Homework -4

Answer: Frequency reuse in cellular networks can be defined as a technique which is used to allow efficient utilization of the limited available spectrum by reusing the same frequencies across different cells within an area.

In any cell network, the coverage area can be divided into multiple small cells and each cell will be assigned a set of channels. Using the same frequencies as long as they are separated to avoid interference. Which results in efficient spectrum utilization by frequency planning and reuse patterns. Instead of having different frequencies to different cells. Which results in quickly exhaust the available spectrum. The reuse pattern is known as clusters. Where each cell in the cluster is given an unique set of frequencies and then same pattern is repeated over the entire area.

The frequency reuse can be is determined depending on several different factors like no. of available channels, the desired capacity and the expected signal propagation characteristics.

The reuse factor can be denoted by Letter ‘N’ which represents the no. of cells in a single cluster. Higher the value of N which means that the same frequency is reused less frequently. Resulting in less interference and less capacity and vice-versa

The factors that influence the frequency reuse pattern are as follows:

1. Propagation medium: The propagation medium like buildings, terrain and obstacles can affect the signal propagation and interference levels.

2. Cell radius: Smaller the size means higher the reuse factor to mitigate interference and larger cell sizes means lower reuse factor.

3. Transmiting power: Higher the power levels, higher the chance for co-channel interference, indicating higher reuse factor.

4. Modulation and coding schemes: Robust modulation and coding techniques can improve interference tolerance, allowing for a lower reuse factor.

2.

Answer:

Cell splitting and cell sectoring are techniques are used in cellular networks to increase capacity by improving frequency reuse and reducing interference.

**Cell Splitting:** It can be defined has a process involving division of the congested cell into smaller cells with each its own base station and frequencies. This process is used when a cell becomes overloaded due to an increased no. of users or network has more traffic. By dividing the cell we can have more no. of channels per cell which increases the capacity of the network.

When a cell is split the original cell is then replaced with several smaller cells and will have a less power transmiting and less radius. This in turn reduces the distance between the user and the base stations which results in increasing signal quality and higher data rates. The reduced cell size allows efficient frequency reuse as we can use the same frequencies at less distance without causing interference.

**Cell Sectoring:**It can be defined as another technique which is used for increase capacity in the cellular networks. In this method the coverage area in the cell is divided into multiple different sectors as three or six by using directional antennas. Each sector is allocated a separate set of channels or frequencies, effectively creating multiple smaller cells within a single cell site.By dividing the cell into sectors we can increase the capacity of the cell in each sector. This sectoring approach reduces interference between users in different sectors as the directional antennas focus the transmission and reception in only a single direction. The sectoring improves the overall signal quality by concentrating the transmitted power in specific directions rather than spreading it in all directions.

Both cell splitting and cell sectoring contribute to increasing the capacity of cellular networks by:

* To reduce the distance between users and base stations which improves the signal quality and data rates.
* To enable more efficient frequency reuse by creating smaller coverage areas.
* To decrease co-channel interference by separating users into different sectors.
* To accommodate more users within the same area.

3.

Answer:

It can be defined has technique used for establishing a connection between two mobile phones in any cellular network. The mechanism used to find and ring any mobile device when the incoming call or data session is needed to establish. The paging process will use the network resources efficiently and save the battery life. In any cellular networks the area is divided into multiple areas each consisting of several cells. When a mobile device is idle, the mobile device periodically monitors the paging channel to for incoming calls/messages. The paging channel is also known as control channel used by the network to send paging messages between the mobile devices.

A call or data session is established with a mobile device bythe following paging process:

* The network first finds the last known location area of the mobile device based on its registration or update within the network.
* The network then sends a paging message on it’s paging channel of all cells within that area where the mobile device is located.
* The paging message will have a unique identifier of the mobile device like IMSI or TMSI when roaming.
* All idle mobile devices within the area monitor the paging channel regularly for their identifiers.
* When a mobile device recognizes its identifier in the paging message then it sends a response to the network telling about its availability and readiness to establish the connection.
* The network then allocates the necessary resources and proceeds with the starting the call

4.

Answer:

It can also be called as handover. It is important technique in maintaining an ongoing call between two different mobile phones when they move from one cell to a different cell in the cellular network. It can be defined has process of transferring an active call or data session from one cell to another as the mobile device moves out of range.

The primary objective of the handoff process is to have continous connection, less interruptions and call drops as the user moves in the network. This is achieved by continuously monitoring the signal strength and quality of the current connection and initiating a handoff when necessary.

The handoff process involves the following steps:

* Measurement and Monitoring: The mobile device and the base station continuously measure and monitor the signal strength and quality of the current connection.
* Handoff Initiation: When the signal strength or quality of the connection falls below a predefined threshold. The handoff process is initiated.
* Neighbor Cell Scanning: The mobile device scans and identifies potential target cells that can provide better signal quality.
* Handoff Decision: Based on the results. The network decides which target cell is most suitable for the handoff.
* Resource Allocation: The network allocates the required resources in the target cell to accommodate the ongoing call or data session.
* Handoff Execution: The active call or data session is seamlessly transferred from the cell to the target cell.
* Connection Release: Once the handoff is completed the resources allocated in the last cell are freed.

Handoffs can are two different types. They are:

* Hard handoff (break-before-make) and
* Soft handoff (make-before-break)

5.

Answer:

The following are the challenges associated with 5G networks:

* High bandwidth
* Capacity requirements
* Spectrum allocation and management
* Network density
* New architecture
* Energy efficiency and sustainability
* Security and privacy

To addresses the 5G challenges:

* We can increase bandwidth and capacity
* Efficient spectrum utilization
* Increase the network density by having more small cells
* Network virtualization and slicing
* Advanced antenna technologies
* Improved energy efficiency methods
* Enhanced security and privacy

6. n = 4. Consider 7-cell reuse pattern.

Reuse factor = q= D/R =

= = = 4.583

Signal to interference ratio= S/I = = = = 73.53

SNRdb = 10log(S/I) = 10log(73.53)= 10\*1.8664=18.664db

Since S/I is greater than minimum, N=7 can be used.

1. n = 3.

Reuse factor = q= = = 4.583

Signal to interference ratio = S/I = = = = 16.04

SNRdb = 10log(S/I) = 10 log(16.04) = 10\*1.205 = 12.05db

Since SNRdb value is less than the minimum. So, the next N value is

N= i2+j2 + i\*j

Let i=j=2;

N= 22+22+2\*2= 4+4+4=12

* Reuse factor q = = = =
* S/I =
* SNRdb = 10log(S/I)= 10log(36) 10\* 1.556= 15.56

Since, it’s greater than minimum S/I value , N=12, can be used.

7.

Given:

Total bandwidth = 33MHz

Channel bandwidth = 25khz \* 2 simplex channels= 50Khz duplex channel

Total available channel’s for voice= (Total bandwidth allocated – bandwidth for control channels)/ bandwidth per channel

=(33MHz- 1MHz)/50KHz = 640 channels

a) For N = 4 (four-cell reuse):

Number of channels per cell = 640 / 4 = 160 channels

b) For N = 7 (seven-cell reuse):

Number of channels per cell = 640 / 7 = 91 channels

c) For N = 12 (twelve-cell reuse):

Number of channels per cell = 640 / 12 = 53 channels

Distributing control channels and voice channels equitably in each cell.

For N = 4:

Total channels per cell = 160

Control channels = 1 MHz / (4 × 50 kHz) = 5 channels

Voice channels = 160 - 5 = 155 channels

For N = 7:

Total channels per cell = 91

Control channels = 1 MHz / (7 × 50 kHz) = 3 channels

Voice channels = 91 - 3 = 88 channels

For N = 12:

Total channels per cell = 53

Control channels = 1 MHz / (12 × 50 kHz) = 2 channels

Voice channels = 53 - 2 = 51 channels

Therefore, the equitable distribution of control channels and voice channels in each cell for the three systems is:

a) Four-cell reuse: 5 control channels and 155 voice channels

b) Seven-cell reuse: 3 control channels and 88 voice channels

c) Twelve-cell reuse: 2 control channels and 51 voice channels

8.

Ans:

In the above given figure, the process for terminating a mobile call for a roaming user in a GSM network is shown. From the figure we can see the following terms as MS-ISDN, MSRN and TMSI.

MS-ISDN (Mobile Subscriber ISDN number): It can be defined has the international directory number given to assigned to a mobile subscriber user. It’s a unique number given to each user which is used to identify the subscriber's plan to the network. This number can be used for routing calls to the user’s mobile device.

MSRN (Mobile Subscriber Roaming Number): It can be defined has a temporary number assigned to a roaming mobile user who visit’s place outside their own regular network by the visited network, which means the user is currently roaming in. This number then will be used for performing the routing of the incoming calls to the roaming user within the visited network. The MSRN is valid only for the limited duration of the roaming as it is temporary.

TMSI (Temporary Mobile Subscriber Identity):It can be defiend has temporary identifier assigned to a mobile device by the carrier in the roaming network where the user is present. It can be used for identifying the mobile device within the roaming network for the signal. The TMSI will be changed for security purpose periodically and used as a alternative to the permanent subscriber identity (IMSI) for privacy of the user in the roaming network.

Based on the figure, how a roaming user is reached by a PSTN (Public Switched Telephone Network) call initiator:

1. The PSTN call initiator dials the MS-ISDN of the roaming user.

2. The call is routed to the user’s home network based on the MS-ISDN.

3. The home network then goes through the Home Location Register to find the user's location and their routing information.

4. The HLR then gives the information to the home network that the user is roaming.

5. The home network then requests a roaming number which is a MSRN from the visited network for sending the call to the roaming user in the who’s outside his own network area.

6. The visited network then assigns the MSRN to the roaming user and send’s it to the home network.

7. After that the home network routes the call to the visited network using the MSRN.

8. The visited network then uses the TMSI to identify and locate the roaming user’s mobile device in its coverage area.

9. The visited network calls the mobile device using the TMSI.

10. Then mobile device responds to the calling request, and then call is established between the PSTN call initiator and the roaming user mobile device.