Experiment No.: Date:

Title : To study performance evaluation of handover algorithm for Absolute Signal Strength measurement.

Learning Objectives: At the end of this experiment, students will be able to:

- Understand handoff threshold.
- Understand probability of outage.
- Understand probability of assignment of MS to BTS.

Pre-requisite : Basic concepts of Mobile communication, handoff, need for handoff

Apparatus : Computing facility, MATLAB

Theory :

Handoff refers to a process of transferring an ongoing call or data session from one channel connected to the core network to another. The channel change due to handoff may be through a time slot, frequency band, codeword, or combination of these for time-division multiple access (TDMA), frequency-division multiple access (FDMA), code-division multiple access (CDMA), or a hybrid scheme. Handoff is also called as 'Handover'. A schematic diagram of handoff is given in **Figure**. Processing of handoff is an important task in any cellular system. Handoffs must be performed successfully and be imperceptible to the users. Once a signal level is set as the minimum acceptable for good voice quality (Prmin), then a slightly stronger level is chosen as the threshold (PrH) at which handoff has to be made, as shown in **Fig 1**. A parameter, called power margin, defined as

$$\Delta = \mathbf{PrH - Prmin}$$

is quite an important parameter during the handoff process since this margin Δ can neither be too large nor too small. If Δ is too small, then there may not be enough time to complete the handoff and the call might be lost even if the user crosses the cell boundary. If Δ is too high o the other hand, then MSC has to be burdened with unnecessary handoffs. This is because MS may not intend to enter the other cell. Therefore Δ should be judiciously chosen to ensure imperceptible handoffs and to meet other objectives

Reasons for a Handoff to be conducted:

1. To avoid call termination when the phone is moving away from the area covered by one cell and entering the area covered by another cell.
2. When the capacity for connecting new calls of a given cell is used up.
3. When there is interference in the channels due to the different phones using the same channel in different cells.
4. When the user behaviors change

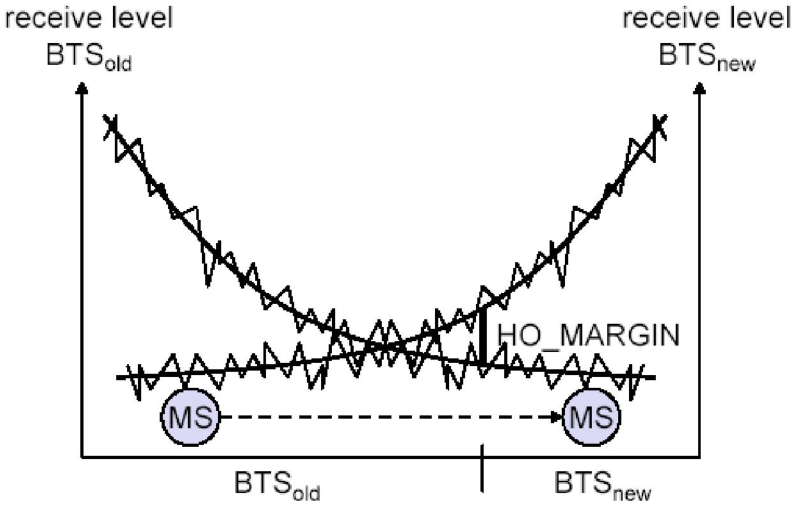

Fig.1 Handoff decision

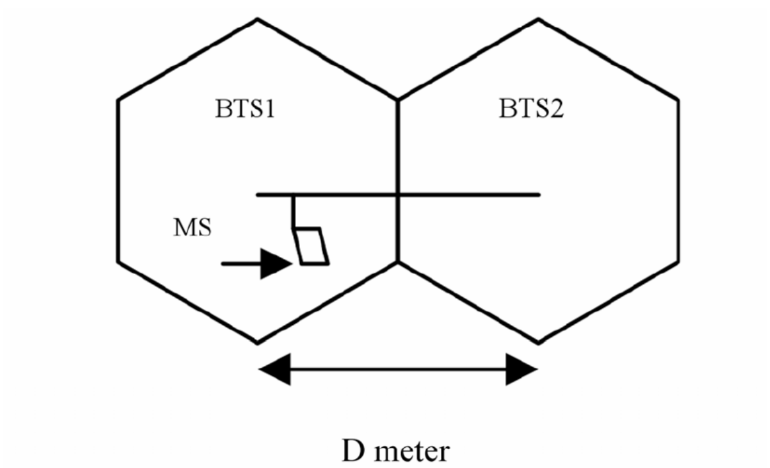

Fig 2 System Model

Consider two base stations, BTS1 and BTS2 are separated by D meters. Mobile station (MS) is moving from BTS1 to BTS2 with constant speed. The signal level received from two BTSs (in dB) at a distance, d from BTS1 can be expressed as follows

$P_{rx1}(d) = K_1 - K_2 \log(d) + x_1(d) \qquad d \in (0, D)$ *meters.*

$P_{rx2}(d) = K_1 - K_2 \log(d) + x_2(d)$

K1 and K_2 are due to path losses. K_2 is actually 10n, where n is path loss component. Assume $K_1 = 0$ and $K_2 = 30$. $x_1(d)$ and $x_2(d)$ are two independent zero mean stationary Gaussian processes, and there mean are $\mu_1 = K_1 - K_2 \log(d)$ & $\mu_2 = K_1 - K_2 \log(D-d)$ respectively.

When received signal from BTS1 is less than a specified value and at the same time received signal from BTS2 is more than minimum value of received signal for continuation of a call then handover (HO) will take place from BTS1 to BTS2

$Prx1\ (d) \leq Prho$ *and* $Prx2\ (d) \geq Prmin$: HO: BTS1 →BTS2

$Prx2\ (d) \leq Prho$ *and* $Prx1\ (d) \geq Prmin$: HO: BTS2 → BTS1

P_{rho} = Absolute value of received power from any BTS after which handover should take place.
P_{rmin} = Minimum value of received power for which call is possible.
If signal strength becomes less than P_{rmin} then there will be call drop for ongoing call and new call will not be possible.
At a distance, d from BTS1 if received signal strengths from both BTSs go below P_{rmin} then call will not be possible i.e., there will be outage. Probability of outage,

$$P_{out} = prob\ (P_{rx1}\ (d) \leq P_{rmin} \text{ and } P_{rx2}\ (d) \leq P_{rmin})$$

Since these two events are statistically independent,

$$P_{out} = prob\ (P_{rx1}\ (d) \leq P_{rmin}) \text{ and } prob\ (P_{rx2}\ (d) \leq P_{rmin})$$

$$= Q\left(\frac{\mu 1 - Prmin}{\sigma}\right) x\ Q\left(\frac{\mu 2 - Prmin}{\sigma}\right)$$

Where, $Q(x)$ is Q-function and $P\ (X \leq x) = Q\left(\frac{\mu - x}{\sigma}\right)$

When received signal from serving BTS will be less than P_{rho} then there will be handover to other BTS. Current BTS should be able to serve the MS i.e., received power from it should be more than Prmin. So probability of assignment (or handover) to any BTS can be obtained as follows: Probability of assignment to BTS1,

$$P_{assn1} = prob\ (P_{rx1}\ (d) \leq P_{rho} \text{ and } P_{rx2}\ (d) \geq P_{rmin})$$

(Since these two events are statistically independent)

$$P_{assn1} = Q\left(\frac{\mu 1 - Prho}{\sigma}\right) \text{ x } Q\left(\frac{Prmin - \mu 2}{\sigma}\right)$$

Similarly, probability of assignment (or handover) to BTS2 can be obtained as follows

$$P_{assn2} = Q\left(\frac{\mu 2 - Prho}{\sigma}\right) \text{ x } Q\left(\frac{Prmin - \mu 1}{\sigma}\right)$$

NOTE: The above model was referred from paper titled "Performance evaluation of signal strength based handover algorithms" by Sanjay Roy Dhar

Procedure:

Write a MATLAB code to calculate
1) Probability of outage 2) Probability of assignment to BTS1 & BTS2

And plot following results:
1) Probability of outage v/s distance of MS from BTS1
2) Probability of outage vs. standard deviation of shadow fading
3) Probability of assignment to BTS1 v/s distance of MS from BTS1
4) Probability of assignment to BTS2 v/s distance of MS from BTS1

Conclusion: