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Internal Assesment Test - II

Sub:	Wireless Communication							Code:	10EC81
Date:	16/ 04 / 2018	Duration:	90 mins	Max Marks:	50	Sem:	8th	Branch:	ECE (A,B)
Answer Any FIVE FULL Questions									

		Marks	OBE	
			CO	RBT
1.	A service provider wants to provide cellular communications to a particular geographic area. The provider is licensed 5MHz. Each system subscriber requires a bandwidth (channel B.W) of 10 KHz. If the service provider implements a cellular system with 35 transmitter sites and cluster size of 7, determine the new system capacity?	[10]	CO2	L3

Soln:

Assume the cluster size N = 7
The allocated B.W/cell= System B.W/ Number of cells in a cluster $=5*10^6/7=714$kHz
Bandwidth per cell = **714 kHz.**
No. of cluster 35/7= **5.**
Each cell has a capacity =714kHz/10kHz/user = **71 users**
Total system capacity =35 cells*71 users/cell = **2485 users.**
This is a system capacity increase of =5 times.

		Marks	CO	RBT
2.	Explain capacity expansion techniques: i) Cell Splitting ii) Cell Sectoring iii) Overlaid cells	[10]	CO2	L4

Soln:

i) Cell Splitting

The process of subdividing a congested cell into smaller cells. (each with its own base station and a corresponding reduction in antenna height and transmitter power). Cell splitting preserves the geometry of the architecture and therefore simply scales the geometry of the architecture
The increased number of cells would increase the number of clusters which in turn would increase the number of channels reused and capacity.
Assume that Cell A has become saturated and is unable to support its traffic load. Using cell splitting, six new smaller cells with approximately one-quarter the area of the larger cells are inserted into the system around A in such a way as to be halfway between two co channel cells.
These smaller cells will use the same channels as the corresponding pair of larger co-channel cells. In order that the overall system frequency reuse plan be preserved, the transmit power of these cells must be reduced by a factor of approximately 16 or 12dB

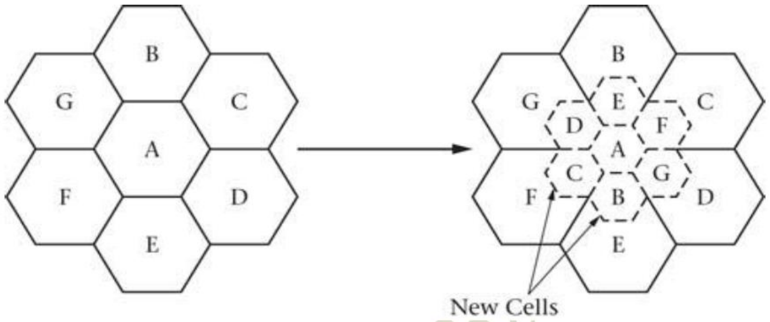


Fig: 3.4 Increase capacities by cell splitting

Cell splitting effectively increases system capacity by reducing the cell size and therefore reducing the frequency reuse distance thus permitting the use of more channels.

ii) Cell Sectoring

Another technique to increase cellular system capacity
Uses directional antennas to effectively split a cell into 3 or sometimes 6 new cells. It seek methods to decrease the D /R ratio.

Reuse Factor/ frequency reuse ratio :

$$Q = D/R = (3N)^{1/2}$$

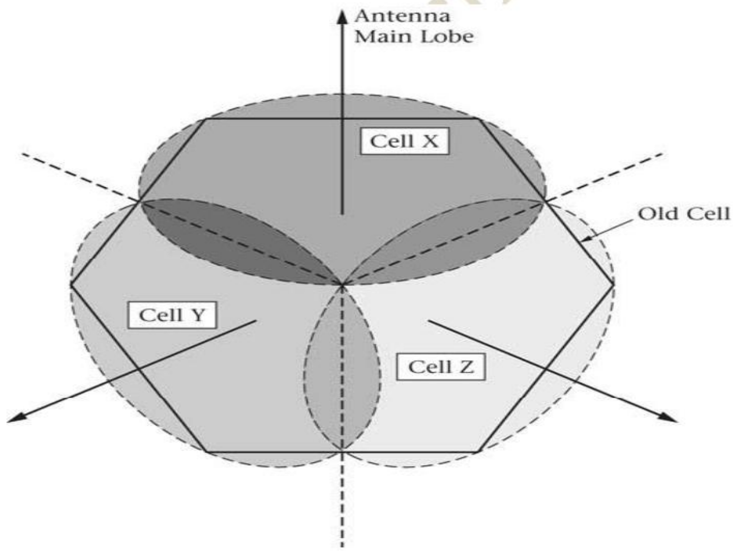


Figure 3.5: Increasing capacity by cell sectoring

Fig: Three directional antennas with 120^{o} beamwidths to illuminate the entire area previously services by omnidirectional antenna

It provides interference reduction, hence S/I ratio increases.
To address co-channel interference. It does not require new cell sites and additional antennas and triangular mounting only.
Demerits: Increased network system architecture complexity
Sectoring of a cell results in a reduction in the amount of interference that the sector experiences from its co channel neighbors in adjacent

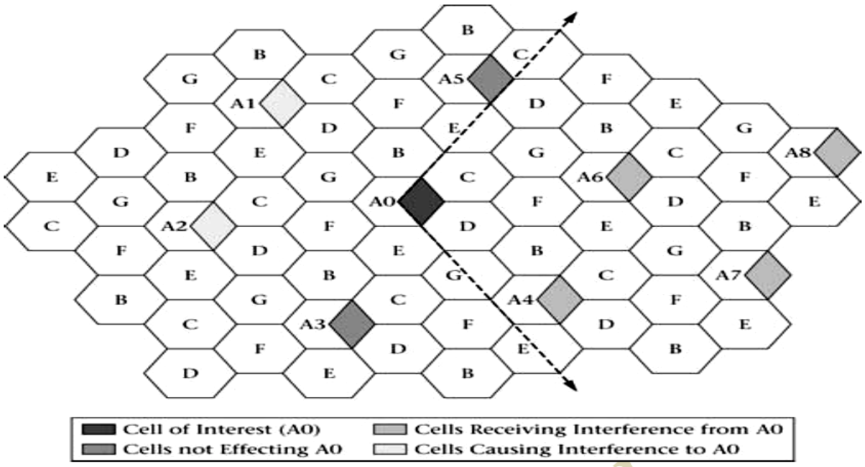


Fig 3.6: Interference reduction due to cell sectoring

iii) Overlaid cells

This method can be used to expand the capacity of cellular systems in two ways.

- ❑ Split-band analog systems.
- ❑ Reduced cluster size systems

Overlaid cells in a split-band system:

An operational wideband analog system could be upgraded to increase its capacity by overlaying another analog system with narrower bandwidth requirements over it. In such a split-band overlay system, channels are divided between a larger macrocell (using AMPS or TACS) and the overlaid microcell (using NAMPS or NTACS) that is contained in its entirety within the macrocell. Channels are divided among a larger macrocell that coexists with a smaller microcell contained entirely within the macrocell „
BS serves both macro- and microcells „
R1, D1: macrocell; R2, D2: microcell.
D2/R2>D1/R1 „
SIR for microcells substantially greater than that for macrocells -- and this situation may be exploited to increase network capacity by using split-band analog system, or reuse partitioning

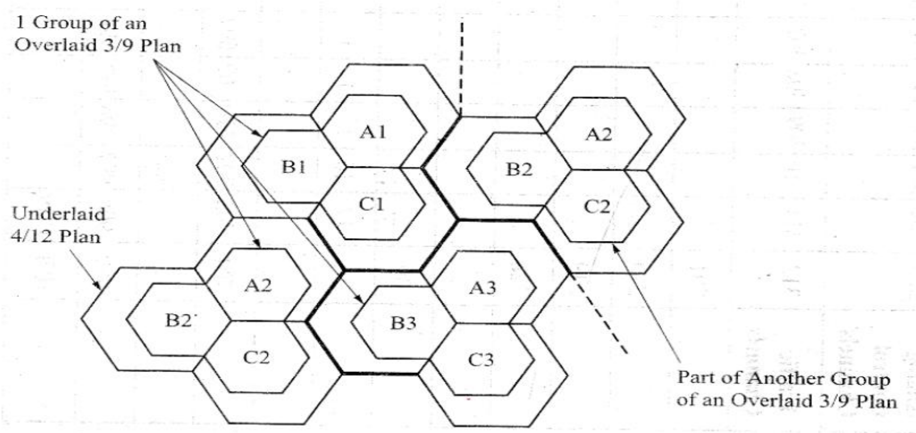


Figure 3.8 Overlaid cells in a reduced cluster size system

3. (a)	Determine frequency reuse distance for cell radius 5km and cluster size of 7.	[4]	CO2	L3

Soln: Given N=7,
We know that

$$D = R(3N)^{1/2}$$
$$=5(3*7)^{1/2}$$
$$= 5(21)^{1/2} = 5(4.5823) = 22.913km$$

(b)	Write a note on channel assignment strategies.	[6]	CO2	L2

Soln:

Need for channel allocation to handle random/ dynamic traffic with different scenarios of activities that might cause the amount of traffic to change.
The traffic scenario within the business district can be dealt with to some degree through channel allocation techniques.

Three main methods to achieve efficient channel allocation :

1. Fixed channel scheme: The procedures of this scheme are
Examines system wide traffic patterns over time. Fine tune the system by allocationg additional channels where needed. This means that instead of equally dividing up the channels over the cells, some cells will receive larger channel allocations than others. Use very complex algorithms to determine the final allocation of channels, and these allocations are periodically updated as a traffic usage database grows.

2. Channel borrowing scheme:

A high-traffic cell can borrow channels from low-traffic cells and keep them as needed or until the offered traffic returns to normal.
While borrowing channel, it should not effect on performance of the borrowed cell. After the traffic over the borrowed channel is complete, the channel is returned to use in its original cell.

3. Dynamic channel allocation (DCA):

All the available channel are placed in channel pool . Each channel assigned a new call based on Signal to interference statistics. Each Channel can be used by each cell until necessary SIR is met. This is an extremely complex system that uses many network resources to accomplish its operation.

4.	Explain mobility management concept. Explain the functions of location management with a neat diagram	[10]	CO2	L4

Soln:

Most important characteristics of wireless communication system is the ability to provide mobility to the user.
It explains how the network knows where the subscriber is (Location Management) and how it keeps track of and is in contact with the mobile station as the user moves from one cell to another (Hand Off Management)
Mobility management = Location management + Hand off management

Location management:

It is the process of keeping track of the present or last known location of the

MS and delivery of both voice and data to it as it moves around.
Its main objectives are:

1. Provide continuous radio link
2. Know the location of the device
3. Direct the packet in a network
4. Determine MS status in network
5. Check availability of the MS

Basic functions performed by Location management:

1. Location updating
2. Sending paging messages
3. Transmission of location information between network elements

It is performed by MS. After initial power up / system registration, the MS and BS will exchange their identification information.MS is attached to a BS and is located initially and Periodically checked for accuracy and accidental detach from system. MS sends update message every time it changes point of access(AP) in a network and exchange information for handoff. Location update request msg: if MS receives ID of BS from a different LA. If a connection fails, system pages group of surrounding stations to track a MS. When MS is turned on -→ new registration info
Balance is required between number of update messages and number of cells to be paged. Greater degree of certainty in locating the MS --→ if frequent paging
Two types of updating schemes

1. Static: cellular network's geographic layout determines updating requirements.
2. Dynamic : user's mobility and cellular system layout determines updating algorithms

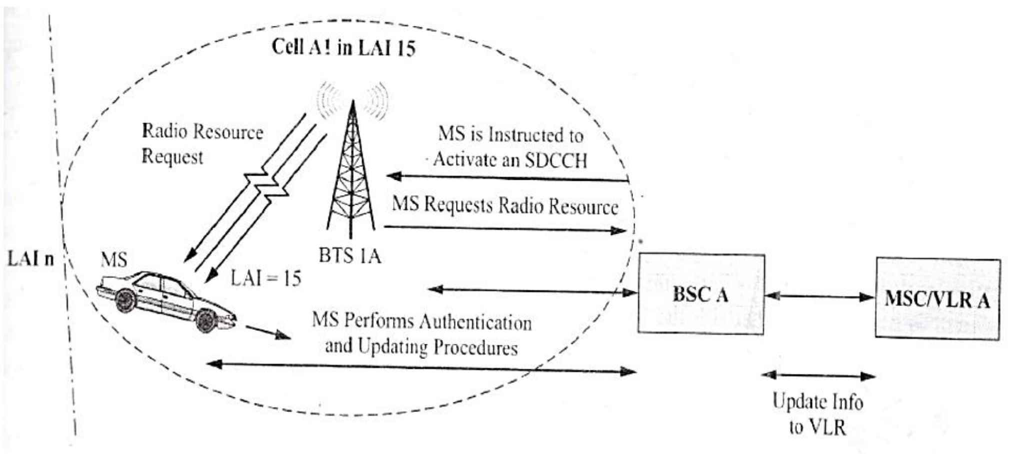


Fig 3.12: Cellular location updating.

Location Updating - Static method

In this approach, a group of cells is assigned a location area identification value (LAI). Each BS in the LA broadcasts its ID number in a periodic fashion over a control channel. The MSs that are attached to the base station within the LA are required to listen to the control channel for the LA ID. If the LA ID changes, the MS will have to send a location update message to the new BS. The BS will forward the updated information to the VLR database location in the fixed position of the wireless network.

Now, if there is an incoming message for an MS, a paging message will be sent to all the cells in the LA where the MS is listed as being present. The MS, unless it has moved in to another LA, will respond to the paging message.

Drawback: PING-PONG Effect: This effect can occur if the mobile is moving in a path that takes it back and forth between the borders of 2 LA s. --→ can affect hand off process.

5.	What is the received power in dBm for a signal in free space with a transmitting power of 1 kW, frequency of 1800 MHz, and distance from the receiver of 2000 meters if the transmitting antenna and receiving antenna both use dipole antennas with gains of approximately 1.6? What is the path loss in dB?	[10]	CO4	L3

Soln:

Given Pt = 1 W, f = 1900MHz, d = 1000 mts,
Gt = Gr = 1.6, Path Loss PL in db = ?
Pr in dBm = ?

Using Frii's equation

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}$$

where

$\lambda = c/f = (3x\ 10^8)/(1900 \text{ x } 10^6) = 0.15789$ mts

Pr in watts = $1 \text{ x}1.6 \text{ x}1.6 \text{ x } (0.15789)^2 / (4\pi)^2 \text{ x } (1000)^2$
$= 4.042 \text{ x } 10^{-10}$ W or 4042nW
Pr in dBW = $10 \log (0.4042 \text{ x } 10^{-9}) = - 93.934$ dB
Pr in dBm = $10 \log (0.4042 \text{ x } 10^{-9} \text{ x } 10^3) = - 63.934$ dBm.
Path Loss PL in watt = Pt – Pr = $1 - 0.4042 \text{ x } 10^{-9} \approx 1$W
Path Loss PL in dB = 10 log(1) = 0 db
Path Loss PL in dBm = $10 \log(1 \text{ x } 10^3) = + 30$dBm

6.	Explain how radio resource management and power management are done in wireless communication systems.	[10]	CO2	L4

Soln:

Power management includes Interference management, Energy management and Connectivity management. We know that in cellular systems the use of many closely spaced low-power RBSs allows for frequency reuse and hence increased system capacity. At the same time, interference also increases. Interference can be reduced by use of power control algorithms for the adjustment of the MS output power and RBS output power allow for nearly constant received signal strength at both the MS and RBS receivers.

This use of power control provides several system advantages

1. the amount of co channel interference (CCI) is reduced.

2. risk of signal coupler saturation is reduced at RBS

3. power consumption of MS is reduced

The last advantage has additional ramifications in the reduction of battery requirements, which translates to longer time between charging and lighter and smaller mobile terminals.

Power control algorithm:

Design objectives are :

- Achieve SIR tolerance with good quality communications
- Must constantly adjust to change in RSS caused by fading or mobility of MS

Usual Power control algorithm has 2 phases:

Phase I: MS registers with BSS, Determine minimum output power to avoid possibility of a call drop

Phase II: Additional measurements to reduce power, Output power of RBS is adjusted, Use complex algorithms achieve maximum SIR for all radio links.

Power saving schemes

Motive: to conserve MS battery power during txn /reception/standby mode

1. Discontinuous transmission (DTX)

- Mobile may be programmed to transmit only during speech activity
- RBS sets discontinuous transmission (DTX) bit to either permit or disallow this mode and includes extra over head msg to mobile during initial registration of mobile.

2. Sleep mode

- Another technique to save MS battery power is to put MS into sleep mode during periods of no activity
- For this, RF circuitry is powered off while waiting btwn msgs
- Mobile will periodical awaken and read ctrl channel msgs from the system so as to not miss a paging msg

3. Energy efficient designs

- Use of most power-efficient semiconductor technologies
- Additional power savings: Power efficient modulation and coding schemes
- Protocol design -Software/hardware design
- Advanced DSP technology – software radios, reconfigurable wireless radio systems

Radio Resources Management (RRM)

It is the system level control of co-channel interference and other radio transmission characteristics in wireless communication systems

Two types of RRM

1. Static RRM: Involves manual as well as computer aided fixed cell planning or radio Network planning.

2. Dynamic RRM: Adaptively adjust the radio network parameters to the traffic load, user Positions, Quality of service requirements, etc.

Provide functional improvements for RF operation Implement system power control to reduce interference. Maximize capacity from above concept

Best available radio channel selection Use wireless radio resource management scheme to enable handoff operations

7.	Explain various path loss models.	[10]	CO4	L4

Soln: Types of Path loss model

- Free space model
- Two-ray model
- Okumura model
- Okumura-Hata model

Free space model

- This model is used to predict received signal strength when the transmitter and receiver have a clear line-of-sight path between them.

Examples :
Satellite communication
Microwave line-of-sight radio link
The received signal power at distance d (Friis free space equation)

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2}$$

Where

Pt : transmitted power, d : T-R separation distance (m)
Pr : Received power, Gt: transmitter antenna gain , λ : =c/f
Gr : receiver antenna gain

- Limitation: It does not give accurate result when applied to mobile radio environments.

Two-ray model

- It is also called Ground Reflection Model
- It is the simple approximation model for a land mobile outdoor environment.
- It is reasonably accurate model for predicting large scale signal strength over distance of several kilometers

In this Model that considers both the direct (LOS) path and a ground reflected path between transmitter and the receiver.

- Generally, the two antenna each have different height.
- The received signal having two components, the LOS component and the

multipath component formed predominantly by a single ground reflected wave.

- The equation that approximates 2- ray model

$$P_r = P_t G_t G_r \frac{h_t^2 h_r^2}{d^4}$$

Where h_t and h_r are the height of the transmitting and receiving antennas

Analysis: For $d >> h_t h_r \rightarrow P_r \propto 1/d^4$
EM wave undergoes an attenuation from -6 dB to -12 dB every time the distance it travels doubles.
The approximation equation for path loss using two ray model can be written as
Path Loss = 40 log d – (10 log Gt + 10 log Gr + 20 log h_t+ 20 log h_r)
The 2-ray ground reflected model may be thought as a case of multi-slope model with break point at critical distance with slope 20 dB/decade before critical distance and slope of 40 dB/decade after the critical distance. When the distance d between antennas is less than the transmitting antenna height, two waves are added constructively to yield bigger power. As distance increases, these waves add up constructively and destructively, giving regions of up-fade and down-fade.

Okumura model

The **Okumura model** is a Radio propagation **model** that was built using the data collected in the city of Tokyo, Japan. This model is one of the most widely used models for signal prediction in urban areas. Wholly based on measured data - no analytical explanation It is the simplest & best for in terms of path loss accuracy in cluttered mobile environment. Common standard deviations between predicted & measured path loss ≈ 10dB to 14dB

Useful for

Frequencies ranging from 150 MHz-1920 MHz
Frequencies can be extrapolated to 3GHz
Mobile station antenna height: between 1 m and 3 m
Link distance: 1km to 100km
Base station antenna heights from 30m-1000m

Okumura developed a set of curves in urban areas with quasi-smooth terrain. This model is fairly good in urban and suburban areas, but not as good in rural areas. Disadvantage with this model is its slow response to rapid changes in terrain

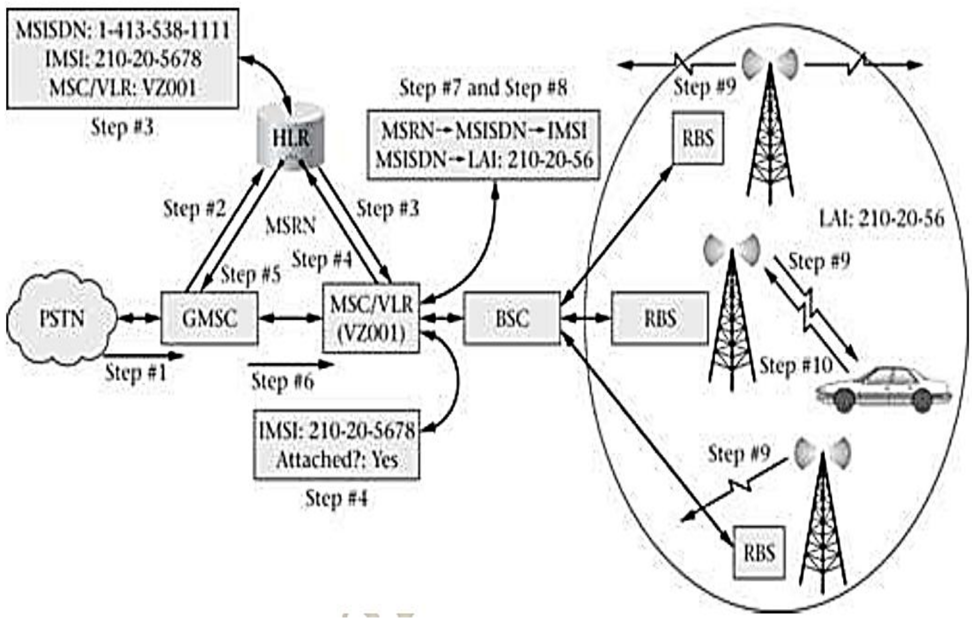
Hata model

The **Hata model** is a radio propagation **model** for predicting the path loss of cellular transmissions in exterior environments, valid for microwave frequencies from 150 to 1500 MHz. It is an empirical formulation of the graphical path loss data provided by Okumura. This model has been proven to be accurate and is used by computer simulation tools. Hata presented the urban area propagation loss as standard formula and supplied correction equations for application to other situations. The predictions of the Hata model compare very closely with the original Okumura model, as long as d exceeds 1 km. Hata model is well suited for large cell mobile systems, but not PCS which have cell size on the order of 1 km radius.

8.	Explain call establishment in mobile terminated call with a neat flow diagram which includes GMSC, MSC/VLR and BSC.	[10]	CO1	L4

Soln: Basic operations are

- GMSC operations
- MSC/VLR operations
- BSC operations



Step #1: Any incoming call to a MS from the PSTN is first routed to the network's GMSC.

Step #2: GMSC first determines where the mobile is located at that particular moment in time by examining the mobile station's MSISDN to find out which HLR the mobile subscriber is registered in.

Using SS7 (SCCP), the MSISDN forwarded to the HLR with a request for routing information to facilitate the setup of the call

Step #3: The HLR looks up which MSC/VLR is presently serving the MS and the HLR send a message to the appropriate MSC/VLR requesting an MS roaming number (MSRN), so that the call may be routed.

This operation is required since this information is not stored by the HLR; therefore, a temporary MSRN must be obtained from the appropriate MSC/VLR.

Step #4: An idle MSRN is allocated by the MSC/VLR and the MSISDN number is linked to it. The MSRN is sent, back to the HLR.

Step #5: The MSRN is sent to the GMSC by the HLR. ained from the appropriate MSC/VLR.

Step #6: Using the MSRN, the GMSC routes the call to the MSC/VLR.

Step #7: When the serving MSC/VLR receives the call, it uses the MSRN number to retrieve the mobile's MSISDN. At this point the temporary MSRN number is released.

Step #8: Using the mobile's MSISDN, the MSC/VLR determines the location area where the mobile is located.

Step #9: The MS is paged in all the cells that make up this location area.

Step #10: When the MS responds to the paging message, authentication is performed and encryption enabled. If the authentication and encryption functions are confirmed, the call is connected from the MSC to the BSC to the RBS where a traffic channel has been selected for the air interface