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Techniques for Improving Channel Capacity of Downlink in GSM Systems

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Abstracts: - The continuous increase in the cellular mobile users in recent times and the associated impairments in the system has been a lot of concerns to both the users and the network operators. It is required to be offer very high capacity in a limited spectrum allocation. The allocated spectrum becomes gradually congested and eventually becomes used up. Congestion of the Spectrum means that the call blocking probability has increased and this is not desired in the system. This paper looks at techniques of enhancing the cellular capacity with Cell Splitting and Cell Sectoring and coverage zone approaches.

I. INTRODUCTION

Cellular systems accommodate a large number of users over a large geographic area, within a limited frequency spectrum. Since system bandwidth is scarce and its capacity is limited.. There is the need to make the maximum use of the scarce resource optimally for maximum use of quality of service provision improved data throughput. Like new multiple access schemes, Antenna adaptive power control, powerful channel coding, voice activity exploitation, and lower rate speech coding. The enhance of GSM system network through Cell Splitting and Cell Sectoring is one of the techniques use in the minimize the effect of interference in GSM network. Cell splitting allows an orderly growth of the cellular system. It increases the capacity of a cellular system since it increase the number of times that channels are reused. Based station in adjacent cells are assigned channel groups which contain completely different channels than neighbouring cells. The base station antennas are designed to achieve the desired coverage with in cell. While in Cell sectoring, an already existing cell is partioned into sectors with each sector being covered by directional antenna which radiates energy in a specified direction unlike the omnidirectional antenna that radiates energy isotropically. Therefore any base station that is not within the sectored covered by the directional antenna cannot interfere with the transmitted signal from the base station. The approach is superior to sectoring since antennas are placed at the outer edges of the cell, and any base station channel may be assigned to any zone by the base station. Cell splitting and zone microcell techniques do not suffer the inefficiency faced by sectored cells.

II. FREQUENCY REUSE CONCEPT

The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning. The actual radio coverage of a cell is known as the footprint. When using hexagons to model coverage areas, base station transmitters are depicted as either being of the centre of the cell. Normally omni directional antennas are used in centre excited cells and sectored directional antennas are used in corner excited cells.

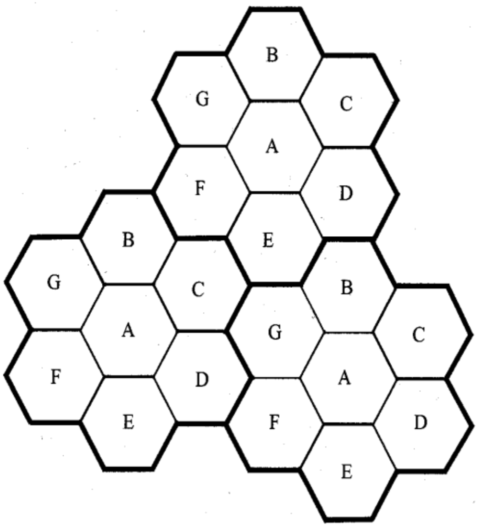

Fig 1: Cellular network with Frequency Reuse

III Cell Splitting

Cell splitting is the process of subdividing a congested cell into smaller cells, each with its own base station and an corresponding reduction in antenna height and transmitted power. It is also increase the capacity of a cellular system, since it increases the number of times that channels are reused. The consequence of the cell splitting is that the frequency assignment has to be done again, which affects the neighboring cells. Because of alerted signaling condition this also affects the traffic in control channels.

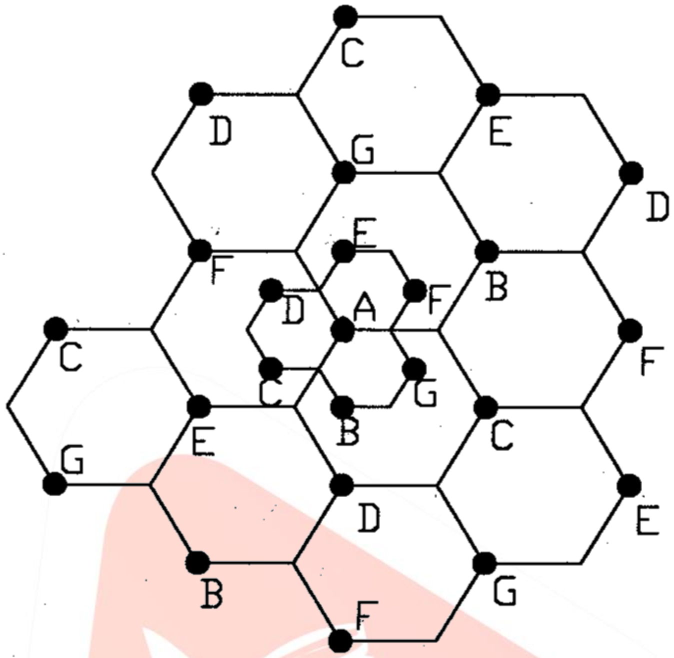

Fig 2: Each cell in a cluster is split into approximately four smaller cells by reducing R by half.

Here, it is assumed that the cells cluster is congested and as a result, the cell blocking probability has risen above an acceptable level. Imagine if every cell in the cluster was reduced in such a way that the radius R of every cell in half (R/2).In order to cover the service area with smaller cells, approximately four times as many cells would be required. The increased number of cells would increased the number of clusters over the coverage region, which in turn would increased the number of channels capacity in the coverage area. The smaller cells were added in such a way as to preserve the frequency reuse plan of the system. In this case, the radius of each new microcell is half that of the original cell.

For the new cells to be smaller in size, the transmit power of these cells must be reduced. This is necessary to ensure that the frequency reuse plan for the new microcells behaves exactly as for the original cells.

$$Pr[\text{old cell}] \infty Pt1R^{-n} \quad (1)$$

And

$$P[\text{new cell}] \infty Pt2(R/2)^{-n} \quad (2)$$

Where Pt1 and Pt2 are the transmit powers of the larger and smaller cell base station, respectively, and n is the path loss exponent. If we take n = 4 and set the received power equal (assumed perfect power control) to each other. Then

$$Pt2 = Pt1 / 16 \qquad (3)$$

In other words, the transmit power must be reduced by 12 dB in order to fill in the original coverage area with microcells, while maintaining the S/I requirements.

IV Sectoring cell

Channel allocation scheme being a technique by which the scarce resource (spectrum) is accessed by mobile users is limited by many factors, prominent among them being interference. However, to increase channel capacity is to keep the cell radius unchanged and their methods to decrease the ratio. Sectoring increase signal interference ratio, so that the cluster size reduced. First the SIR is improved using directional antennas, then capacity improvement is achieved by reducing the number of cells in a cluster, thus increasing the frequency reused.

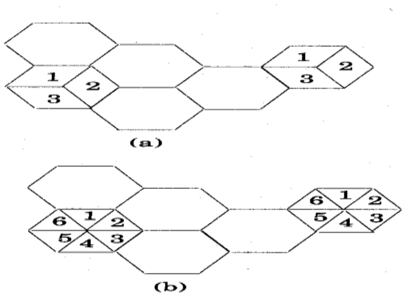

Fig 3 (a) Sectoring (b) 60° Sectoring

The co channel interference in a cellular system may be decreased by replacing a single omnidirectional antenna. By using directional antennas, a given cell receive interference and transmit with only a fraction of the available co-channel cells. Therefore channel allocation is always related to the network capacity in terms of number of available channel and system configuration. High capacity systems based on the reuse of allocated channel in a cellular planned network are highly deployed in this work.

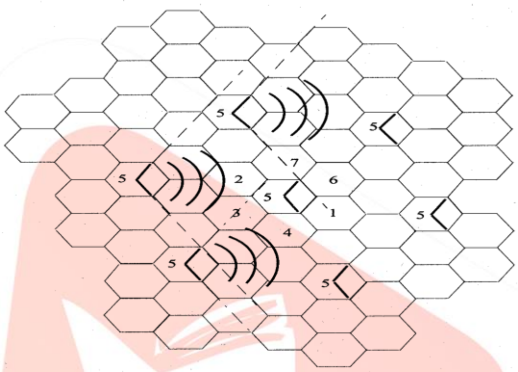

Fig 4 Interference Reduction.

V Conclusion

In conclusion, the improving channel capacity of a GSM system can be increased using the technique Cell Splitting and Cell Sectoring. The extent to which the capacity increment can be achieved is dependent on signal to interference ratio of the system after the cell splitting. The increment in channel capacity after Cell Splitting helps to reduce the call blocking probability and call delay or queuing probability. In Cell Sectoring, the Sectoring increases SIR so that the cluster size may be reduced. By this approach the SIR is improved using directional antennas, then channel capacity improvement is achieved by reducing the number of cell in cluster. The Both Cell Splitting and Cell Sectoring techniques has the capability of increasing the capacity of a congested GSM System.

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