

# Handoff / Handover Mechanism for Mobility Improvement in Wireless Communication

Liton Chandra Paul<sup>1</sup>

1

*Received: 7 December 2012 Accepted: 31 December 2012 Published: 15 January 2013*

---

## Abstract

The aim of this paper is to investigate the handoff / handover concepts in wireless communication. Mobility is the distinct feature of wireless mobile cellular system. As a mobile subscriber move between different radio networks, a handover process is needed to change its point of attachment. The continuation of an active call is one of the most important quality measurements in cellular systems. Handoff process enables a cellular system to provide such a facility by transferring an active call from one cell to another. Usually, continuous service is achieved by supporting handoff which is the transfer of an ongoing call from the current cell to the next adjacent cell as the mobile moves through the coverage area. The paper represents the current approaches of handoff initialization, detection strategies and their relative benefits and disadvantages.

---

**Index terms**— handoff/handover, wireless communication, soft handoff, hard handoff, RSS threshold, MCHO, NCHO, MAHO.

## 1 Introduction

obility is the most important feature of a wireless cellular communication system. Usually, continuous service is achieved by supporting handoff (or handover) from one cell to another. Handoff is the process of changing the channel (frequency, time slot, spreading code, or combination of them) associated with the current connection while a call is in progress. On the other hand, in cellular telecommunications, the term handover or handoff refers to the process of transferring an ongoing call or data session from one channel connected to the core network to another channel. In satellite communications, it is the process of transferring satellite control responsibility from one earth station to another without loss or interruption of service.

American English uses the term handoff, and this is most commonly used within some American organizations such as 3GPP2 and in American originated technologies such as CDMA2000. In British English the term handover is more common, and is used within international and European organizations such as ITU-T, IETF, ETSI and 3GPP, and standardized with in European originated standards such as GSM and UMTS. The term handover is more common than handoff in academic research publications and literature, while handoff is slightly more common within the IEEE and ANSI organizations [1]. The time over which a call is maintained within a cell without handoff is called dwell time.

## 2 II.

## 3 Types of Handoff Handover

Handoffs are broadly classified into two categories—hard and soft handoffs. Usually, the hard handoff can be further divided into two different types—intra- and inter-cell handoffs. The soft handoff can also be divided into two different types—multi-way soft handoffs and softer handoffs.

41 Hard handoff means -break before make? that is the connection to the source is broken before or 'as' the  
42 connection to the target is made. In a hard handoff, the link to the prior BS is terminated before or as the user  
43 is transferred to the new cell's BS. That is why hard handoff is also known as -break before make?. In this case,  
44 the MS is linked to no more than one BS at any given time. Hard handovers are intended to be instantaneous  
45 in order to minimize the disruption to the call. A hard handover is perceived by network engineers as an event  
46 during the call. It requires the least processing by the network providing service. When the mobile is between  
47 base stations, then the mobile can switch with any of the base stations, so the base stations bounce the link  
48 with the mobile back and forth. This is called ping-ponging [1]. Hard handoff is primarily used in OFDMA  
49 (orthogonal frequency division multiple access) and TDMA (time division multiple access) (i.e. GSM), where  
50 different frequency ranges are used in adjacent channels in order to minimize channel interference. So when  
51 the MS moves from one BS to another BS, it becomes impossible for it to communicate with both BSs (since  
52 different frequencies are used). If during ongoing call mobile unit moves from one cellular system to adjacent  
53 cellular system which is controlled by same mobile telephone switching office (MTSO), a handoff procedure which  
54 is used to avoid dropping of call is referred as Intra System Handoff. When a mobile signal becomes weak in a  
55 given cell and MTSO find other cell with in its system to which it can transfer the call then it uses Intra system  
56 handoff.

57 Finally, if during ongoing call mobile unit moves from one cellular system to a different cellular system which  
58 is controlled by different MTSO, a handoff procedure which is used to avoid dropping of call is referred as Inter  
59 System Handoff. When a mobile signal becomes weak in a given cell and MTSO cannot find other cell with in  
60 its system to which it can transfer the call then it uses Inter system handoff. On the other hand, Inter system  
61 handoff is the handover between different radio systems, e.g. UMTS -GSM.

## 62 4 Soft Handoff

63 Soft handoff is a "Make before break" handoff. That is, the mobile station (MS) is up on a call and moves  
64 from one base station (BS) to another, but the MS starts communicating with a new BS before terminating  
65 communications with the old BS. Soft handoffs can only be used between BSs on the same frequency. The  
66 technique improves reception as MSs move between cells (on cell boundaries). During soft handoff the MS  
67 actually communicates with more than one BS at a time, so that when it's time to move from the weaker BS to  
68 the stronger one, the MS is already in communication with the stronger one. During a soft handoff, the mobile  
69 station receives independent closed loop power control bits from the two BSs and perform "Or of Downs" logic  
70 to determine how to adjust its power. That means the mobile station will increase its power level if and only if  
71 both power control bits from the two BSs are 0 (indicating up). If the power control bit from any base station  
72 equals to '1' (indicating down), the mobile station shall decrease its power. Soft handover or soft handoff refers  
73 to a feature used by the CDMA and W-CDMA standards, where a cell phone is simultaneously connected to two  
74 or more cells (or cell sectors) during a call. If the sectors are from the same physical cell site, it is referred to as  
75 softer handoff.

76 In power controlled CDMA systems soft handoff is preferred over hard handoff strategies. This is more  
77 pronounced when the IS-95 standard is considered wherein the transmitter [the base station] power is XIII Issue  
78 XVI Version I 2 ( ) Year .

79 adjusted dynamically during the operation. Here the power control and soft handoff are used as means of  
80 interference-reduction, which is the primary concern of such an advanced communication system. The previous  
81 and the new wideband channels occupy the same frequency band in order to make an efficient use of bandwidth,  
82 which makes the use of soft handoff very important. The primary aim is to maintain a continuous link with the  
83 strongest signal base station otherwise a positive power control feedback would result in system problems. Soft  
84 handoff ensures a continuous link to the base station from which the strongest signal is issued. A softer handoff  
85 occurs when the MS is communicating with two sectors of a cell. ? Make before break.

86 ? New connection is established before the old connection is released, avoiding a cut in the connection during  
87 handoff.

88 ? After the successful handoff the old connection is released. ? Used in CDMA where adjacent cells use same  
89 frequency range.

## 90 5 Handoff Management

91 Handoff management means maintaining the traffic connection with a moving user when crossing cell boundaries.  
92 Handoff occurs when the quality or the strength of the radio signal falls below certain parameters (signal quality  
93 reason) it may also occur when the traffic capacity of a cell has reached its maximum or is approaching (traffic  
94 reason). GSM standard identifies about 40 reasons for a handoff. Handoff is initialized by the mobile or by the  
95 base station.

## 96 6 Handoff Initialization

97 A hard handoff occurs when the old connection is broken before a new connection is activated. The performance  
98 evaluation of a hard handoff is based on various initiation criteria. Relative signal strength with threshold

---

99 introduces a threshold value to overcome the ping-pong effect. Handover only occurs if the signal at the current  
100 BS is less than a predefined threshold and the signal from a neighboring base station is stronger.

101 For a high threshold (e.g., Th1), this scheme performs the same as the relative signal strength scheme. On the  
102 other hand, if the threshold is set quite low (e.g., Th3), the mobile may move far into the new cell. Threshold  
103 should not be used alone because its effectiveness depends on prior knowledge of the crossover signal strength  
104 between the current and the candidate base stations. Handover occurs only if the current signal level drops below  
105 a threshold, and the target base station is stronger than the current one by a hysteresis margin H. Handover  
106 occurs at L4, if the threshold is either Th1 or Th2. Handover occurs at L3, if the threshold is at Th3. Scheme  
107 avoids the ping-pong effect and execution of handover if signal from the serving base station is still strong enough.  
108 Decreasing threshold in the RSS-HT new cause increase the probability of handoff and therefore the number of  
109 handoffs and the number of wrong handoff increase.

## 110 7 Performance Matrics for Handoff

111 ? Call blocking probability -The probability that a new call attempt is blocked. ? Handoff blocking  
112 probability -The probability that a handoff attempt is blocked. ? Handoff probability -The probability that  
113 while communicating with a particular cell, an ongoing call requires a handoff before the call terminates. This  
114 metric translates into the average number of handoffs per cell. ? Call dropping probability -The probability that  
115 a call terminates due to handoff failure. This metric can be derived directly from the handoff blocking probability  
116 and the handoff probability. ? Rate of handoff -The number of handoff per unit time.

117 ? Duration of interruption -The length of time during handoff for which the mobile terminal is in  
118 communication with neither base station.

119 VIII.

## 120 8 Handoff Detection

121 Handoff decision is made & initiated based on measurement. Different systems use different approaches to execute  
122 handoff processes and these are characterized by handoff protocols. The terminal measures continuously level  
123 of signal in current channels and compare it with some other different channels. Based on the measurement  
124 results, the decision-making process of handoff may be centralized or decentralized i.e. handoff decision is made  
125 by handset, the network or the association between them, depending on the handoff control protocol. There are  
126 three strategies have been proposed to detect the need for handoff such as:

127 -Mobile Controlled Handoff (MCHO) -Network Controlled Handoff (NCHO).

128 -Mobile Assisted Handoff (MAHO).

129 The evolution of mobile communications is toward decentralization, implying that both the management and  
130 setup of handoff procedures will be partially entrusted to the MS. Thus, advanced mobile systems typically follow  
131 MAHO.

### 132 9 a) Mobile Controlled Handoff (MCHO)

133 The mobile station (MS) continuously monitors the signals of the surrounding base stations (BSs) & initiates the  
134 handoff process when some handoff criteria are met. That is, in this method, the mobile station continuously  
135 monitors the signal strength and quality from the accessed base station and several handoff candidate base  
136 stations. This method has Very short reaction time (on the order of 0.1 seconds). The surrounding base stations  
137 (BSs) measure the signal coming from mobile station (MS) & network initiates the handoff process when some  
138 handoff criteria are met. On the other hand, in this method, the base station monitors the signal strength and  
139 quality from the mobile station and when these deteriorate below some threshold, the network arranges for a  
140 handoff to another base station. The network examines all the surrounding base station to monitor the signal  
141 from the mobile station and report the measurement result back to the network. The network then chooses a  
142 new base station for the handoff and informs both the mobile station through the old base station and the new  
143 base station. NCHO is used in first generation cellular systems such as Advanced Mobile Phone System (AMPS),  
144 TACS (total access communication system), and NMT (advanced mobile phone system). In general, the handoff  
145 process (including data transmission, channel switching, and network switching) takes 100-200 ms.

### 146 10 c) Mobile Assisted Handoff (MAHO)

147 In this method, the handover is more decentralized. Both the mobile station & the base station supervise the  
148 quality of the link (i.e. RSSI, WEI). The network asks the MS to measure the signal from the surrounding  
149 BSs. But the network makes the handoff decision based on report from the MS. The mobile station does the  
150 received signal strength indication (RSSI) measurement of neighboring base stations. This handover strategy  
151 is used by the GSM cellular standard and mobile station transmits the measurement result to the base station  
152 twice a second. The decision as to when and where to execute the handover is still made in the network. In  
153 the circuit-switched GSM (global system mobile), the BS controller (BSC) is in charge of the radio interface  
154 management. This mainly means allocation and release of radio channels and handoff management. The handoff  
155 time between handoff decision and execution in such a circuit-switched GSM is approximately 1 second.

156 For MCHO, NCHO and MAHO, handoff failure can occur for a number of reasons. Some of them are listed  
157 below: a) The network takes too long to set the handoff after the handoff has been initiated. b) There is no  
158 available channel on the target base stations. c) The target link fails in some way during the execution of handoff.  
159 d) Handoff is denied by the network, either for lack of resources or because the portable has exceeded some  
160 limit on the number of handoffs which may be attempted in some period of time. e) In some other systems,  
161 handoffs can due to resource blocking (e.g. DECT). Summary IX.

## 162 11 Conclusion

163 Future generation wireless networks should ensure the best connectivity service to mobile subscriber anywhere  
164 at any-time. One way to improve the performance of wireless network is to use efficient handoff schemes when  
165 user is switching from one cell to another. In this paper we present an overview about the issues related to  
166 handoff initiation and decision and discuss about different types of handoff techniques in wireless communication.  
Throughout this paper we have gone through several scenarios and mechanisms of handover. <sup>1 2 3</sup>



Figure 1: Figure 2 :

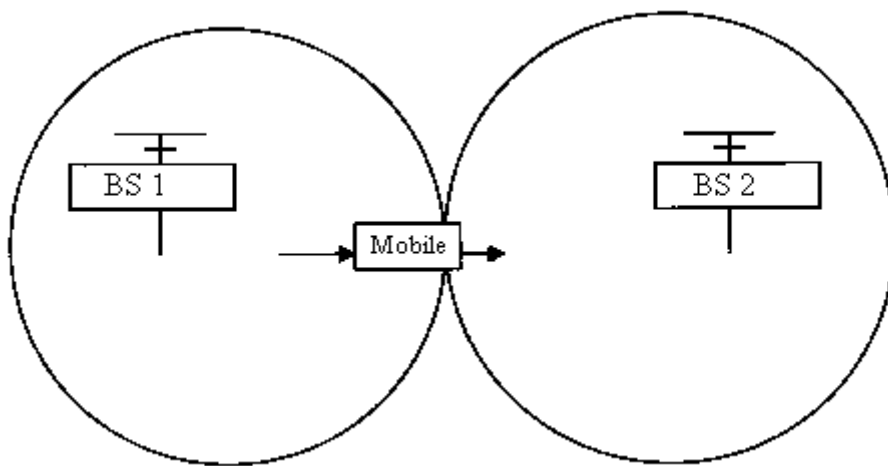
167

---

<sup>1</sup>© 2013 Global Journals Inc. (US) is assigned to B, it remains so until the relative signal Handoff / Handover Mechanism for Mobility Improvement in Wireless Communication

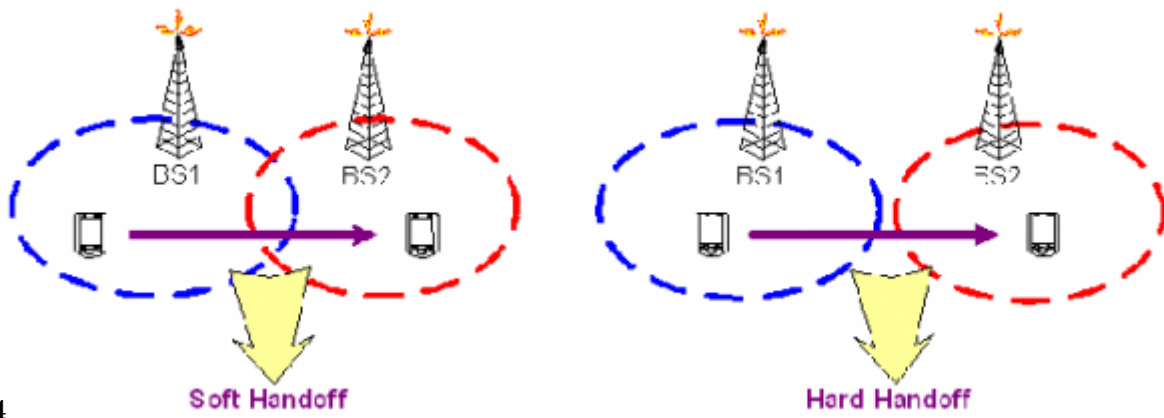
<sup>2</sup>© 2013 Global Journals Inc. (US) XIII Issue XVI Version I

<sup>3</sup>Handoff / Handover Mechanism for Mobility Improvement in Wireless Communication



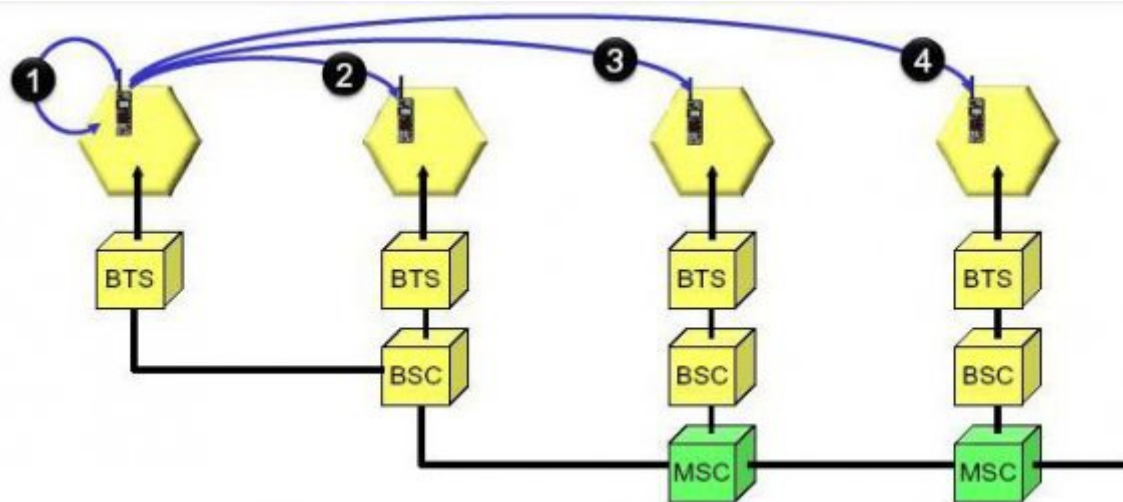
3

Figure 2: Figure 3 :



4

Figure 3: Figure 4 :



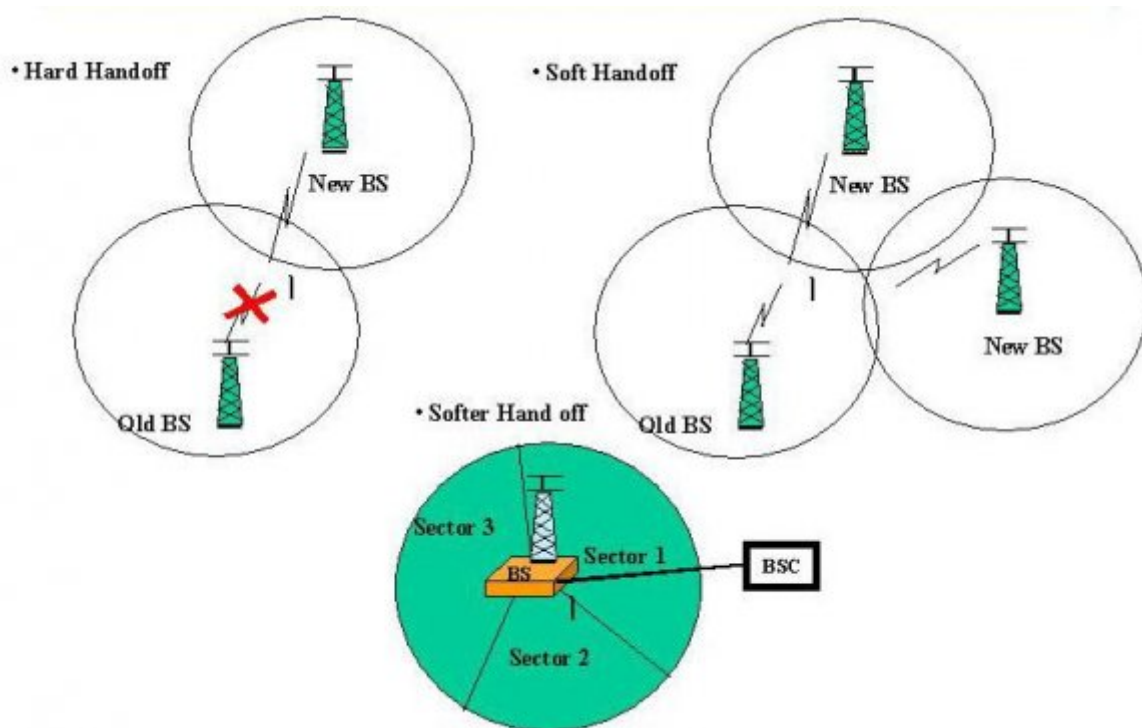
5

Figure 4: Figure 5 :



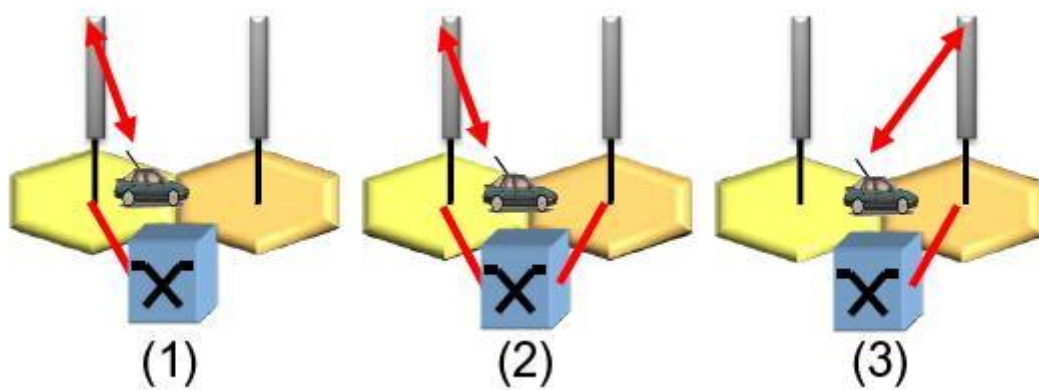
6

Figure 5: Figure 6 :



7

Figure 6: Figure 7 :



8

Figure 7: Figure 8 :?

9

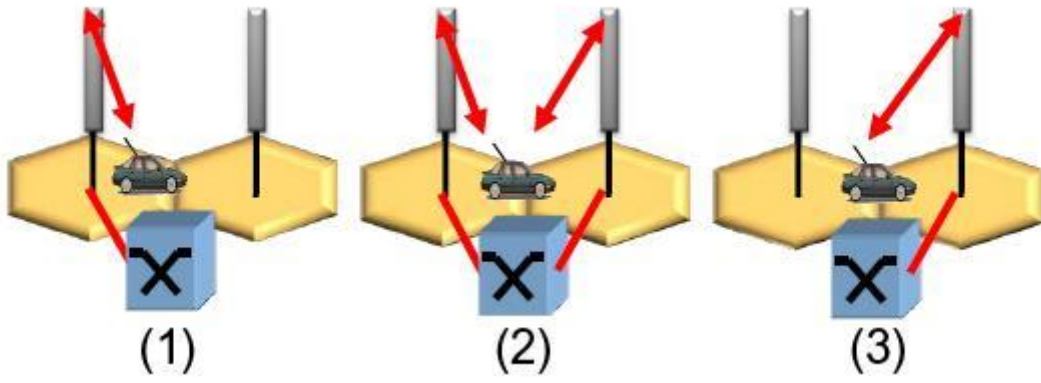


Figure 8: Figure 9 :

10

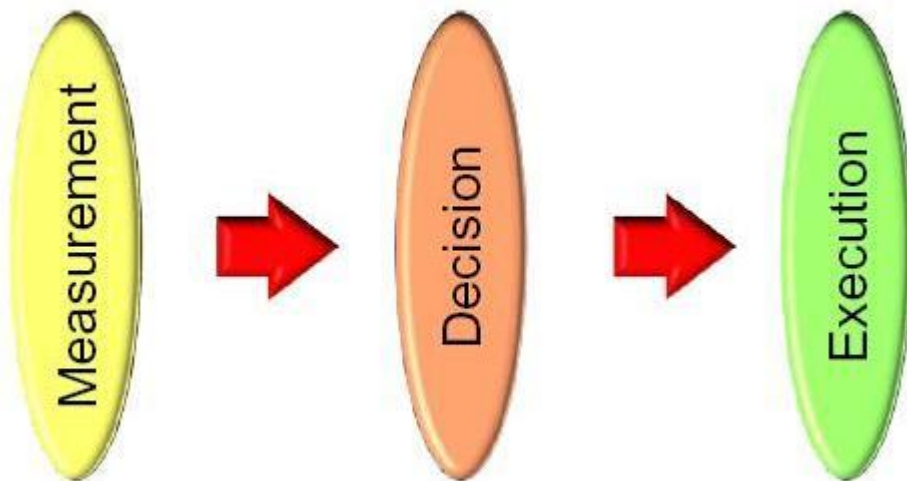
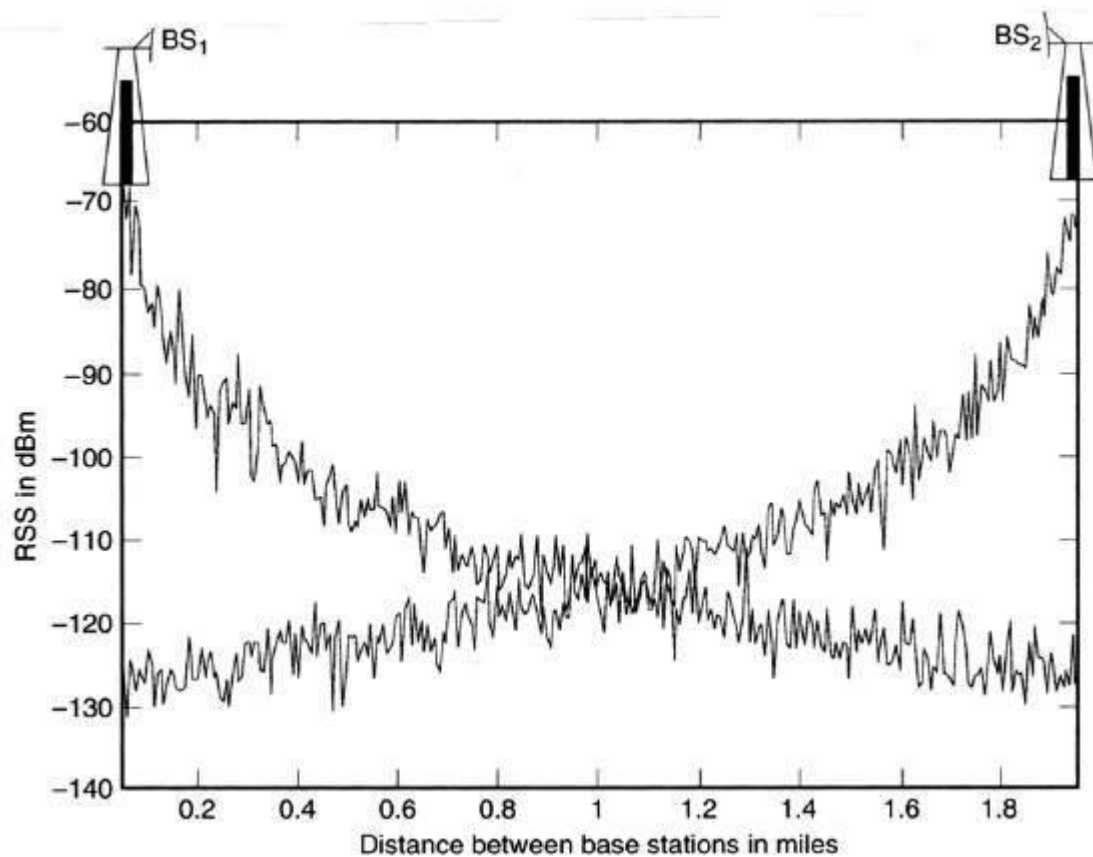
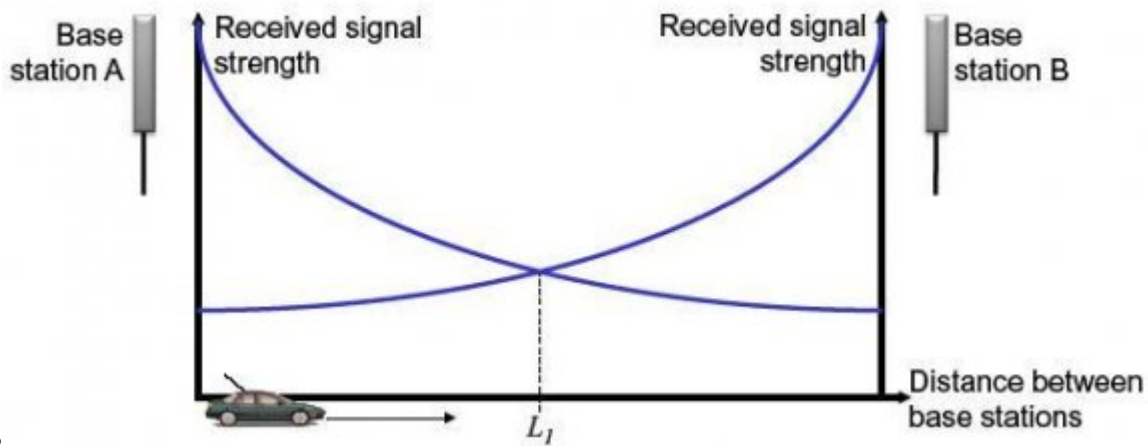


Figure 9: Figure 10 :



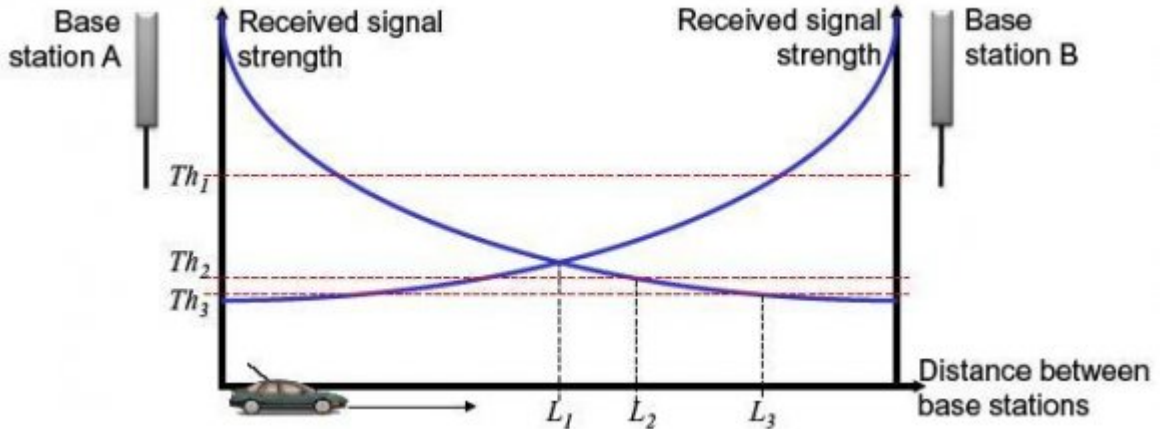
112)

Figure 10: Figure 11 : 2 ( )



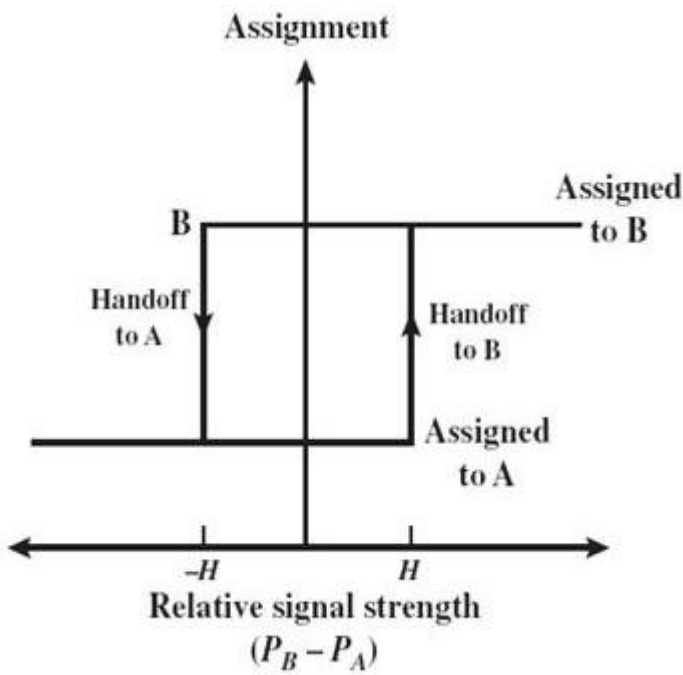
12

Figure 11: Figure 12 :



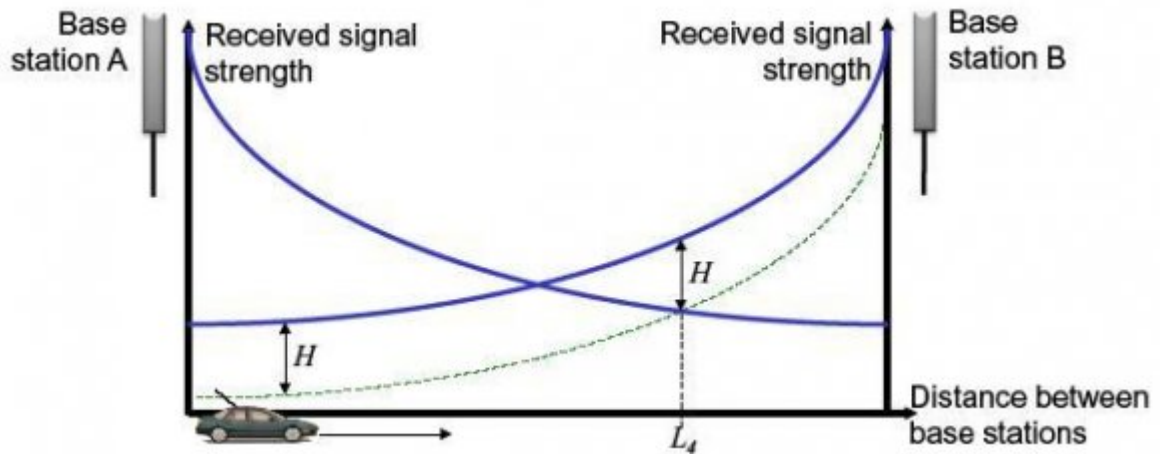
13

Figure 12: Figure 13 :



14

Figure 13: Figure 14 :



15

Figure 14: Figure 15 :



- 
- 168 [Krishna et al.] , B Krishna , Lakshmi Rao , Narayan Mishra , Soft , In , Systems . Richardson, Texas, USA.  
169 Department Of Electrical Engineering, University of Texas at Dallas, 2601 N. Floyd Rd
- 170 [Biglieri et al. ()] , Ezio Biglieri , Luigi Fratta , Bijanjabbari . 1999.
- 171 [Nas?fekiz et al. ()] ‘An Overview of Handoff Techniques in Cellular’. Tara Nas?fekiz , Salih , Kemal  
172 Sibelkügüköner , Fidanboylu . *Networks? International Journal of Information Technology* 2006. 2 (6) .
- 173 [Alagu and Meyyappan (2011)] ‘Analysis of handoff schemes in wireless mobile network’. S Alagu , Meyyappan  
174 . *International Journal of Computer Engineering Science* 2250:3439. November 2011. 2.
- 175 [Gudmundson (1991)] ‘Analysis of handover algorithms’. M Gudmundson . *Proc. IEEE VTC '91*, (IEEE VTC  
176 '91) May 1991. p. .
- 177 [Wells (1984)] ‘Cellular system design using the expansion cell layout method’. J D Wells . *IEEE Trans. Veh.*  
178 *Technol* May 1984. p. 33.
- 179 [Handoff-Handover Technique Improved the Mobility in Cellular Phone Communications Canadian Journal on Electrical and Elec  
180 ‘Handoff-Handover Technique Improved the Mobility in Cellular Phone Communications’. *Canadian Journal*  
181 *on Electrical and Electronics Engineering* April 2013. 4 (2) . Amer Tawfeeq Abed
- 182 [Noerpel and Lin (1997)] *Handover Management for a PCS Network*, Y Noerpel , Lin . December 1997. IEEE  
183 Personal Communications.
- 184 [Handover management in GSM cellular system International Journal of Computer Applications (2010)]  
185 ‘Handover management in GSM cellular system’. [http://en.wikipedia.org/wiki/Soft\\_](http://en.wikipedia.org/wiki/Soft_handover)  
186 **handoverJahangirkhan** *International Journal of Computer Applications* October 2010. 8 (12) p.  
187 .
- 188 [Farahd and Mahmood ()] ‘Investigation of Horizontal and Vertical Handoff in Mobile Networks’. E Farahd ,  
189 Mahmood . *Mosharaka International conference on Communication, Propagation and Electronics*, 2010.  
190 (Member of IEEE)
- 191 [Lohi et al. ()] *Key issues in Handover Design and Multi-Layer Cellular System Design. Centre for Telecommu-*  
192 *nication Research. King's College London Strand*, Mahboubeh Lohi , A H Dilshanweerakoon , Aghvami .  
193 1999. London WC2R 2LS, England.
- 194 [Linnhoff-Popien] Claudia Linnhoff-Popien . *Peter Ruppel, Mobile Communications. Mobility Management .v7.0*  
195 *.1/5*,
- 196 [Multiaccess] *Mobility and Teletraffic in Wireless Communications*, Multiaccess . Kluwer Academic Publishers.  
197 4.
- 198 [Dr and Mawjoud ()] ‘Simulation of Handoff Techniques in Mobile Cellular Networks’. S A Dr , Mawjoud . *Al-*  
199 *Rafidain Engineering* 2007. 15 (4) . Electrical Engineering Department, University of Mosul
- 200 [Pollini (1996)] ‘Trends in handover design’. G P Pollini . *IEEE Commun. Magazine* March 1996. p. .