KLS Vishwanathrao Deshpande Institute of Technology

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

University / Model Question Paper

Scheme & Solution

Faculty Name	:	Ashwini Garaddi
Course Name	:	Wireless Communication System
Course Code	:	BEC703
Year of Question Paper	:	model QP
Date of Submission	:	18/07/25

Faculty Member

HoD

Head of the Department

Dept. of Electronics & Communication Engg.

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Dean (Acad.)

Model Question Paper BEC703

Seventh semester B.E. Degreen Examination

Wireless Communication Systems

Time: 3hrs. **Max. Marks: 100**

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.

			M	L	C
		Module - 1			
Q1	a.	Define Wireless communication system. Explain Rayleigh fading wireless channels.	10	1	1
	b.	Explain basics of wireless channel modelling.	10	1	1
		OR			
Q2	a.	Explain the Doppler impact and Doppler fading on wireless channel.	10	1	1
	b.	Note on coherence time.	10	1	1
		Module – 2			
Q3	a.	Explain CDMA mechanism	10	1	2
	b.	Explain correlation properties of random CDMA spreading sequences.	10	1	2
		OR			
Q4	a.	Explain MIMO OFDM	10	1	2
	b.	Note on SC-FDMA.	10	1	2
		Module – 3			
Q5	a.	Explain first generation cellular system.	10	2	3
	b.	Note on 3G Broad band wireless system.	10	1	3
		OR			
Q6	a.	Explain 2G Digital cellular systems.	10	1	3
	b.	Explain GSM System Architecture.	10	2	3
		Module – 4			
Q7	a.	With neat diagram explain MIMO system model	10	1	4
	b.	Note on MIMO Beamforming.	10	1	4
		OR			
Q8	a.	Explain singular value decomposition of MIMO channel.	10	1	4
	b.	Explain SVD and MIMO Capacity	10	1	4
		Module – 5			
Q9	a.	Explain Radio interface Architecture.	10	2	5
	b.	Explain Uplink SC-FDMA Radio Resources	10	1	5
		OR			
Q10	a.	Write the Principles of LTE design.	10	2	5
	b.	Explain Hierarchical structure of LTE.	10	1	5

Head of the Department
Dept. of Electronics & Communication Engg.

2025- Model Question paper with Scheme and Solution
Wireless Communication Systems (BEC703)

Q1 a) Define wireless communication system Explain Rayleigh fading wireless channels. 10M

⇒ A wireless Communication system is a method of transmitting information between two or more points without the use of Physical cables or wires

Rayleigh fading wireless channel:-

It is a Phenomenon where the received signals amplitude and phase fluctuate randomly due to multipath propagation Specifically when there is no dominant line of sight path between transmitter and receiver this fading is modeled using a Rayleigh distribution which describes the statistical behaviour of the signals magnitude

The complex fading Coefficient has be expressed in terms of its real and imaginary components as

$$h = ae^{j\theta} = \sum_{i=0}^{L-1} (x_i + jy_i) = x + jy$$

thus x, y which are the real and imaginary Components of the fading coefficient $ae^{j\theta}$ are derived from the summation of a large number of random multipath Components $x_i y_i$ Especially in a rich urban setting which allows for a large number of Scatterers

The above assumption is valid as $L \to \infty$ ie the number of multipath Components is fairly large hence x, y are distributed as $N(0, \frac{1}{2})$ x, y is Given by the standard multivariant as

$$f_{x,y}(x, y) = \frac{1}{\pi} e^{-(x^2+y^2)}$$

One Can now derive the statistics of the fading coefficient $ae^{j\theta}$ in terms of its amplitude and phase factors a, θ as

$x = a\cos\phi,\ y = a\sin\phi$

the joint distribution $f_{A\Phi}(a,\phi)$ can be derived from $f_{XY}(x,y)$.

$$f_{A\Phi}(a,\phi) = \frac{1}{\pi} e^{-a^2} J_{XY}$$

$$J_{XY} = \left| \begin{bmatrix} \cos\phi & \sin\phi \\ -a\sin\phi & a\cos\phi \end{bmatrix} \right| = a$$

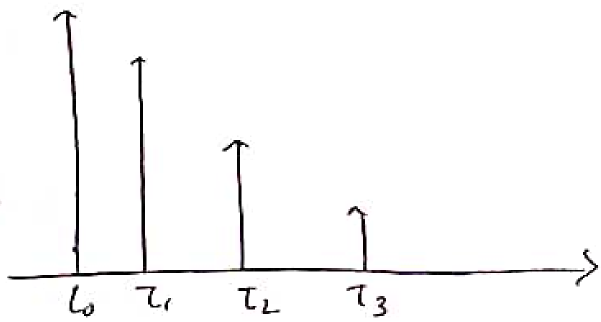
$$f_{A\Phi}(a\,\phi) = \frac{a}{\pi} e^{-a^2}$$

$$f_A(a) = \int_{-\pi}^{\pi} f_{A\Phi}(a\,\phi)\,d\phi = 2a e^{-a^2} \quad 0 \le a \le \infty$$

$$E = \{|h|^2\} = E\{a^2\} = E\{x^2+y^2\} = 1$$

(b) Explain basics of wireless channel modelling — 10M

⇒



Schematic of an L = 4 tap wireless channel profile

* the fading wireless channel consist of several multipath components arising from the presence of multiple non line of sight signal propogation paths then NLoS components arise from the scattering effects of objects in the wireless environment such as buildings trees vehicles water bodies

Wireless channels can be modeled as

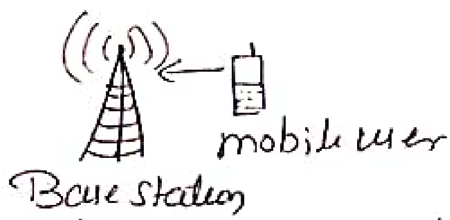
$$h(t) = \sum_{i=0}^{L-1} a_i \delta(t - T_i)$$

where each $\delta(t-T_i)$ corresponds to delays the signal by $T_i a_i$

2a) Explain the Doppler impact and Doppler fading on wireless channel. 3M 10M

→ Doppler Fading :-

The doppler shift is a fundamental principle related to the Electromagnetic wave is defined as the perceived change in the frequency of the wave due to relative motion between the transmitter and receiver



Doppler fading due to user mobility

The schematically as shown the perceived frequency is higher than the true frequency if the transmitter is moving towards the receiver and lower otherwise

Doppler fading is inherent in wireless communication due to the untethered nature of mobile transceiver which Enables mobility in wireless in wireless comm^n s/m. Leads to relative motion b/w the transmitter and receiver

→ Doppler impact :-

Consider the impulse response of the i^{th} component of the multipath channel given as $a_i \delta(t-\tau_i)$

Let the Vehicle be moving with velocity v at an angle θ with respect to the line joining the mobile and base Station. as the delay of the i^{th} Signal component is also changing let the initial distance for the i^{th} signal component be d_i the initial propagation delay is

$$T_i = \frac{d_i}{c}$$

After small interval of time t this distance by $Vt\cos\theta$. Since $V\cos\theta$ is the component of the velocity in the direction of the base station. Hence the delay of the i^{th} component after time t is correspondingly given as

$$T_i(t) = \frac{d_i - Vt\cos\theta}{c}$$

$$= \frac{d_i}{c} - \frac{Vt}{c}\cos\theta$$

$$= T_i - \frac{Vt}{c}\cos\theta$$

flat fading wireless channel coefficient is

$$h = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c T_i}$$

The model for time varying channel coefficient has

$$h(t) = \sum_{i=0}^{L-1} a_i e^{-j2\pi f_c}\left(T_i - \frac{V\cos\theta}{c}\right)$$

b) Note on coherence time 10m

→ The coherence time interval T_c for a time varying channel. Consider the i^{th} multipath component of the time varying channel coefficient.

which given as

$$a_i(t) = a_i e^{-j2\pi f_c T_i} e^{j\pi f_d t}$$

The value of this i^{th} component corresponding to $t = 0, \frac{\pi}{2}$ can be obtained as

$$t = 0 \Rightarrow a_i(0) = a_i e^{-j2\pi f_c t}$$

$$t = \frac{1}{4f_d} \Rightarrow a_i e^{-j2\pi f_c T_i} e^{j2\pi f_d \frac{1}{4f_d}} = j a_i e^{-j2\pi f_c T_i}$$

Channel can change time $t=0$ to $t=\frac{1}{4fd}$ Since Phase changes by Pi/2

This value of the coherence time Tc defined as

$$T_c = \frac{1}{4 f_d^{max}} , \quad f_d^{max} = \frac{v}{c} f_c$$

Consider wireless channel changing with time the coherence time Tc is the approximate duration of time for which the wireless channel can be assumed to be constant

$$T_c = \frac{1}{2B_d}$$

$B_d = 2 f_d$ is doppler spread of the wireless channel

Q3 a) Explain CDMA mechanism

10M

→ It is multiple access technology based on Code division In other words different users are multiplexed using different Codes

Consider a two user scenario i.e. two users accessing radio channel simultaneously let a_0 denote the Symbol of the user 0 while a denote the transmit symbol corresponding to the user

Let the code c_0 of the user 0 be given as

$C_0 = [1, 1, 1, 1]$ the above code C_0 is of length N=4 chips Each Element of the code is termed as a chip

The transmitted signal x_0 of the user 0 is then given by multiplying the code C_0 with the symbol a_0

$$x_0 = a_0 \times [1, 1, 1, 1]$$
$$= [a_0, a_0, a_0, a_0]$$

The structure of above transmit signal x_0 can be interpreted as follows the symbol a_0 of the user 0 is multiplied by the code C_0 to yield 4 chips $x_0(i)$

$$0 \le i \le N-1$$

Similarly code $C_1 = [1, -1, -1, 1]$ correspond to the code of the user 1

Hence the sequence of chips correspond to the code of the user 1

Hence the sequence of chips corresponding to the user 1 as $x_1 = a_1 \times [1, -1, -1, 1] = [a_1, -a_1, -a_1, a_1]$

$$\begin{array}{ccccc} & a_0+a_1 & a_0-a_1 & a_0-a_1 & a_0+a_1 \\ \times & 1 & 1 & 1 & 1 \\ \hline & (a_0+a_1) + & (a_0+a_1) + & (a_0-a_1) + & (a_0+a_1) \end{array} = 4 \cdot a_0$$

$$\begin{array}{ccccc} & a_0+a_1 & a_0-a_1 & a_0-a_1 & a_0+a_1 \\ \times & 1 & 1 & 1 & 1 \\ \hline & (a_0+a_1) - & (a_0-a_1) - & (a_0-a_1) + & (a_0+a_1) \end{array} = 4a_1$$

to yield $4 a_1$ which is proportional to the transmitted symbol a_1 of the user 1 thus unlike in GSM or FDMA in which the signal of different users are transmitted in different time slot in CDMA.

(b) Explain Correlation Properties of random CDMA spreading Sequence

10m

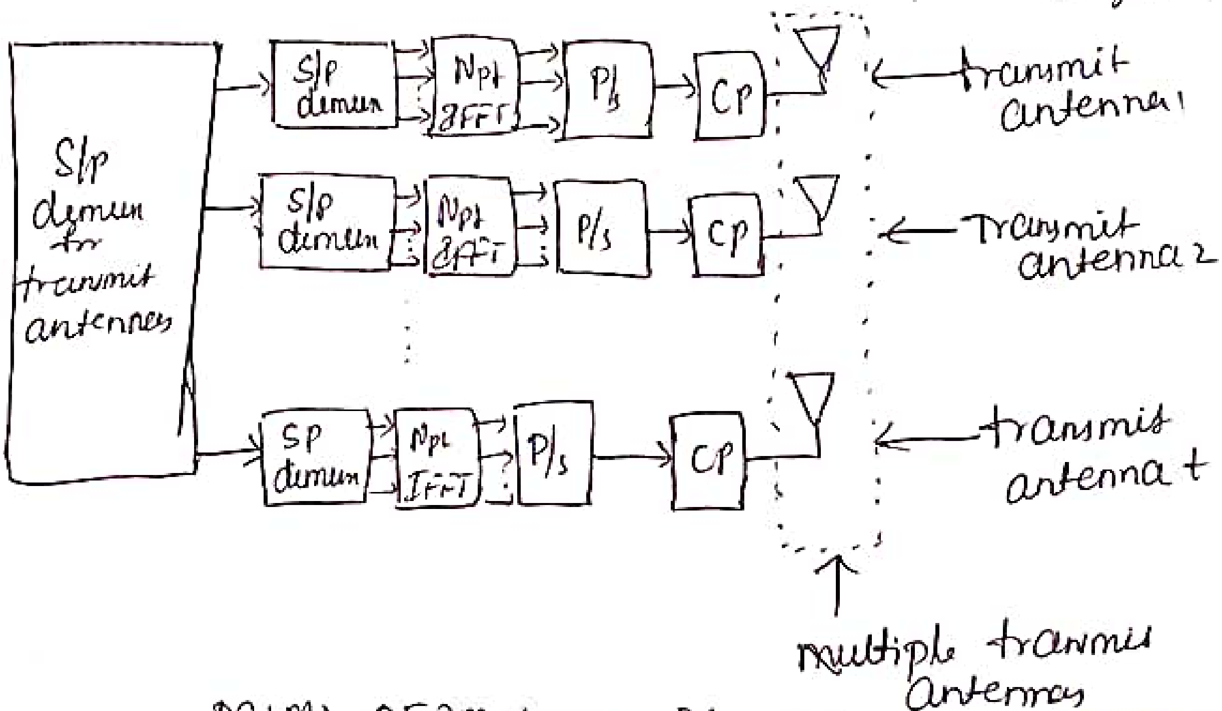
CDMA spreading sequence can be choosen as PN sequence which has noiselike properties in other words one can choose a chip sequence $C_k(i)\ 0 \le i \le N-1$ for the user k such that $P(C_k(i) = +1) = P(C_k(i) = -1) = \frac{1}{2}$

4) a Explain MIMO OFDM: 10m

→ It is combination of the multiple input multiple o/p wireless technology with that of OFDM to further increase the rate in broadband multi antenna wireless s/m

$$y(n) = \sum_{l=0}^{L-1} h(l)\,x(n-l) + w(n)$$

$$= h(0)x(n) + \underbrace{h(1)x(n-1) + \dots + h(L-1)x(n-L+1)}_{\text{ISI from previous symbols}} + w(n)$$



MIMO OFDM transmitter schematic

where $w(n)$ denotes the noise

$$y(t) = \sum_{l=0}^{L-1} H(l)\,x(n-l) + w(n)$$

$$= H(0)x(n) + H(1)x(n-1) + \dots + H(L-1)x(n-L+1) + w(n)$$

described as

$$\tilde{y}(0) = \tilde{H}(0)\tilde{x}(0)$$

$$\tilde{y}(1) = \tilde{H}(1)\tilde{x}(1)$$

$$\vdots$$

$$\tilde{y}(N-1) = \tilde{H}(N-1)\tilde{x}(N-1)$$

we have $E\{C_K(i)\} = \frac{1}{2} \times (+1) + \frac{1}{2}(-1) = 0$

$$E\{C_K(i) C_K(i)\} = E\{C_K(i)\} E\{C_K(i)\} = 0 \times 0 = 0$$

$C_K(i)$ is uncorrelated with chip $C_K(i)$

$$E\{C_K(i) C_j(i)\} = E\{C_K(i)\} E\{C_i(i)\}$$

let $r_{00}(K)$ denote the autocorrelation of the chip Sequence of the user $K=0$ lost $K \neq 0$

$$r_{00}(K) = \frac{1}{N} \sum_{i=0}^{N-1} C_0(i) C_0(i-K)$$

The average or Expected valued of $r_{00}(K)$ can be

$$E\{r_{00}(K)\} = E\{\frac{1}{N} \sum_{i=0}^{N-1} C_0(i) C_0(i-K)$$

$$= \frac{1}{N} \sum_{i=0}^{N-1} E\{C_0(i) C_0(i-K)\}$$

$$= \frac{1}{N} \sum_{i=0}^{N-1} E\{C_0(i)\} E\{C_0(i-K)\}$$

$$= \frac{1}{N} \sum_{i=0}^{N-1} 0 = 0$$

Thus the average value Expected value of the Correlation $E\{r_{00}(K)\}$ is zero for lost $K \neq 0$ Consider $r_{00}^2(K)$

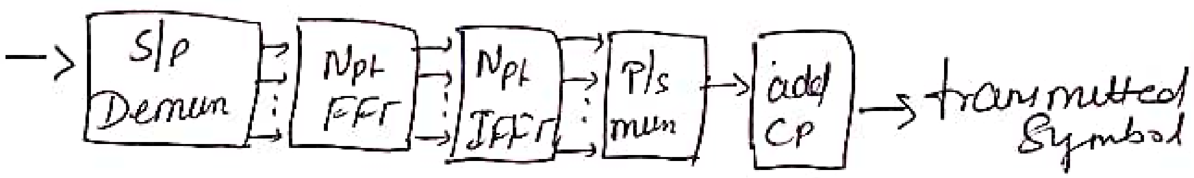
$$r_{00}^2(K) = \frac{1}{N^2} \left(\sum_{i=0}^{N-1} C_0(i) C_0(i-K)\right)\left(\sum_{j=0}^{N-1} C_0(i) C_0(j-K)\right)$$

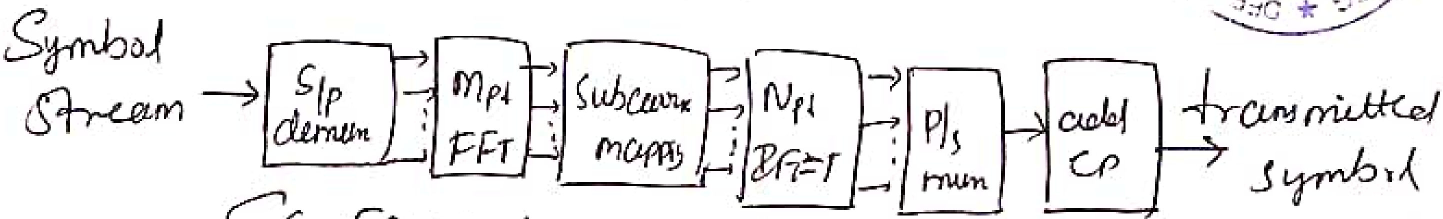
$$= \frac{1}{N^2} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} C_0(i) C_0(i-K) C_0(j) C_0(j-K)$$

b) Note on SC-FDMA <u>10m</u>

3½

→ SC-FDMA which stands for Single carrier frequency Division for multiple access can be Employed to reduce the peak to average power ratio in an OFDM s/m Consider the following hypothetical modification of the OFDM transmitter by the insertion of an N-point FFT block before the N-point IFFT block it Can then be Seen that the FFT and IFFT Conclue the Effect of Each other Introduction of the m-point FFT in SC-FDMA schematic is shown





SC-FDMA transmitter Schematic

⇒ SC-FDMA-Receiver!-

the SC-FDMA receiver schematic is as shown the SC-FDMA Receiver incorporate two new blocks compared to the OFDM receiver the purpose of these additional blocks Can be described as after the N-point FFT operation at the Receiver original FFT block size of m finally then m-point FFT Performed on to generate the Symbol Stream.

5) a) Explain first generation Cellular system 10m

→ The first generation cellular s/m were characterised by their analog modulation schemes and were designed primarily for delivering voice service they were different from their producers mobile communication systems in that they used the cellular concept and provided automatic switching and handover of on-going calls

The more successful first generation systems were amps in the United states and its variant total access communication systems in Europe and Japan these systems were almost identical from a radio stand point with the major difference being the channel bandwidth the amps system was built on a 30kHz channel size.

5 b) Note on 3G Broad band wireless systems 10m

→ Third generation systems were a significant leap over 2G providing much higher data rates significant increase in voice capacity and supporting advanced services and applications including multimedia work on 3G Began in the Early 1990s when the International telecommunication union began invitation

6a) Explain 2G Digital cellular systems

→ Improvement in processing abilities of hardware platforms over time enabled the development of 2G wireless systems 2G systems were also aimed Primarily towards the voice marked but unlike the first generation systems used digital modulation

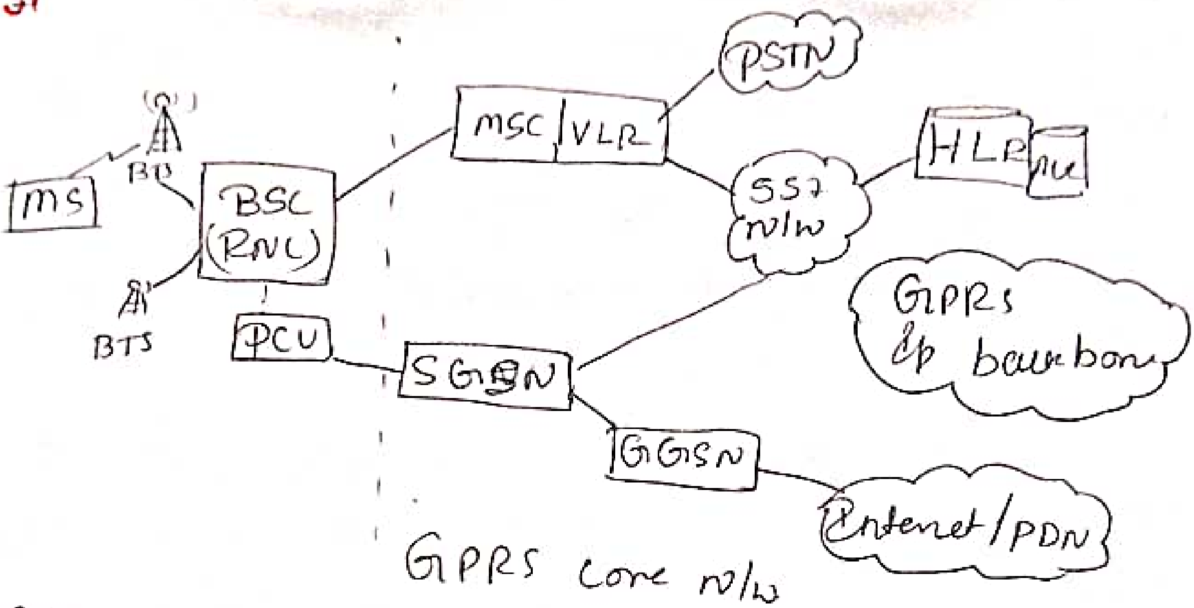
2G systems also used simple encryption to provide a measure of security against eaves dropping and fraud which were a source of major concern with first generation analog s/m

Examples of 2G digital cellular system include the global s/m for mobile communication (GSM) IS-95 CDMA and IS-136 TDMA systems

In 1982 many European Contries came together under the auspices of the Conference of European Posts and telegraphs to develop and standardise a Pan European s/m for mobile services the Group was called the Group special mobile (GSM) and their main charter was to develop a s/m that could deliver inexpensive wireless voice service and work seamlessly across all the europe, By 1989 the European telecommunication standard institute took over the development of the GSM standard and the first version called GSM phase 2

6 (b) Explain GSM Sm Architecture 10m

→ 3f



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The GSM air interface is based on a TDMA scheme where eight users are multiplexed on a single 200kHz wide frequency channel by assigning different time slots to each user.

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7 a) with neat diagram Explain mimo s/m model 10m

→ Consider a mimo s/m model with transmit antennas and receive antennas such a mimo s/m is also termed an r×t s/m

Let $x_1, x_2 \ldots x_t$ denote the t symbol transmitted from the t transmit antennas in the mimo s/m

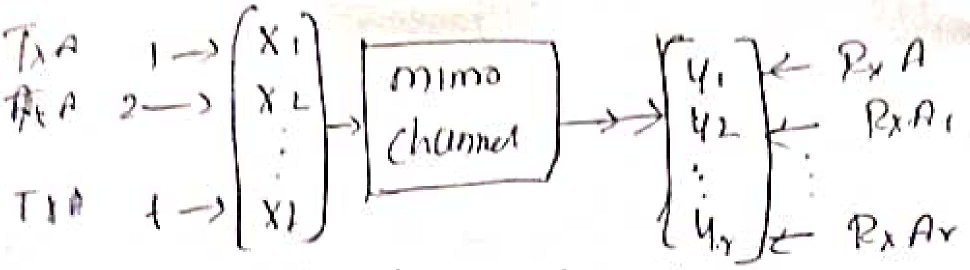
transmit vector

$$X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_t \end{bmatrix}$$

Let $y_1, y_2 \ldots y_r$ denote receive symbol across the r receive antennas in the mimo s/m

r dimensional receive symbol vector

$$y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_r \end{bmatrix}$$



X = transmit vector

y = Receive vector

mimo slm input - output schematic

where h_{ij} represents fading channel coefficient b/w j^{th} & i^{th} transmit antenna

$$H = \begin{bmatrix} h_{11} & h_{12} \cdots & h_{1t} \\ h_{21} & h_{22} \cdots & h_{2t} \\ \vdots & & \vdots \\ h_{r1} & h_{r2} \cdots & h_{rt} \end{bmatrix}$$

$$y = Hx + n$$

$$\underbrace{\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_r \end{bmatrix}}_{y} = \underbrace{\begin{bmatrix} h_{11} & h_{12} \cdots & h_{1t} \\ h_{21} & h_{22} \cdots & h_{2t} \\ \vdots & \vdots & \vdots \\ h_{r1} & h_{r2} & h_{rt} \end{bmatrix}}_{H} \underbrace{\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_t \end{bmatrix}}_{x} + \underbrace{\begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_r \end{bmatrix}}_{n}$$

$$y_1 = h_{11}x_1 + h_{12}x_2 + \cdots + h_{1t}x_t + n_1$$

$$y_2 = h_{21}x_1 + h_{22}x_2 + \cdots + h_{2t}x_t + n_2$$

$t = 1$

$$\underset{y}{\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_r \end{bmatrix}} = \underset{h}{\begin{bmatrix} h_1 \\ h_2 \\ \vdots \\ h_r \end{bmatrix}} x + \underset{n}{\begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_r \end{bmatrix}}$$

$r=1$

$$y = \underbrace{[h_1\ h_2 \dots h_t]}_{h'} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_t \end{bmatrix} + n$$

$r=t=1$

$y = hx + n$

$R_n = E\{nn^H\}$

$$= E\left\{ \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_L \end{bmatrix} [n_1^*\ n_2^* \dots n_L^*] \right\}$$

$= \sigma_n^2 I_r$

$E = \{ n_i(k)\ n_j^*(l) \} = 0$ if $k \neq l$ Hence

$E = \{ n(k)\, n(l)^H \} = \sigma^2 \delta(k-l) I$

when data function $\delta(k-l) = 1$ if $k=l$ and 0

(b) Note on mimo Beamforming

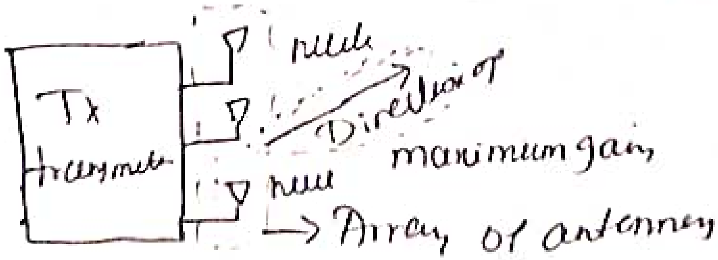
10m

It is a content of a mimo wireless s/m here only Spatial dimension is used for transmission amongst the many dimensions that are available.

$y = Hx + n$

$= U \Sigma V^H x + n$

$$= (u_1\ u_2 \dots u_t) \begin{bmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \sigma_2 & \dots & 0 \\ 0 & 0 & \dots & \sigma_t \end{bmatrix} \begin{bmatrix} V_1^H \\ V_2^H \\ \vdots \\ V_t^H \end{bmatrix} x + n$$



Thus the Symbol $\bar{x}_1$ is being transmitted along the abstract direction representation by the vector v_1 in t dimensional space substituting this in mimo s/m

$$y = [u_1 u_2 \cdots u_t] \begin{bmatrix} \sigma_1 & 0 & \cdots & 0 \\ 0 & \sigma_2 & \cdots & 0 \\ \vdots \\ 0 & \cdots 0 & \cdots & \sigma_t \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ \vdots \\ 0 \end{bmatrix} \bar{x}_1 + n$$

$$= [\bar{u}_1 \; u_2 \cdots u_t] \begin{bmatrix} \sigma_1 \\ 0 \\ \vdots \\ 0 \end{bmatrix} \bar{x}_1 + n$$

$$= \sigma_1 u_1 \bar{x}_1 + n$$

$$\bar{y}_1 = u_1^H y$$

$$= u_1^H (\sigma_1 u_1 \bar{x}_1 + n)$$

$$= \sigma_1 u_1^H u_1 \bar{x}_1 + u_1^H n$$

$$= \sigma_1 \bar{x}_1 + \bar{n}_1$$

$$SNR = \frac{\sigma_1^2 E\{(\bar{x}_1)^2\}}{\sigma_n} = \sigma_1^2 \frac{P}{\sigma_n^2}$$

where $P = E\{|\bar{x}_1|^2\}$ is the transmit power corresponding to the symbol $\bar{x}_1$

8)a) Explain singular value decomposition of mimo channel

→ In this section we will began to Explore the singular value Decomposition of the mimo channel matrix H which is a very important tool to stand the behaviour of a mimo wireless communication s/m Consider an $r \times t$ mimo channel H with $r \geq t$

$$H = \underbrace{\begin{bmatrix} u_{11} & u_{12} \cdots & u_{1t} \\ u_{21} & u_{22} \cdots & u_{2t} \\ \vdots & \vdots & \vdots \\ u_{r1} & u_{r2} \cdots & u_{rt} \\ u_1 & u_2 & u_t \end{bmatrix}}_{U} \underbrace{\begin{bmatrix} \sigma_1 & 0 \cdots & 0 \\ 0 & \sigma_2 \cdots & 0 \\ \vdots & \vdots & \\ 0 & 0 \cdots & \sigma_t \end{bmatrix}}_{\Sigma}$$

$$= \begin{bmatrix} v_{11}^* & v_{21}^* \cdots & v_{t1}^* \\ v_{12}^* & v_{22}^* \cdots & v_{t2}^* \\ \vdots & \vdots & \\ v_{1t}^* & v_{2t}^* \cdots & v_t^* \end{bmatrix}$$

$$= U \Sigma V^H$$

we have

$$\|u_i\|^2 = \|v_i\|^2 = 1, \quad 1 \le i \le t$$

$$u_i^H u_j = v_i^H v_j = 0 \quad i \ne j \quad 1 \le i,j \le t$$

$$V.V = VV^H = I_t$$

$$\sigma_1 \geq \sigma_2 \geq \cdots \geq \sigma_t$$

8 b) Explain SVD and mimo capacity

10M

The singular value decomposition is central to understanding the spectral multiplexing properties of the mimo channel and deriving the fundamental limit on the capacity.

$$y = Hx + n$$

Let SVD of the channel matrix H be given as H

$H = U\Sigma V^H$ thus replacing H with its SDV

$$y = \underbrace{U\Sigma V^H}_{H} x + n$$

$$\underbrace{U^H y}_{\tilde{y}} = U^H (U\Sigma V^H x + n)$$

$$\tilde{y} = \underbrace{U^H U \Sigma V^H}_{I_t} x + \underbrace{U^H n}_{\tilde{n}}$$

$$= \Sigma V^H x + \tilde{n}$$

$$\tilde{y} = \Sigma V^H x + \tilde{n}$$

$$= \Sigma V^H V \tilde{x} + \tilde{n}$$

$$= \Sigma \tilde{x} + \tilde{n}$$

$$R_{\tilde{n}} = E\{\tilde{n}\tilde{n}^H\}$$

$$= E\{U^H n (U^H n)^H\}$$

$$= E\{U^H n n^H U\}$$

$$= U^H E\{n n^H\} U$$

$$= \sigma_n^2 I_t$$

$$C_1 = \log_2 \left(1 + \frac{P_1 \sigma_1^2}{\sigma_n^2}\right)$$

$$C_2 = \log_2 \left(1 + \frac{P_2 \sigma_2^2}{\sigma_n^2}\right)$$

$$\vdots$$

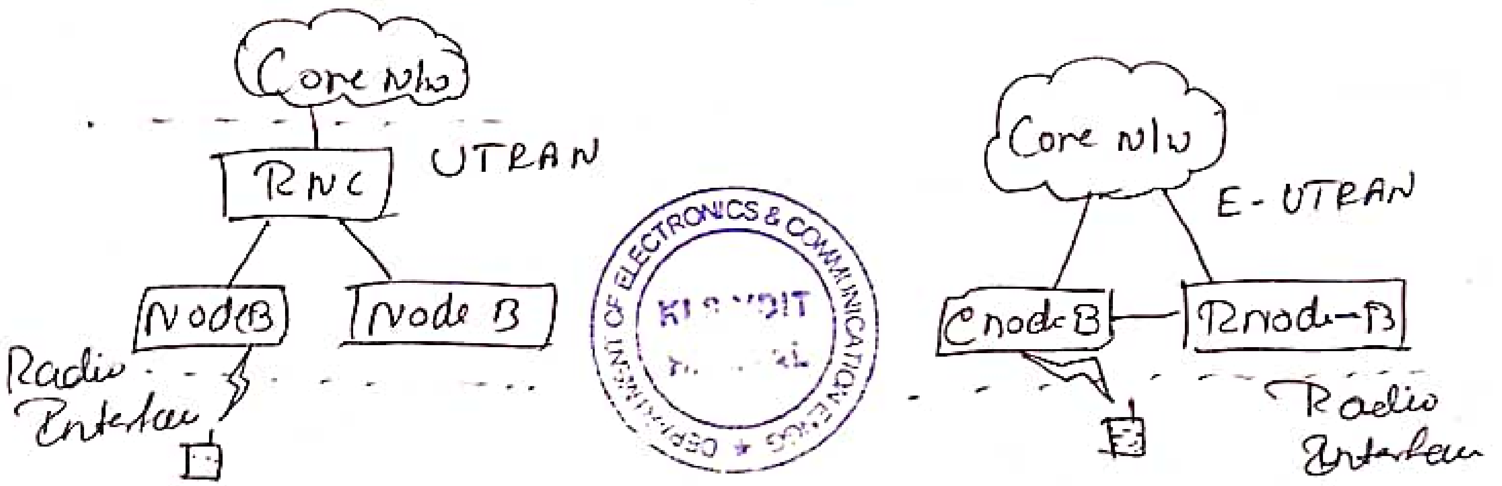
$$C_t = \log_2 \left(1 + \frac{P_t \sigma_t^2}{\sigma_n^2}\right)$$

$$C = \sum_{i=1}^{t} \log_2 \left(1 + \frac{P_i \sigma_i^2}{\sigma_i^2}\right)$$

$$P_1 + P_2 + \cdots + P_t \leq P$$

20Q a) Explain Radio interface Architecture 10m

→ The radio Interface of a wireless network is the interface b/w the mobile terminal and the base station and thus in the case of LTE it is located b/w the RAN E UTRAN and the user equipment compared to the UMTS terrestrial Radio access network for 3G sim which has two logical entities the Node B the UTRAN N/w architecture is simpler and flatter it is composed of only one logical node



Radio Interface architecture of UTRAN and EUTRAN

The LTE radio interface aims for a long term Evolution so it is designed with a clear state approach as opposed to high speed packet access which was designed as an addon to UMTS in order to increase throughput of packet switches services

9b Explain uplink SC-FDMA Radio Resources ?

→ uplink transmission SC-FDMA with a CP is adopted as discussed in SC-FDMA possesses most of the merits of OFDMA while enjoying a lower PAPR. A lower PAPR is highly described in the uplink as less expensive power amplifier are needed at UE and the coverage is improved generated by the DFT Spread OFDM compared to conventional OFDM the SC-FDMA Receiver has higher complexity

* <u>Frame structure</u>:- the uplink frame structure is similar to that for downlink the difference is that now we take about SC-FDMA symbols and SC-FDMA sub carrier in frame structure type 1 an uplink radio frame consist of 20 slots of 0.5ms each and one of such frame consists of two slots

* Physical Resources Blocks for SC-FDMA

PB can be Regarded as Conventional OFDM with DFD It is frequency the Resource grid for the uplink is similar to the one for the downlink.

$$N_{RB}^{min,UL} \leq N_{RB}^{UL} \leq N_{RB}^{max,UL}$$

18 when $N_{RB}^{min, UL} = 6$ & $N_{RB}^{UL} = 110$ correspond to the smallest and largest uplink bandwidth respectively

DC subcarrier is used in the uplink as the dc interface is spread over the modulation symbols due to the DFT based according

10a) write the Principles of LTE design 10m

→ It is designed completely new standard with new numbering and new documentation and it is not built on the previous versions of 3GPP Stand and Earlier Elements were brought as only if their was a compelling reason for them to exist in the new standard

* Network architecture, unlike 3G network LTE was designed to support packet switching traffic with support for various QoS classes of services Previous generations of networks such as UMTS / HSPA and EVDO also support packet switched traffic but this was achieved by subsequent add ons to the Initial version of the standard

* Data rate and Latency:- the design target for downlink peak data rates for LTE are 100 mbps and 50mbps respectively when operating at the 20MHz frequency division duplex channel size the user plane latency is defined in terms of the time it takes to transmit a small ElP packet from the UE to the Edge node of the radio access N/w

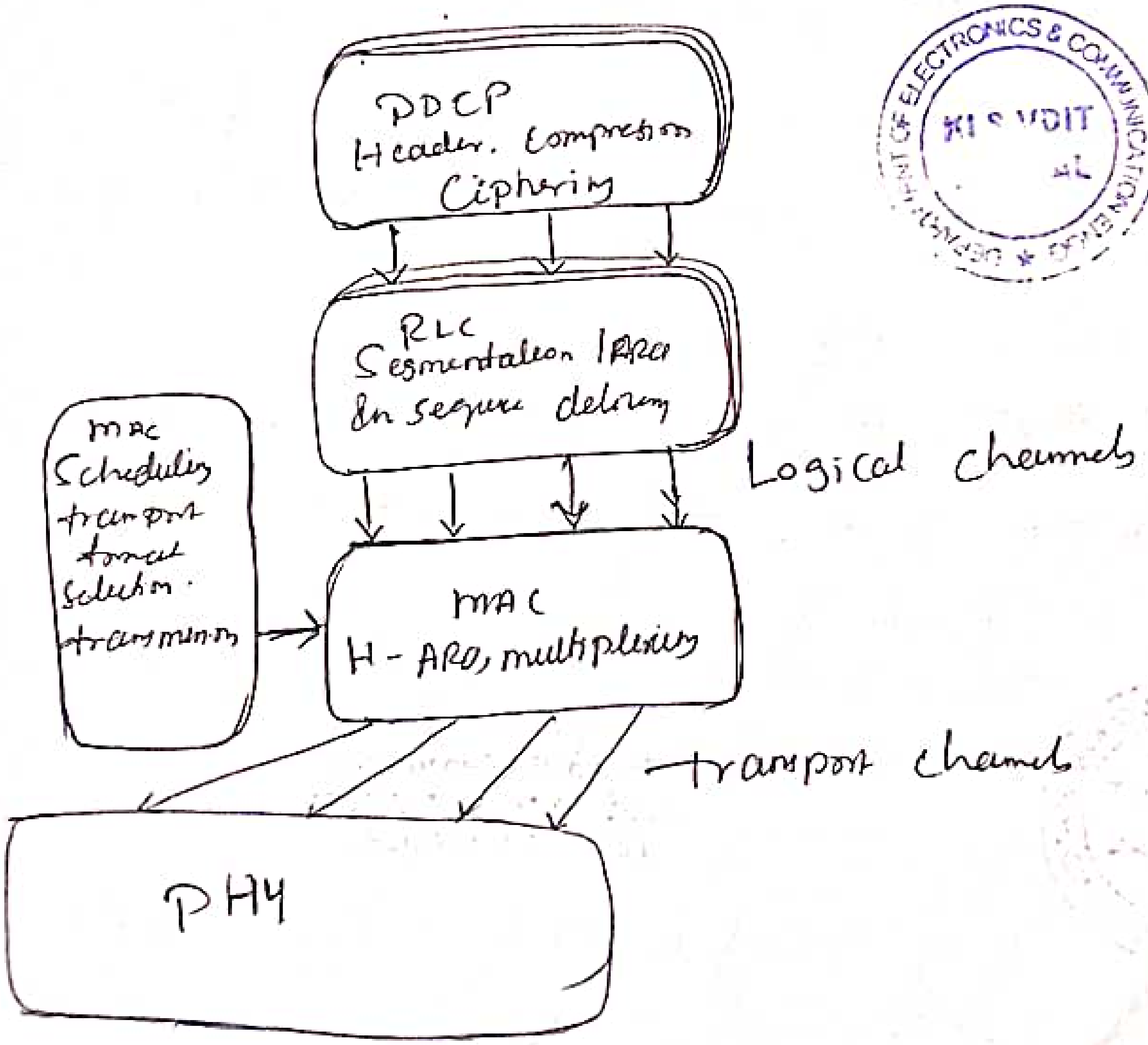
* Performance Requirements: The target performance require - ment of LTE are specific in terms of spectrum Efficiency mobility and coverage and they are in general Expressed relative to the 3GPP Release 6 HSPA

* Spectrum Efficiency the average downlink user data rate and spectrum Efficiency target is three to four times that of the baseline HSDPA network similarly in the uplink the average user data rate and spectrum Efficiency

* Radio Resource management: the radio resource management requirement cover various aspects such as Enhanced support for End to End QoS Efficient support for transmission.

10 b) Explain Hierarchical Structure of LTE 10m

→ There are 3 different channel types defined in LTE logical channels transport channels and Physical channels each associated with a service access point between different layers then channels are used by the lower layers of the protocol stack to provide service to the higher layers



* PDCP - The main function of PDCP include IP packet header compression and decompression based on Robust Header Compression.

* RLC: The main function of the RLC sublayer are segmentation and concatenation of data units, Error correction through the automatic Repeat request protocol.

* MAC: the main function of MAC layer is Error correction through the hybrid ARQ mechanism

* Physical layer: The main function of PHY is actual transmission and reception of data in form of transport blocks.

HOD

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