Archives

понедельник, 28 сентября 2009 г.

3.6 Concentric Cell Technology

3.6.1 Concept

In the GSM network, concentric cell technology is used to divide the service area into two parts: overlay and underlay. In essence, the concentric cell technology concerns channel allocation and handover. When combining this technology with various frequency planning technologies, you can both expand network capacity and improve network quality.

The underlay covers the traditional cells, and the overlay covers the areas near the base station. Generally, 4 x 3 frequency reuse pattern is used for the underlay. For overlay, the frequency reuse patterns, such as 3 x 3, 2 x 3, or 1 x 3, are used. Therefore, all carriers can be divided into two groups, one for underlay, and the other one for overlay. The overlay and underlay share the same base station address, one set of antenna feeder system, and one BCCH, so you must set the BCCH on the underlay.

If the capacity of the overlay is great, you can group the channel numbers according to Table below.

In this case, the overlay has more channel numbers, which is beneficial for the base station to absorb nearby traffic volume.

Channel number grouping for 6MHz bandwidth concentric cell (a)

Logical channel	Channel number																														
Underlay (12)	66	67	68	69	70	71	72	73	74	75	76	77																			
Overlay (18)													78	79	80	81	82	83	84	85	86	87	88	98	90	91	92	93	94	95	

If traffic volume is evenly distributed, you can enhance the underlay capacity through grouping the channel numbers according to Table below.

In this case, the underlay can absorb more traffic volume.

Channel number grouping for 6MHz bandwidth concentric cell (b)

Logical channel	Channel number																														
Underlay (24)	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89							
Overlay (6)																									90	91	92	93	94	95	

3.6.2 General Underlay Overlay

General underlay overlay (GUO) aims to restrict the intra-frequency interference. To realize this purpose, you can reduce the overlay coverage area. That is, if the transmit power of the overlay carriers is lower than that of the underlay carriers, the coverage area of the overlay is smaller than that of the underlay.

The handover between the overlay and underlay is related to the receiving level of the MS and the TA (timing advance) from the MS to the base station. You should allocate the

channel numbers (such as BCCH number) with looser frequency reuse aggressiveness to the MSs in the underlay. For the MSs in the overlay, you should allocate the channel numbers with aggressive frequency reuse to them. In this case, you can expand the network capacity by using aggressive frequency reuse pattern in overlay.

For general underlay overlay, the coverage area of the underlay is inconsistent with that of the overlay, so problems concerning traffic and handover control are often caused. The general underlay overlay is applicable to the areas near the base station where the traffic is concentrated. The more concentrated the traffic near the base station, the more apparent the effect of capacity expansion is. However, the transmit power of the carriers in the overlay is low, so it is hard for the base station to absorb indoor traffic volume. In this case, when the traffic volume is evenly distributed, the general underlay overlay has little effect on capacity expansion.

3.6.3 Intelligent Underlay Overlay

Intelligent underlay overlay (IUO) technology can ensure that the coverage areas of call carriers are the same. For an IUO, the transmit power of the carriers in the underlay and overlay is the same.

In an IUO, the frequencies of a base station are divided into two layers: one is regular layer, and the other one is supper layer. At the regular layer, the frequency reuse distance is large, so you can use looser frequency reuse pattern, such as 4 x 3 frequency reuse pattern. At the supper layer, the frequency reuse distance is relatively small, so you can use aggressive frequency reuse patterns, such as 2 x 3 and 1 x 3 frequency reuse pattern.

In an IUO, the interference at the supper layer is great, so designated equipments and handover algorithms on C/I must be provided.

In an IUO, the conversation is first established at the supper layer, and then the BSC monitors the C/I of the channels at the supper layer without any stop. If the C/I is greater than the Good C/I Threshold, the conversation seizes a channel at the supper layer. If the C/I is smaller than the Bad C/I Threshold, the conversation seizes a channel at the regular layer. In addition, you can control the traffic volume at the supper layer and the regular layer by adjusting the handover threshold.

For an IUO, the transmit power of the carriers at the regular layer is the same as that at the supper layer, so the network can absorb the traffic flexibly, which is beneficial for the expansion for actual network capacity.

If the IUO technology is used, you must add the functions, including the estimation of intra-frequency protection C/I for downlink channels and the handover algorithms related to IUO, to the system.

3.6.4 Characteristics of Concentric Cell Technology

The characteristics of concentric cell technology are listed below:

- Any change of the network structure is unnecessary.
- Special software and designated algorithms on channel allocation and handover are needed.
- The system has no special requirement on hardware.
- GUO is applicable to the areas near the base station where the traffic is concentrated.
- The overlay coverage of the GUO is small, so the intra-frequency reuse attenuation factor (q) is great, which increases interference in the network.
- The transmit power of the overlay carriers in the GUO is low, so it is hard for the carriers to absorb indoor traffic.
- The transmit power of the underlay carriers in the GUO is the same, so the carriers can absorb indoor traffic, which contributes to network capacity expansion and good conversation quality.

For the comparison between the GUO and IUO, see Table:

A comparison between GUO and IUO.

	Coverage area	Frequency reuse pattern	Transmit power	Logical channel allocation	Handover algorithm
GUO	Underlay	4 x 3	High	BCCH/TCH	Power& Distance
	Overlay	3 x 3/2 x 3/1 x 3	Low	TCH	
IUO	Underlay	4 x 3	Same	BCCH/TCH	C/I
	Overlay	3 x 3/2 x 3/1 x 3	Same	TCH	

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