MEDIUM ACCESS (DLL)

C   A   medium

bus   D   B   E

MOBILE

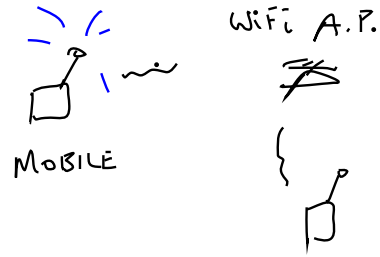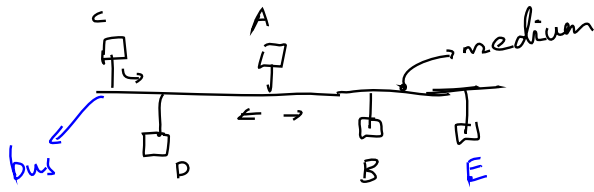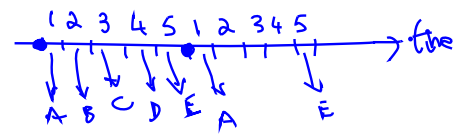WiFi A.P.

ETHERNET LANS.

CSMA : Carrier Sense Multiple Access

RANDOM - ACCESS PROTOCOLS

     ⤷ Schedule for transmission not decided in Advance

TDMA : Time Division Multiple Access

1 2 3 4 5 1 2 3 4 5 → time

A B C D E A   E

IDEA:

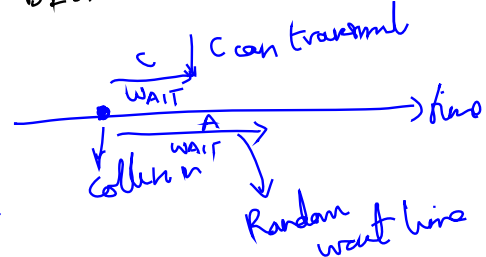If node has data to send, create a frame & sends it

BROADCAST → ALL NODES ON NETWORK ARE DESTINATION OF FRAME

UNICAST → SINGLE NODE IS DESTINATION OF FRAME

MULTICAST → A SUBSET OF NODES IS DESTINATION OF A FRAME (PACKET)

What if there is a collision?

     A → B

     C → D   at same time

C   C can transmit
WAIT

collision   WAIT A

Random wait time

1) COLLISION DETECTION — So that A & C know that a collision occurred

A → B   detected
Frame   collision

2) BACK-OFF FOR Random Time
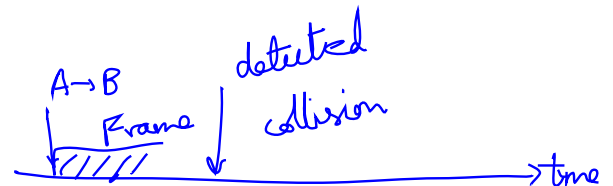
3) CARRIER SENSE. If node has data to send, first sense the "medium" to see if a transmission is ongoing. Don't transmit if medium is busy
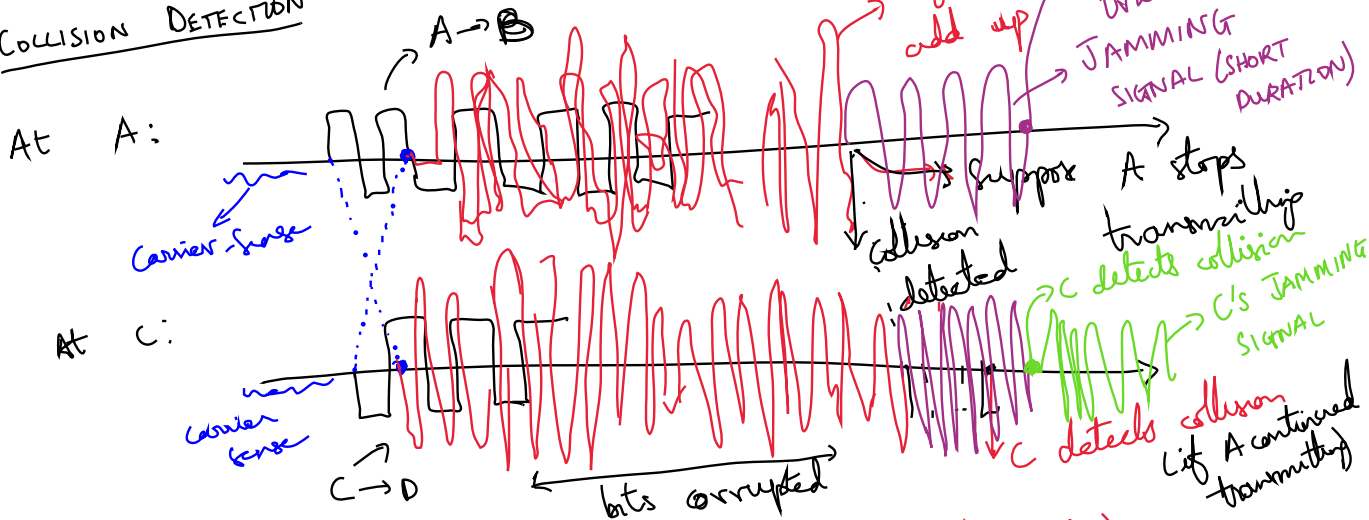

C got data
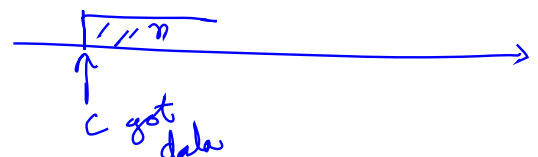
IEEE 802.3

CSMA-CD

COLLISION DETECTION

CARRIER-SENSE

__Not busy__ ~~~~~~~~→ noise ~~~~~~~~→ time

__busy__ ⎍⎍⎍⎍⎍ → time

If energy of signal > threshold ────→ conclude that channel
is busy
↓
larger than noise
energy

COLLISION DETECTION

At A:

A→B

signals add up

A stopped transmission JAMMING SIGNAL (SHORT DURATION)

Carrier-Sense

Collision detected

suppose A stops transmitting

At C:

C detects collision

C's JAMMING SIGNAL

Carrier sense

C→D

bits corrupted

C detects collision (if A continued transmitting)

idea: Another threshold for collision detection (th2)

energy > th2 then collision

th1 → busy
th2 → collision

0 ────────────────────→ Energy per time unit

typical noise

single transmission

collision of 2 transmitters

FLOW CHART

RECEIVED A MSG FROM HIGHER LAYER

Channel Idle → NO

↓ YES

Transmit after a short gap → set to be $9.6 \mu s$

A → B

B gets time to process A → B frame (CRC check etc.)

$9.6 \mu s$

C.S.

C → B

C got a MSG to send

COLLISION - DETECTION

if collision? → No → Continue transmission

↓ YES

Send 32 bit JAMMING SEQUENCE

↓
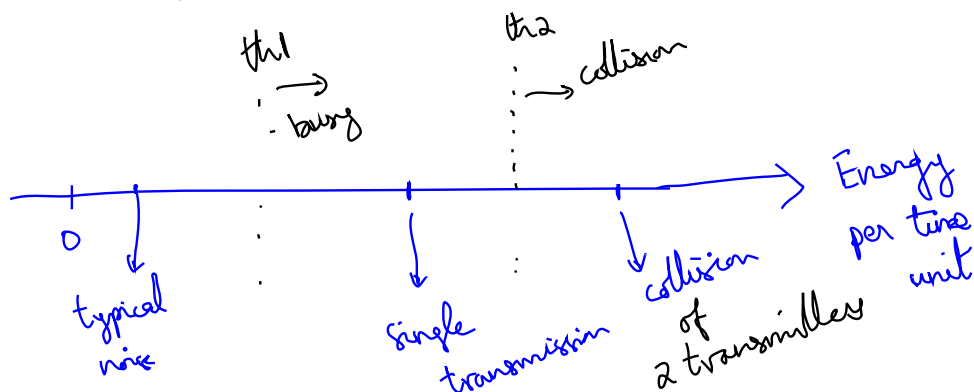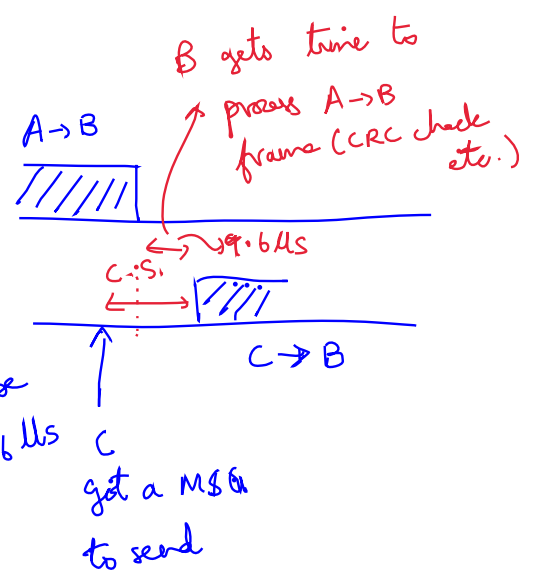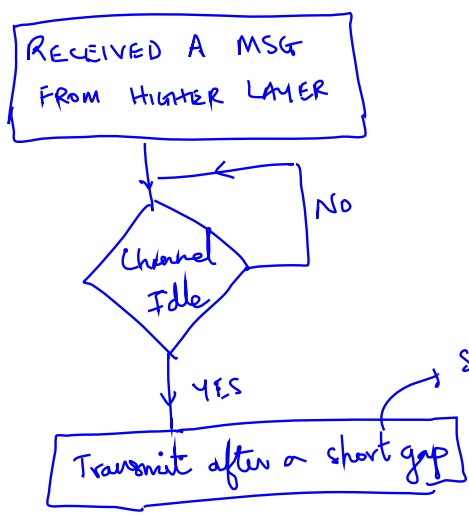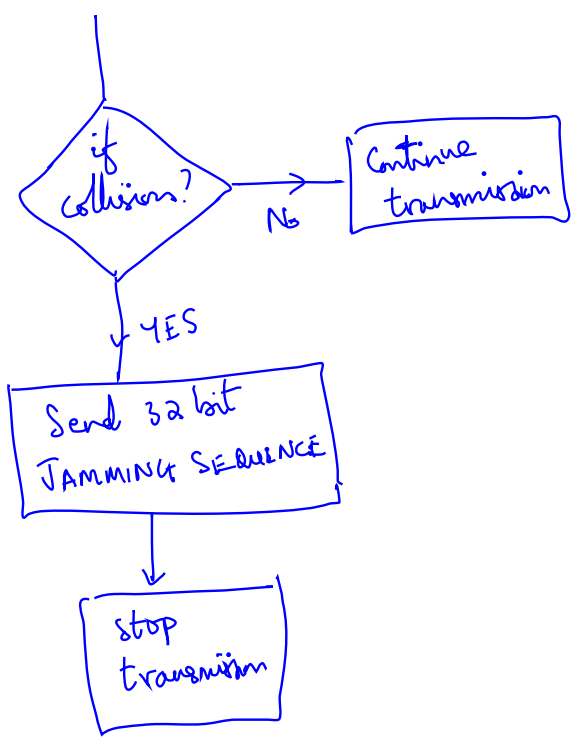
stop transmission

FRAME DETAILS IN 802.3

$2^{48} \to$ MAC address ; $2^{32} \to$ IPv4

Start Frame Delimiter

PREAMBLE	SFD	DEST MAC ADDR	SRC MAC ADDR	LENGTH	PAYLOAD	CRC
7 bytes	1 byte	6 bytes	6 bytes	2 bytes	46 - 1500 bytes	4 bytes

(48 bits)

$64 - 1518$ bytes

Why min-frame size?

2500m (max)
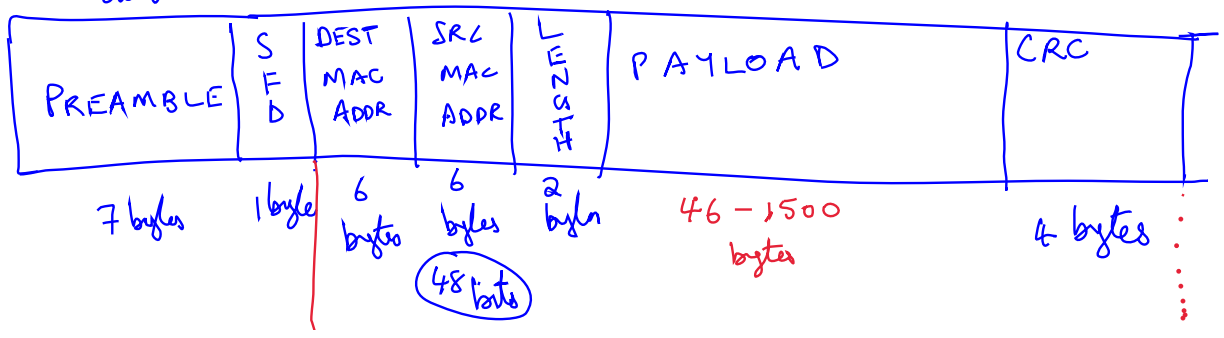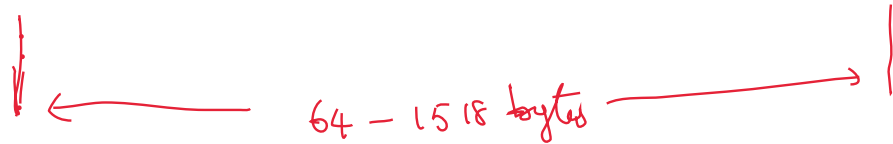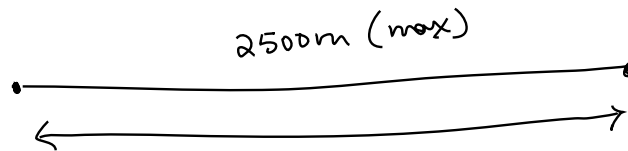
$$R_{TT} = \frac{5000}{2 \times 10^8} = 25 \, \mu s$$

'A' must detect collision before his frame ends, if a collision occurs at the receiver

B   C   A

→A→B

COLLISION AT B

12.5 μs

time   time

A   C

A's frame

25 μs

C wants to transmit

→C's frame

Want A's frame to continue till here

A M amplifies M M C

(amplify repeater reproduces signal on one link onto other link)
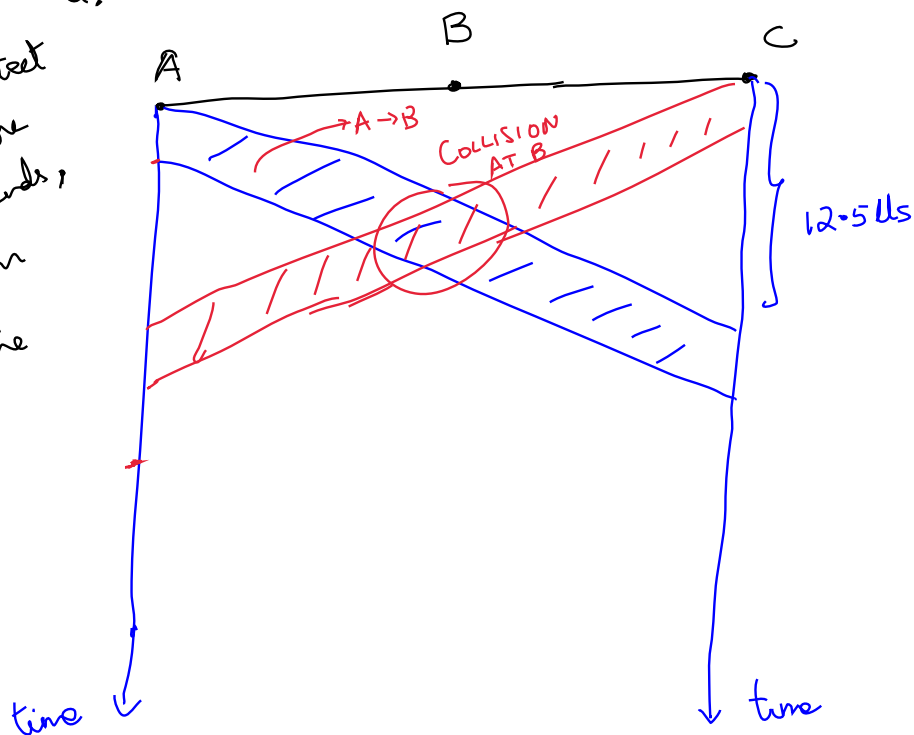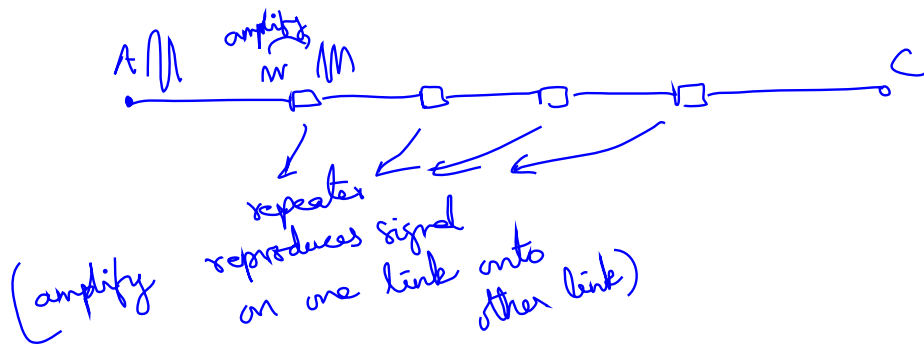
≈ 50 Us RTT in worst case

64 bytes , 10Mbps ⟶ 512 Us
transmission
rate

MAX - FRAME SIZE

very long

Large Frames

1) Higher prob. of getting a bit in error in Frame

'P → suppose prob. of bit error
N → frame length
Prob No error = $(1-P)^N$ ⟶ assuming bit errors are independent

2) Others need to wait longer to get a chance to transmit
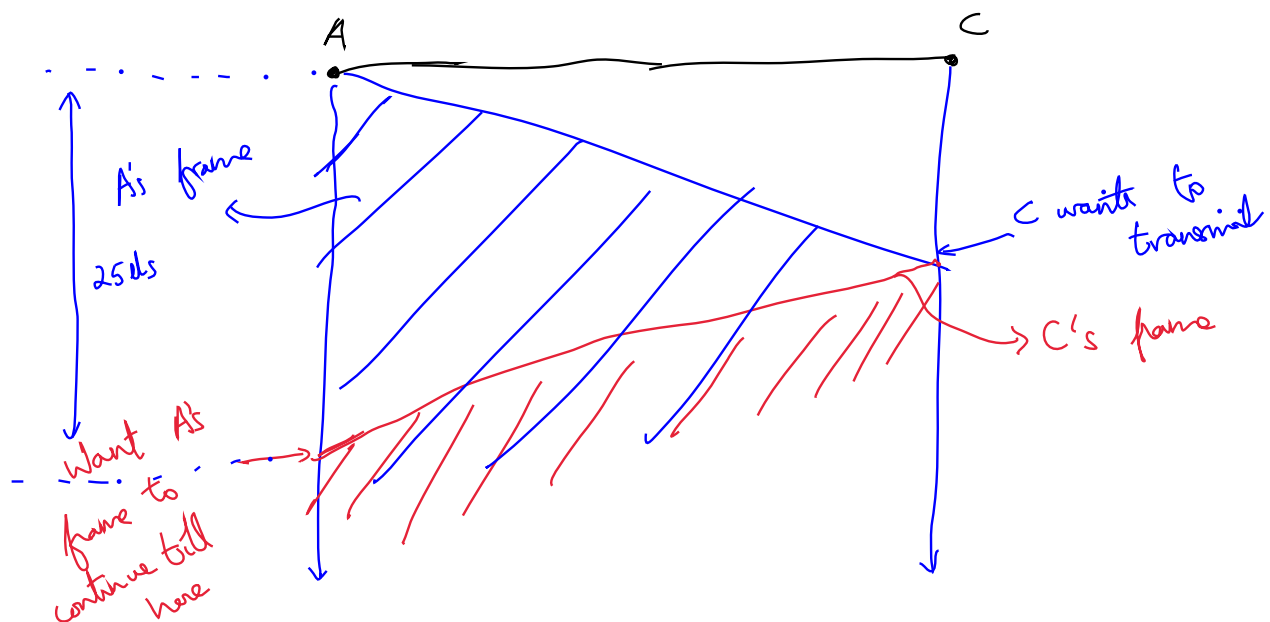
3) Memory requirements at NIC card go up.

Back-off

A C retransmit
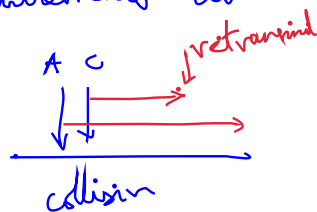
collision

Δ — min wait time

Wait $\in$ Δ . U.

$\{0, 1, \dots, 2^K\}$

larger if more have collided.

Exponential back-off:

1st collision : K = 1 ;
2nd collision : K = 2
3rd ⋮ K = 3
10th ⋮ K = 10

FLOW CHART

iff   K = 10

```
┌─────────────────┐
│ (sot FRAME To    │
│      SEND        │
└─────────────────┘
        │
      [N=0]
        │
#collisions ◄─── 
for this
frame
        │
     ◇ Carrier ◇ ── busy ──┐
     ◇ Sense  ◇            │
        │                   │
      idle                  │
        │                   │
┌─────────────────┐         │
│   Wait for      │         │
│    9.6 Ms       │         │
│     &           │         │
│ start transmitting│       │
└─────────────────┘         │
        │
     ◇ Has collision ◇ ── yes ──► ┌──────────┐
     ◇  occured?    ◇             │ 32 BIT   │
        │                          │ JAMMING  │
       No                          │  Seq.    │
        │                          └──────────┘
┌──────────┐                            │
│  DONE    │                         [N++]
└──────────┘                            │
                                   ◇ N < 15? ◇ ── YES ──► ◇ N ≤ 10 ◇
                                        │                      │
                                       No                  ┌────────┐
                                   ┌────────┐              │ K=10   │
                                   │ ABORT  │              └────────┘
                                   └────────┘
We discard
frame
```

Wait for $4 \times 51.2 \mu s$

Select $u \in \{0, 1, \ldots, 2^K\}$

$K = N$

$N \leq 10$

$K = 10$