→ observed power greater than transmitted power of own signal, means collision occurred.

18/9/17

Multiple Access Continued ...

- CSMA/CD:
  - Carrier sense Multiple Access with collision Detection
  - Recieving signal strength (RSS-value) ← high, low, 0
  - while transmitting, sender is listening to medium for collision.
    - Transmit + Recieveng (use of transceivers)
  - If collision occurs, defer transmission (ie stop transmitting, wait for a Random time)
    - (a) Abort transmission
    - (b) Transmit jam signal to inform other to stop as collision occurred
    - (c) backOFF waiting time

when transmitting without error/collision transmit own data and recieve own data.

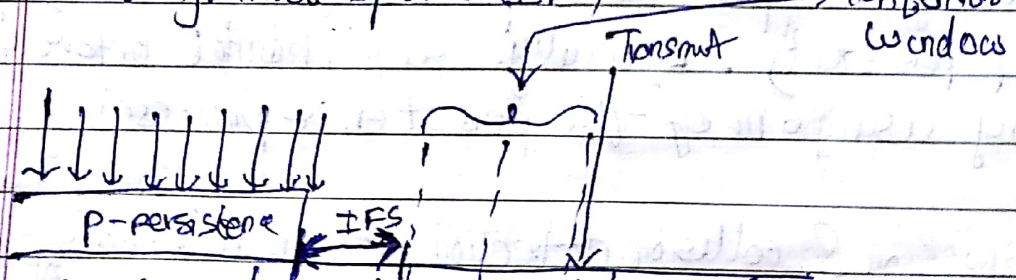
when collision occurs RSS value hikes & Trasmitting own data but recieving extra data.

- Actual Procedures (same as flow diagram in ppt slide 20)
  1. use one of the persistence process (non persistence / persistence or p-persistent). Basically sense channel before transmitting by using one of the persistence processes.
  2. Transmission & collision detection are simultaneous and continuous processes
     if collision detected then
     - (a) Abort transmission
     - (b) transmit a jam signal (48 bit) to notify other station and make them aware of collision. also notifies to discard the transmitted frame.
     - (c) After sending jam signal backoff (wait) for a Random time
     - (d) Transmit again.

- CSMA/CD
- Through put of CSMA/CD is better than Aloha & Slotted Aloha.
- CSMA/CD is used for bus topology LAN's (ethernet)

- CSMA/CA: (Carrier Sense Multiple Access With Collision Avoidance)
- specifically applicable for wireless networks
- avoid collision before it happens

1. Apply any one of the three persistence method (sensing)
2. Interframed space (IFS)



Ifs is a time interval used to avoid collision
we wait for IFS time, even if the channel is idle we don't transmit immediately, we wait for IFS

3. Contention windows: (Backoff method)

K=2.
{0,1,2,3}
↑ Random selection
now wait for 2 time slots (contension window) and then transmit blindly

Contention window is an amount of time divided into slots. A station that is ready to send chooses a Random number of slots as its waiting time

4. Transmit & receive & wait for acknowledgment.
- positive ack and timeout timer help guarantee that the receiver has received the frame.

CSMA/CD is implemented by IEEE 802.3 ethernet LAN
CSMA/CA is applicable on WIRELESS LAN
IEEE 802.11

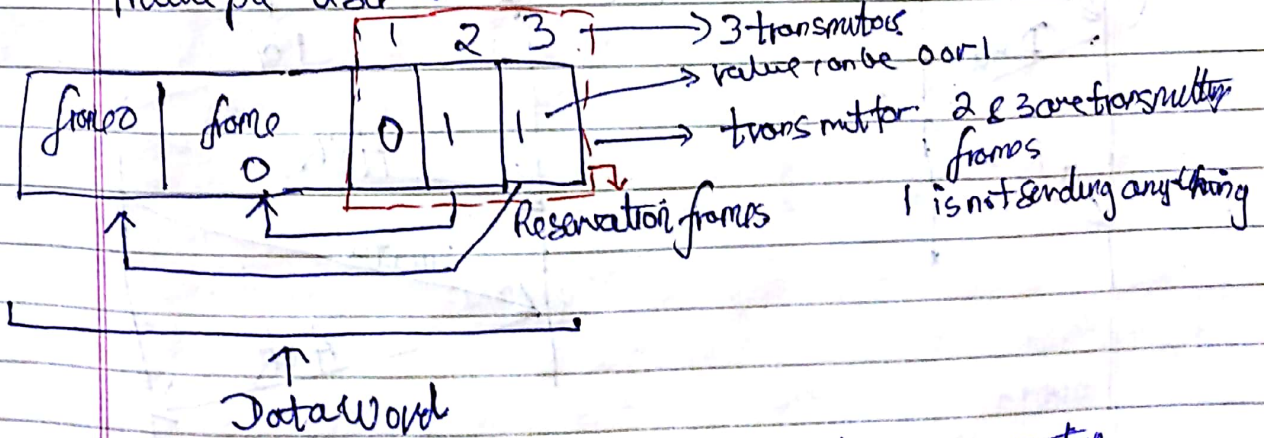
• Controlled ACCESS Protocols:

→ 3 methods
1. Reservation
2. Polling
3. Token passing

→ In controlled Access, stations consult one another to find which station has the right to send. A station cannot send until it is authorized by other's.

1. Reservation Access Method

- identifying the sequence of frames transmitted by multiple user's



→ In reservation method, a station needs to make a reservation before sending data. Reservation frames precede data frames in each interval

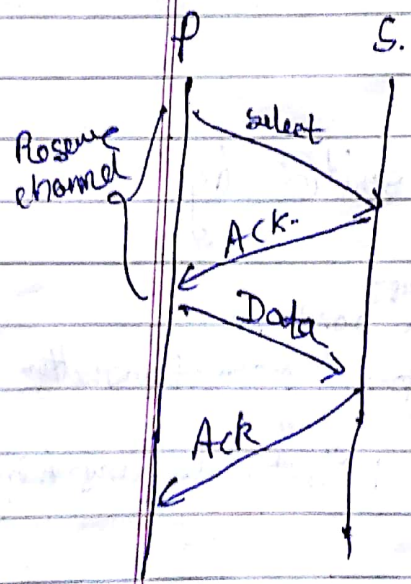
plot slide 24 example → 5 stations, ∴ 5 mini slots inside the reservation frame
in first interval station 1, 3, 4 have reservation. In second interval only station 1 has reservation.

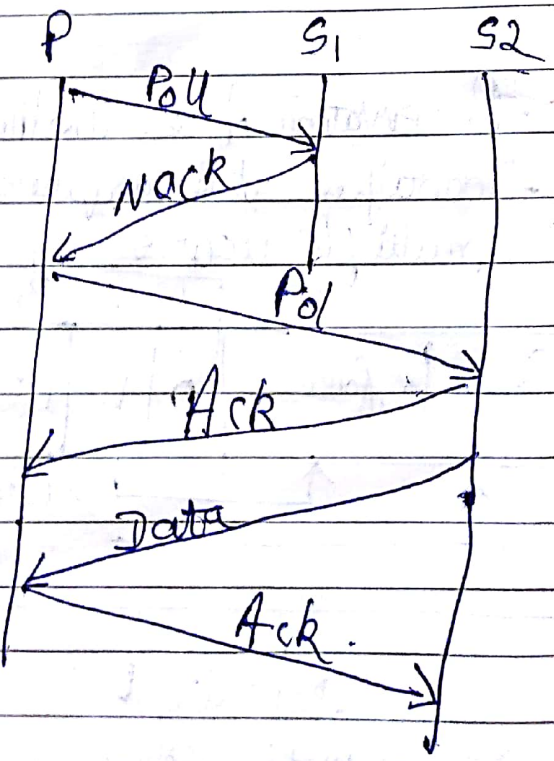
→ It is network specific can't be used everywhere.

2. Polling Protocol (has 2 functions)
→ for topologies with one device as primary device and others as secondary device
→ All data exchanges must be made through primary device.

Select
- function is used when primary device needs to send the data.
- select & Ack signal is used to reserve the channel

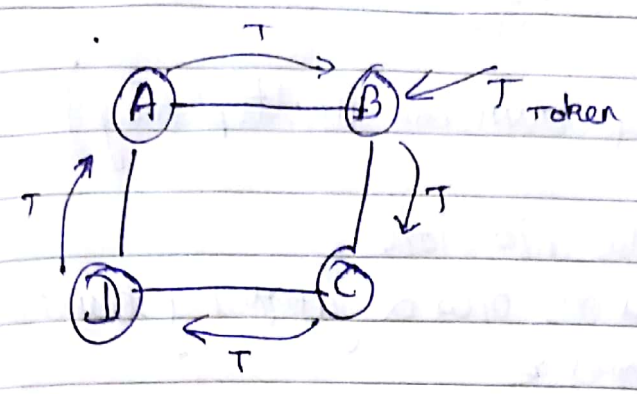
Poll
- function is used when primary device wants to receive data.
- Ask each & every secondary device if they want to send any data
- -ve ack means no
+ve ack means yes and then receive data





→ Draw back
If Primary device fails then system fails.

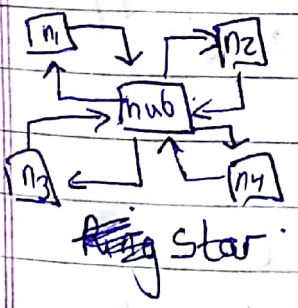
3. Token Passing Protocol:



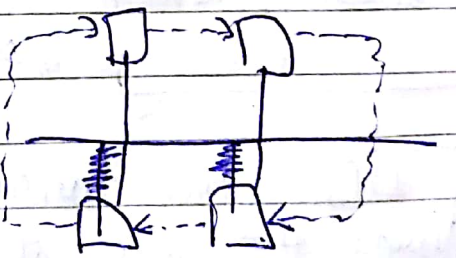
token is allocated to B. it sends some data for a very short while and then B passes the token to C. data C transmits for a short time and then token is passed to D.

- Token is the controller to govern communication.
- The network is organised in a logical ring. For each station there is a predecessor and a successor in the ring. The current station has the right to access the channel as it holds a special packet called Token which circulates through the ring.
- when station has data to send, it waits for the token to come to it

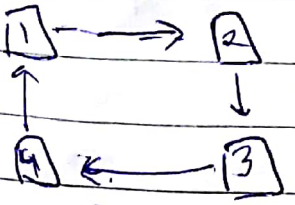
Q. Is star topology can implement token passing protocol?
yes



Star



Bus.



Ring

is a multiple access method in which available bandwidth of a link is shared in time, frequency or code among different stations

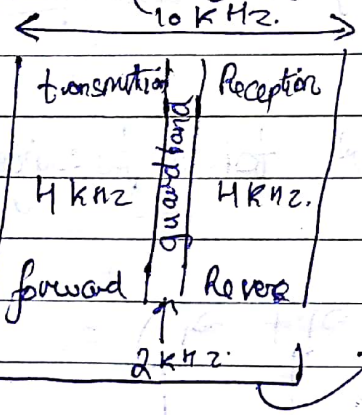
- Channelization
  - FDMA
  - TDMA
  - CDMA

Multiplexing

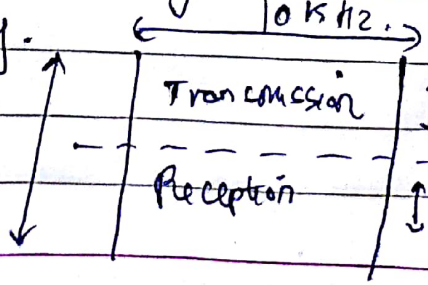
1. FDM (frequency division Multiplexing)
   - frequency is divided into slots
   - we use guard bands b/w 2 frequency bands. to avoid interference
   - A single subband can be use TDD or FDD for communication
2. TDM (Time division Multiplexing)
   - is a digital process that allows several connection's to share high bandwidth of a link. They share time. There is no division of BW
   - each connection occupies a portion of time

Duplexing

1. FDD (frequency division duplexing)
   - A single frequency band is divided into a forward channel and reverse channel



2. TDD (time division duplexing)
   - divide the time slot into forward time slot & Reverse time slot for transmission & reception respectively.



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* - Bandwidth of TDD is more as full channel bandwidth is used. only time division is there
* - Synchronus transmission is given by FDD as no waiting. ~~In FDD~~ In TDD you have to wait as alternate transmit & receive takes place.

FDMA
TDMA
→ for Allocation

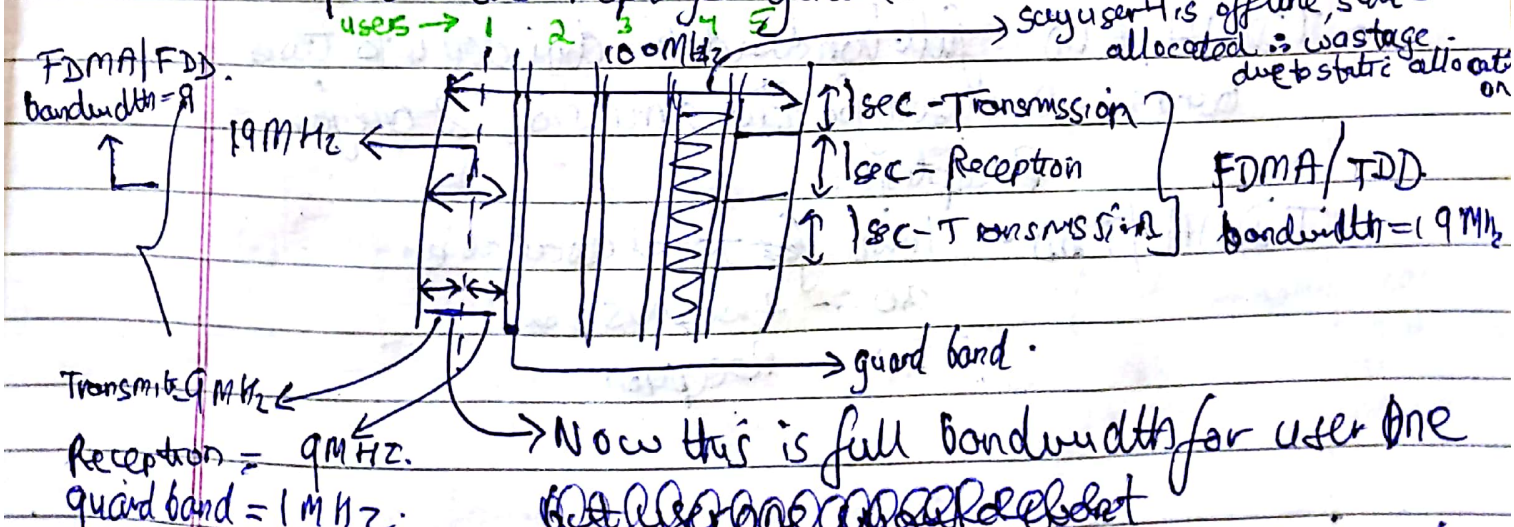
wastage of Bw in FDD → guard band.

FDM - physical layer concept where actual signal is generated
FDMA is ~~in data link layer~~ is access method in Data Link Layer

3 Types of Channelization

1. FDMA (Frequency Division Multiple Access)

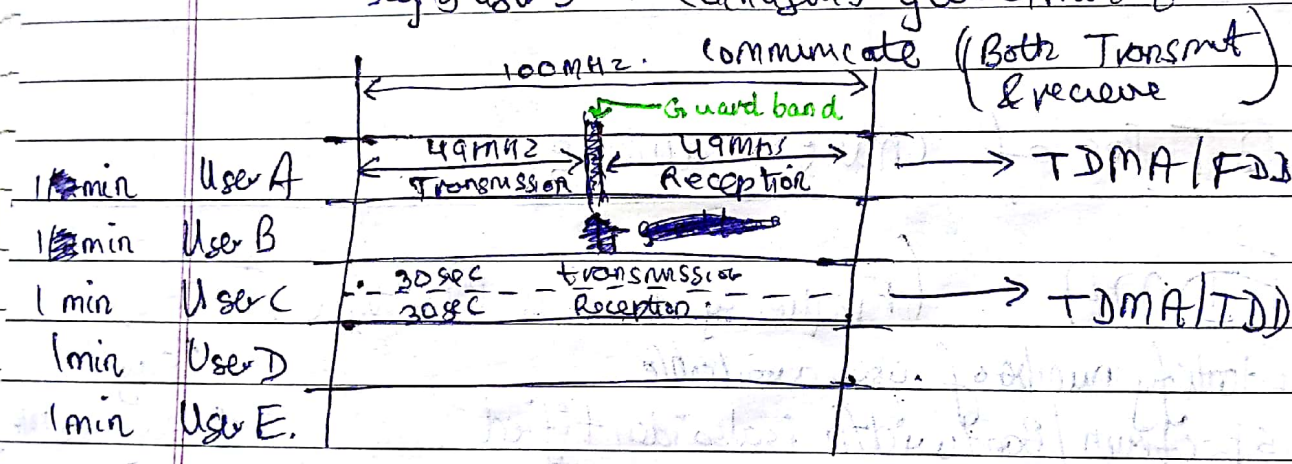
- Identify number of users available. // say 5
- spectrum / Bandwidth is also identified. // say 100 MHz
- divide given frequency band into the number of users and each user is assigned a band.
- Some part is also kept for guard band.



there is
- static division of frequency, based on number of users
- wastage of Bandwidth.
- All users will get their dedicated frequecy band.

2. TDMA (Time Division Multiple Access)

- Superframe of limited time
  say 1 hr
  say 5 user's - each user is given 1 min to communicate (Both Transmit & receive)



- each user is given full bandwidth for 1 min

- TDMA/FDD - full bandwidth is divided into two bands - One used for transmission & one for Reception.
- TDMA/TDD - 1 min for total available
  30 s - transmission
  30 s - Reception

channel occupies entire BW

CDMA differs from TDMA as all stations can send data simultaneously; there is no time sharing.

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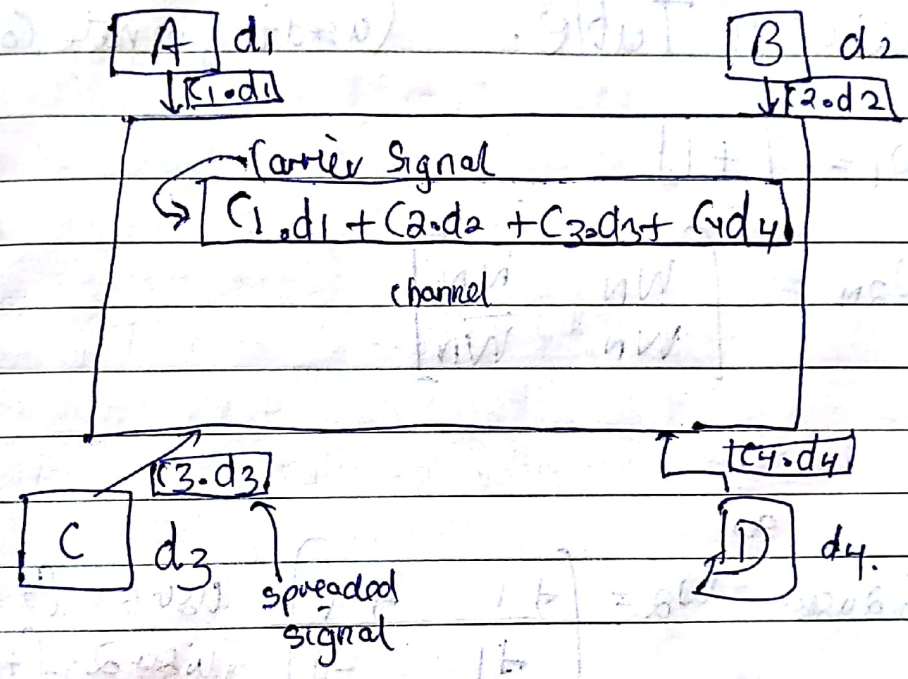
3. CDMA (Code Division Multiple Access)

- is a part of DSSS
- code the data in such a way that no one understands, then multiplex and send
- DSSS (Direct spread spectrum scheme)
  - CDMA
  - FHMA

* - one channel carries all transmission's simultaneously



d - data
C - code/language

- say $A \xrightarrow{d_1} D$
  - D receives full carrier signal.
  - D must know A's code (i.e. transmitter code/language)

* Properties of code used in CDMA

1. Auto correlation
   $C_i \cdot C_i$ = High Value
   CDMA Rake Receiver does this multiplication.
   (means we will be able to get data as this high value can be differentiated from data)
2. Cross correlation
   $C_i \cdot C_j = 0$ (neutralization of others data)

- Receiving at 1) → $(d_1c_1 + d_2c_2 + d_3c_3 + d_4c_4)$

→ Sender was A ∴ multiply by c_1.

→ $(d_1c_1 + d_2c_2 + d_3c_3 + d_4c_4) \cdot c_1$

$= d_1 + d_2c_2c_1 + d_3c_3c_1 + d_4c_4c_1$

✓ × × ×

* Walsh Table. (used to generate Code for CDMA)

Representation

Bit 0 → -1

Bit 1 → 1

Silence of user is treated as 0

- $W_1 = [+1]$

- $W_{2N} = \begin{bmatrix} W_N & W_N \\ W_N & \overline{W_N} \end{bmatrix}$

so

for 2 users $W_2 = \begin{bmatrix} +1 & +1 \\ +1 & -1 \end{bmatrix}$ user 1 [+1 +1]

user 2 - [+1 -1].

for 4 users can be calculated only using W_2.

$W_4 = \begin{bmatrix} +1 & +1 & +1 & +1 \\ +1 & -1 & +1 & -1 \\ +1 & +1 & -1 & -1 \\ +1 & -1 & -1 & +1 \end{bmatrix}$

User 1 c_1

User 2 c_2

User 3 c_3

User 4 c_4

User 1 = [+1 +1 +1 +1]

$d_1 = -1$. ie sending bit 0

$d_1 \cdot c_1 = [-1 \ -1 \ -1 \ -1]$

Example

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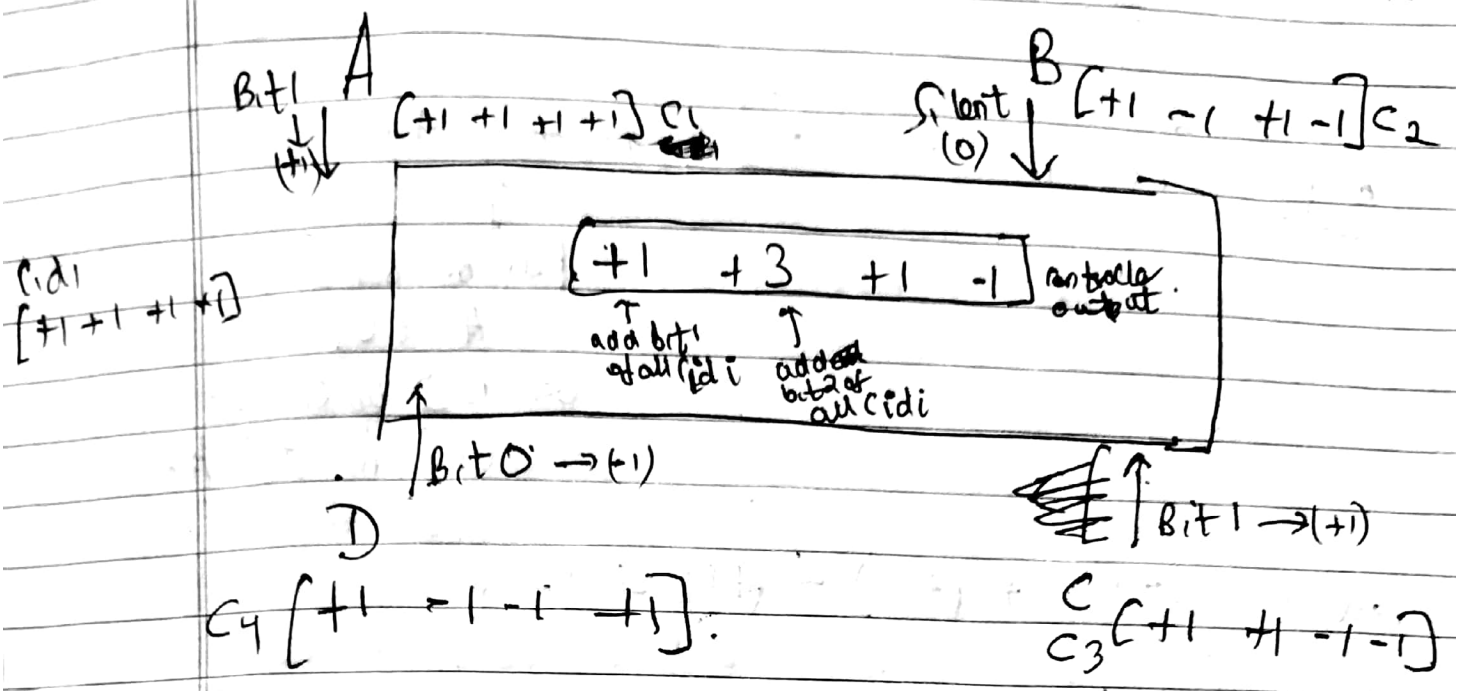
Cada = [0 0 0 0]



C4d4 = [-1 +1 +1 -1]

C3d3 = [+1 +1 -1 -1]

* Components
- CDMA transmitter
job is to multiply data with code.

- CDMA controller
input is all spreaded data from all users.
combine all signals

* Before transmission a handshake must take b/w sender & receiver to exchange the keys.
- CDMA Reciever
A → D
say Reciever is D
Recieved signal [+1 +3 +1 -1] → This is Recieved by all nodes

for D calculate sop.

step1 $[+1 \quad +3 \quad +1 \quad -1] \cdot [+1 \quad +1 \quad +1 \quad +1]$

↑

Key or code of A i.e C_1 which D exchanged during handshake

step2 $= (+1) + (+3) + (+1) + (-1)$

$= +4.$

step3 Now divide the output by number of users. (only for walsh table Method)

$\Rightarrow +4/4 = (+1)$

mean high voltage.

$\therefore$ Recieved bit is 1

example 2

for [redacted].

D → 0 → B.

$[+1 \quad +3 \quad +1 \quad -1] \cdot [+1 \quad +1 \quad +1 \quad +1]$ → C4

= [redacted]

$= (+1) + (+3) + (-1) + (-1)$

$= (-4)$.

$-4/4 = -1$

means low voltage.

∴ Received bit is 0

book pg 351
2 numericals

WIRELESS LAN

- protocols used is CSMA/CA.
- IEEE has defined specifications for a wireless LAN called IEEE 802.11 which covers physical and data link layers

- There are 2 types of service sets

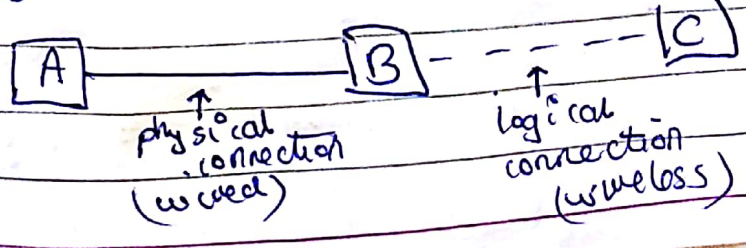
1. BSS: Basic Service Set
   - AP: access point

   Category 1 BSS without AP eg Bluetooth.
   Category 2 BSS with AP. eg Router, cellular network

   - IEEE 802.11 defines BSS as building blocks of a wireless LAN
   - It is made up of a stationary or mobile wireless station and an optional base station called as Access Point (AP)
   - A BSS without AP is a standalone network. It cannot send data to other BSS. It is called adhoc architective
     A BSS with AP is called infrastructure BSS.

2. ESS (Extented service set).
   - many BSS are included ESS (2 or more BSS with AP's)
   - AP redirect request to one which is connected to server
   - BSS 's are connected through distributed system. (controller distributed systems)

So we need protocols we use CSMA/CA



hidden terminal problem

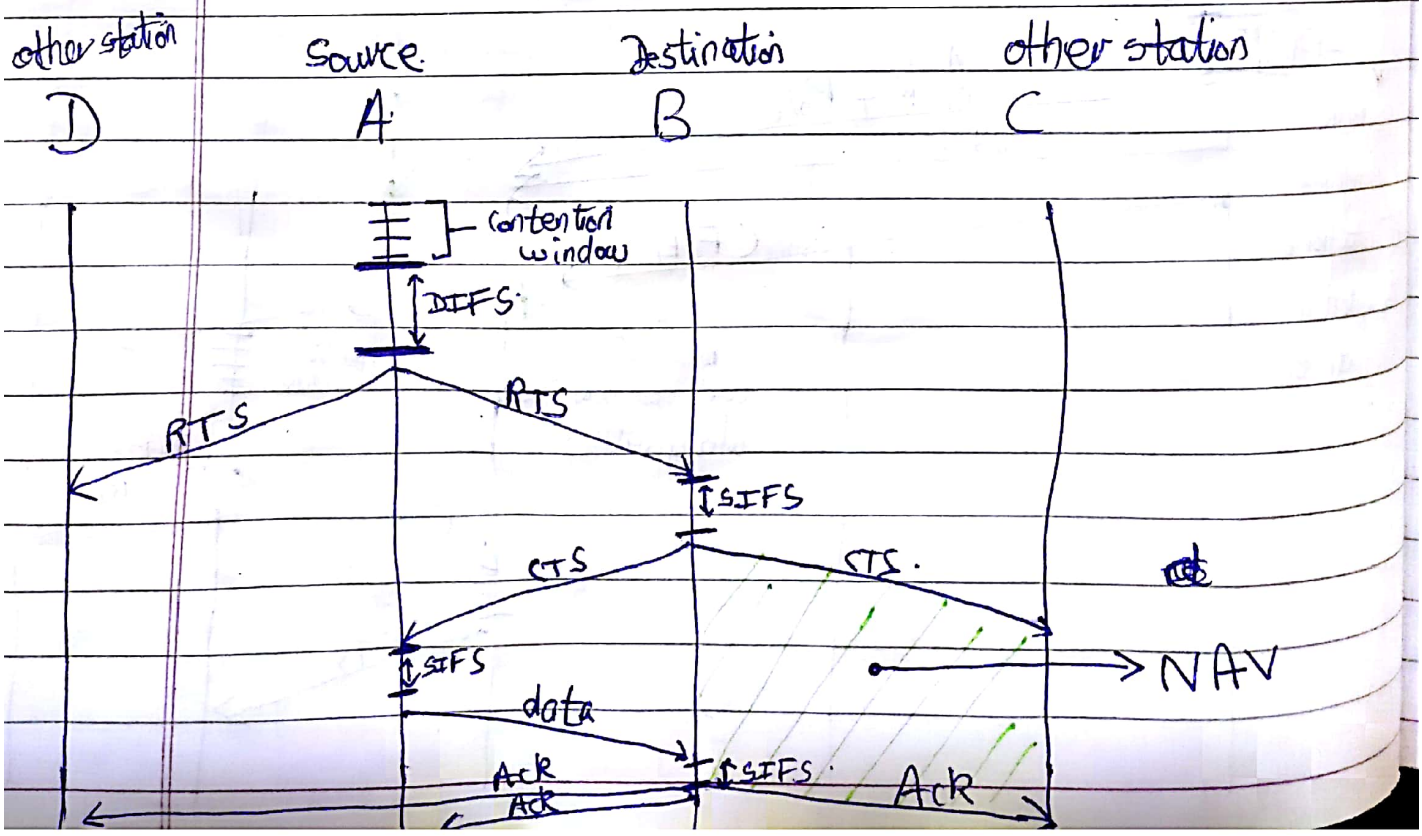
A & B are communicating but C does not know. If no multiple access protocol is used then collision will occur at B

Data link layer ← MAC ← PCF / DCF
LLC

MAC sublayers:
1. DCF
2. PCF

1. DCF (Distributed coordination function)

- uses CSMA/CA as access method
- Before sending frame, source senses the medium
  (a) channel uses persistence strategy with back off until channel is idle.
  (b) After station is found idle, the station waits for a period of time called DIFS (distributed inter frame space) then it sends a control frame called (Request to send) RTS.
- After receiving RTS and waiting for SIFS (short inter frame space) the destination sends a control frame called Clear to send (CTS) to source. It indicates that destination is ready to recieve
- Source sends data after waiting for SIFS time.
- destination after waiting for SIFS time sends ack.



SIFS → constant time interval

DIFS → SIFS + 2 * slot time

- RTS is sent to all neighbours, informing them that a comm is going to take place. There after all other stations do not transmit or recieve.
- CTS is also sent to all neighbours.
- other stations do not perform any communication until sender and they themselves recieve acknowledgement.
- Contension Window

  Let K=3 Range { 0, 1, 2, 3, 4, 5, 6, 7 }

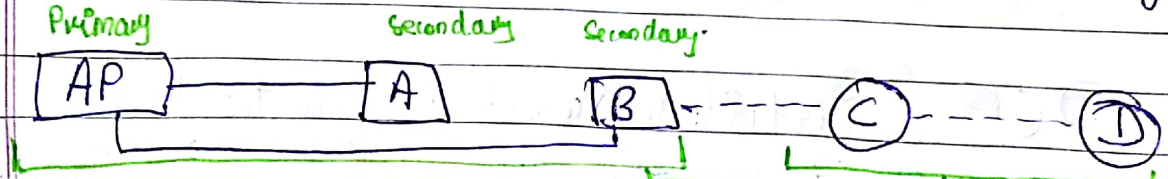
  ↑ say I choose 4.

  means transmitter waits for 4 time slots.
- NAV (network allocation vector)

  when station sends an RTS frame, it includes duration of time that it needs to occupy the channel. The station's that are affected by this transmission creates a timer called NAV that shows how much time must pass before these station's are allowed to check channel for idleness.

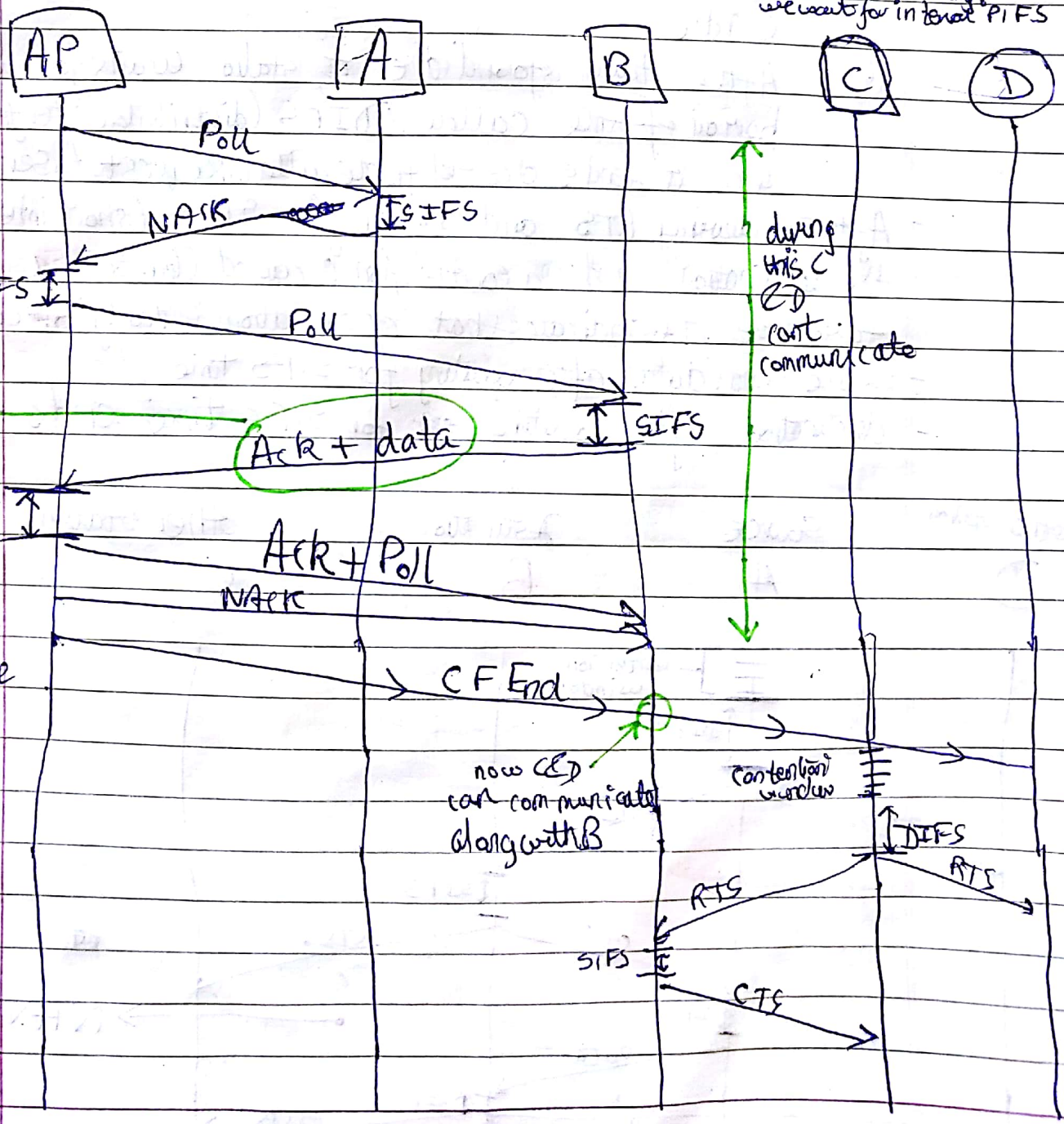
2. PCF (Point Coordination Function)

- It is an optional access method that can be implemented only in infrastructure network. It is implemented on top of DCF.



A & B are physically connected to AP
C & D form a Adhoc network.

2 diff types of communication, so we need switching we account for interval PIFS



- AP performs polling for station's that are capable of being polled stations are polled one after another, sending any data they have to AP.
- To give priority to PCF over DCF, interframe space PIFS (PCF IFS) is defined. PIFS is shorter than DIFS.
- If at same time station wants to use only DCF and an AP wants to use PCF, then the AP has the priority.
- To manage b/w PCF & DCF we use Beacon & CFend signals (frames)
- B: Beacon frame signal
  CF: contention free end frame signal.
- Adhoc network is wireless (can do only DCF) ie C & D.
- CFend - means contention free slot ended ie closing PCF so now we can switch to DCF mode.
- PIFS = SIFS + slot time