Lecture 6: Frequency Reuse Concepts

Channel Assignment Strategies

Channel assignment affects the performance of the system, especially when it comes to handoffs. There are several channel assignment strategies. We will discuss two basic types:

A. Fixed Channel Assignment

In this channel assignment, channels are pre-allocated to different cells meaning that each cell is assigned a specific number of channels and the frequencies of these channels are set. Such a channel assignment has the following aspects:

1. Any call attempts in a cell after all channels of that cell become occupied gets BLOCKED (meaning that the caller gets a signal indicating that all channels are occupied),
2. Very simple and requires least amount of processing,
3. A variation of this method is the Borrowing Strategy:
    a. Cells in this strategy are allowed to borrow channels from adjacent cells if their channels are fully occupied while adjacent cells have free channels,
    b. MSC (Mobile Switching Center) monitors the process and gives permission to borrowing cell to borrow channels putting in mind (i) donating cell is not affected by the borrowing process, (ii) no interference will occur by moving the channel from one cell to another.

B. Dynamic Channel Assignment

In this channel assignment, channels are NOT pre-allocated to any cells meaning that any channel can be allocated to any desired cell during the operation of the system. Such a channel assignment has the following aspects:

1. MSC monitors all cells and all channels,
2. Each time a call request is made, serving BS requests a channel from the MSC,
3. MSC runs an algorithm that takes into account:
    a. Possibility of future blocking in cells
    b. Frequency being used for channel
    c. The reuse distance of the channel
4. MSC assigns a channel only if it is not used and if it will not cause co-channel interference with any cell in range,
5. This algorithm provides higher capacity (less blocking),
6. It requires huge computational power,
7. MSC collects real-time data of channel occupancy, traffic distribution, and radio signal strengths indicators (RSSI).

Handoff Strategies

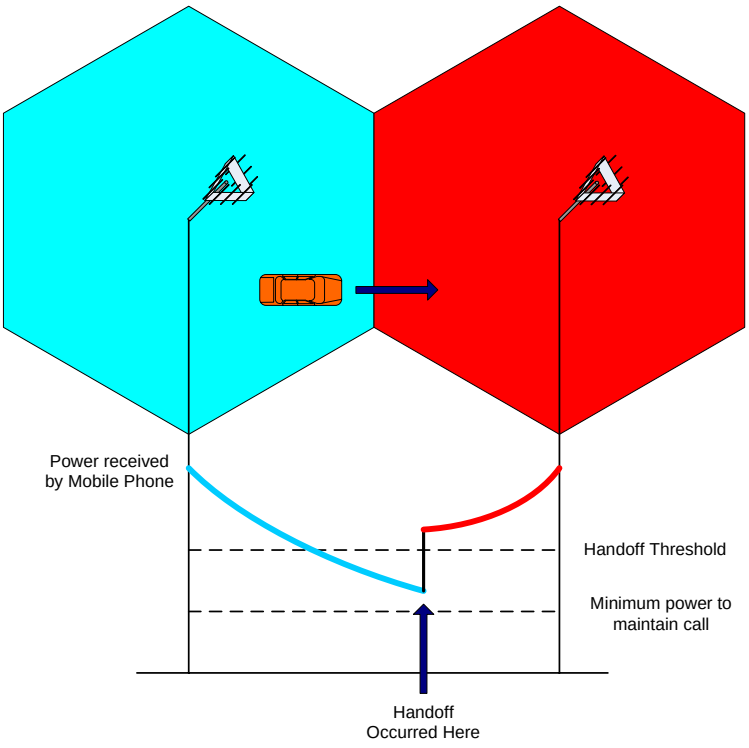
Handoff (H.O.) is the process of transferring an active call from one cell to another as the mobile unit moves from the first cell to the other cell without disconnecting the call. The amount of received power by the mobile phone or the amount of received power by the tower or both are usually used to determine whither a H.O. is necessary or not. The following points are put into mind:

- Most systems give higher priority to H.O. over call initiation (it is more annoying to have an active call disconnected than to have a new call blocked),
- Handoffs must be completed successfully as much as possible as infrequently (as few times) as possible and must be unnoticeable to the user (the user should not feel the H.O)

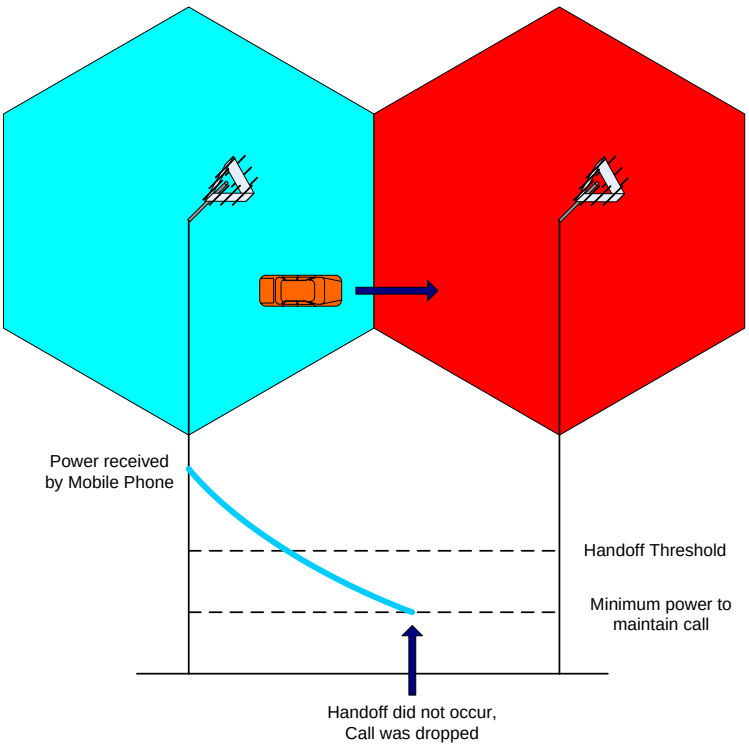
To meet these requirements, two power levels are defined:

- Minimum acceptable signal to maintain the call $P_{\text{Minimum to maintain call}}$: this is the minimum power received by the mobile phone or tower that allows the call to continue. Once the signal drops below this level, it becomes impossible to maintain the active call because the signal is too weak (noise level becomes high relative to signal level). This is a fundamental power level that is usually in the range of -100 dBm to -90 dBm (0.0000000001 mW to 0.000000001 mW).
- Handoff Threshold $P_{\text{Threshold}}$: this power limit is usually selected to be few dB's (5 dB to 10 dB) above the minimum acceptable signal to main the call level.
- The margin $\Delta = P_{\text{Threshold}} - P_{\text{Minimum to maintain call}}$ should not be too large or too small. If it is:
    - Too large, unnecessary handoffs will occur because the handoff threshold is high and will be reached very often even while the mobile phone is still deep inside the serving cell. Unnecessary handoffs put a lot of strain (a lot of work) on the MSC and system and reduce network capacity because of the need of free channels in other cells,
    - Too small, calls may get dropped before a successful handoff takes place because not enough time is available for the handoff where the signal power will drop very quickly from the handoff threshold to the minimum power to maintain a call.

The following two figures show two handoff situations. In the first case, a successful handoff takes place where the mobile phone is switched from one tower to another while in the second case, the signal power drops to the minimum value needed for maintating a call and the call is dropped without a handoff.



Successful Handoff



Unsuccessful Handoff

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When studying handoffs, we need to observe the following points:

- During high demand times (when most channels are occupied), excessive delay in handoff may occur because of high computational load on the MSC, which may cause signal power of calls needing a handoff to reach level of minimum power to maintain a call.
- MSC has to ensure that any drop in signal power is not due to signal fluctuations (it has to monitor the signal over relatively long periods of time). So, MSC monitors signal power to determine if the mobile unit is moving away, stationary, or moving closer.
- Speed of mobile unit determines time needed for handoff:
    - For slow drop in power, slow handoffs is possible,
    - For fast drop in signal power, fast handoff is required to insure the signal power does not reach the minimum power to maintain a call.