2.8 Coverage And Capacity Improvement

As the demand for wireless service increases, the number of channels assigned to a cell becomes insufficient to support the required number of users.

Techniques to expand the capacity of cellular systems:

Cell splitting: increases the number of base stations in order to increase capacity.

Sectoring: relies on base station antenna placements to improve capacity by reducing co-channel interference.

Coverage zone: distributes the coverage of a cell and extends the cell boundary to hard-to-reach places.

Cell Splitting

Cell splitting is the process of subdividing a congested cell into smaller cells as shown in figure 2.8.1, each with its own base station and a corresponding reduction in antenna height and transmitter power.

Cell splitting increases the capacity of a cellular system since it increases the number of times that channels are reused. Cells are split to add channels with no new spectrum usage.

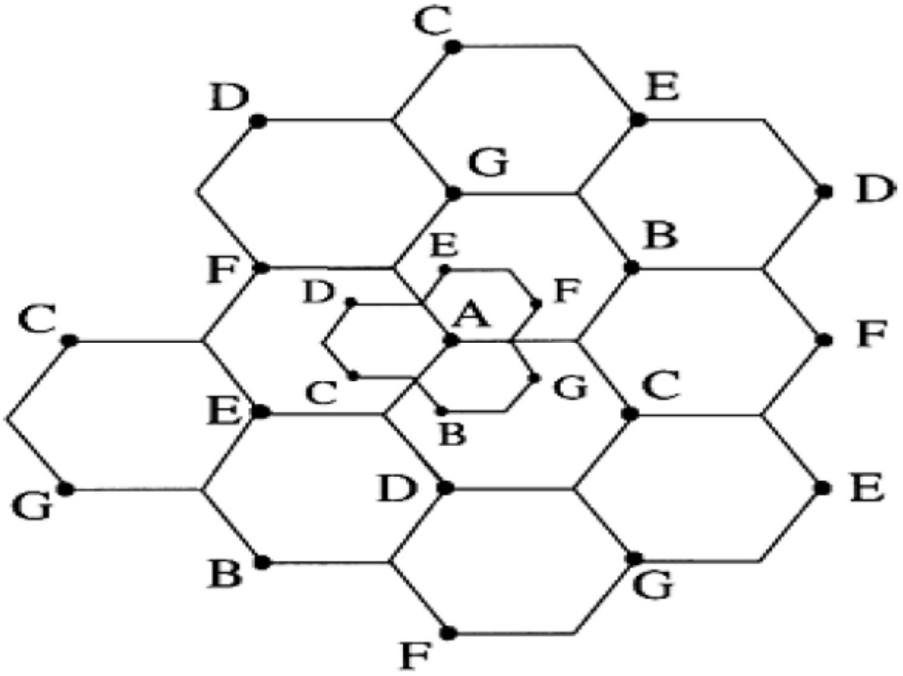

Fig 2.8.1: Cell splitting

[Source :"Wireless communications" by Theodore S. Rappaport,Page-55]

Sectoring

The technique for decreasing co-channel interference and thus increasing system capacity by using directional antennas is called sectoring.

The factor by which the co-channel interference is reduced depends on the amount of sectoring used. Sectoring improves Signal to Interference ratio.

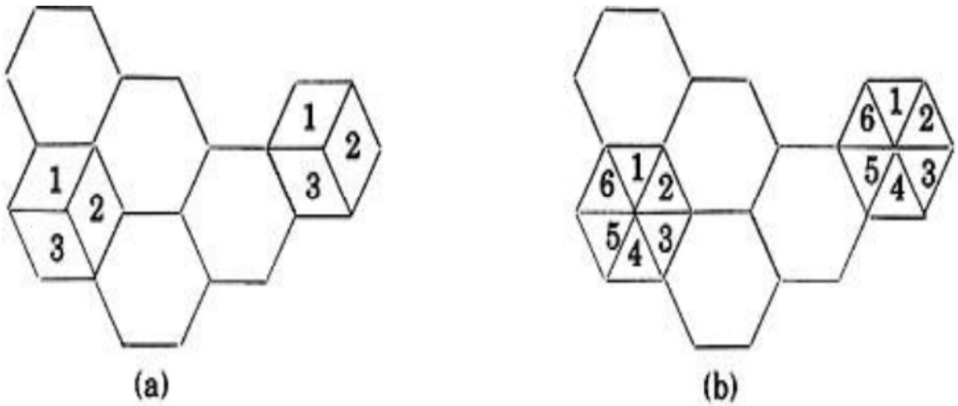

Fig 2.8.2 : Cell Sectoring

[Source : "Wireless communications" by Theodore S. Rappaport,Page-59]

The technique for decreasing co-channel interference and thus increasing system capacity by using directional antennas is called sectoring. The factor by which the co-channel interference is reduced depends on the amount of sectoring used.

A cell is normally partitioned into three 120^0 degree sectors or six 60° sectors.

When sectoring is employed, the channels used in a particular cell are broken down into sectored groups and are used only within a particular sector, as illustrated in Figure 2.8.2. Assuming 7-cell reuse, for the case of 120° sectors, the number of interferers in the first tier is reduced from 6 to 2. This is because only 2 of the 6 co-channel cells receive interference with a particular sectored channel group.

The improvement in S/I implies that with 120° sectoring, the minimum required S/I of 18 dB can be easily achieved with 7-cell reuse, as compared to 12-cell reuse for the worst possible situation in the un sectored case. Thus, sectoring reduces interference, which amounts to an increase in capacity by a factor of 12/7. or 1.714.

Microcell Zone Concept

The increased number of handoffs required when sectoring is employed results in an increased load on the switching and control link elements of the mobile system.

A solution to this problem was proposed by Lee . This proposal is based on a microcell concept for 7 cell reuse, as shown in figure 2.8.3.

In this scheme, each of the three (or possibly more) zone sites are connected to a single base station and share the same radio equipment. The zones are connected by coaxial cable, fiber optic cable, or microwave link to the base station. Multiple zones and a single base station make up a cell.

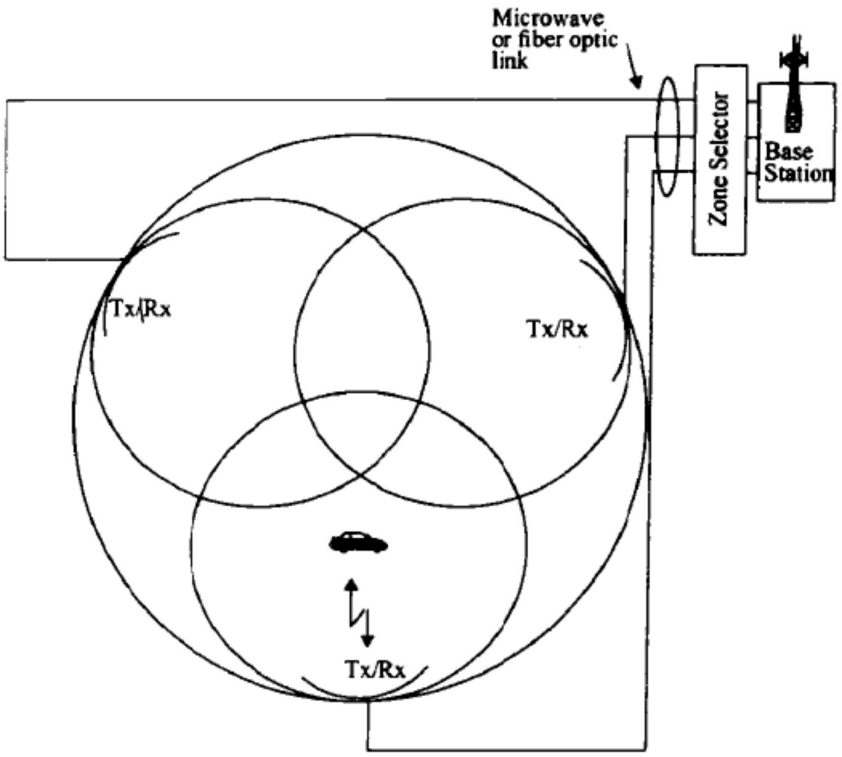

Fig 2.8.3 : Micro Cell Concept

[Source : "Wireless communications" by Theodore S. Rappaport,Page-62]

As a mobile travels within the cell, it is served by the zone with the strongest signal. This 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.

As a mobile travels from one zone to another within the cell, it retains the same channel. Thus, unlike in sectoring, a handoff is not required at the MSC when the mobile travels between zones within the cell.

The base station simply switches the channel to a different zone site. In this way, a given channel is active only in the particular zone in which the mobile is traveling, and hence the base station radiation is localized and interference is reduced.

The co-channel interference in the cellular system is reduced since a large central base station is replaced by several lower powered transmitters (zone transmitters) on the edges of the cell. Decreased co-channel interference improves the signal quality and also leads to an increase in capacity,