1.2 CHANNEL ASSIGNMENT STRATEGIES

For efficient utilization of the radio spectrum, a frequency reuse scheme that is consistent with the objectives of increasing capacity and minimizing interference is required.

Types

Fixed channel assignment strategies and Dynamic channel assignment strategies.

Fixed channel assignment strategies

Each cell is allocated a predetermined set of channels.

Any call attempt within the cell can only be served by the unused channels in that particular cell. If all the channels in that cell are occupied, the call is blocked and the subscriber does not receive service.

Dynamic channel assignment strategies

In a dynamic channel assignment strategy, voice channels are not allocated to different cells permanently. Instead, each time a call request is made, the serving base station requests a channel from the MSC.

The switch then allocates a channel to the requested cell following an algorithm that takes into account the likelihood of fixture blocking within the cell, the frequency of use of the candidate channel, the reuse distance of the channel, and other cost functions.

Handoff Strategies

When a mobile moves into a different cell while a conversation is in progress, the MSC automatically transfers the call to a new channel belonging to the new base station.This is called handoff.

Illustration of a handoff scenario at cell boundary is shown in Figure 2.5.1.

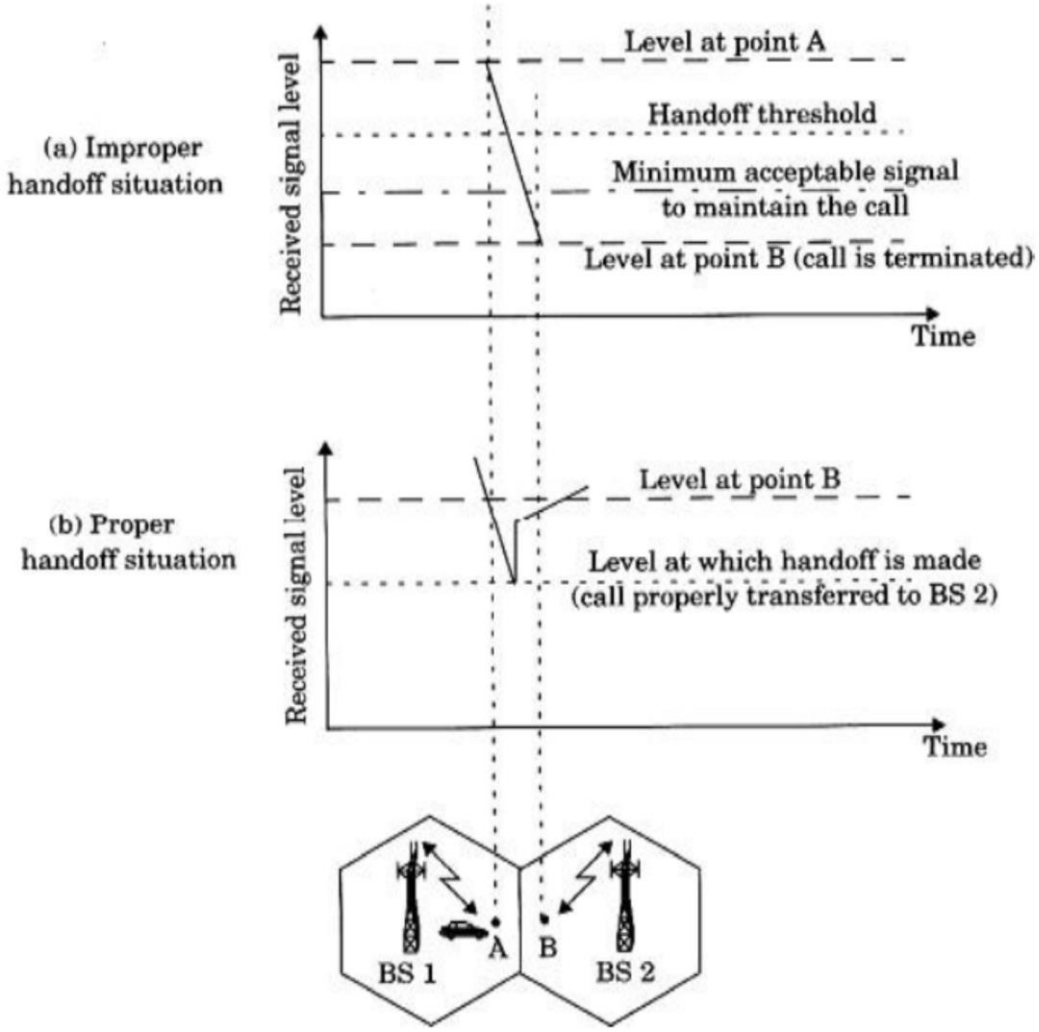

Fig 2.5.1 : Handoff Scenario

[Source : "Wireless communications" by Theodore S. Rappaport,Page-31]

Processing handoffs is an important task in any cellular radio system.

Many handoff strategies prioritize handoff requests over call initiation requests when allocating unused channels in a cell site.

Handoffs must be performed successfully and as infrequently as possible, and be imperceptible to the users.

In order to meet these requirements, system designers must specify an optimum signal level at which to initiate a handoff.

Once a particular signal level is specified as the minimum usable signal for acceptable voice quality at the base station receiver (normally taken as between —90 dBm and -100 dBm), a slightly stronger signal level is used as a threshold at which a handoff is made.

This margin, given by $\Delta = P_{r\ handoff} - P_{r\ Minimum\ usable}$ cannot be too large or too small. If Δ is too large, unnecessary handoffs which burden the MSC may occur, and if Δ is too small, there may be insufficient time to complete a handoff before a call is lost due to weak signal conditions.

Figure (above) illustrates a handoff situation. It demonstrates the case where a handoff is not made and the signal drops below the minimum acceptable level to keep the channel active. This dropped call event can happen when there is an excessive delay by the MSC in assigning a handoff, or when the threshold z\ is set too small for the handoff time in the system.

Excessive delays may occur during high traffic conditions due to computational loading at the MSC or due to the fact that no channels are available on any of the nearby base stations (thus forcing the MSC to wait until a channel in a nearby cell becomes free).

In deciding when to handoff, it is important to ensure that the drop in the measured signal level is not due to momentary fading and that the mobile is actually moving away from the serving base station. In order to ensure this, the base station monitors the signal level for a certain period of time before a handoff is initiated.

The time over which a call may be maintained within a cell, without handoff is called the dwell time . The dwell time of a particular user is governed by a number of factors, which include propagation, interference, distance between the subscriber and the base station, and other time varying effects. During the course of a call, if a mobile moves from one cellular system to a different cellular system controlled by a different MSC, an intersystem handoff becomes necessary.

Prioritizing Handoffs

One method for giving priority to handoffs is called the guard channel concept, Here a fraction of the total available channels in a cell is reserved exclusively for handoff requests from ongoing calls which may be handed off into the cell.

This method has the disadvantage of reducing the total carried traffic, as fewer channels are allocated to originating calls. Guard channels, however, offer efficient spectrum utilization when dynamic channel assignment strategies, which minimize the number of required guard channels by efficient demand based allocation, are used.

Practical Handoff Considerations

In practical cellular systems, several problems arise when attempting to design for a wide range of mobile velocities. High speed vehicles pass through the coverage region of a cell within a matter of seconds, whereas pedestrian users may never need a handoff during a call. Particularly with the addition of microcells to provide capacity, the MSC can quickly become burdened if high speed users are constantly being passed between very small cells. By using different antenna heights (often on the same building or tower) and different powerlevels, it is possible to provide "large" and "small" cells which are co-located at a single location. This technique is called the umbrella cell approach and is used to provide large area coverage to high speed users while providing small area coverage to users traveling at low speeds.

The umbrella cell approach (Fig: 2.5.2) ensures that the number of handoffs is minimized for high speed users and provides additional microcell channels for pedestrian users.

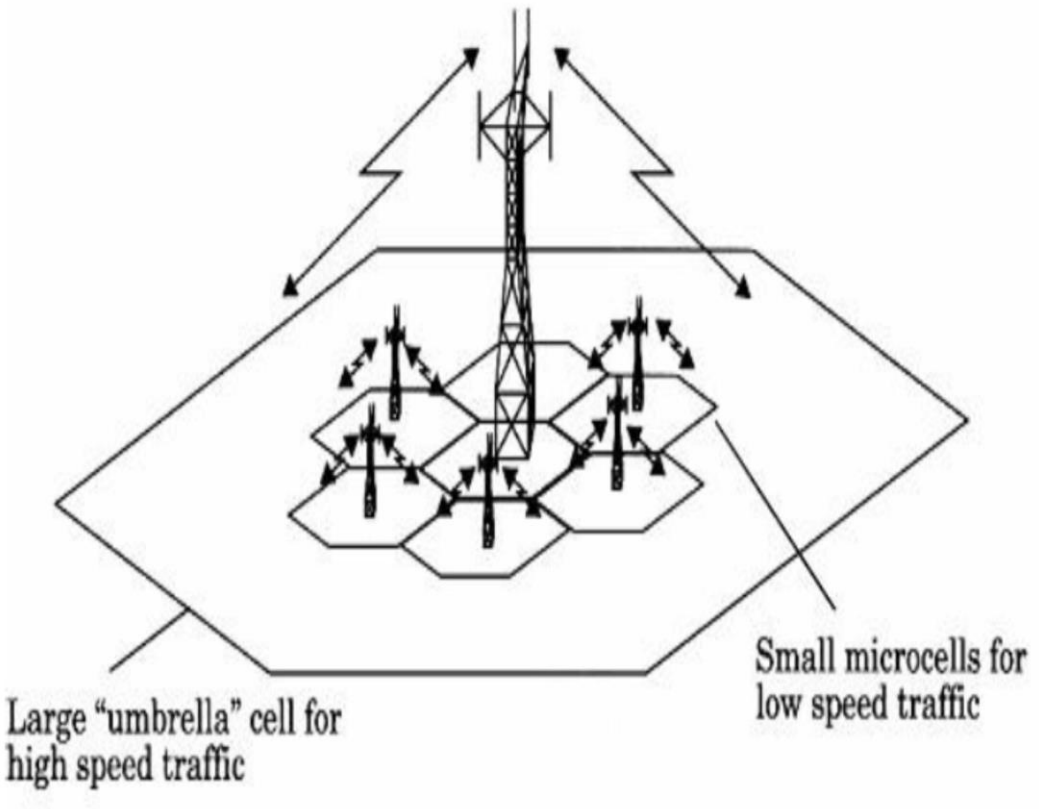

Fig 2.5.2: The umbrella cell approach

[Source : "Wireless communications" by Theodore S. Rappaport,Page-35]

The speed of each user may be estimated by the base station or MSC by evaluating how rapidly the short term average signal strength on the RVC changes over time, or more sophisticated algorithms may be used to evaluate and partition users.

If a high speed user in the large umbrella cell is approaching the base station, and its velocity is rapidly decreasing, the base station may decide to hand the user into the co-located microcell, without MSC intervention.

In first generation analog cellular systems, the typical time to make a handoff, once the signal level is deemed to be below the handoff threshold, is about 10 seconds. This requires that the value for Δ be on the order of 6 dB to 12 dB.

In GSM, the mobile assists with the handoff procedure by determining the best handoff candidates, and the handoff, once the decision is made, typically requires only 1 or 2 seconds. Consequently, Δ is usually between 0 dB and 6 dB in modem cellular systems.

In CDMA, by simultaneously evaluating the received signals from a single subscriber at several neighboring base stations, the MSC may actually decide which version of the user's signal is best at any moment in time. This technique exploits macroscopic space diversity provided by the different physical locations of the base stations and allows the MSC to make a "soft" decision as to which version of the user's signal to pass along to the PSTN at any instance .

The ability to select between the instantaneous received signals from a variety of base stations is called soft Handoff.