Prof: Kalmesh. M. Wadeshatti

Karnatak Law Society's

Vishwanathrao Deshpande Institute of Technology, Haliyal - 581 329

Department of Electronics & Communication Engg.

Sub:WC and LTE Broadband **Max marks:100**

Sub Code:17EC81 **Sem/Div: 8 (A & B)**

Note: Answer any one question from each module. Each Question carries equal Marks

PART A

Module 1

1. a). Briefly Explain the IP based flat network Architecture. 10M

   b). Describe the TDL for broadband wireless channel. 10M

OR

2. a). What is frequency Reuse? Explain the Reuse of f=1/7. 10M

   b). What is coding and interleaving? Explain the convolutional encoder used in BCH. 10M

Module 2

3. a). What is cyclic prefix? Explain importance of cyclic prefix in OFDM. 10M

   b). Briefly Explain the OFDM operation with block diagram. 10M

OR

4. a). What is timing synchronization? Explain Timing synchronization. 10M

   b). Briefly explain the design considerations of SC-FDE and OFDM. 10M

PART B

Module 3

5. a). Explain Transport channel and Physical channel. 10M

   b). What is physical resource block? Explain it for OFDMA. 10M

OR

6. a). Write a short note on MIMO modes. 10M

   b). What is sub block interleaving? Explain the rate matching. 10M

Module 4

7. a). Explain Resource mapping of demodulation reference signals. 10M

   b). Describe the H-ARQ in the Uplink with the different modes. 10M

OR

8. a). Briefly explain cell search process. 10M

   b). How the Power control in Uplink for UEs? Explain. 10M

Head of the Department
Dept. of Electronic & Communication Engg.
KLS V.D.I.T., HALIYAL (U.K.)

Module 5

9. a). Explain EPS bearer service with architecture. 10M

b). Briefly explain the PDU header and formats for RLC. 10M

OR

10. a). What are the functions of RRC? Explain the RRC states. 10M

b). What is the default mode of mobility management? Explain the mobility management over X2 interface. 10M

WC&LTE 4G Broadband _ 17EC81

Scheme & Solution

Q1
a IP based flat network Architecture.

LTE is flat radio and core network architectur Flat means fewer nodes and less hierarchical structure for the network. Lower cost and low latency are the designed requirements and it also fewer interface and protocol related processing, reduced interoperability testing. Fewer nod allows the better optimization of radio interfac The 3GPP network architecture is shown in fig which has four network elements in the data path: the base station or Node-B, Radio network controller (RNC), serving GPRS service node (SGS and gateway GPRS service node.

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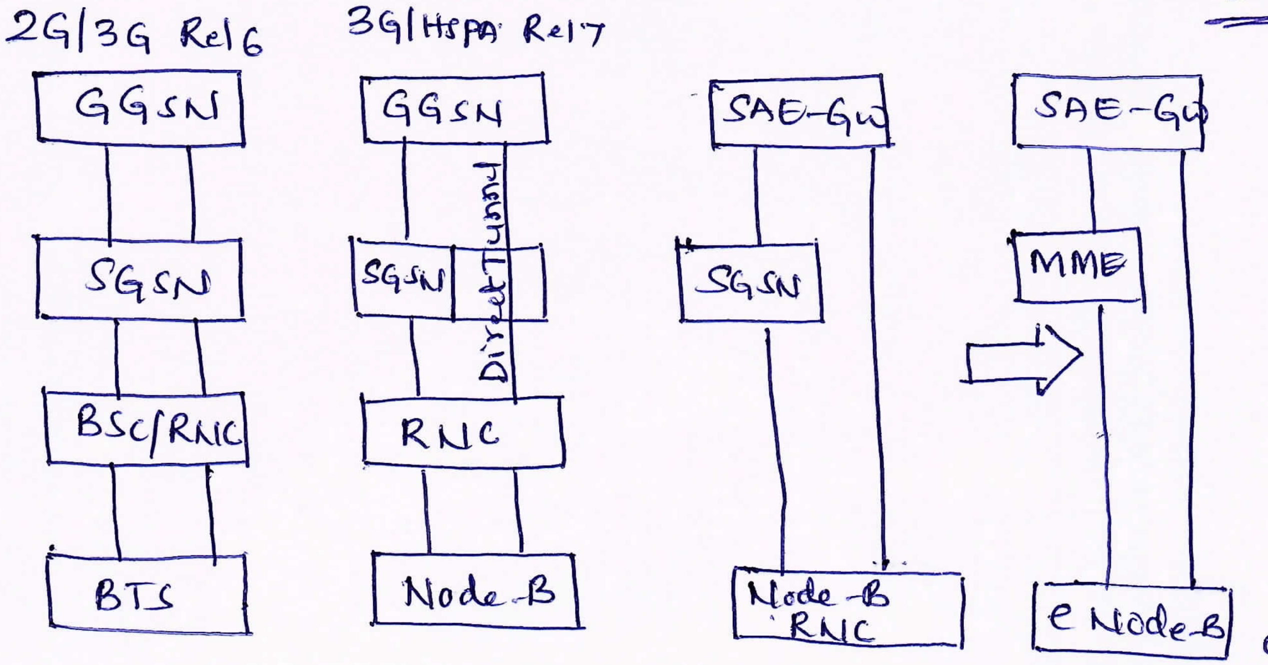

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Release 7 introduce direct tunneling option from RNC
to GGSN. LTE will have only two network elem
in the data path, the enhanced node-B or eNode-B
and System Architecture evolution gateway (SAE-
The Control Path includes the functional entity call
Mobility Management Entity (MME) which provi
mobility and session management

The LTE flat architecture is that all services
including voice, supported IP packet networking
LTE envisions evolved packet switched core (EP
over which all the services are supported
LTE has been designed for IP services with flat
architecture due to backward compatibility, non IP
aspects of the 3GPP, GPRS tunneling protocol and
PDCP (packet data Convergence protocol) exists
within the LTE network architecture 04M

Q1

b Time delay tap line (TDL) for broad band wir
less channel. The channel model for the broad band wireless channel undergo path loss and shadowing and it is described by the TDL

$$h[k,t] = h_0\delta[k,t] + h\delta[k-1,t] + \cdots + h_v\delta[k-v,t]$$

The discrete time channel is time varying with respect to t and has a non negligible span of V+1 channel taps. the channel is sampled at a frequency $f_s = 1/T$, where T is the symbo period and duration of the channel is vT. The V+1 sampled values are over a period of (V+1) seconds. The o/p of channel is described.

$$Y[k,t] = \sum_{j=-\infty}^{\infty} h[j,t]\,x[k-j]$$

$$\triangleq h[k,t] * x[k]$$

x[k] is the input sequence of data with rate 1/T. The channel can be represented as a time varying (V+1)×1 vector

$$h(t) = [h_0(t), h_1(t) \cdots h_v(t)]^T$$

06M

Tap delay model is general and accurate.

The design attributes of the channel based on some key communication parameter on h(t) are as follows;

Total received power <u>or</u> the relative value of the hi terms. Number of effects caused the recei ver power vary over long (path loss), mediu shadowing and short (fading) distances.

How quickly does the channel change with th parameter t.?

The channel coherence time specifies the perio of time over which the channel value is corre ated. The coherence time depends on how fas the transmitter and receiver are moving relati to each other.

The approximate value of the channel duration, thus is the delay spread and is measured and approximated based on the propagation distance and environment.

KD4M

Q 29 Frequency reuse.

In cellular system service area is subdivided into smaller geographical area called the cell. and each served by their base station. To minimise the interference between cells the transmitted power just regulated to provi required signal strength at the cell boundarie Therefore different cell allows operation on the same frequency channel at the same tim The same frequency channel can be reassigned to the different cell as long as those cells are specially isolated.

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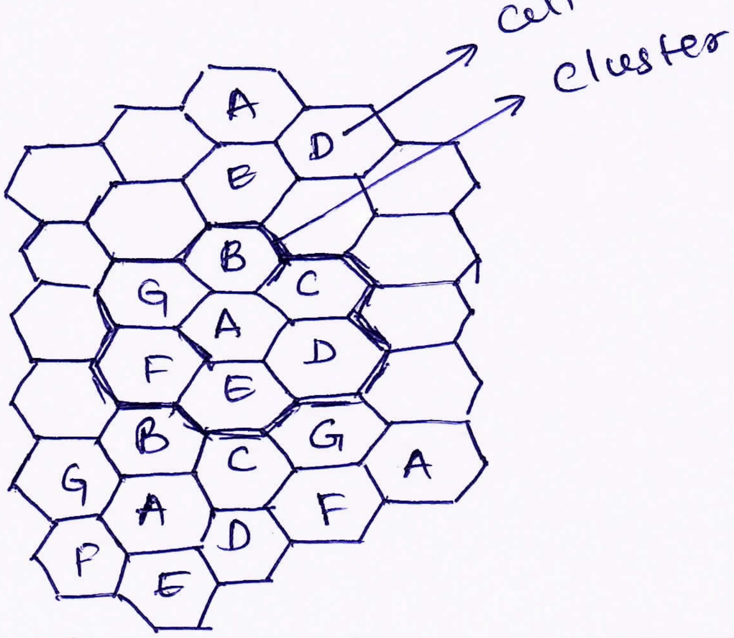
The rate at which the frequencies can be reused should be determined by the interference between base stations is kept to an acceptable level. The frequency planning requirement determine a proper frequency reuse factor, $f \leq 1$ where $f = 1$, All cell reuse all the frequency

$f = 1/3$, Given frequency band is used by only one cell of 3 cells

$f = 1/7$ frequency band used only 1 cell of 7.

The Standard hexagonal Cellular system with 1/7 is shown in below figure 04M



Cells labelled with same letter use the same frequency channel. The cluster is outline in bold and consists of seven cells with different frequency channel. The hexagonal shape of cell is conceptual, it has been wid ely used in the analysis of cellular system. for its simplicity and analytical Convene

Cellular system overall system capacity is increased by making the cells smaller an turning down the power

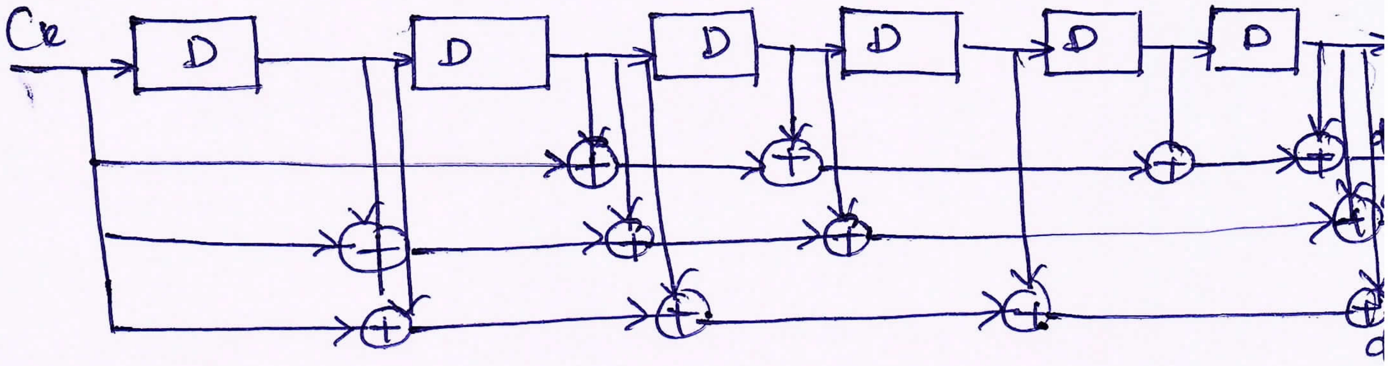
As the cell size decreases the power of each base station also decreases. 04

Q2b Coding and interleaving as a form of time diversity, in multicarrier systems they can capture frequency diversity, it introduces the redundancy at the transmitter to allow the receiver to recover the input signal. The error correction codes (ECC), coding techniques can be categorized by their coding rate $r \leq 1$ for example the output of a rate 1/3 code has three times the original rates, it introduces two redundant bits for every original information bit. the rate 1/3 lowers the transmitted bit rate by a factor of 3, which is data rate multiplied by 1/3 02M

The convolutional encoder defined by LTE for the use in the Broad cast channel (BCH. The rate 1/3 code, there is one input bit (C_k) and three output bits d_k^i. The constraint length of this code is 7 and there are the 6 delay element or 64 possible states. The generator polynomial is G_i and they are denoted in octal notation. Ex $G_0 = 133$, and binary form is 1011011, 0 means the output does not include this tap 1 means it does

It includes modulo 2 summed contribution from the input and delay element, convolutional codes will include in each output the first and last tap, it is shown in below figure

<u>04M</u>



$d_k^0 = G_0 = 133$ (octal) $d_k^1 = G_1 = 171$(o), $d_k^2 = G_2 = 162$(

The rate 1/3 parallel concatenation is called th turbo encoder defined by LTE

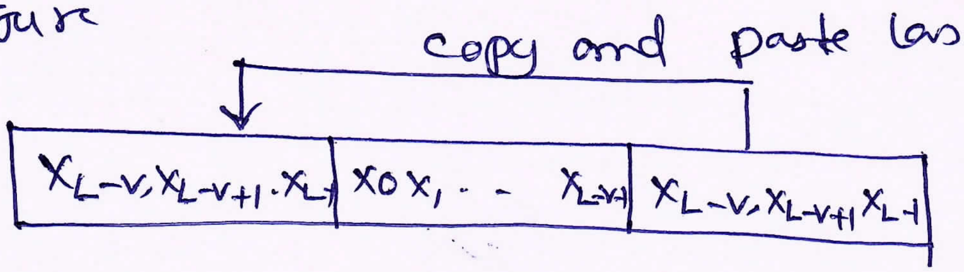
Interleaving is used in both convolutional coding and turb encoding, the interleaver shu ffles the coded bit to provide the robustne to burst error caused by either bursty nois and interference Interleaving makes it very difficult for error correcting decoder to re construct the intended bits

Interleaving spread out the coded bit and deinterleaving is done at the receiver to receiv the frame or block.

<u>04M</u>

Module-2

Q3a cyclic prefix is a technique adding a specific types of redundancy in to the transmitted vector called cyclic prefix. By the circular convolution copy of last v symbols added in between two OFDM symbols that is shown in figure



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For OFDM, it utilizes the FFT algorithm for computing DFT and IFFT algorithm. The FFT reduces the number of required multiplications and additions from $O(L^2)$ to $O(L \log L)$. IFFT operation at the transmitter allows all the subcarriers subcarriers to be created in the digital domain and requires only single radio to be used, rather than L radios. In order for IFFT/FFT to create ISI free channel must appear to provide circular convolution. The cyclic prefix is added to the transmitted signal. This creates $(x(n))_L$

$y(n) = [x(n)] \circledast [h(n)]$

By adding the gaurd band at least v samples between OFDM symbols. OFDM symbol is made independent before and after. The OFDM symbol in time domain as a length L vector given.

$x = [x_1, x_2 . x_3 \ldots x_L]$

After appying the cyclic prefix, the actual transmitted signal

$x_{cp} = [\underbrace{x_{L-v}\ x_{L-v+1}\ x_{L-1},}_{\text{Cyclic prefix}} \underbrace{x_0, x_1, \ldots x_{L-1}}_{\text{original data}}]$

- 01M

The out put $y_{cp} = h \circledast x_{cp}$ where h is the length v+1 vector, Ycp has $(L+v)+(v+1)-1 = L+2v$ samples. First v samples of ycp contains interference from the preceding OFDM symbol and discarded. The last v samples disperse in the subsequent OFDM symbol and is also discarded. This leaves exactly L samples for the desired output y. which is precisely required to receive L data symbols embedded in x

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Q3b OFDM operation with block diagram. The key steps of OFDM Communication system. is shown in figure

① In OFDM is to break the wide band signal of band width B into L narrow band signals (subc rriers) each of bandwidth B/L, each subcar er expriences flat fading, ISI free Communication. The L sub carriers for a given OFDM represented by vector x, which contains L carrou symbols

② use the single wide band radio instead of L independent narrow band radios, the subcarri are created digitally using an IFFT operation,

③ IFFT/FFT to decompose the ISI channel into orthogonal subcarriers, a cyclic prefix of length v must be appended after the IFFT operation the resulting L+V samples. and are sent in serial through the wideband channel the resulting L+V symbols are then sent in serial through the wide band channel.

④ After the receiver the cyclic prefix is discarded and then L received symbols are demodulated by using an IFFT operation, which results in L data symbols, each of the form $Y_l = H_l X_l + N_l$ for sub carrier l.

5. Each sub carrier can be equilized via an FEQ

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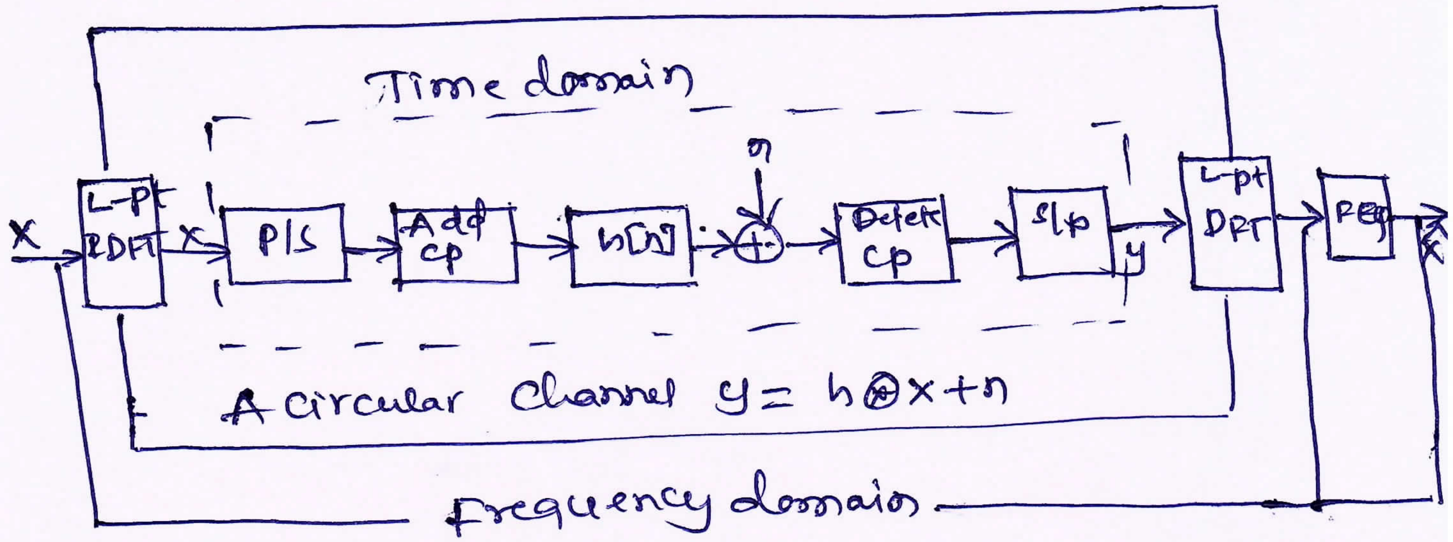


by simply dividing by the complex channel gain H[i] for that sub carrier

04M

$\therefore \hat{X}_l = X_l + N_l / H_l$

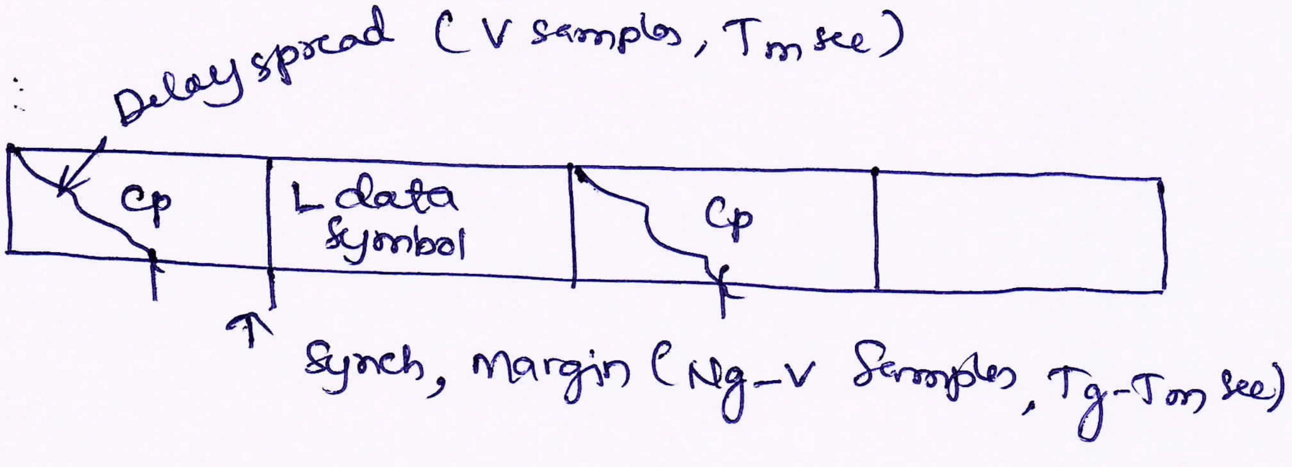
Q4a. Timing synchronization: The timing offset of the symbol and the optimal timing instants need to be determined. This is called as timing synchronization

L time domain samples after the cyclic prefi by the receiver this corresponds to the perfect timing synchronization and If the cyclic prefi length Ng equivalent to the channel impulse response V

02M

Timing offset of τ second without any degra dation $0 \le \tau \le T_g - T_m$, where T_g is gaurd time (cyclic prefix duration) & T_m is the maximum channel delay spread.

$\tau < 0$, Sampling earlier than at the ideal instant
$\tau > 0$, Sampling later than at the ideal instant
Timing offset results in phase shift (exp(-j4 which is fixed for all the sub carrier



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Timing offset within this window $0 \leq \tau \leq T_m - T_g$, Interfymbol interference (ISI). This is for $\tau > 0$ and for $\tau < T_m - T_g$. desired energy is lost as in interference from the preceeding. symbol. The SNR loss can be approximated by

$$\Delta SNR(\tau) = -2\left(\frac{\tau}{LT_s}\right)^2,$$

From the observation

SNR decreases quadratically with the timing offset

Longer OFDM symbol immune from timing offset

more subcarrier helps

$\tau \leq LT_s$. Timing synchronization, the timing error should be kept small compared to the guard interval.

To minimize the SNR loss due to imperfe timing synchronisation, the timing error should be kept small compared to the guard interv and small margin in the cyclic prefix is helpful.

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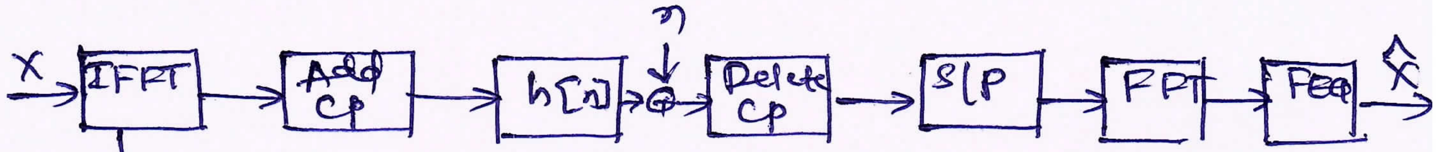
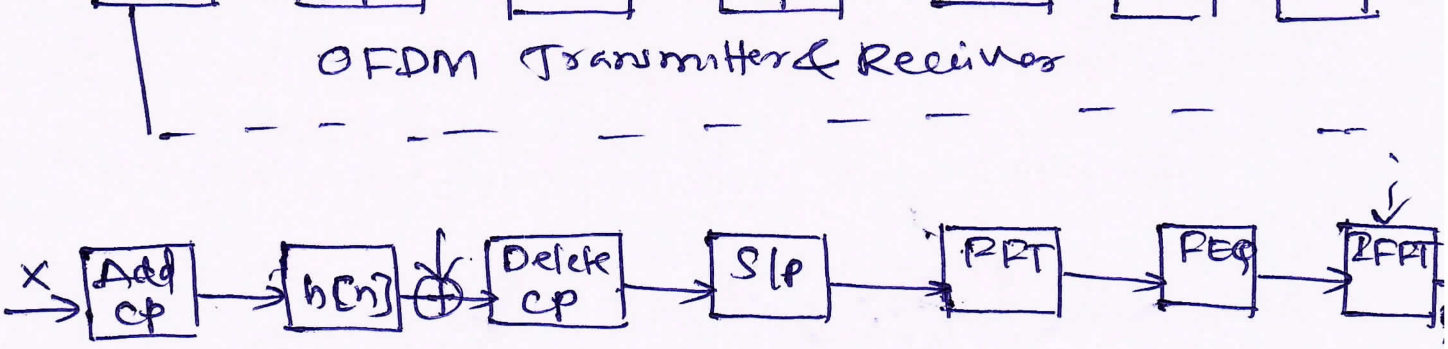
Q'4b Design Consideration of SC-FDE and OFDM.

SC-FDE is single carrier frequency domain equilizer, The alternative approach to the OFD is SC-FDE. SCFDE maintains three importan benefits ① low Complexity ② Excellent BER Pe ormance ③ decoupling of ISI from other types of interference. By SC-FDE peak to average power ratio is reduced (PAPR) and relative to multi Carri modulation

02M



OFDM Transmitter & Receiver



SC-FDE Transmitter and Receiver

The Principle difference is that ~~the~~ IFFT formerly in the transmitter is in the SC-FDE Receiver. SC-FDE utilizes the Cyclic prefix at least as long as the Channel delay spread. Transmitted sequence is QAM symbol, which have the low PAR

04M

SC-FDE receiver an FFT is applied, in SC-FDE operation at receiver in the frequency domain

The received signal appears to be circularly convolved ∴ $y[n] = x[n] \circledast h[n] + w[n]$. where: $w[n]$ is noise

$$FFT\{y[n]\} \triangleq Y[m] = H[m]\,X[m] + W[m].$$

Frequency domain $X[m]$ is not precisely data symbol

OFDM system transmitted time domain signal x[was not the actual data symbol.

1-tap FEQ is applied at the virtual subcarrier

$$\hat{X}[m] = \frac{Y[m]}{H[m]}$$

and is converted back into the time domain using an IFFT operation to give $x[n]$. which are the estimated data symbol.

$H[m]$ estimated using the pilot signal of other standard method.

Channel estimation & synchronization are bit different. SC-FDE include the preamble that preamble in the time domain

SC-FDE more dispersive spectrum compared to OFDM.

O4M

The FDD mode.

There are 8 parallel H-ARQ processes in the a link for the non subframe bundling operation The UE retransmits the Corresponding PUSCH in subframe n+4 for FDD mode, upon detect on NAK in subframe n-5

The TDD mode, the number of H-ARQ process determined by the DL/UL Configuration.

For TDD UL/DL Configuration 1-6 and the norm H-ARQ operation. detection of NAK in the subframe n, the UE retransmit in subframe n+k with k given in

04M

TDD UL/DL Configuration	DL subframe number n									
	0	1	2	3	4	5	6	7	8	9
0	4	6				4	6			
1		6			4		6			4
2				4					4	
3	4								4	4
4									4	4
5									4	
6	7	7				7	7			5

The value of k for TDD Configuration

04M

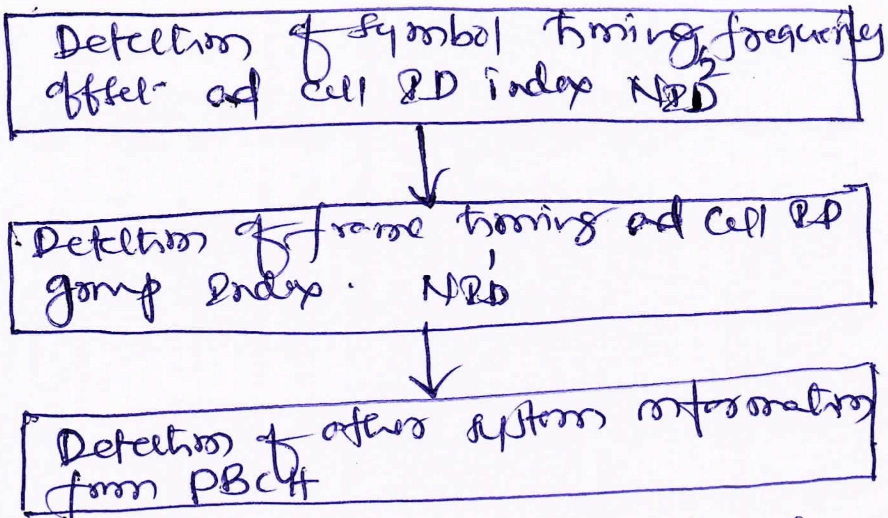
Q 89 Cell search procedure.

when UE is power on, it needs to acquire the time and frequency synchronization with cell and detect the physical layer cell ID of the cell through the cell search procedure or synchronization procedure. Synchronization is important for LTE system relies on orthogonal intra cell transmission in both uplink and down link.

During cell search procedure different types of information need to be identified which including symbol and frame timing, frequency cell identification, transmission bandwidth, antenna configuration and the cyclic prefix length. 02M

primary synchronization carrying the information about the physical ID within the cell ID group $N_{ID}^{(2)} = 0, 1, 2$ and the secondary synchronization carrying the physical layer group $N_{ID}^{(1)}$ 0,-1.-16 the cell ID determined. $N_{ID}^{cell} = 3N_{ID}^{1} + N_{ID}^{2}$

cell search procedure different schemes for different Bandwidth ie TDD and FDD. achieved by defining common synchronization signal structure for all supported bandwidths six resource block (72 subcarriers)



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In cell search, UE detects the symbol timing and cell ID index $N_{ID}^{(2)}$ from the primary synchronization signal. This is achieved through the matched filter between received signal and primary synch sequence. Frequency & Timing synchronization performed based on the primary synchronization signal

Next step UE detects the cell ID group index $N_{ID}^{(1)}$ and frame timing from both secondary synchronization signal. The sequence pair of secondary signal (d_1, d_2) is defined & (d_2, d_1) is not allowe

After cell search UE detects the broadcast chann to obtain the other physical information ie system Bandwidth, number of transmit antennas and system frame number

04M

Q8b Power control in the uplink for UEs

The uplink is SC-FDMA based transmiss the orthogonality is achived in between Intra cell Interference. The inter cell interference ca a major interference and it degrades the performance at cell edge UEs. The power control in the uplink controls the interference caused by the neighbouring cell. and maintains required SNR at the serving cell

SINR is for UEs is different for the base station. LTE specifies Fractional power control (FPC) which allows partial compensation of path loss and shadowing. FPC allows UE with higher path loss.

-Cell edge UE operate with lower SINR requirements. so that they generate the less interference to other cells and minor impact on the interior UEs

The FPC scheme. UE adjusts the transmission power OLPM

$$P = \min\{P_{max}, 10\log M + P_0 + \alpha \cdot PL\} [dBm]$$

P_{max} → maximum UE transmission power

M → Number of assigned PRBs

P_0 → parameter controls mean received SNR

PL → downlink path loss estimate calculation in UE

path loss = $10 \log M + P_0 + \alpha \cdot PL \leq P_{max}$ then the received power at the eNode-B is

$$P_r = P - P_L = 10 \log M + P_0 + (\alpha - 1) \cdot PL \ [dBm]$$

$\alpha = 1$ → constant received power

$\alpha = 1$ → same as the transmission power

for $0 < \alpha < 1$ is the FPC, and different U have the different Pr depending on the path lo

for open loop and closed loop UE sets its transmission power using the following formula

$$P = \min\{P_{max}, 10 \log M + P_0(j) + \alpha(j) \cdot PL + \Delta_{mcs} + f(\Delta i)\} \ [dBm]$$

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three different PUSCH transmission types

for PUSCH (re) transmission types, corresponding to $j = 0, 1, 2$

For PUSCH (re) transmission corresponding to semi persistent grant $j = 0$

For PUSCH (re) transmission corresponds to dynam scheduling grant $j = 1$

For PUSCH (re) transmission corresponding to the random access response grant $j = 2$

02M

Module-3

Q 5a Transport Channel and physical channel

There are the 3 different channel type ① logi al Channel, Transport Channel & physical chan

Transport channel. It is charectrised by How & with what charectristics data transferred ov the radio interface; channel coding, modulati antenna mapping. Which includes downlink and uplink transport Channel.

Downlink transport channels

Downlink shared channel (DL-SCH). used for transmitting the downlink data, including control and trafic data and is associated with logical c

Broadcast channel. (BCH) It is associated with BC used to broadcast the system information over entire coverage area

Multicast Channels (MCH): It is associated with MCCH & MTCH logical channel for multicast & Bro cast

Paging Channel (PCH) Associated with PCCH it is mapped to dynamically allocate the resources

Uplink transport Channel.

Uplink shared channel (UL-SCH): It is counter part of DLSCH, associated with CCCH, DCCH & DTCH

Random access channel (RACH): It transmit the small amount of data for initial access. 21

DCI - Downlink control information, related to scheduling assignment, modulation & coding schemes, Transmit power control command

Uplink control Information (UCI): It informa current indication on the downlink transmissi scheduling request of the uplink. 05M

Physical Channel - Actual transmission.

Downlink physical channel, physical downlin control channel (PDCCH). It carries informatio about transmission format and resource allocation, physical downlink shared channel (PDSCH) - This Carries user data and higher layer signaling

PBCH → Physical Broadcast channel. PMCH → Phy cal multicast channel, PHICH → physical Hybri ARQ indicator channel., PCFICH → Physical control format indicator channel.

uplink physical channels

PUCCH → physical uplink control channel → It carries information including channel quality Indicator (CQI

PUSCH → Physical uplink shared channel - It carri user data and higher layer signalings

Physical random Access channel (PRACH)

05M

5b physical resource block is described by tim frequency resource grid, It makes initiative of radio resource allocation. Each column and Eac row of resource grid corresponds one OFDM symb and one OFDM sub carrier. The smallest time fre ency unit in a resource grid is denoted as a resource element.

The structure of each resource grid characterise by the three parameter

02M

The number of downlink resource blocks (N^{DL}_{RB})

This is depends on the transmission bandwidth

$N^{min,DL}_{RB} \le N^{DR}_{RB} \le N^{max,DL}_{RB}$, $N^{min,DL}_{RB} = 6$, & $N^{max,DL}_{RB} = 110$, smal for largest & Bandwidth.

Number of each subcarrier, N^{RB}_{sc} - It depends on the sub carrier spacing Δf, satisfying $N^{RB}_{sc} \Delta f = 180$ KHz. The value of N^{RB}_{sc} for different sub carrier spacing. The total sub carrier $N^{DL}_{RB} \times N^{RB}_{sc}$ sub carrier in each resource grid.

The number of OFDM symbol in each block (N^{DL}_{symb}) It depends on both cp length and the sub carrie spacing.

Therefore, each downlink resources grid has $N^{DL}_{RB} \times N^{SC}_{RB} \times N^{DL}_{symb}$ resource elements.

For example 10 MHz Bandwidth, $\Delta f = 15$ KHz and normal cp, $N^{DL}_{RB} = 50$

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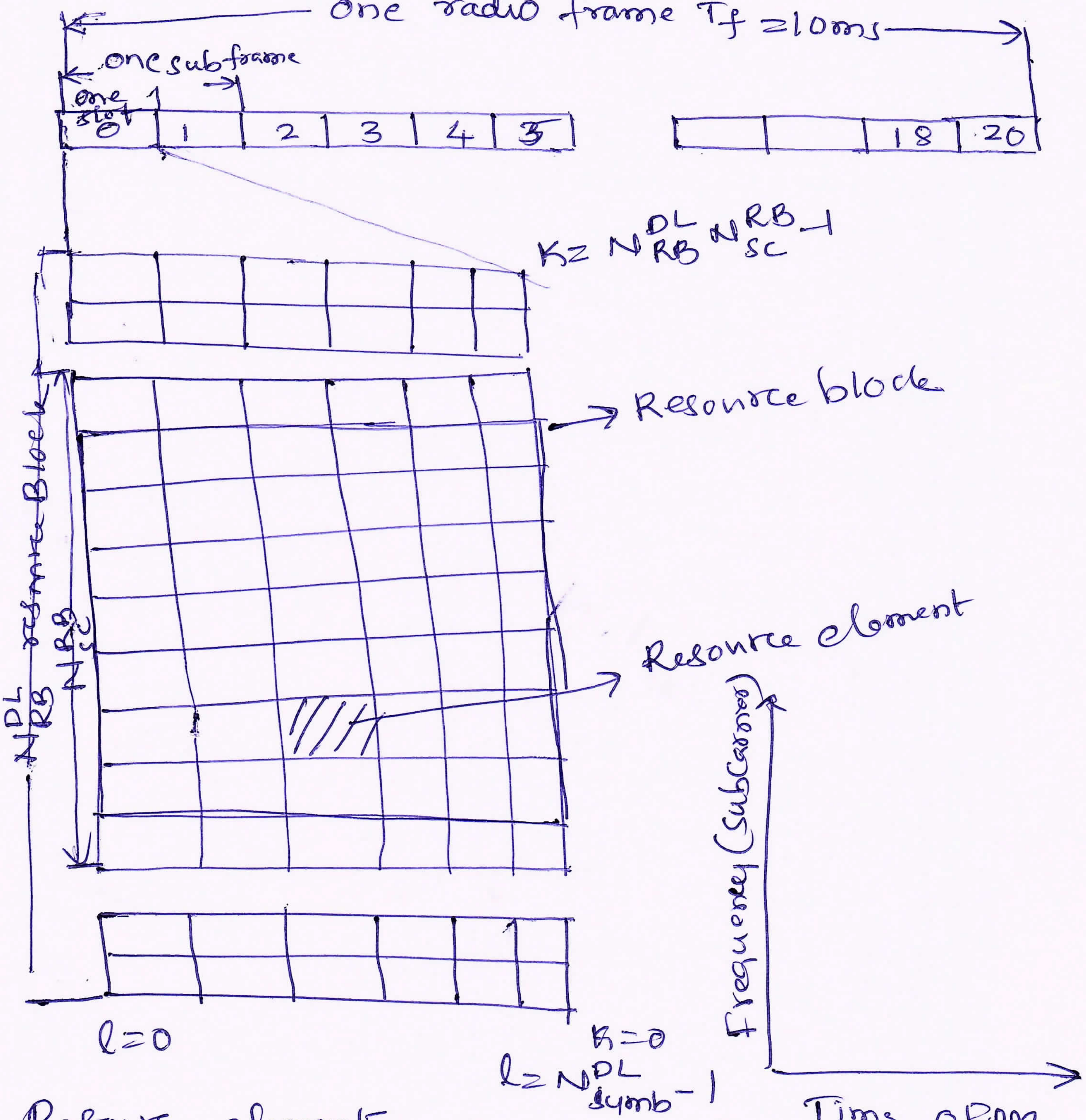
$N^{SC}_{RB}=12$ and $N^{DL}_{symb}=7$, so there are $50\times 12\times 7$ 25

$= 4200$



Resource element → index (k, l)

k → frequency domain index $k = 0, 1, \ldots N^{DL}_{RB} N^{RB}_{sc} -$

l → Time domain index $l = 0, 1, \ldots N^{DL}_{symb} - 1$

04M

Q6a MIMO modes

Downlink MIMO Modes and uplink MIMO modes. Multiantenna transmission and Receptio on can improve bothe the reliability and throughput.. In LTE two transmit antenna at cell site and two receive antenna at UE MIMO is supported with up to four transmit & four receive antenna

Downlink transmission supports both single user MIMO and multiuser MIMO. one or mu ple data streams are transmitted to a single modulation transmission to the different UE usi the same time frequency resource

Transmit diversity with space frequency block codes (SFBC)

open loop spatial multiplexing & closed loop pr coding channel rank=1

conventional direction of arrival (DOA) based beam forming. MIMO modes restricted by the UE capa bility. PDSCH supports all the MIMO modes. supports PMCH

05M

MIMO modes in the uplink

MIMO mode supported in the uplink comp xity and cost are the major concern

MUMIMO is supported, which allocates sam time and frequency resource to two UEs with each transmitting on a single antenna. This is called as spatial division multipl access (SDMA). The only one transmit antenna selected per UE. To seperate stream for different UEs, channel transmit antenna channel state information is required at the e-Node-B which is obtained through the uplink reference signal that are orthogonal to the UEs, uplink MU-MIMO requir power control, as the near far problem. arises when multiple UEs are multiplexed on the same radio resources.

UE with two <u>or</u> more transmit antenna closed loop adaptive antenna selection transmit diversity shall be supported.

OSM

Q 6b Sub block interleaving

Interleaving is performed by each bit strea 3.1 done by a block interleaver. The inter colu permutation are different for turbo coding and convolutional coding

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Bit Collection: Virtual circular buffer is formed by collecting its bits from the interleaved streams. Systematic bits are placed at the beginning followed by the bit by bit interleaving of two interleaved parity streams. The interleaving guarantees that an equal number of parity1 and parity2 bits are transmitted.

Bit selection: To select the output bit sequence the sequence length L should be determined

The L bits are read from virtual Circula buffer. bit selection depends on the redundancy version of the current transmission. The retransmission associated with HARQ process.

04M

Rate matching in LTE repeatation or punctur in order to generate the transport block The transport block fit the pay load size. determined by the modulation scheme and the number of resource block allocated for the transport block. The rate matching defined for Coded block.

02M

Q79 Resource mapping of demodulation reference sig

35

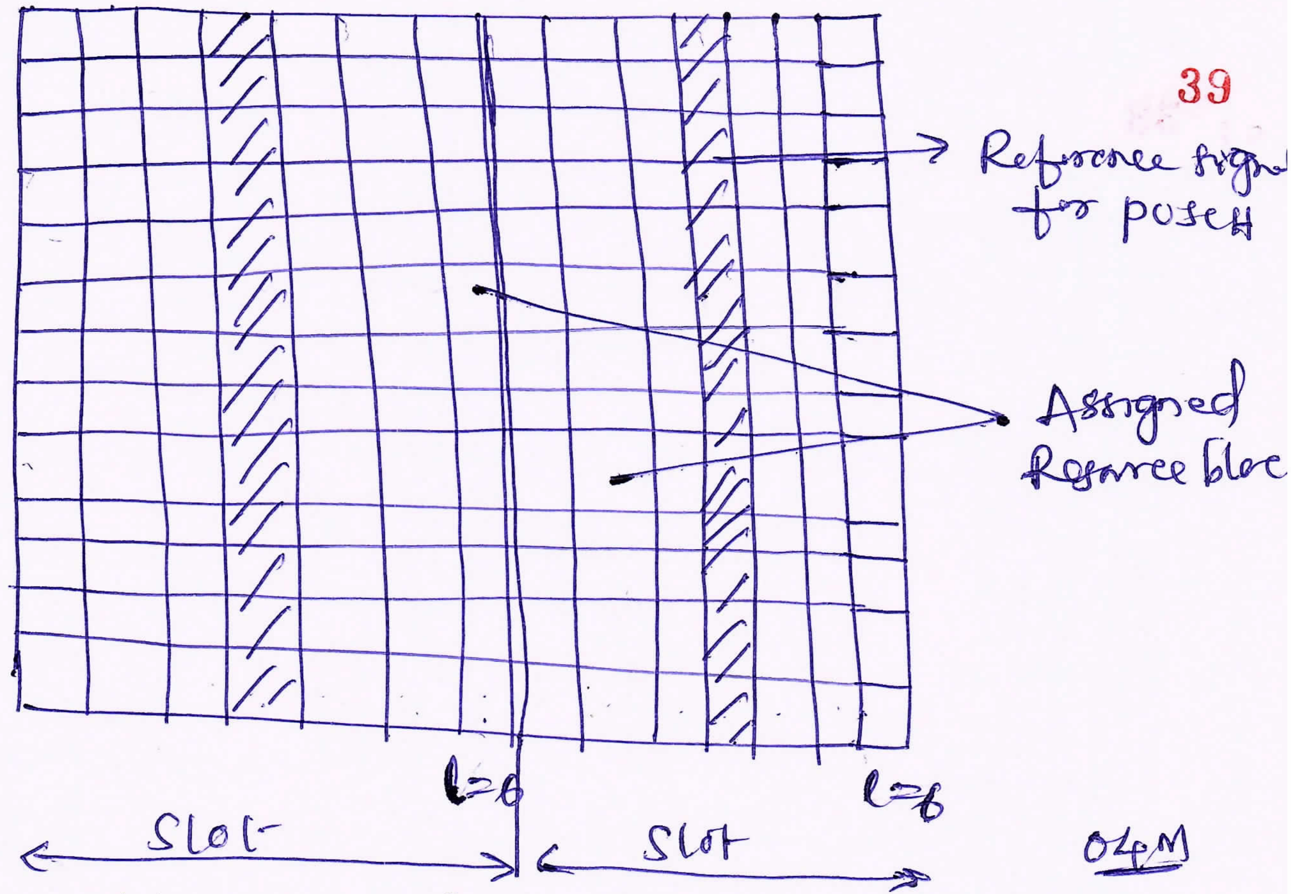
The generation of base sequence depends on the reference signal sequence length $M_{sc}^{RS} = m N_{sc}^{RB}$ with $1 \le m \le N_{RB}^{max,UL}$, where m is the size of the seq ence.

02M

The resource mapping of the demodulation referen signal is different for PUSCH and PUCCH chann the reference signals are inserted in the time'd main, which is to preserve the low PAPR prop rty of the SC-FDMA.

For PUSCH the demodulation reference sequen is mapped to the resource elements (k, l), with l=3 Normal cp and l=2 for extended cp. with increasing order first k and then slot no. The demodulation reference signal mapping for PUSCH is shown in figure with the normal cp

PUCCH supports six different formats and the resource mapping to SC-FDMA symbols for different formats listed in the table. PUCCH demodulation reference symbols are differen for different formats. There are 10 CQI/PMI modulated symbols for PUCCH format. 2/2a/2b and there are the two reference symbols in each slot. There are a total of



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that fill the whole subframe which is 14-SC-FDMA symbols

As PUCCH formats 1/1a/1b has fewer information bits than PUCCH format 2/2a/2b the reference symbol for format 1/1a/1b than there are formats 2/2a/2b which can be used to improve the channel estimation the resource mapping of PUCCH demodulation reference signal together with PUCCH symbols, which are modulated with normal CP

02M

PUCCH formats	Set of values for l	
	Normal cyclic prefix	Extended cyclic prefix
1, 1a, 1b	2, 3, 4	2, 3
2	1, 5	3
2, 2a	1, 5	N/A

Q7b H-ARQ in the uplink

H-ARQ retransmission protocol is used on the uplink, eNode-B is capability to request retransmission of incorrectly received data packets. uplink H-ARQ process. Corresponds to ACK/NAK information carried on PHICH

LTE uplink applies synchronous H-ARQ protocol that is the retransmission is selected on the p odic interval. Synchronous retransmission is pre sed on the uplink

02M

The number of H-ARQ processes and the time interval between the transmission and retransmission depends on the duplexing mode

There are two types of H-ARQ operation in the uplink. The non subframe bundling & subframe bundling operation in which four redundancy versions are transmitted.

H-ARQ retransmission back to back without waiting for H-ARQ ACK/NAK feedback. When TTI bundling is used, the eNode-B waits for four TTI to receive and decode. the four redundancy versions. before sending HARQ ACK/NAK over the PHICH on the down link.

Q9a EPS bearer service architecture.

The end-to-end connectivity through the network is made via the bearer service and bearer service architecture is shown with figure

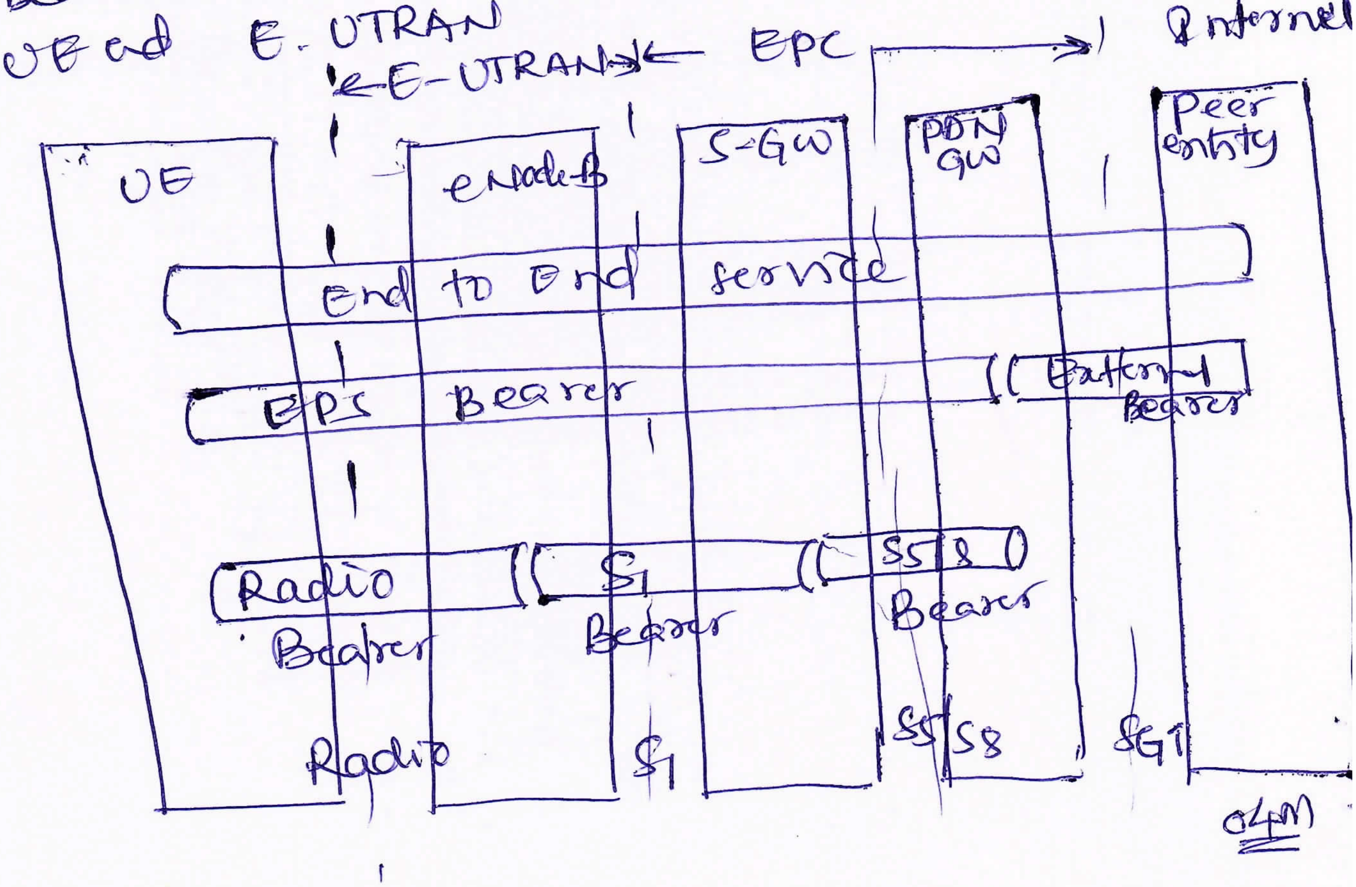
EPS bearer has cross multiple interface and across each interface it is mapped to the transport layer bearer. S

02M

S5/S8 bearer transports the packets of an EPS bearer between SGW & PDN-GW

S1 bearer transports the packets of an EPS bearer between eNode-B and SGW

Radio interface bearer is referred to the radio bearer which transfers data between a UE and E-UTRAN



04M

Signaling radio Bearers (SRB) Carry the
radio resource Control (RRC) signaling me
ages. DRB data radio bearer Carry the
user plane data. Radio bearers are map
ed to the logical channel through layer 2 pr
cols

Bearers can be divided into two class

Guaranteed Bit rate (GBR) bearers: These
bearer defined the min rate to UE.
Bit rate higher than the minimum o all
owed if resources are available. applicatio
such as voice, streaming video, & real tim
gaming

Non Guaranteed Bearers (: These donot define
the guarantee of minimum bit rate to the
UE. the achived bit rate depends on the
system load, the number of UE served by
eNode-B. and the scheduling algorithms
Non GBR application web browsing, email,
FTP and. P2P file sharing

04M

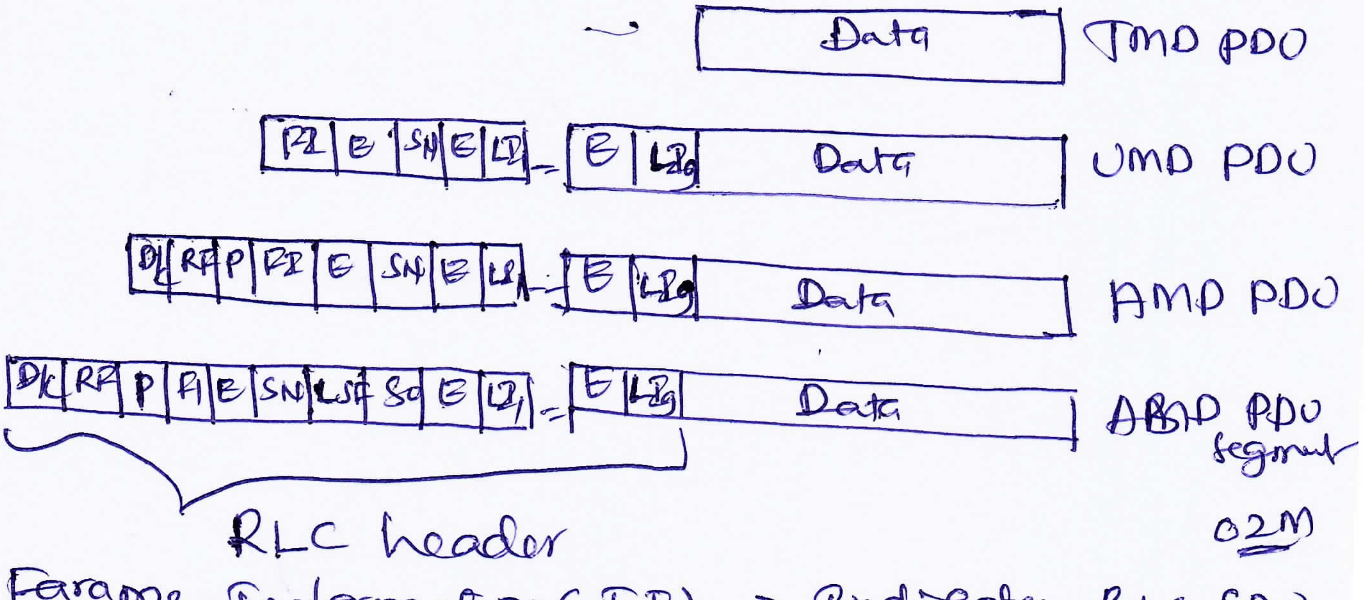
Q9b PDU header and formats for RLC

RLC P catagorized into RLC data PDU ad RLC control PDU

RLC data PDU are used by TM, UM ad AM RLC entities to transfer upper layer PDU called TM data (TMD), UM data (UMD), AM data (UMD)

the formats of the different RLC data PDU shown in fig, TMD PDU consists of only data PDU and no RLC headers added RLC headers different for UMD PDU and AMD PDU. but contains common field

02M



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Farame Information (FI) → indicates RLC SDU segmented at the beginning or end of data field

Length Indicator (LI) → indicates length in bytes of the corresponding data field.

Extension bit (E) — Indicates whether the data field follows or set of E field and LI field follo

SN field: This corresponds to the sequence number of UMD or AMD. It consists of 10 bits for AMD PDU and 5 bits or 10 bits of UMD PDU. PDU sequence number carried RLC header is independent of the SDU i.e. the PDCP sequence number

AMD PDU segments

Data/Control (D/C) — Indicates whether the RLC PDU is an RLC data PDU or RLC control

Resegmentation flag (RF): The RF field indicates whether the RLC PDU is an AMD PDU or AMD PDU segment

Polling (P) bit — Indicates whether the transmitting side of an AM RLC entity requests a status report from peer AM RLC entity.

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Q10a Function of RRC

Radio resource connection management, radio bearer control, mobility functions and UE measurement reporting and control. It is also responsible for broadcasting system information and paging.

RRC States: LTE has only two states RRC_IDLE and RRC_CONNECTED. It simplifies machine handling and radio resource management.

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① UE controlled mobility
② Paging
③ Broadcast of system information

① Unicast data transf
② Network controlled mobility
③ paging
④ Broad cast of syst information

In RRC_IDLE – UE can receive broadcas of system information and paging information.
There is no signaling radio bearer is established.

There is no RRC connection
Mobility control is handled by the UE for cel selection and Re selection based on the measurements. UE allocate the ID for UE tracking area.

RRC_Connected- Transmit/Receive to/from the network eNode-B. UE monitors the control channel (PDCCH) associated with shared data channel to determine if the data is scheduled for it

RRC functions.
Introduces the concept of signaling radio bearer (SRB) is a radio bearer that is used for the transmission for RRC and NAS messages
There are 3 different SRBs
SRB0 is for RRC message using CCCH logical channel.
SRB1 for messages and NAS messages prior to the establishment of SRB2 using DCCH
SRB2 is for NAS messages using DCCH.
SRB2 has lower priority than SRB1 and always configured by EUTRAN after security activation.

OGM

Q 10b Default mode for mobility managemen ?

1) X2 interface mobility.

Mobility over the X2 interface consists of three steps shown in below figure

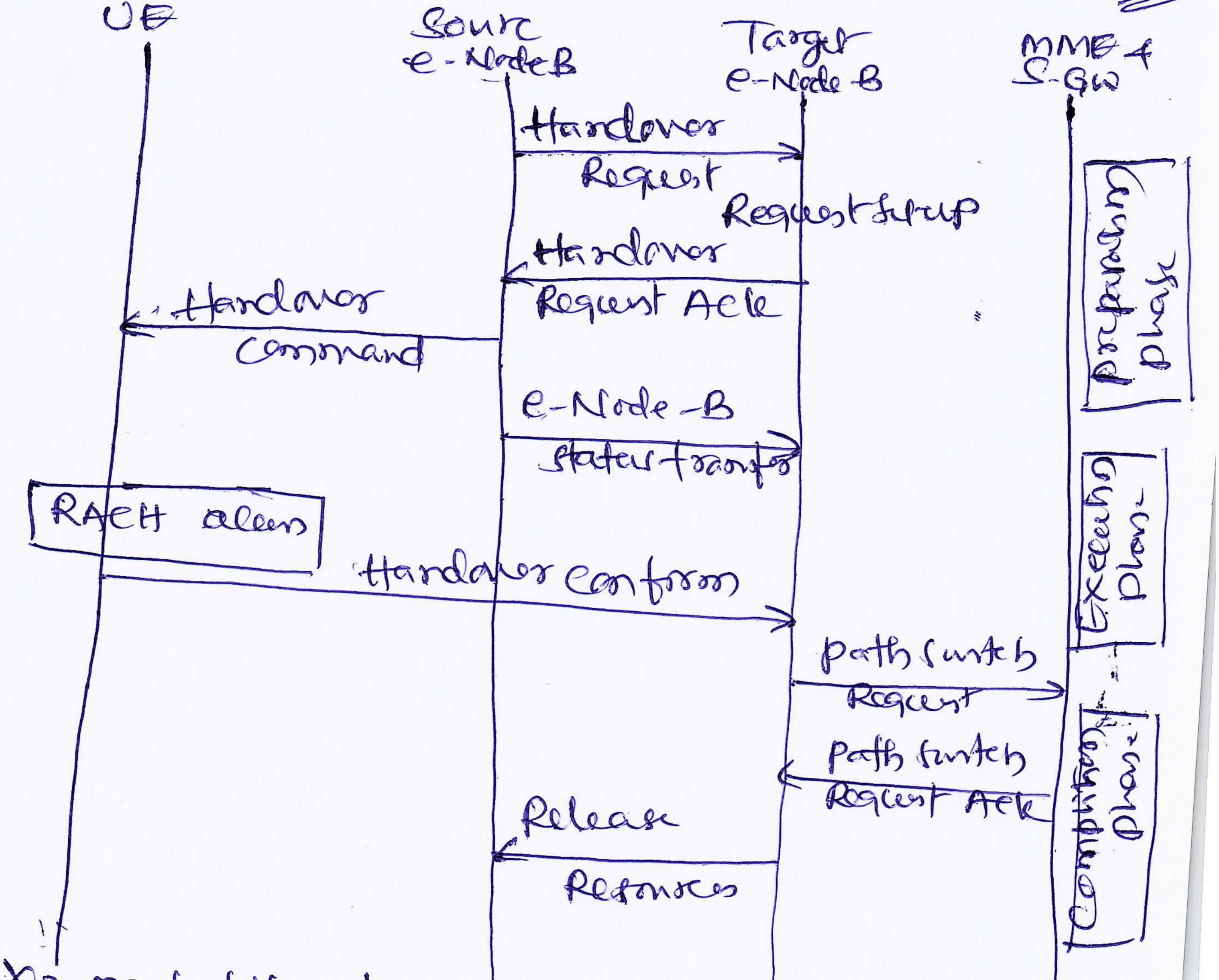
1 preparation phase: once the handover deci on has been made by the source eNode A sends handover request message to the target eNode_B. This message works wit MME & SG-W to set up the resources for UE handover have the same RAB at the target eNode-B with the same set of QOS The target e-Node-B responds to the source e-Node-B with handover request Ack

2 Execution phase: Upon receiving handover request Ack the source eNode_B sends a handover command to the UE while UE completes the RAN related handover procedures the source e-Node B starts data transfer to the target e-Node-B.

3. Completion phase: once the UE completes the handover procedure. It sends handoff complete message to the target e-Node-B then target e-Node-B sends the path

Switch request to the MME/SGW and SGW switches the GTP tunnel from the source e-Node-B to the target e-Node-B. when the data path in the User plane is switched the target eNode-B sends the message to the source e-Node-B to the release of the resources originally used by the UE

OBM



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X2 mobility the source eNode-B selects the handover for one or more RABs. Both the PDCP processed & PDCP unprocessed transfer