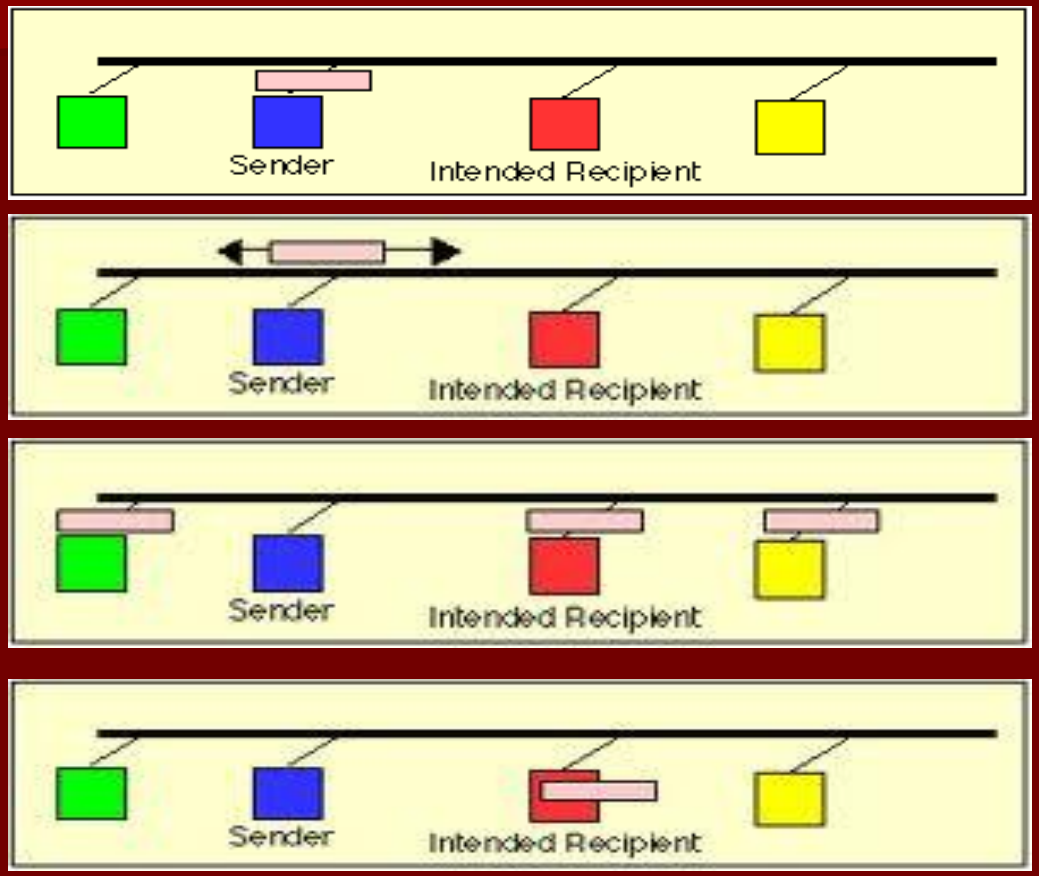
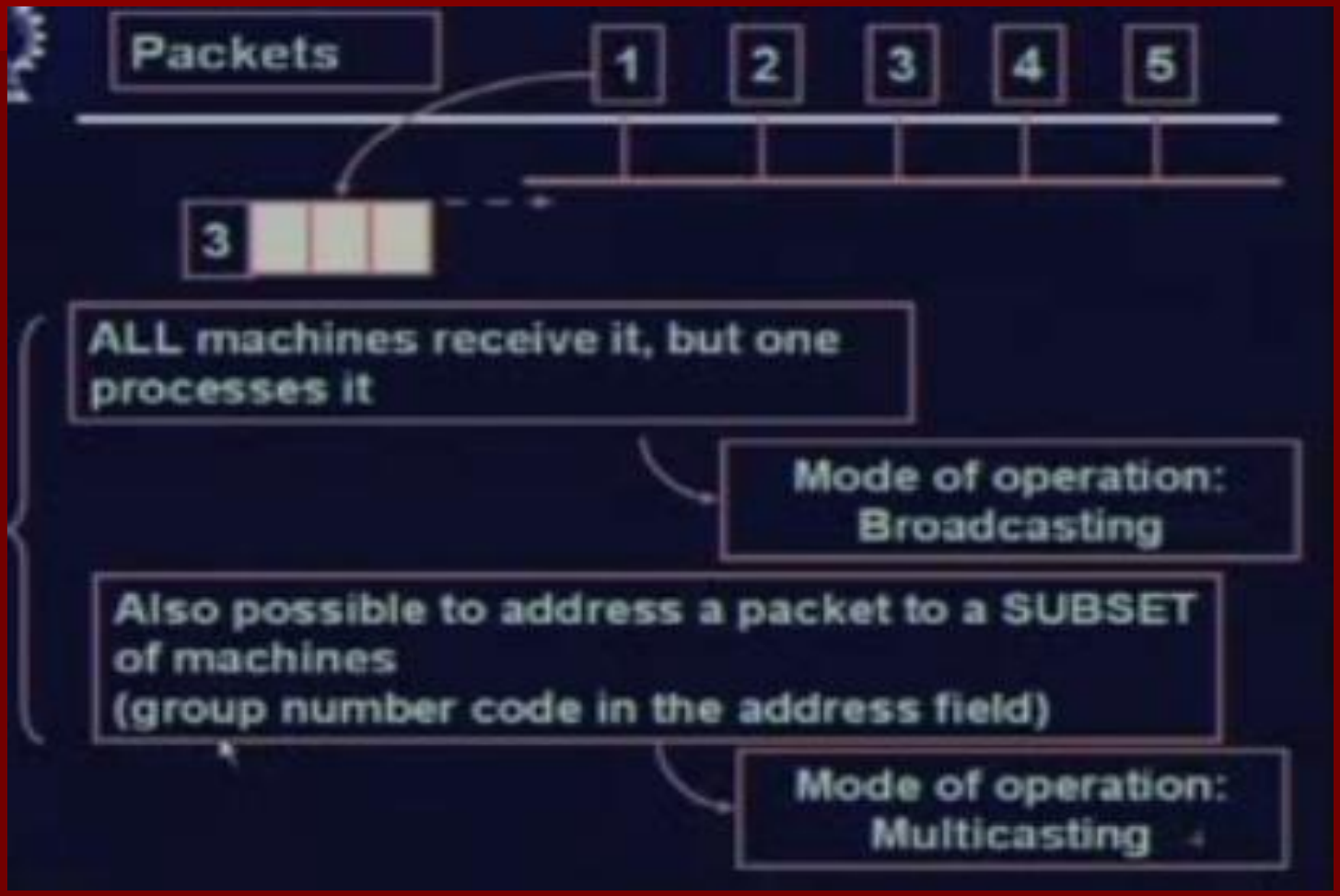
Ethernet – CSMA/CD

SECTION – C


Broadcast Networks
Single communication channel that is shared by all the machines on the network
computer
1
2
3
4
5
General Rule: Smaller, geographically localized networks
Packets
Short messages sent by any machine are received by all others
Address
Fields

A Shared Medium – Collision Domain




Packets
1
2
3
4
5
3
ALL machines receive it, but one processes it
Mode of operation: Broadcasting
Also possible to address a packet to a SUBSET of machines
(group number code in the address field)
Mode of operation: Multicasting

Multiple Access Protocols

Many algorithms for allocating a multiple access channels are known.

- **ALOHA**
  - Pure ALOHA
  - Slotted ALOHA
- **Carrier Sense Multiple Access Protocols (CSMA)**
  - Persistent & Non-persistent CSMA
  - CSMA with Collision detection.
- **Collision free Protocols**
  - A Bit Map Protocol
  - Binary Countdown.

ALOHA
(Abramson's Logic of Hiring Access)

- The basic idea is applicable to any system in which uncoordinated users are competing for the use of single shared channel.
- **Two versions**: Pure & Slotted.
- **Differences**
- They differ w.r.t. whether or not time is divided up into discrete slots into which frames must fit.
- Pure ALOHA does not require global time synchronization; slotted ALOHA does.

ALOHA cont…

- The basic idea is simple: let users transmit whenever they have data to be sent.
- There will be collisions, of course, and colliding frames will be destroyed.
- Due to **Feedback Property of broadcasting** A sender can always find out whether or not its frames was destroyed by listening to the channel.
- If the frame was destroyed, the sender just waits for some time & sends it again.
- Systems in which multiple users share a common channel in a way that can lead to conflicts are widely known as **contention systems.**

Pure ALOHA

- In this case, we've made the frames all the same length because the **throughput** of ALOHA systems is maximized by having a uniform size rather than allowing variable length frames.
- Whenever two frames try to occupy the channel at the same time, there will be a collision & both will be garbled.
- If the first bit of a new frame overlaps with just the last bit of a frame almost finished, both frames will be totally destroyed, & both will have to be retransmit later.

(See Fig 1.)

Throughput is avg rate of successful message delivery over a communication channel, measured in bits/sec.

In pure ALOHA, frames are transmitted at completely arbitrary times

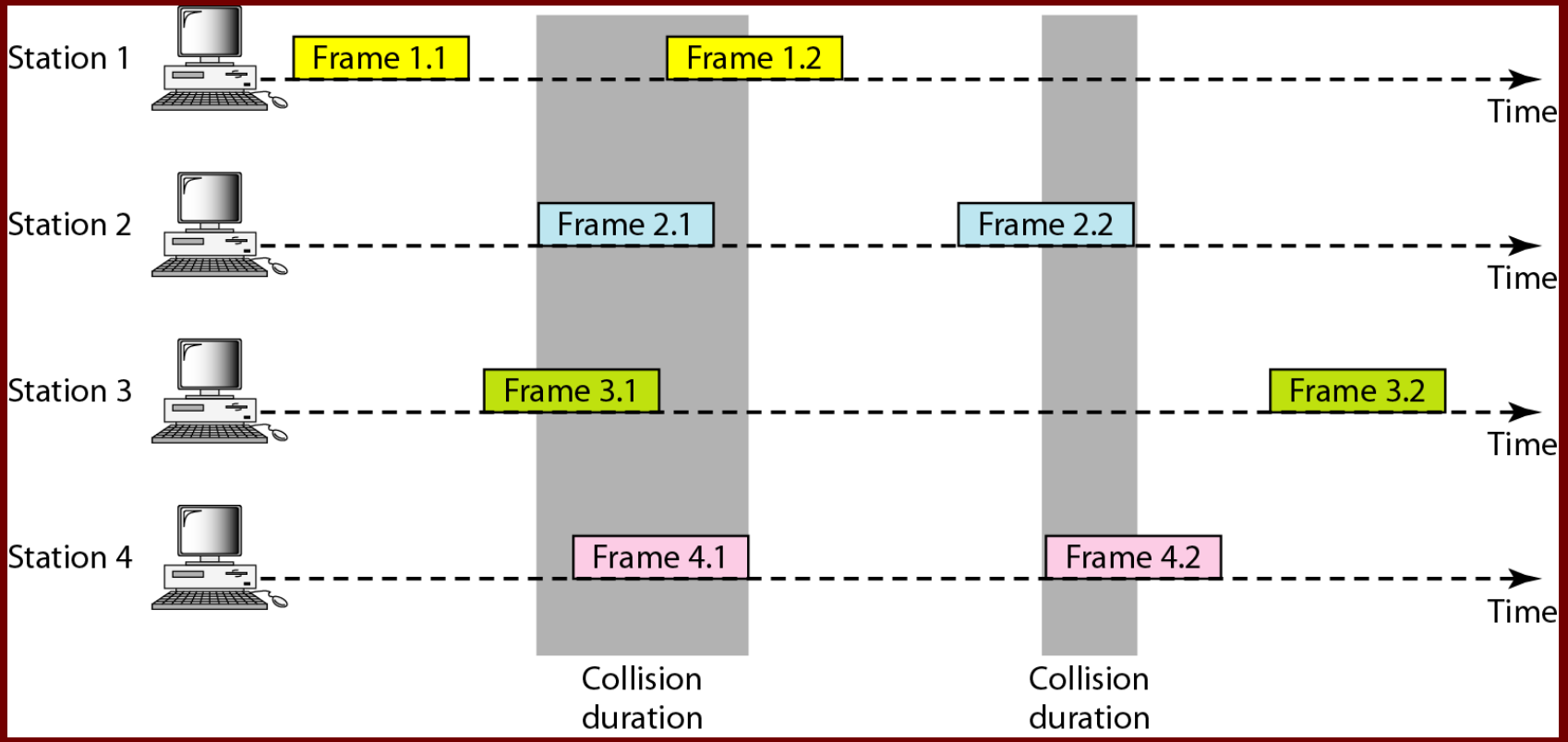


Figure 1

What is the efficiency of an ALOHA Channel??

- What fraction of all transmitted frames escape collisions under these chaotic circumstances?
- Lets consider an infinite collection of interactive users sitting at their computers (stations).
- A User is always in one of the two states:

  (a) **Typing** (b) **Waiting**

- Initially all users are in typing state. When a line is finished, the user stops typing, waiting for a response.
- The station then checks the channel to see if it was successful
- If YES, the user sees the reply & goes back to typing
- If NO, the user continues to wait & the frame is retransmitted over & over until it has been successfully sent.

- Let the "**frame time**" denote the amount of time needed to transmit the standard fixed-length frame(i.e. the frame length divided by the bit rate).
- Assume that the infinite population of users generate new frames according to Poisson distribution.
- If N>1, the user community is generating frames at a higher rate than the channel can handle, & nearly every frame will suffer a collision.
- In addition to the new frames, the stations also generate retransmission of frames that previously suffered collisions.

A frame will not suffer a collision if no other frames are sent within one frame time of its start

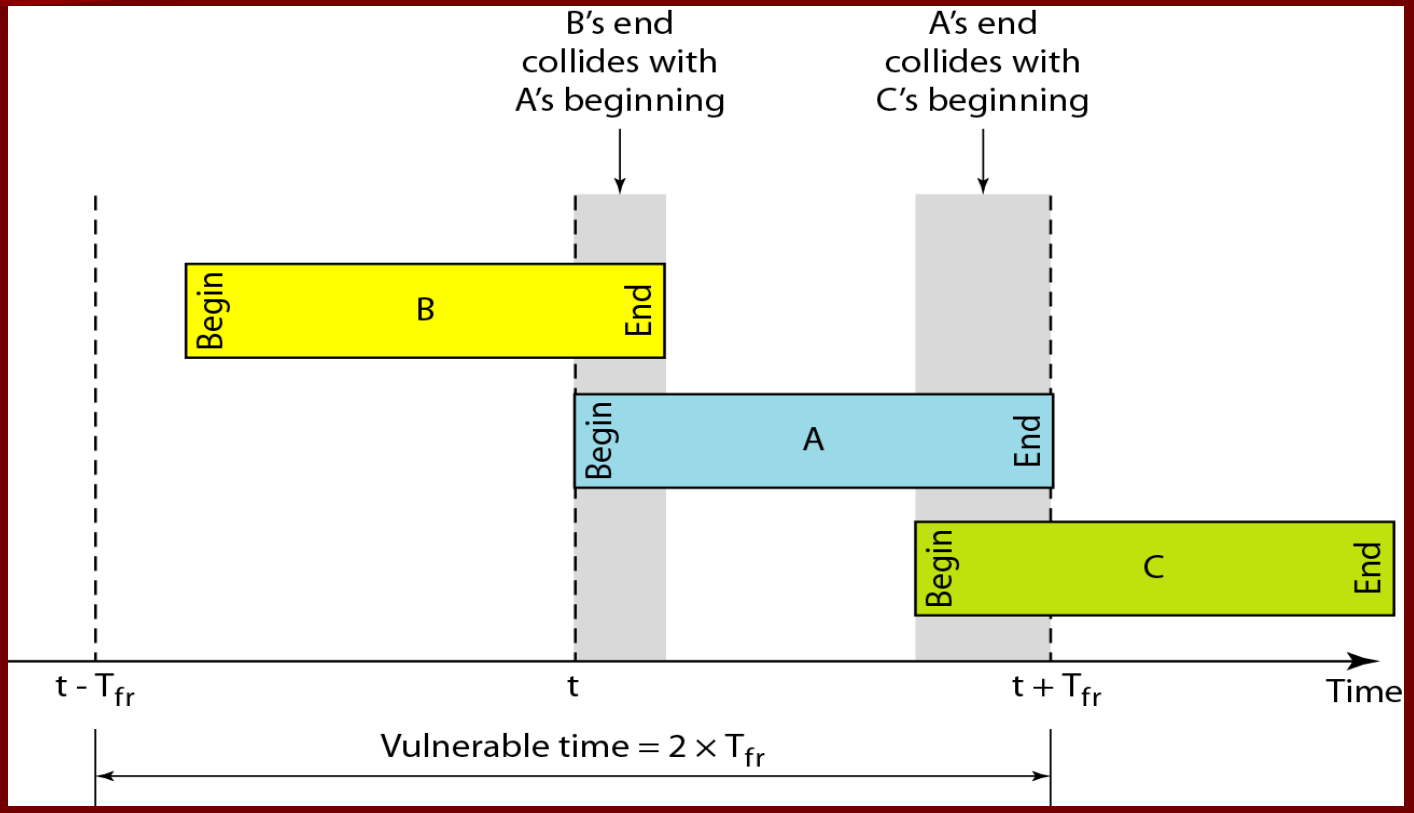


Figure 2 :Vulnerable period for the shaded frame.

- **In pure ALOHA, a station does not listen to the channel before transmitting, it has no way of knowing that another frame was already underway.**

The relation b/t the offered traffic & the throughput is shown in Figure- 3.

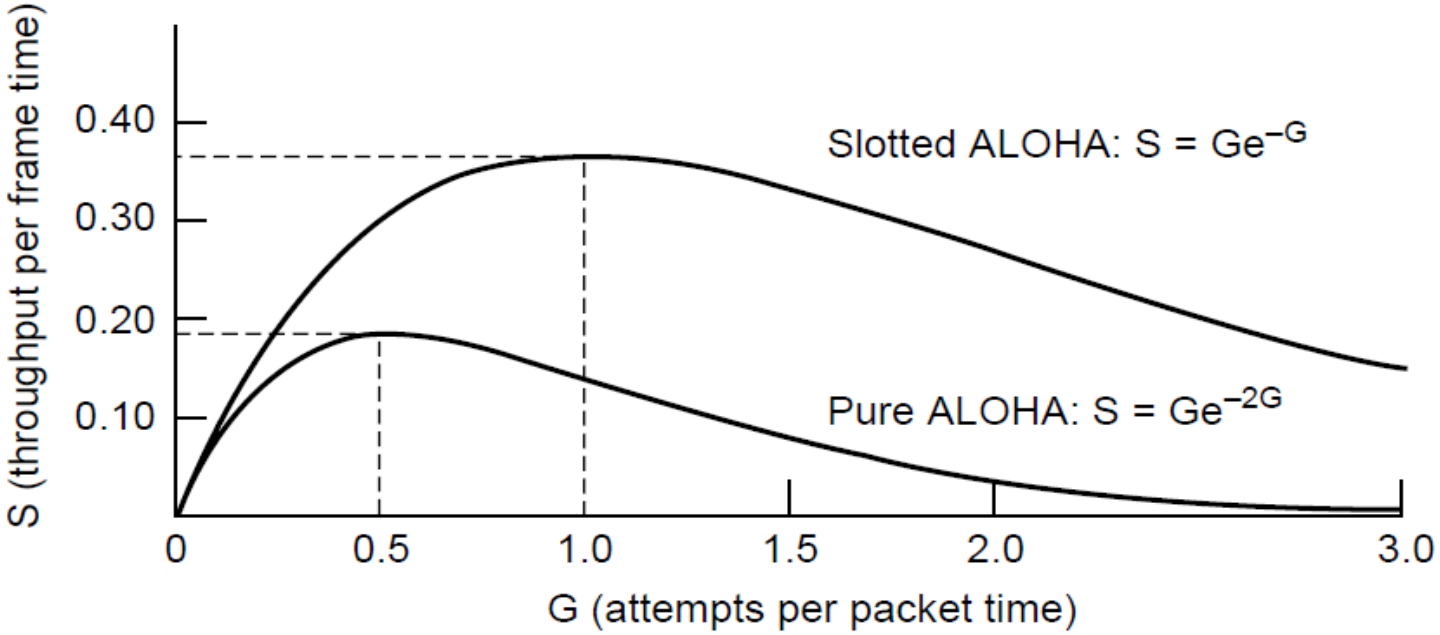


Fig-3. Throughput vs. offered traffic for ALOHA systems.

- The maximum throughput occurs at G= 0.5 with S=1/2e, which is about 0.184.
- The best we can hope for is a channel utilization of 18%.
- This result is not very encouraging, but with everyone transmitting at will, we could hardly have expected a 100% success rate.

Slotted ALOHA

- It's basically a method for doubling the capacity of an ALOHA system.
- Aim was to divide time up into discrete intervals, each interval corresponding to one frame.
- This approach requires the users to agree of slot boundaries.
- One way to achieve synchronization would be to have one special station emit a pip at the start of each interval, like a clock. It has come to be known as **SLOTTED ALOHA**

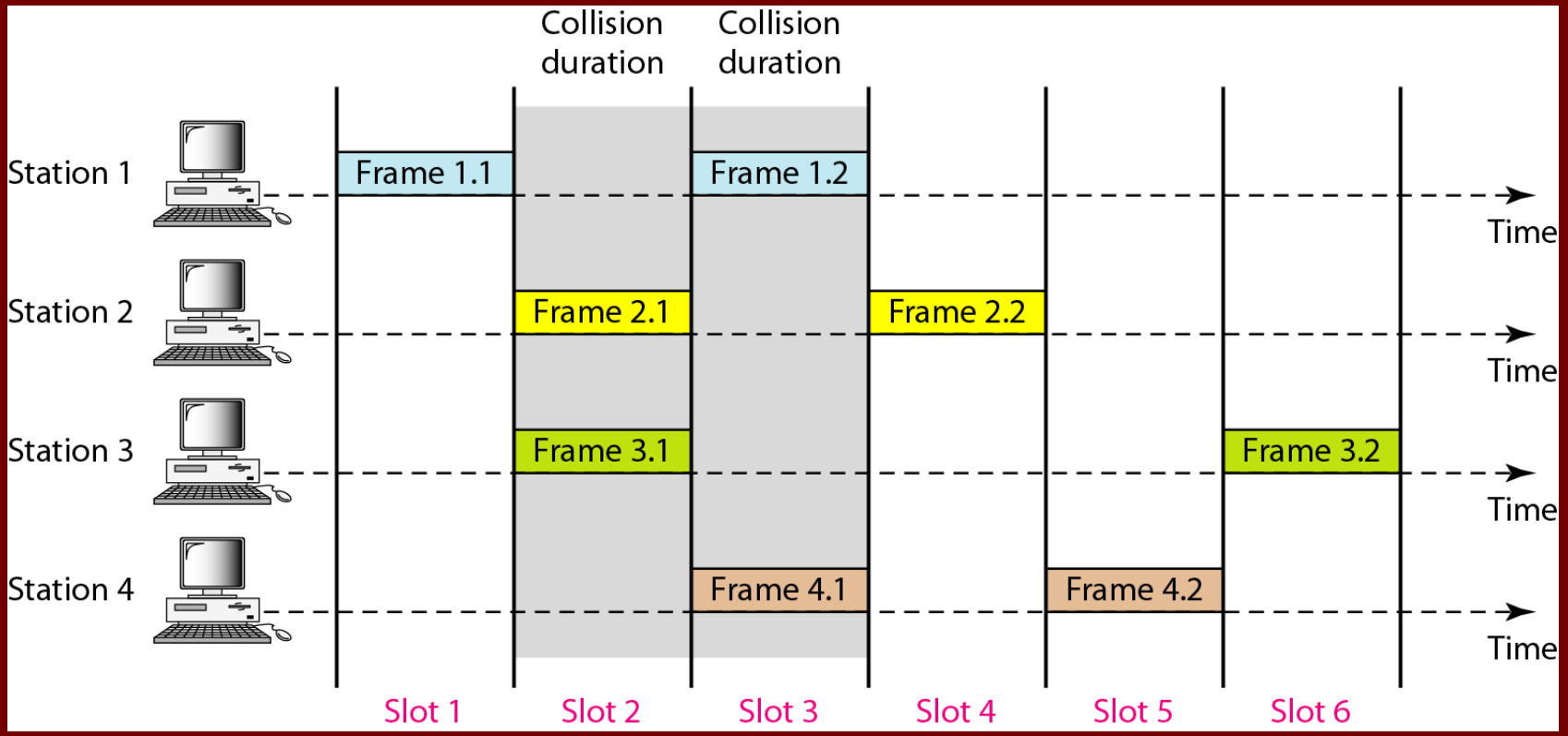


Fig 4: Frames in a Slotted ALOHA network.

- In contrast to pure ALOHA, a computer is not permitted to send whenever a carriage return is typed.
- Instead, it is required to wait for the beginning of the next slot.
- Thus the continuous pure ALOHA is turned into discrete one & the vulnerable period is now halved

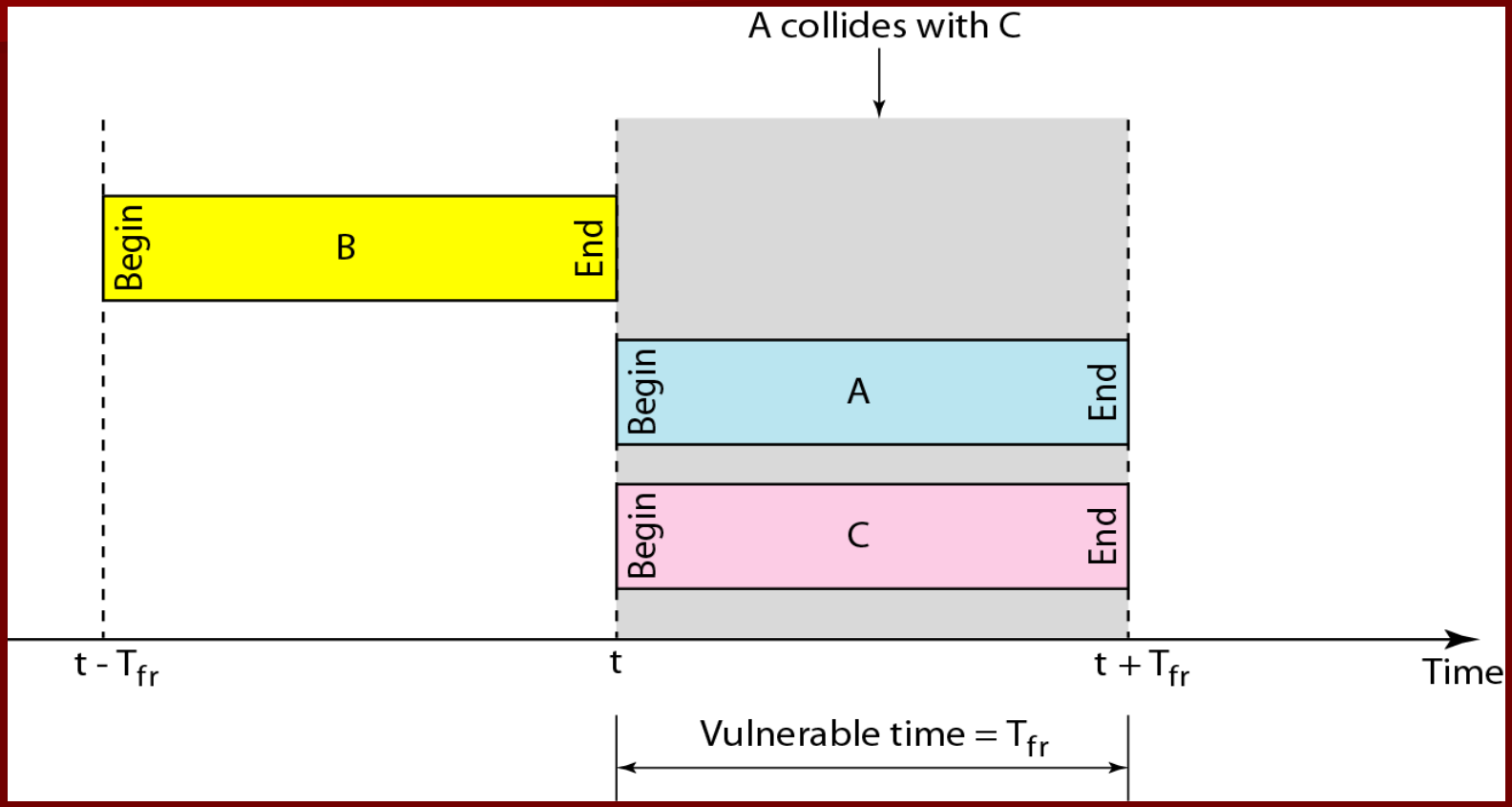


Fig 5: Vulnerable time for Slotted ALOHA Protocol

- **The best we can hope for using slotted ALOHA is 37% of the slots empty, 37% successes & 26% collisions.**

- **Small increase in the channel load can drastically reduce its performance.**

Dynamic Channel Allocation Technologies

- CSMA
- CSMA/CD (old ETHERNET)
- Switching (Fast ETHERNET)

Carrier Sense, Multiple Access (CSMA)

- We can improve the performance of our simple network greatly if we introduce carrier sensing (CS). With carrier sensing, each host listens to the data being transmitted over the cable.

Carrier Sense, Multiple Access (CSMA)

- A host will only transmit its own frames when it cannot hear any data being transmitted by other hosts.
- When a frame finishes, an interface gap of about 9.6 µsec is allowed to pass before another host starts transmitting its frame.

CSMA Collisions

- Collisions can still occur:

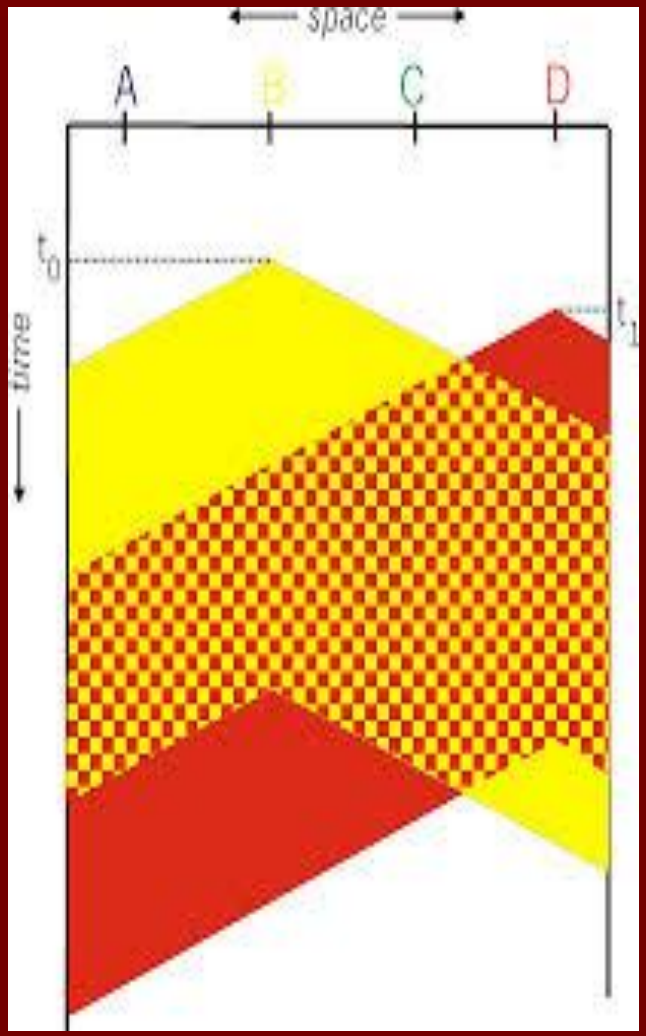
Propagation delay means two nodes may not hear each other's transmission.

- Collision:

Entire packet transmission wasted

- Note:

Role of distance & propagation delay determining collision probability.

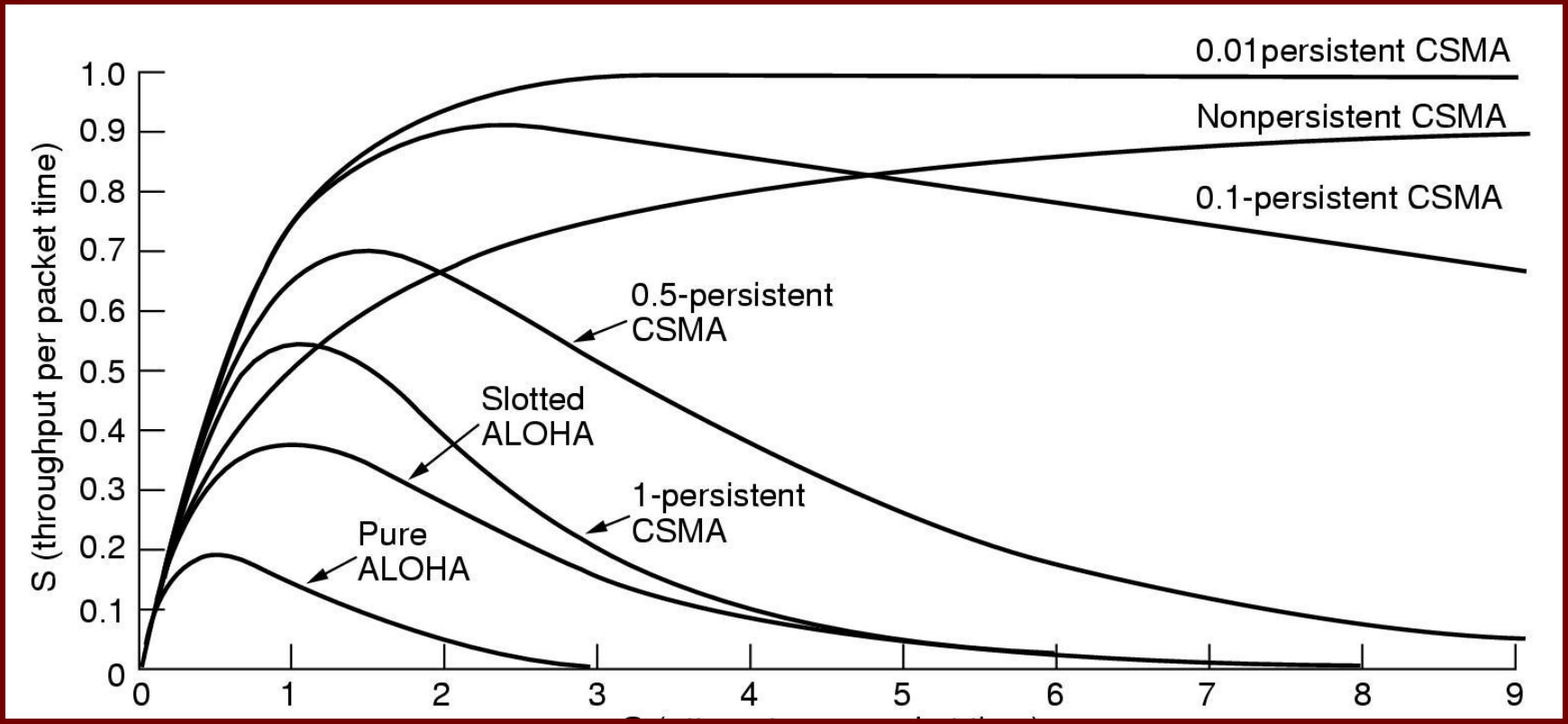


CSMA

- CSMA : listen before transmit. If channel is sensed busy, defer transmission.
- Persistent CSMA: retry immediately when channel becomes idle (this may cause instability)
- p- persistant – retry with probability p.

- Non persistent CSMA: retry after random interval.
- Note: collisions may still exist, since two stations may sense the channel idle, at the same time (or better, within a "vulnerable" window = round trip delay)
- In case of collision, the entire packet transmission time is wasted.

Comparison of Channel Utilization



Collision Detection

- Easy in wired LANs : measure signal strengths, compare transmitted, received signals.
- CSMA/CD is difficult in wireless LANs:

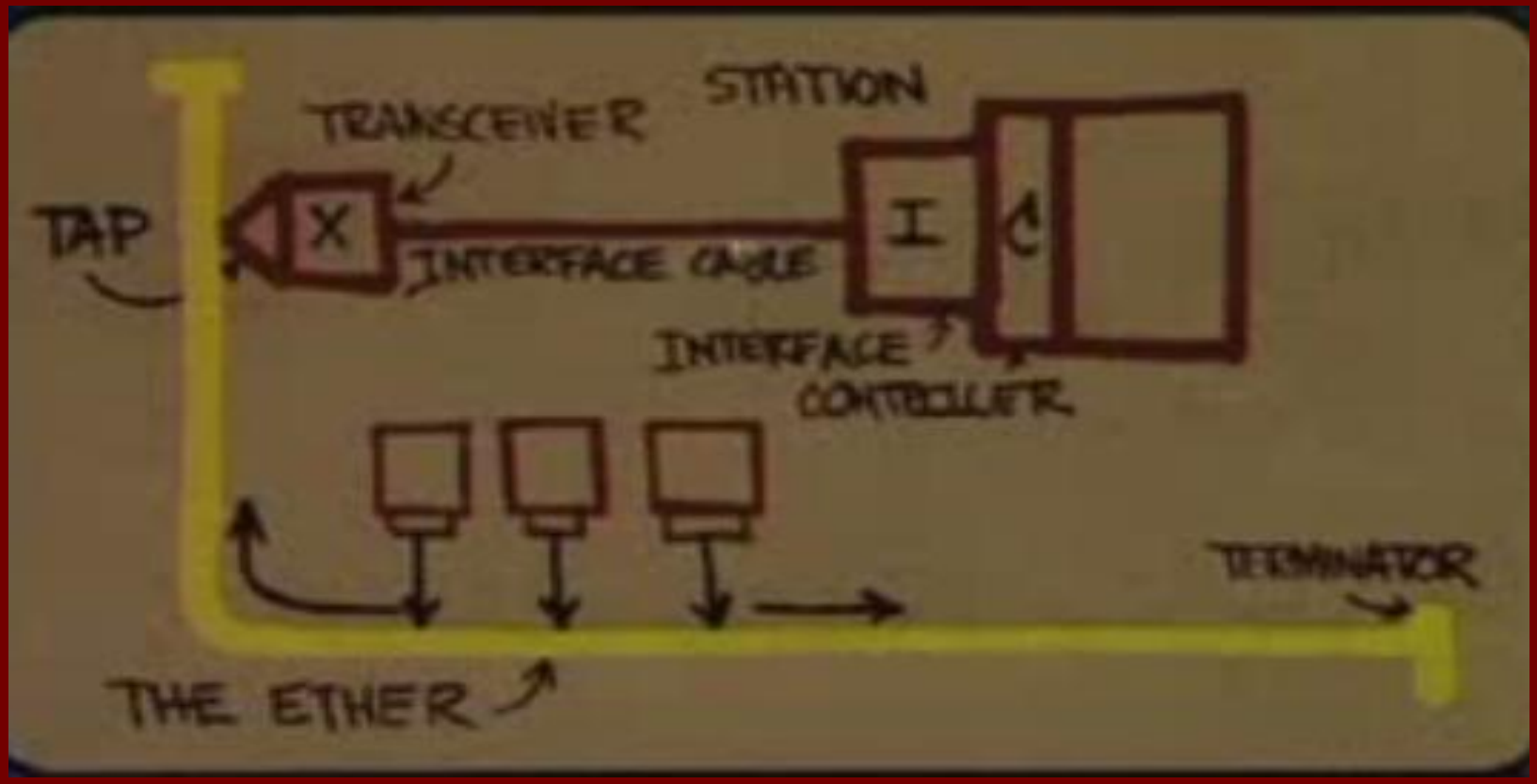
  receiver shut off while transmitting.

Ethernet

- "dominant" LAN technology:

- Cheap $20 for 100Mbs!
- First widely used LAN technology.
- Simpler, cheaper than token LANs and ATM Metcalfe's Ethernet sketch
- Kept up with speed race: 10, 100, 1000 Mbps.

Ethernet


STATION
TRANSCEIVER
TAP
X
INTERFACE CABLE
I
C
INTERFACE
CONTROLLER
TERMINATOR
THE ETHER

Ethernet LAN. IEEE 802.3

- Carrier Sense Multiple Access / Collision Detection (CSMA/CD) is used.
- Ethernet uses a bus topology.
- In CSMA/CD, each station has equal access to the network, but it can broadcast only when the network is idle. Before transmitting, a station: (1)-listens to the network to sense if another workstation is transmitting (carrier sense). If the network is still idle after a certain period, (2) – the station will transmit.

Ethernet LAN. IEEE 802.3

- While transmitting a station must perform collision detection to detect if its message was destroyed,

- If a collision is detected, the detecting station broadcasts a collision or jam signal to alert other stations that a collision has occurred. Each transmitting station then waits a random amount of time (ranging from 10 to 90 ms) before attempting the transmission again.

Ethernet CSMA/CD

1. Adapter gets datagram form and creates frame.

2. If adapter senses channel is idle, it starts to transmit frame. If it senses channel busy, waits until channel idle and then transmits.

3. If adapter transmits entire frame without detecting another transmission, the adapter is done with frame.

Ethernet CSMA/CD

4. If adapter detects another transmission while transmitting, aborts and sends jam signal.

5. After aborting, adapter enters exponential backoff: after the m-th collision, another chooses a K at random from

   $\{0,1,2,\ldots. 2^m - 1\}$. Adapter waits K=512 bit times and returns to Step 2.

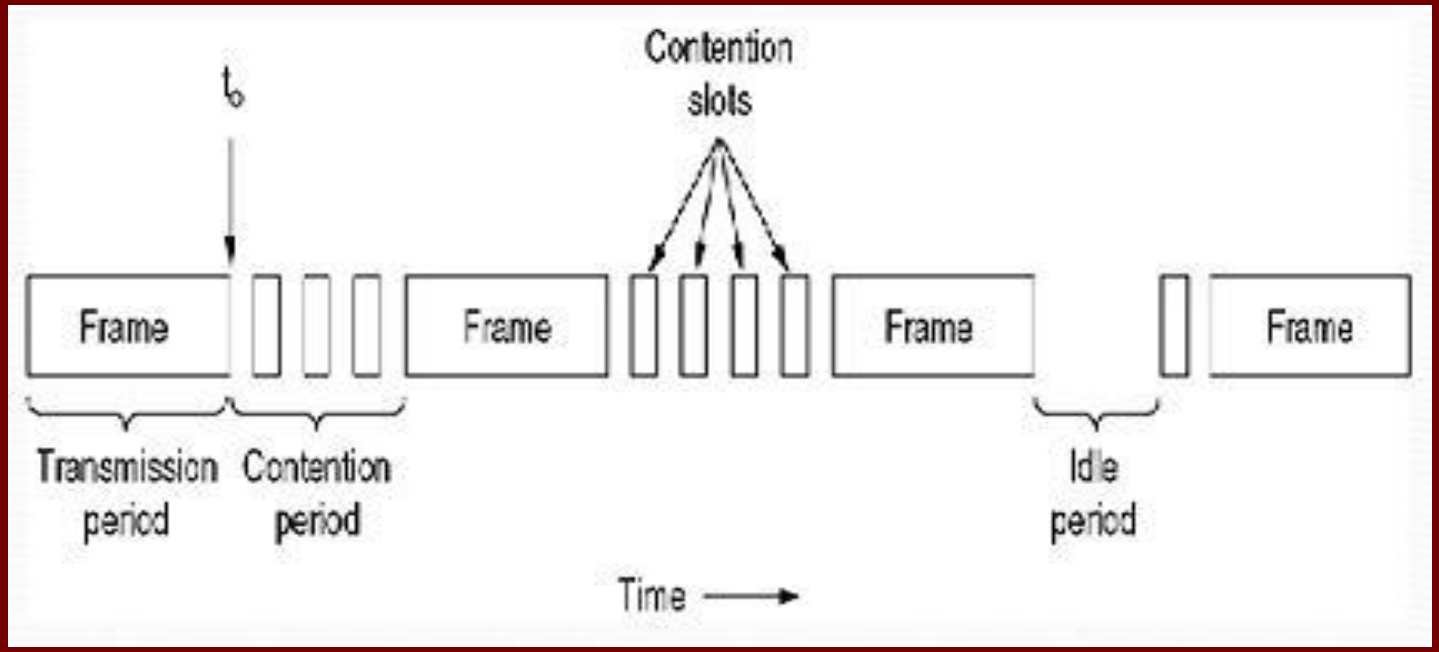
Ethernet CSMA/CD

- Jam Signal : make sure all other transmitters are aware of collision.
- Backoff: Bit time 0.1 microsec for 10 Mbps Ethernet; for K = 1023, wait time is about 50 msec.

Exponential Back off

- Goal: adapt retransmission attempts to estimated current load.
  - Heavy load: random wait will be longer.
- First collision: choose K from {0,1}; delay is K* 512 bit transmission times.
- After second collision: choose K from {0,1,2,3}….
- After ten collisions, choose K from {0,1,2,3,4….1023}

CSMA with Collision Detection

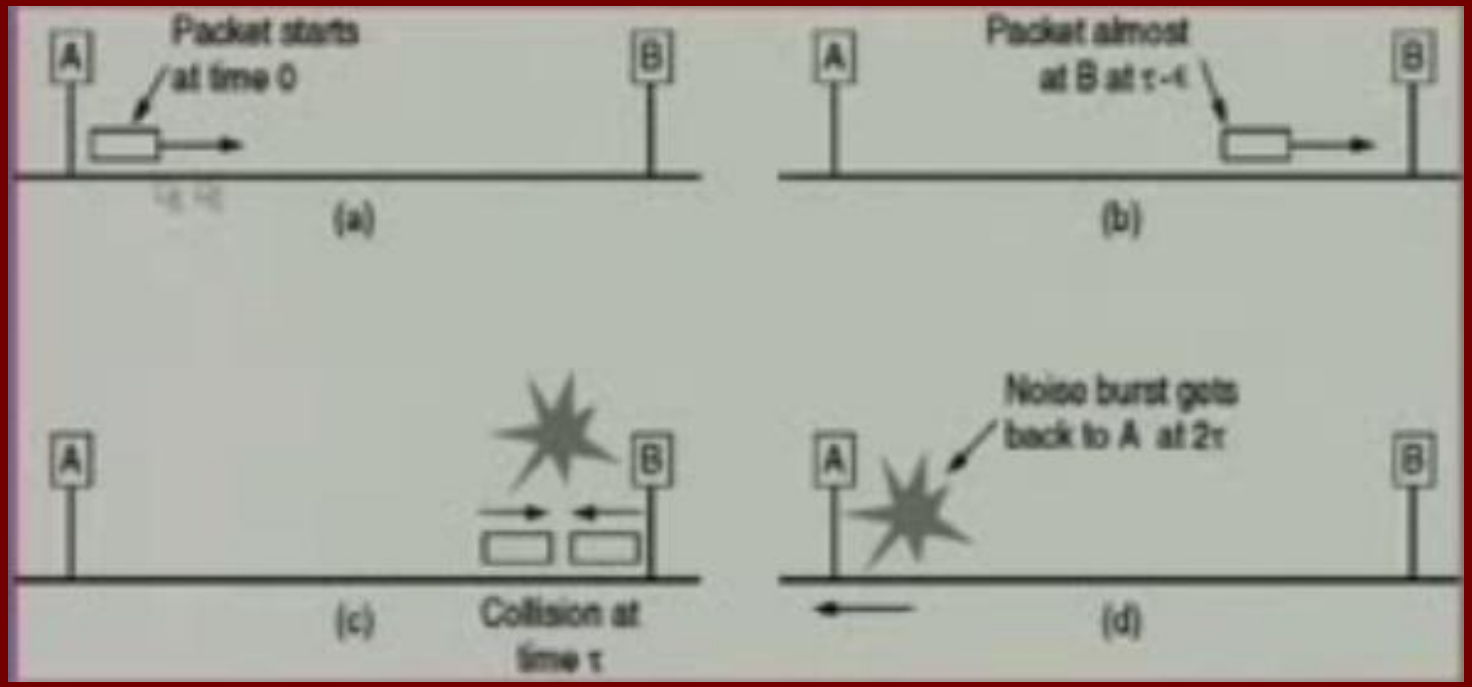


CSMA/CD can be in one of three states: contention, transmission, or idle.

IEEE 802.3 : CSMA/CD Bus LAN

- The minimum length of frames can be varied from network to network. This is important because, depending on the size of the network, the frames must be of a suitable length.
- The standard also makes some suggestions about the type of cabling that should be used for CSMA/CD bus LANs.

Time to Detect Collision



Collision detection can take as long as 2τ

IEEE 802.3: Minimum Frame Length

- To ensure that no node may completely receive a frame before the transmitting node has finished sending it, Ethernet defines a minimum frame size (i.e. no frame may have less than 46 bytes of payload.)

- The minimum frame size is related to the distance which the network spans, the type of media being used and the number of repeaters which the signal may have to pass through to reach the furthest part of the LAN.

- Together these define a value known as the Ethernet Slot Time, corresponding to 512 bit times at 10Mbps.