Data Link Layer(Bridge, Switch)

- Framing
- Flow Control
- Error Control
- Physical Addressing
- Medium Access Control

1. Stop-n-wait protocol

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Sliding window protocols

1. GoBackN

   In GB4, if every 5th frame that is being transmitted is lost and if we have to send 10 packets, then how many transmissions are required?

2. SelectiveRepeat

   In SR4, if every 5th frame that is being transmitted is lost and if we have to send 10 packets, then how many transmissions are required?

	Data	BW
K	1024	1000
M	1024*1024	1000*1000
G	1024*1024*1024	1000*1000*1000

Utilization = w * Tt / (Tt + 2 Tp) = W / (1 + 2a)

ThroughPut = Utilization * BW

Two hosts are connected via a packet switch with 10^7 bits per second links. Each link has a propagation delay of 20 microseconds. The switch begins forwarding a packet 35 microseconds after it receives the same.
If 10000 bits of data are to be transmitted between the two hosts using a packet size of 5000 bits, the time elapsed between the transmission of the first bit of data and the reception of the last bit of the data in microseconds is _____.

Consider two hosts X and Y, connected by a single direct link of rate 10^6 bits/sec . The distance between the two hosts is 10,000 km and the propagation speed along the link is $2x10^8$ m/sec . Host X sends a file of 50,000 bytes as one large message to host Y continuously. Let the transmission and propagation delays be p milliseconds and q milliseconds, respectively . Then the values of p and q are

A p = 50 and q = 100

B p = 50 and q = 400

C p = 100 and q = 50

D p = 400 and q = 50

StationA uses 32 byte packets to transmit messages to Station B using a sliding window protocol. The round trip delay between A and B is 80 ms and the bottleneck bandwidth on the path between A and B is 128 kbps. What is the optimal window size that A should use?

A 20

B 40

C 160

D 320

Consider a 128×10^3 bits/second satellite communication link with one way propagation delay of 150 milliseconds. Selective retransmission(repeat) protocol is used on this link to send data with a frame size of 1 kilobyte. Neglect the transmission time of acknowledgement. The minimum number of bits required for the sequence number field to achieve 100% utilization is _____.

A 3

B 4

C 5

D 6

Consider a 100 Mbps link between an earth station (sender) and a satellite (receiver) at an altitude of 2100 km. The signal propagates at a speed of 3×10^8 m/s. The time taken (in milliseconds, rounded off to two decimal places) for the receiver to completely receive a packet of 1000 bytes transmitted by the sender is

A 15.06

B 54.25

C 7.08

D 4.25

Consider that 15 machines need to be connected in a LAN using 8-port Ethernet switches. Assume that these switches do not have any separate up link ports. The minimum number of switches needed is _____.

A 2

B 3

C 4

D 5

Suppose two hosts are connected by a point-to-point link and they are configured to use Stop-and-Wait protocol for reliable data transfer. Identify in which one of the following scenarios, the utilization of the link is the lowest.

A Longer link length and lower transmission rate

B Longer link length and higher transmission rate

C Shorter link length and lower transmission rate

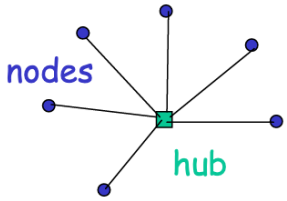
D Shorter link length and higher transmission rate

1. Channel has bit rate of 4Kbps, for what rate of frame does the stop and wait gives efficiency of 50 % ?

Efficiency(U) <= Tt / (Tt + 2Tp)

10BaseT and 100BaseT

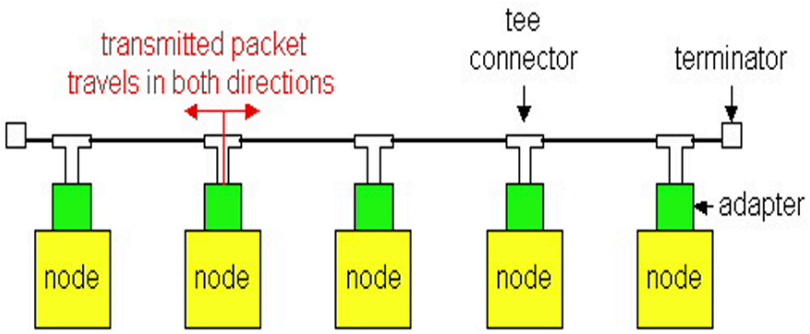
- 10/100 Mbps rate; latter called "fast ethernet"
- T stands for Twisted Pair
- Nodes connect to a hub: "star topology"; 100 m max distance between nodes and hub



- Hubs are essentially physical-layer repeaters:
  - bits coming in one link go out all other links
  - no frame buffering
  - no CSMA/CD at hub: adapters detect collisions
  - provides net management functionality

Ethernet Technologies: 10Base2

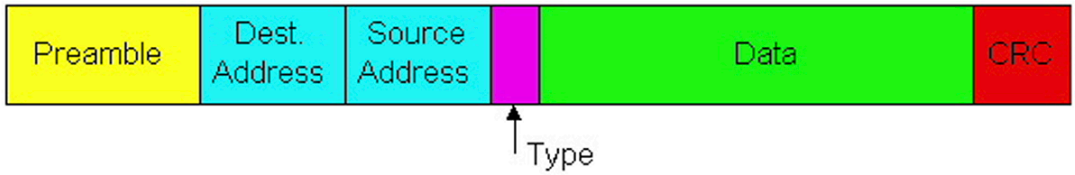
- 10: 10Mbps; 2: under 200 meters max cable length
- thin coaxial cable in a bus topology



- repeaters used to connect up to multiple segments
- repeater repeats bits it hears on one interface to its other interfaces: physical layer device only!
- has become a legacy technology

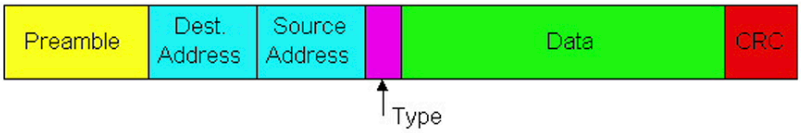
Ethernet Frame Structure (more)

- Addresses: 6 bytes
  - if adapter receives frame with matching destination address, or with broadcast address (eg ARP packet), it passes data in frame to net-layer protocol
  - otherwise, adapter discards frame
- Type: indicates the higher layer protocol, mostly IP but others may be supported such as Novell IPX and AppleTalk)
- CRC: checked at receiver, if error is detected, the



Ethernet Frame Structure

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

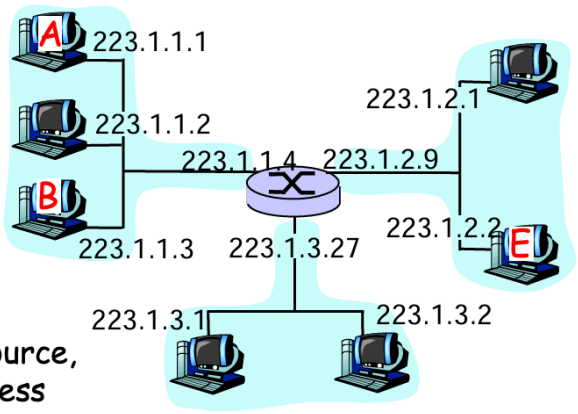


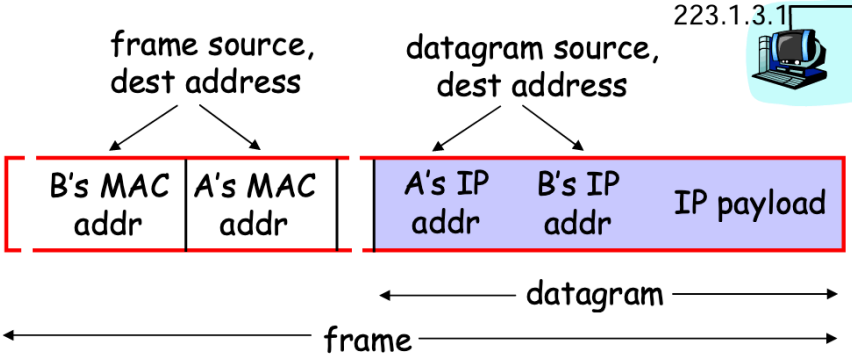
Preamble:

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

Starting at A, given IP datagram addressed to B:

- look up net. address of B, find B on same net. as A
- link layer send datagram to B inside link-layer frame



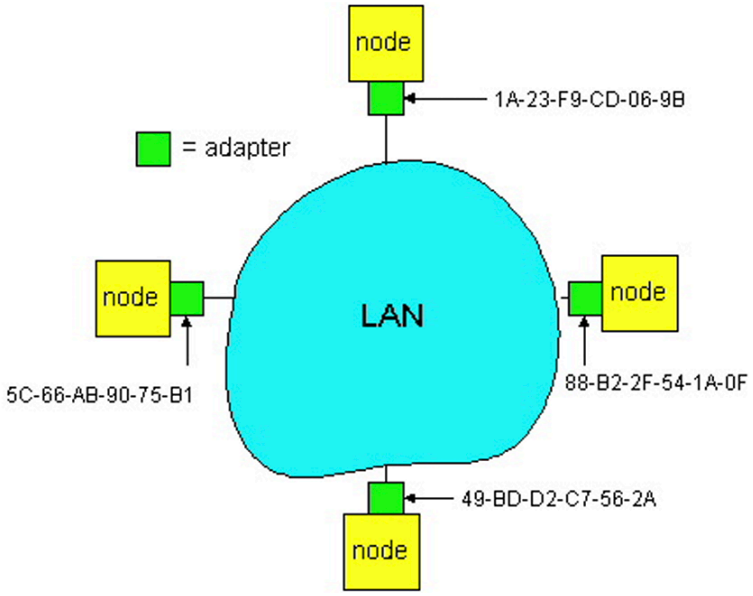


LAN Address (more)

- MAC address allocation administered by IEEE
- manufacturer buys portion of MAC address space (to assure uniqueness)
- Analogy:
  - (a) MAC address: like Social Security Number
  - (b) IP address: like postal address
- MAC flat address => portability
  - can move LAN card from one LAN to another
- IP hierarchical address NOT portable
  - depends on IP network to which node is attached

LAN Addresses and ARP

Each adapter on LAN has unique LAN address

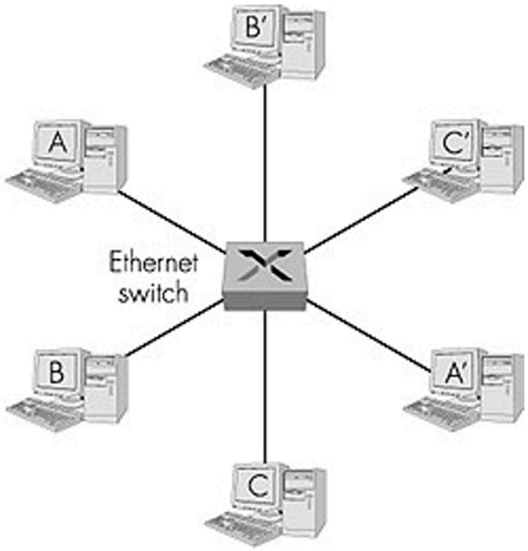


Bridges

- Link layer device
  - stores and forwards Ethernet frames
  - examines frame header and selectively forwards frame based on MAC dest address
  - when frame is to be forwarded on segment, uses CSMA/CD to access segment
- transparent
  - hosts are unaware of presence of bridges
- plug-and-play, self-learning
  - bridges do not need to be configured

Ethernet Switches

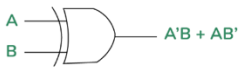
- Essentially a multi-interface bridge
- layer 2 (frame) forwarding, filtering using LAN addresses
- Switching: A-to-A' and B-to-B' simultaneously, no collisions
- large number of interfaces
- often: individual hosts, star-connected into switch
  - Ethernet, but no collisions!



Symbol of XOR Gate

The logic symbol of XOR gate is shown in the following figure. In this figure, the variables A and B represent the input lines and **A'B + AB'** is the output of the XOR gate.

XOR Gate



Truth Table

A (Input 1)	B (Input 2)	X = A'B + AB'
0	0	0
0	1	1
1	0	1
1	1	0

Error Detection and Error Correction : Hamming Distance

Parity Checker : 1 – dimension, 2 – dimension

000	0
001	1
111	1

M1	0011	
M2	1101	
M3	1001	

1. Checksum : Message : 10101000 n(bits) = 4. K(block) = 2

2. CRC : Message = 110101. Generator Polynomial: 1101

3. CRC : Message = 1010001101. Generator Polynomial: 110101