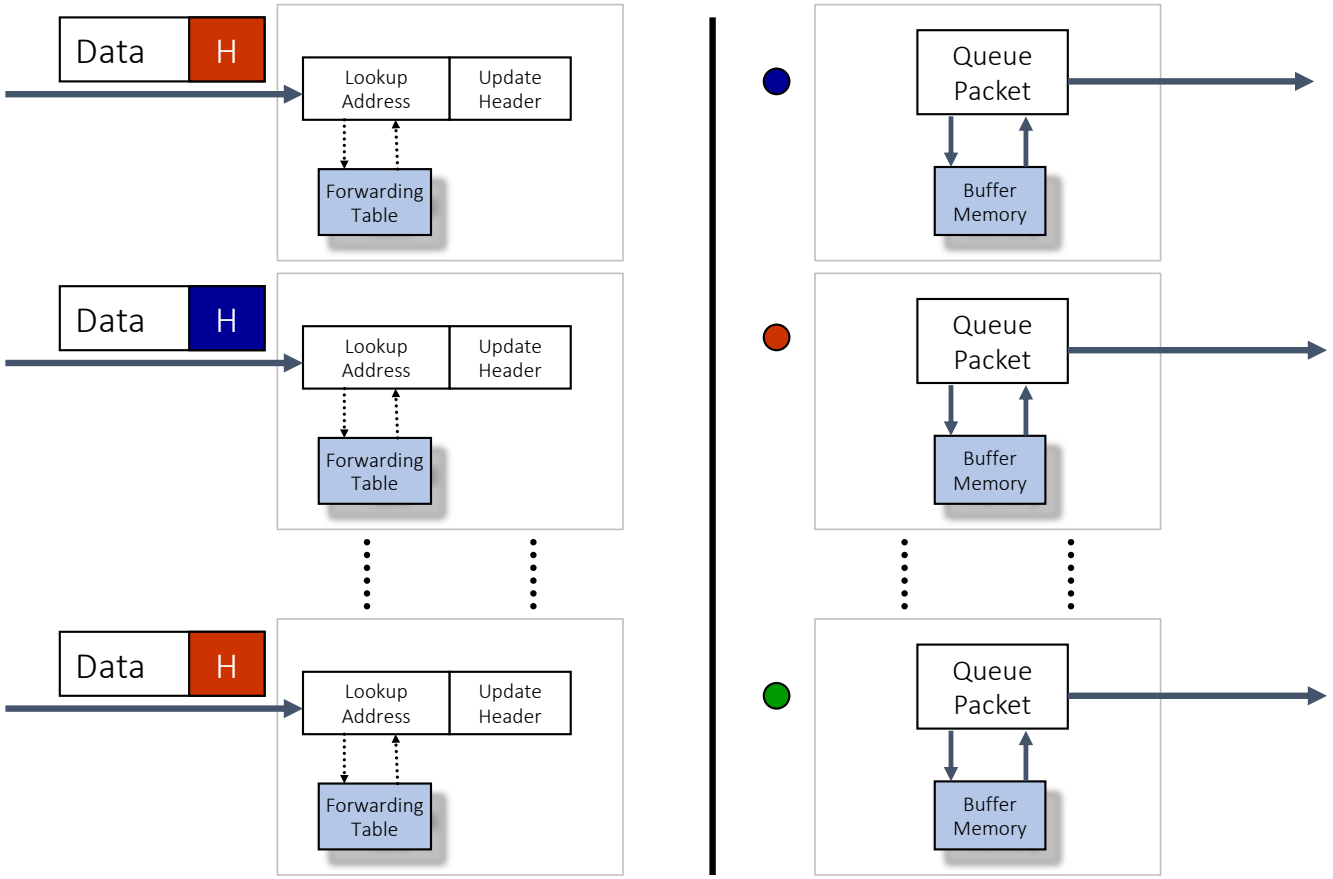

LINKSYS
Secure Easy Setup
Power
DMZ
USB
Wireless-G
Ethernet
WLAN
1
2
3
4
Internet
Wireless-G Broadband Router
With 4-Port Switch
Model WRT54GL
LINKSYS


Ethernet switch
Reset
Internet
1
2
3
4
Power

Generic Packet Switch



Generic Packet Switch



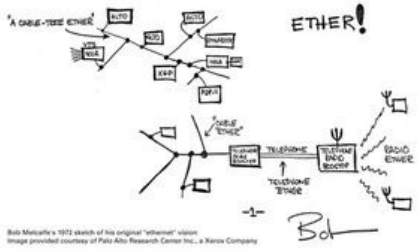
Ethernet Switch

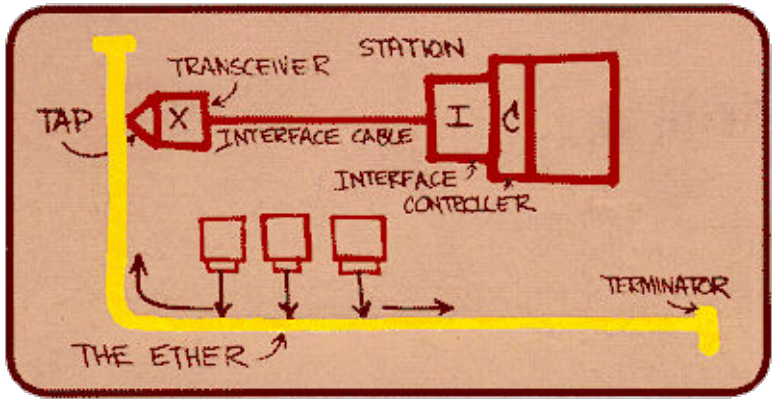
1. Examine the header of each arriving frame.
2. If the Ethernet DA (aka “MAC Address”) is in the forwarding table, forward the frame to the correct output port(s).
3. If the Ethernet DA is not in the table, broadcast the frame to all ports (except the one through which the frame arrived).
4. Entries in the table are learned by examining the Ethernet SA of arriving packets.

Internet Router

1. If the Ethernet DA of the arriving frame belongs to the router, accept the frame. Else drop it.
2. Examine the IP version number and length of the datagram.
3. Decrement the TTL, update the IP header checksum.
4. Check to see if TTL == 0.
5. If the IP DA is in the forwarding table, forward to the correct egress port(s) for the next hop.
6. Find the Ethernet DA for the next hop router.
7. Create a new Ethernet frame and send it.

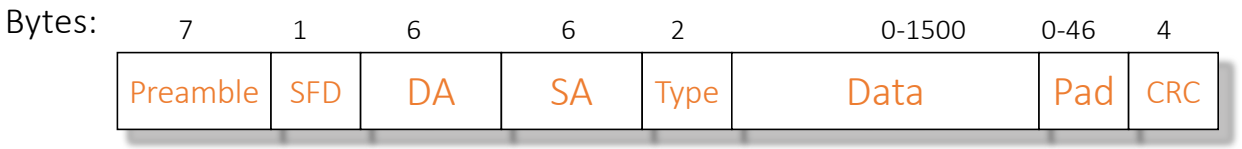
The Original Ethernet





Original pictures drawn by Bob Metcalfe,
co-inventor of Ethernet (1972 – Xerox PARC)

Ethernet Frame Format



1. **Preamble**: trains clock-recovery circuits
2. **Start of Frame Delimiter**: indicates start of frame
3. **Destination Address**: 48-bit globally unique address assigned by manufacturer.
   - 1b: unicast/multicast
   - 1b: local/global address
4. **Type**: Indicates protocol of encapsulated data (e.g. IP = 0x0800)
5. **Pad**: Zeroes used to ensure minimum frame length
6. **Cyclic Redundancy Check**: check sequence to detect bit errors.

The origins of Ethernet

Sharing a “medium”

- Ethernet is (or at least was originally) an example of multiple hosts sharing a common cable (“medium”).
- To share the medium, we need to decide who gets to send, and when.
- There is a general class of “Medium Access Control Protocols”, or MAC Protocols.

CSMA/CD Protocol

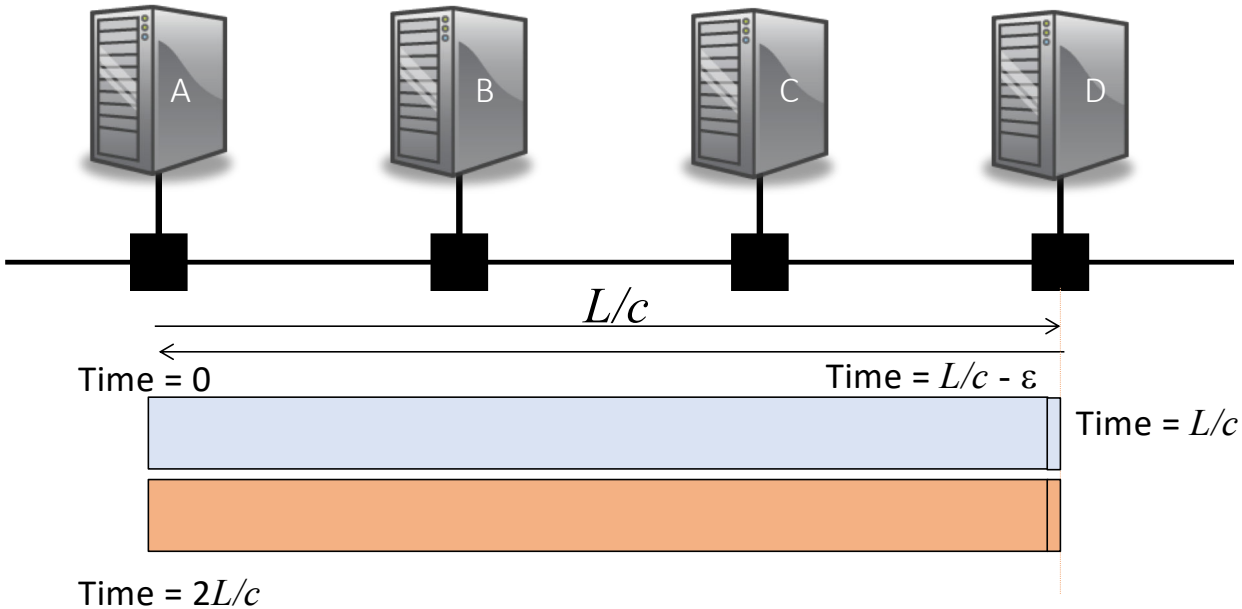
All hosts transmit & receive on one channel
Packets are of variable size.

When a host has a packet to transmit:

1. Carrier Sense: Check the line is quiet before transmitting.
2. Collision Detection: Detect collision as soon as possible. If a collision is detected, stop transmitting; wait a random time, then return to step 1.

binary exponential backoff

CSMA/CD Packet size requirement

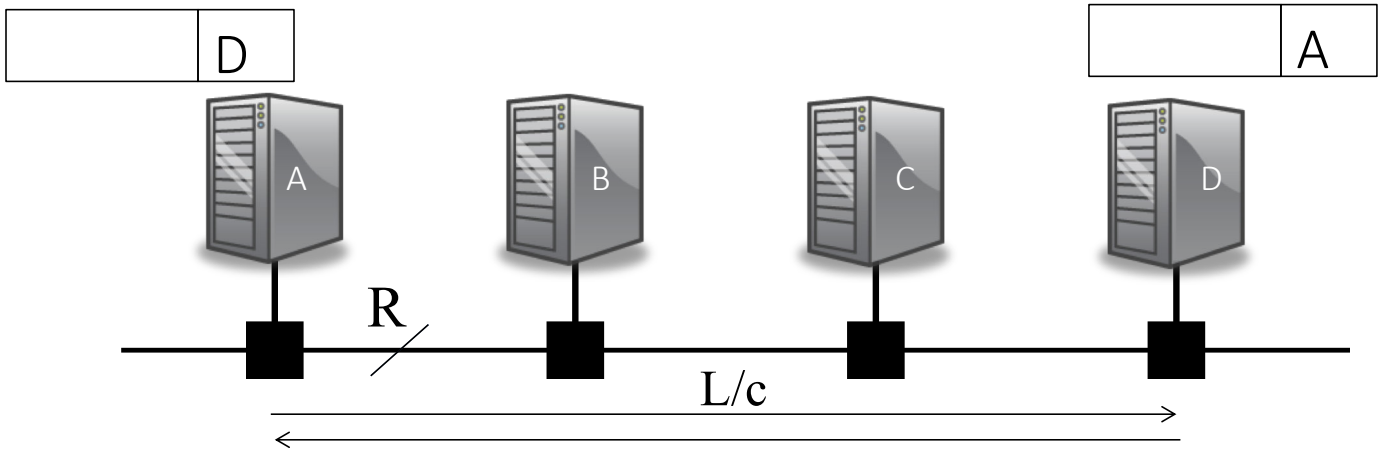


Time = $2L/c$
First time "A" knows about collision

Therefore, "A" is guaranteed to know about the collision while it is still transmitting if:

$$\frac{P}{R} > \frac{2L}{c}$$

CSMA/CD Min packet size requirement



For an end host to detect a collision before it finishes transmitting a packet, we require:

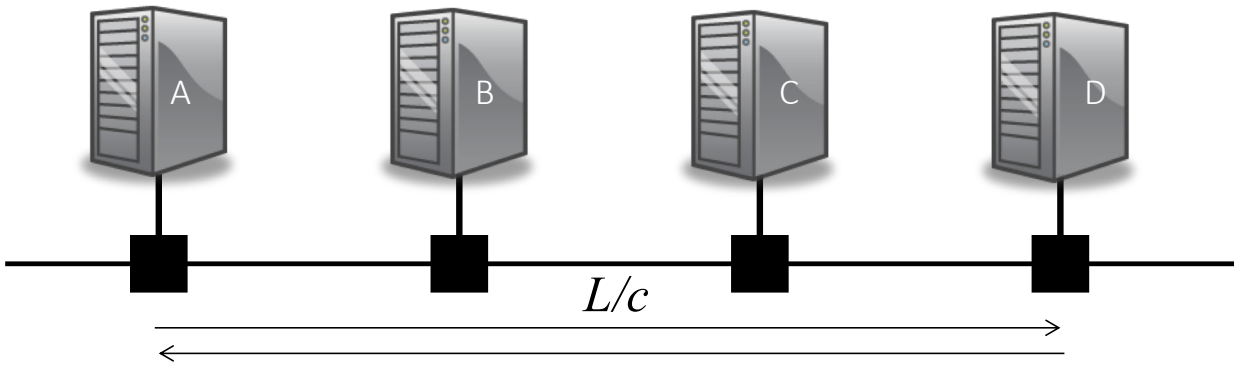
$$\frac{P}{R} > \frac{2L}{c}$$

where P is the size of a packet.

CSMA/CD Min packet size requirement

Example:

R = 10Mb/s, L = 10,000m, c = 2 x 10^8 m/s.



$$\frac{P}{R} > \frac{2L}{c}$$

$$\therefore P_{min} = \frac{2LR}{c} = \frac{2\times10^{11}}{2\times10^{8}} = 1{,}000\ bits$$