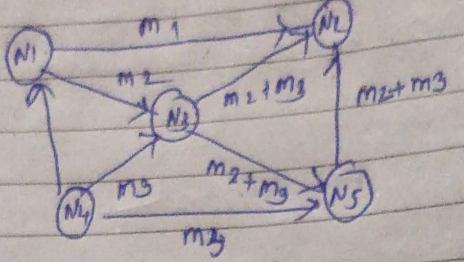
Performance Analysis Issues.

① Network Coding, basic hamming code, Interference suppression & power control, MAC layer scheduling & connection admission in mobile Commⁿ

(*) Introduction to Network Coding:



- In a Communication network there are nodes & links / facilities connecting these nodes.
- The node is capable of accepting the information replicating it & transmitting it to any other connected to it.
- Network coding is a networking technique where operations, which is practice tend to be algebric algorithms are performed on data
- In above fig. N1, N2, N3, N4, N5 are nodes & m1, m2, m3 are message.

* Types of Network Codes
  1. Linear block codes
  2. Convolutional codes.

- Linear Block codes would segment a message into several fixed length blocks and encode each block one by one for transmission
- The convolutional codes would encode the entire data stream into one long code word but transmit it in the form of smaller blocks of data.

* Basic Hamming Code:

— Hamming code is a linear block code.
It is an error correcting code.

Code-word

Data bits | parity bits

$$\text{Code rate } (r) = \frac{K}{n} = \frac{\text{number of message bits}}{\text{total number of bits in a code word.}}$$

Hamming weight of a Codeword (w(x)):
The Hamming weight of a codeword x is defined as the number of non zero elements in the codeword.

Code efficiency:
The code efficiency is defined as the ratio of message bits to the number of transmitted bit per block.

$$\text{Code efficiency} = \text{Code rate} = \frac{K}{n}$$

Hamming distance:
The Hamming distance or simply distance between the two codeword is defined as the number of locations in which their respective element differ.

Code word 1 → 1 1 0 1

Code word 2 → 1 0 1 0

So Hamming distance is 3

- 7 bit Hamming Code is used Commonly but Concept Can be extended to any number of bits

D_7	D_6	D_5	P_4	D_3	P_2	P_1

← 7 bits Hamming Code

D_{15}	D_{14}	D_{13}	D_{12}	D_{11}	D_{10}	D_9	P_8	D_7	D_6	D_5	P_4	D_3	P_2	P_1

↑ 15 bits Hamming code

Parity Bit	Bits to be checked
P_1	1, 3, 5, 7, 9, 11, 13, 15
P_2	2, 3, 6, 7, 10, 11, 14, 15
P_4	4, 5, 6, 7, 12, 13, 14, 15
P_8	8, 9, 10, 11, 12, 13, 14, 15

eg. A bit word 1011 is to be transmitted Construct the even parity Seven-bit Hamming code for this data.

→

D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	1		1		

↑ To be decided.

So for P_1 we have to check bit 3, 5, 7

D_7 D_5 D_3 = 1 1 1 so there is three ones order to even parity we set $P_1 = 1$

D7	D6	D5	P4	D3	P2	P1
1	0	1		1		1

for $P_2 \rightarrow$ check. 3, 6, 7

D7 D6 D3 = 1 0 1.

So we have to make even parity so

set P2 to 0

D7	D6	D5	P4	D3	P2	P1
1	0	1		1	0	1

P2

P4 we have to check 5, 6, 7

D7 D6 D5 = 1 0 1

So P4 = 0

D7	D6	D5	P4	P3	P2	P1
1	0	1	0	1	0	1

So final codeword is 1 0 1 0 1 0 1

(Q9) Encode the data bits 0101 into seven bit even parity Hamming code.

eq. Compute the Hamming Code for the data 1001101

→

D7	D6	D5	P4	D3	P2	P1
1	0	0	1	1	0	1

so check P1 → 1, 3, 5, 7

7 5 3 1 → 1 0 1 1

* Detection & Correction of errors.

(eq) if the 7 bit Hamming Code word received by a receiver is 1011011. Assuming the even parity state whether the received code word is correct or wrong. if wrong, locate the bit in error.

→

D7	D6	D5	P4	D3	P2	P1
1	0	1	1	0	1	1

Analyze bits 4, 5, 6, 7

P4 D5 D6 D7 → 1 1 0 1 → odd parity

so it should be P4 = 0 for even parity
so error present

P2 D3 D6 D7 = 1 0 0 1 → Even parity

~~P2 is ok. no error~~
so P2 = 0 in the 2's position

P1 D3 D5 D7 = 1011 odd parity
so error present

Write the error word

P_4	P_2	P_1

3'rd 2'nd 1's position

$E = 1\ 0\ 1$

$= (5)_{10}$

Hence bit 5 of the transmitted codeword is in error

D_7	D_6	D_5	P_4	D_3	P_2	P_1
1	0	1	1	0	1	1

↑ error bit / Incorrect bit

⇓

1 0 0 1 0 1 1 ← correct codeword.

eg. 1110101

1101 1110 1010 110

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Interference Suppression & power Control

- we need to Control the transmission power of each user. There are two ways to control the transmission power
1. open-loop Control Power
2. Closed loop Control power

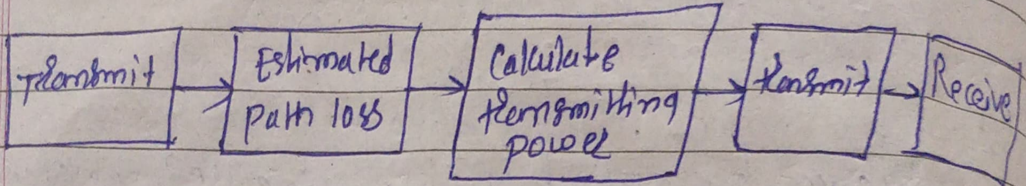

fig (a) open loop power Control

- The mobile sends it's first access probe then waits for a response from the base station.
- If it receives no response, then the second access probe is sent with a higher power.
- The process is repeated until the base station responds.
- If signal answered by the base station is high, then the mobile gets connected with base station which is closer to the mobile cell low transmission power.
- Similarly if the signal is weak, the mobile knows the path loss is greater and transmits high power.
- This is called as open loop power Control.

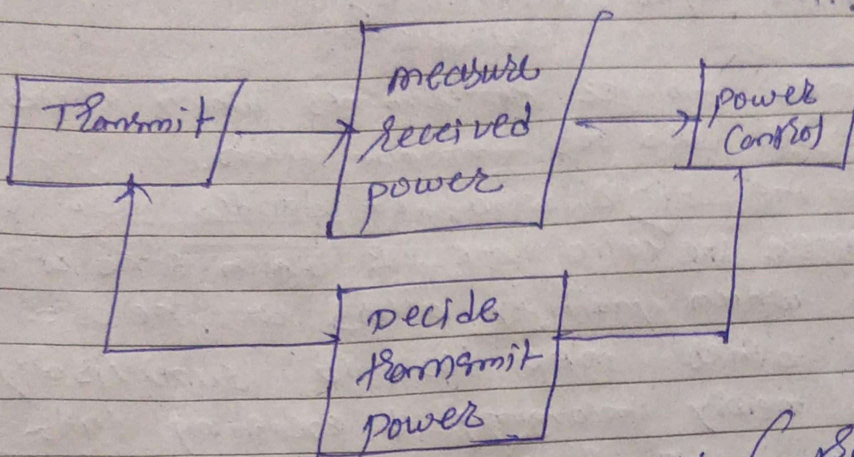

fig. (b) closed loop power control.

- The mobile transmit power is controlled by the base station.
- for this purpose, the base station continuously monitors the reverse link signal quality.
- If the quantity of the connection is low it tells the base station controller to increase its power and if the quality of the connection is very high, the mobile reduces it's power.

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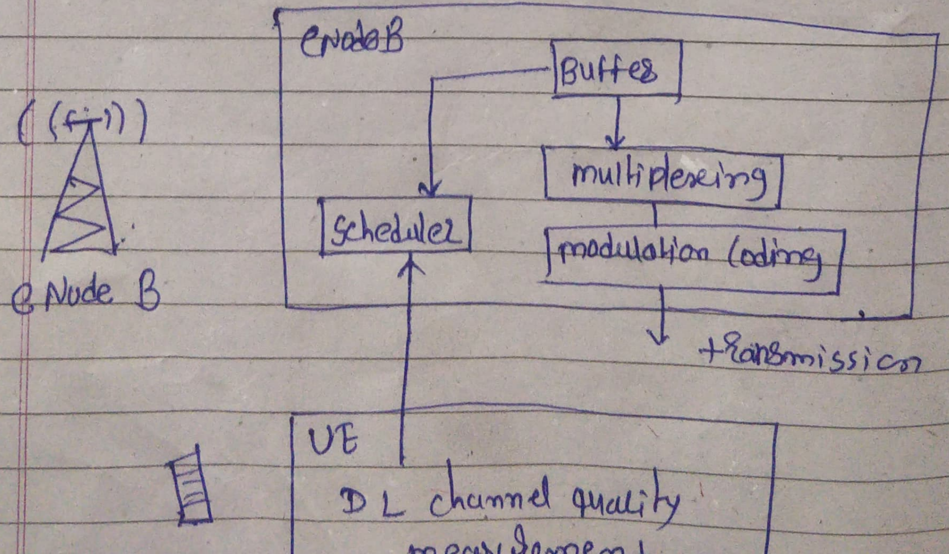
* MAC layer scheduling:

- MAC sublayer determines which access method will be used for communication.
- In the other word, it decides how to communicate through the radio link i.e. which kind of duplex and which multiply access will be used.
- The other MAC task is supervisory over the newly incoming & existing calls.
- This is the role of call admission control (CAC) algorithms.
- Data transmission between mobile terminal & base station is often denoted as
  1. Up link - from mobile terminal to base station
  2. Dow link - from base station to mobile terminal
- MAC protocol is usually used in case of up-link.

- The physical layer, the MAC scheduler assigns bandwidth to user equipment & is responsible for deciding on how uplink & down link channel are used by the eNode B & UEs of a cell.
- It also enforces the necessary Quality of service for UE connections.



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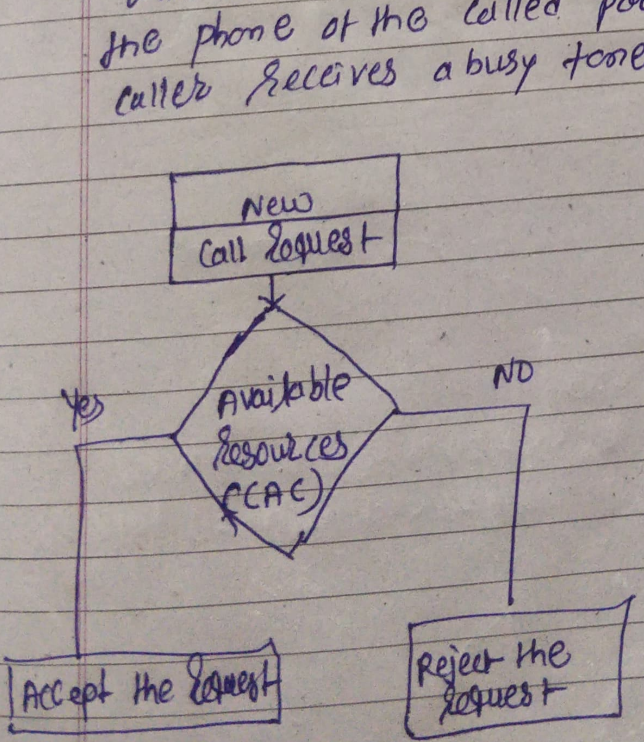
(*) Connection Admission in mobile Communication

- Connection Admission Control (CAC) is the process that decides which connection requests are admitted to the system & allocated resources.
- ~~Cont~~ CAC is a technique to provide quality of service (QoS) in a network by restricting the access to network resources. This can be done using MAC layer scheduling.
- An Admission Control mechanism accepts a new call request provided there are adequate free resources to meet the QoS requirements of the new call.
- Use CAC to regulate voice quality over a WAN link
- voice quality can degrade when too many active calls exist on a link & the amount of bandwidth is oversubscribed.
- CAC regulates voice quality by limiting the number of calls that can be active at the same time on a particular link.
- CAC operates by rejecting a call for bandwidth and policy reasons.
- when a call is rejected due to call admission control the phone of the called party does not ring, & the caller receives a busy tone.



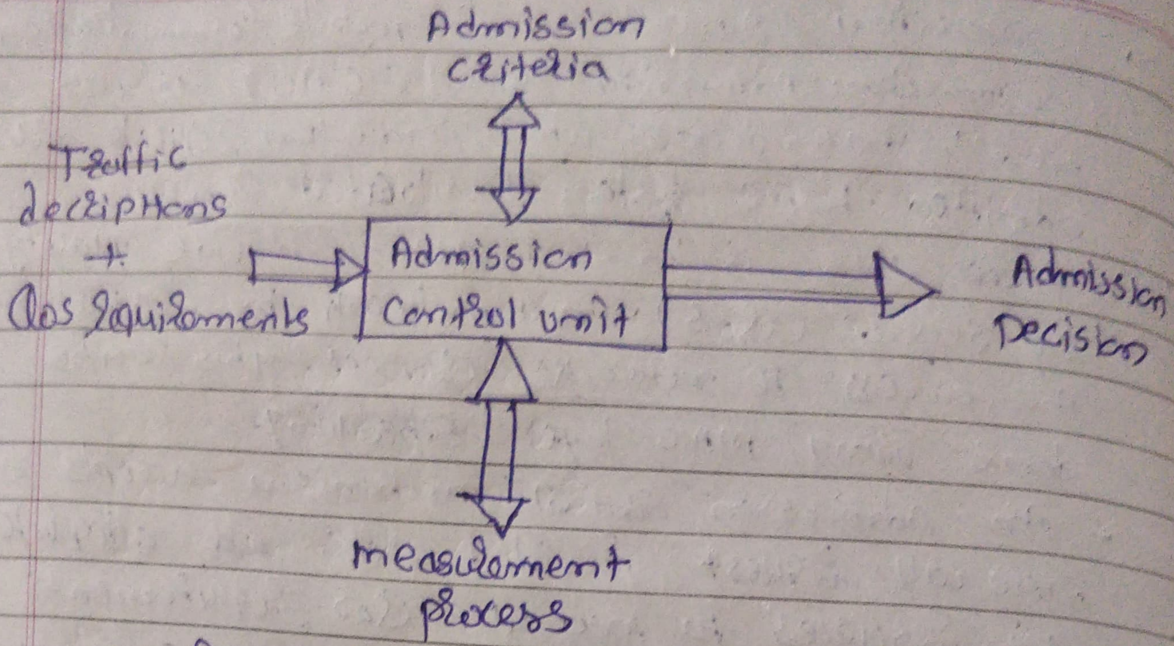


fig. Admission Control Decision