Global Journal of Researches in Engineering
Electrical and Electronics Engineering
Volume 13 Issue 16 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Handoff / Handover Mechanism for Mobility Improvement in Wireless Communication

By Liton Chandra Paul
Pabna University of Science & Technology, Bangladesh

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.

Keywords: *handoff/handover, wireless communication, soft handoff, hard handoff, RSS threshold, MCHO, NCHO, MAHO.*

GJRE-F Classification : *FOR Code: 100510*

Strictly as per the compliance and regulations of :

Handoff / Handover Mechanism for Mobility Improvement in Wireless Communication

Liton Chandra Paul

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.

Keywords: handoff/handover, wireless communication, soft handoff, hard handoff, RSS threshold, MCHO, NCHO, MAHO.

I. Introduction

Mobility 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.

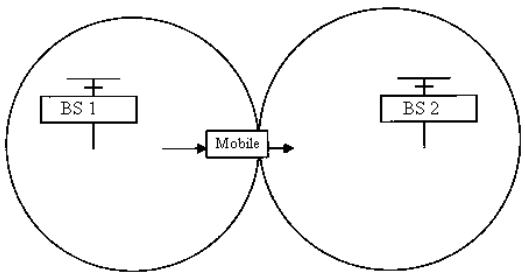

Figure 1 : Handoff / Handover

Author: Lecturer, Dept. of Electronic & Telecommunication Engineering (ETE), Pabna University of Science & Technology, Pabna-6600, Bangladesh. e-mail: litonpaulete@gmail.com

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.

II. Typesof 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.

Hard handoff means —break before makell that is the connection to the source is broken before or 'as' the connection to the target is made. In a hard handoff, the link to the prior BS is terminated before or as the user is transferred to the new cell's BS. That is why hard handoff is also known as —break before makell. In this case, the MS is linked to no more than one BS at any given time. Hard handovers are intended to be instantaneous in order to minimize the disruption to the call. A hard handover is perceived by network engineers as an event during the call. It requires the least processing by the network providing service. When the mobile is between base stations, then the mobile can switch with any of the base stations, so the base stations bounce the link with the mobile back and forth. This is called ping-ponging [1].Hard handoff is primarily used in OFDMA (orthogonal frequency division multiple access) and TDMA (time division multiple access) (i.e. GSM), where different frequency ranges are used in adjacent channels in order to minimize channel interference. So when the MS moves from one BS to another BS, it becomes impossible for it to communicate with both BSs (since different frequencies are used).

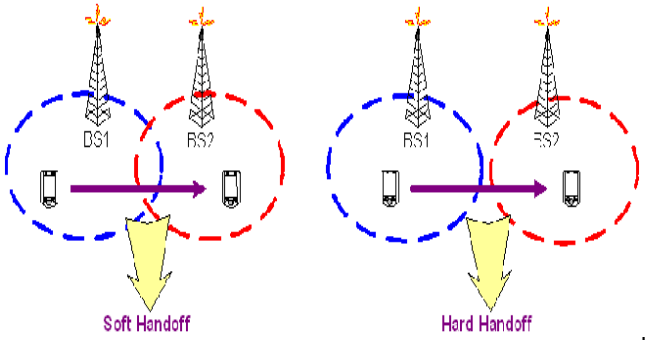

Figure 2 : Representation of Soft handoff & Hard handoff

If the handoff is performed between two time slot or channel in the same base station, it is called intra cell handoff or intra base station handoff. On the other hand, if the link is transferred between two base stations (BS) connected to the same base station controller (BSC), is called inter cell handoff or inter BS handoff.

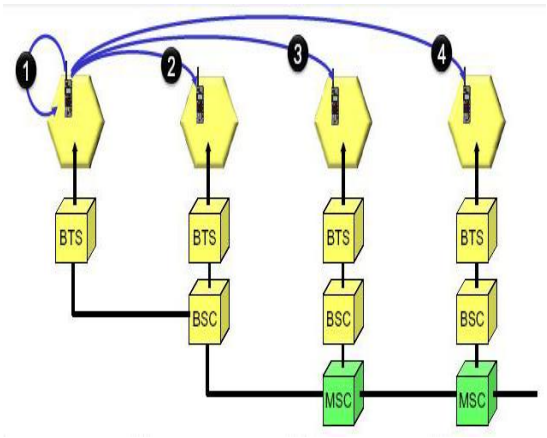

Figure 3 : (1) Intra cell handoff
(2)Inter cell / intra BSC
(3)Inter BSC / intra MSC
(4)Inter MSC handoff

Further, if the link is transferred between two base stations (BS) connected to the different BSCs on the same mobile switching center (MSC), is called inter BSC handoff. The inter BSC handoff is also known as intra MSC handoff. And, if the link transfer takes place at two base stations connected to different BSCs, it is known as inter MSC handoff.

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

Figure 4 : Inter system handoff

III. Soft Handoff

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

In power controlled CDMA systems soft handoff is preferred over hard handoff strategies. This is more pronounced when the IS-95 standard is considered wherein the transmitter [the base station] power is adjusted dynamically during the operation. Here the power control and soft handoff are used as means of interference-reduction, which is the primary concern of such an advanced communication system. The previous and the new wideband channels occupy the same frequency band in order to make an efficient use of

bandwidth, which makes the use of soft handoff very important. The primary aim is to maintain a continuous link with the strongest signal base station otherwise a positive power control feedback would result in system problems. Soft handoff ensures a continuous link to the base station from which the strongest signal is issued. A softer handoff occurs when the MS is communicating with two sectors of a cell.

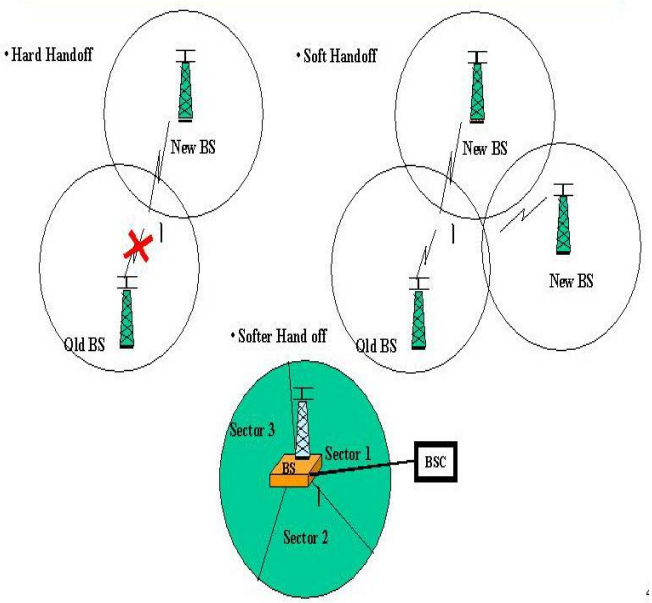

Figure 5 : Hard, Soft & Softer handoff

IV. Comparison Between Hard & Soft Handoff

a) Hard Handoff

- Break before make.
- The terminal is linked to more than one base station at any given time.
- Primarily used in FDMA and TDMA where different frequencies are used in adjacent cells.

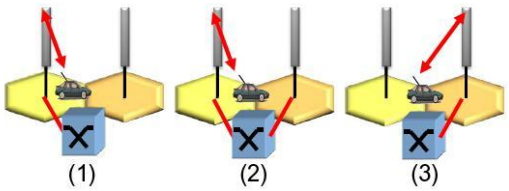

Figure 6 : Hard Handoff

b) Soft Handoff

- Make before break.
- New connection is established before the old connection is released, avoiding a cut in the connection during handoff.
- After the successful handoff the old connection is released.
- Used in CDMA where adjacent cells use same frequency rage.

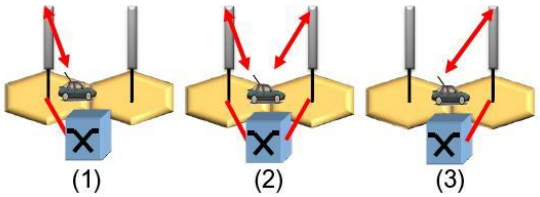

Figure 7 : Soft Handoff

V. Handoff Management

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

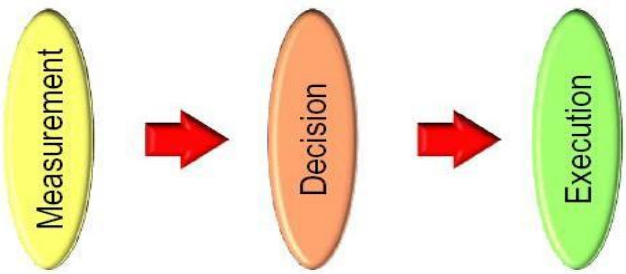

Figure 8 : Overview of handoff process

c) Measurement

- Measurement criteria: signal strength (between mobile and current base station as well as between mobile and neighboring base stations), distance, quality (e.g., in terms of error rates), traffic volume etc.
- Measurement reports exchanged between mobile and base station

d) Decision

- Decision parameters: thresholds and hysteresis margin.
- Network-controlled, mobile-assisted, mobile-controlled handoff

e) Execution

- Handover signaling
- Radio resource allocation
- Re-establishing connections in core and access networks

- Hard and soft handoff
- Inter-cell and intra-cell handoff
- Inter-frequency and intra-frequency handoff
- inter-system and intra-system handoff

VI. Handoff Initialization

A hard handoff occurs when the old connection is broken before a new connection is activated. The performance evaluation of a hard handoff is based on various initiation criteria.

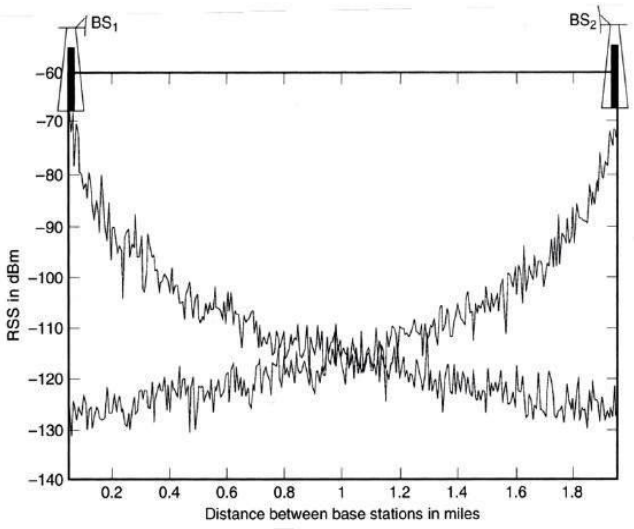

Figure 9 : Signal strength Vs distance

It is assumed that the signal is averaged over time, so that rapid fluctuations due to the multipath nature of the radio environment can be eliminated. Figure-9 shows a MS moving from one BS (BS1) to another (BS2). The mean signal strength of BS1 decreases as the MS moves away from it. Similarly, the mean signal strength of BS2 increases as the MS approaches it.

a) Relative Signal Strength (RSS)

Mobile terminal is handed off from BS A to BS B when the signal strength at B first exceeds that at A. If the signal strength at B first exceeds that at A, the mobile unit is handed back to A. In figure-10 handover occurs at point L_1. Because signal strength fluctuates due to multipath propagation effects, several handoffs may be occurred while BS1's RSS is still sufficient to serve the MS. These unnecessary handoffs are known as the ping-pong effect. As the number of handoffs increase, forced termination probability and network load also increases. But, handoff techniques should avoid such unnecessary handoffs.

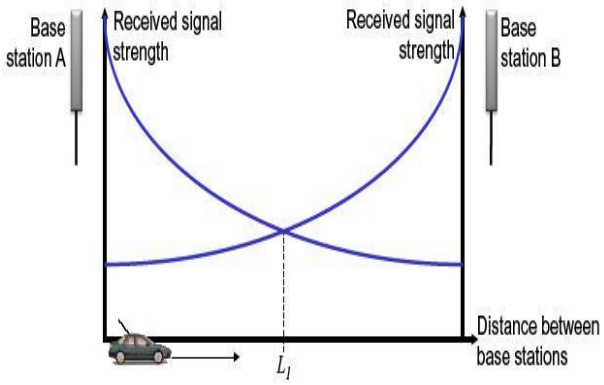

Figure 10 : Signal strength Vs distance for Relative Signal Strength (RSS)

b) Relative Signal Strength with Threshold (RSS-T)

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

For a high threshold (e.g., Th1), this scheme performs the same as the relative signal strength scheme. On the other hand, if the threshold is set quite low (e.g., Th3), the mobile may move far into the new cell. Threshold should not be used alone because its effectiveness depends on prior knowledge of the crossover signal strength between the current and the candidate base stations.

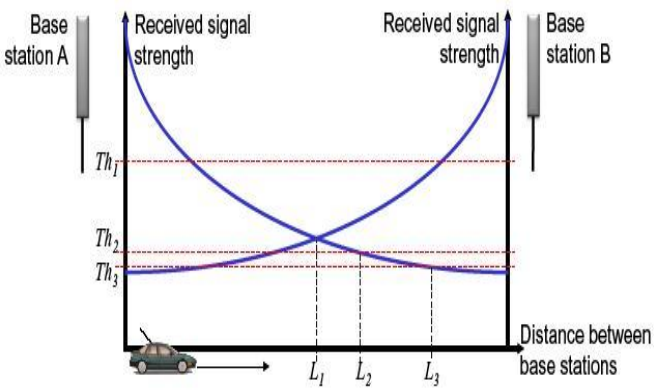

Figure 11 : Signal strength Vs distance for Relative Signal Strength with Threshold Scheme

c) Relative Signal Strength with Hysteresis (RSS-H)

Handover occurs only if the new base station is sufficiently stronger (by a margin H) than the current one. While the mobile is assigned to base station A, the scheme will generate a handover when the relative signal strength reaches or exceeds H. Once the mobile is assigned to B, it remains so until the relative signal

strength falls below –H, at which point it is handed back to A. This scheme prevents the ping-pong effect but the first handover may still be unnecessary if base station A still has sufficient signal strength.

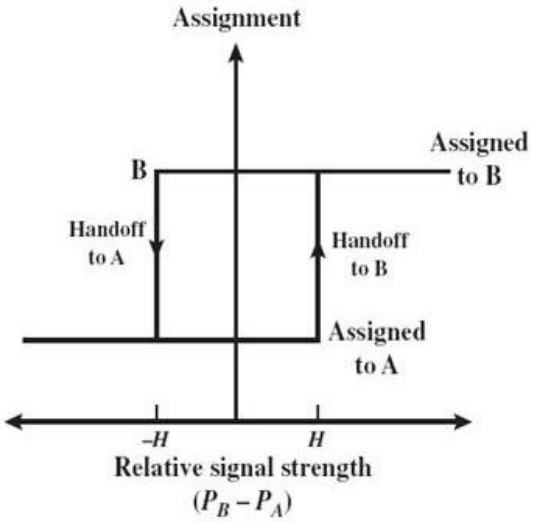

Figure 12 : Hysteresis mechanism

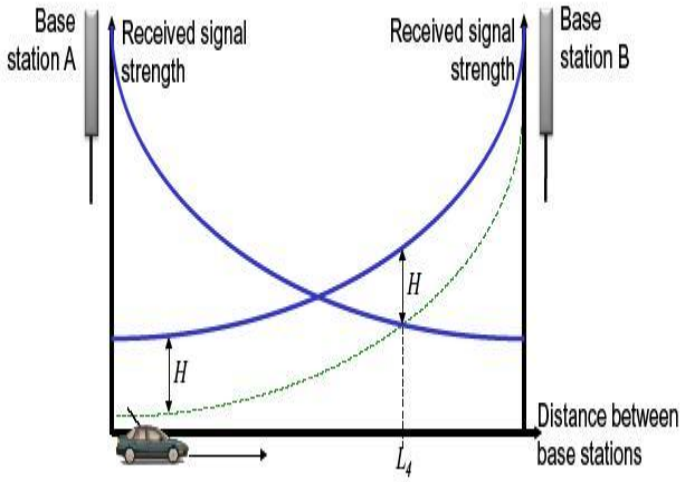

Figure 13 : Signal strength Vs distance for Relative Signal Strength with hysteresis Scheme

d) Relative Signal Strength with Threshold and Hysteresis (RSS-TH)

Handover occurs only if the current signal level drops below a threshold, and the target base station is stronger than the current one by a hysteresis margin H. Handover occurs at L4, if the threshold is either Th1or Th2. Handover occurs at L3, if the threshold is at Th3. Scheme avoids the ping-pong effect and execution of handover if signal from the serving base station is still strong enough. Decreasing threshold in the RSS-HT new cause increase the probability of handoff and therefore the number of handoffs and the number of wrong handoff increase.

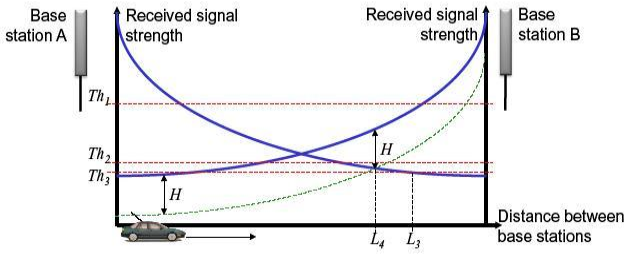

Figure 14 : Signal strength Vs distance for Relative Signal Strength with hysteresis and threshold Scheme

VII. Performance Matrics for Handoff

- Call blocking probability – The probability that a new call attempt is blocked.
- Handoff blocking probability – The probability that ahandoff attempt is blocked.
- Handoff probability – The probability that while communicating with a particular cell, an ongoing call requires a handoff before the call terminates. This metric translates into the average number of handoffs per cell.
- Call dropping probability – The probability that a call terminates due to handoff failure. This metric can be derived directly from the handoff blocking probability and the handoff probability.
- Rate of handoff – The number of handoff per unit time.
- Duration of interruption – The length of time during handoff for which the mobile terminal is in communication with neither base station.

VIII. Handoff Detection

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

– Mobile Controlled Handoff (MCHO)

– Network Controlled Handoff (NCHO).

– Mobile Assisted Handoff (MAHO).

The evolution of mobile communications is toward decentralization, implying that both the management and setup of handoff procedures will be

partially entrusted to the MS. Thus, advanced mobile systems typically follow MAHO.

a) Mobile Controlled Handoff (MCHO)

The mobile station (MS) continuously monitors the signals of the surrounding base stations (BSs) & initiates the handoff process when some handoff criteria are met. That is, in this method, the mobile station continuously monitors the signal strength and quality from the accessed base station and several handoff candidate base stations. This method has Very short reaction time (on the order of 0.1 seconds).

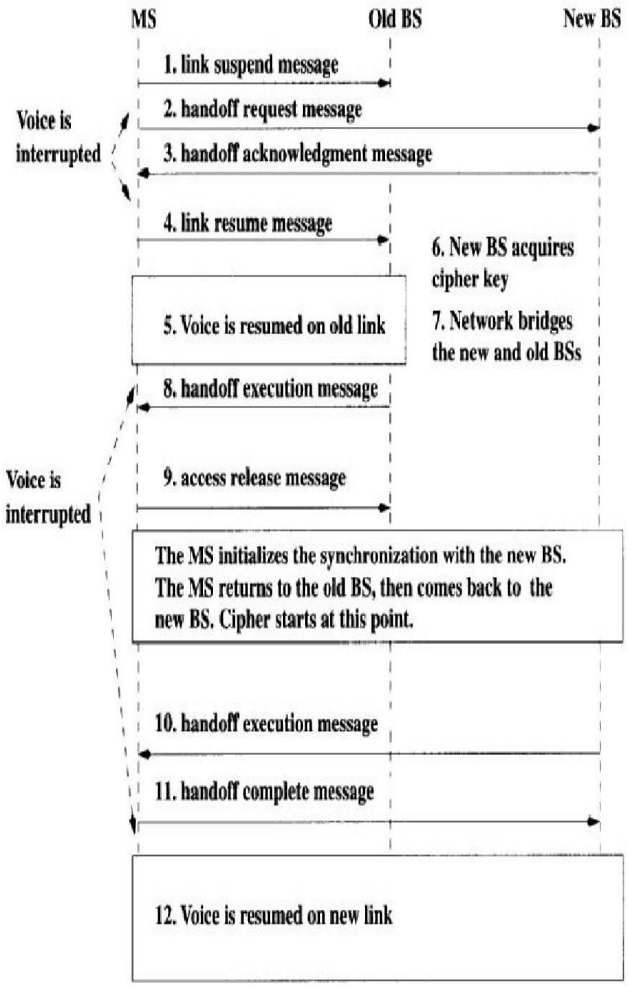

Figure 15 : MCHO inter BS hadoff message flow

b) Network Controlled Handoff (NCHO)

The surrounding base stations (BSs) measure the signal coming from mobile station (MS) & network initiates the handoff process when some handoff criteria are met. On the other hand, in this method, the base station monitors the signal strength and quality from the mobile station and when these deteriorate below some threshold, the network arranges for a handoff to another base station. The network examines all the surrounding base station to monitor the signal from the mobile station and report the measurement result back to the network. The network then chooses a new base station for the handoff and informs both the mobile station through the old base station and the new base station. NCHO is used in first generation cellular systems such as Advanced Mobile Phone System (AMPS), TACS (total access communication system), and NMT (advanced mobile phone system). In general, the handoff process (including data transmission, channel switching, and network switching) takes 100–200 ms.

c) Mobile Assisted Handoff (MAHO)

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

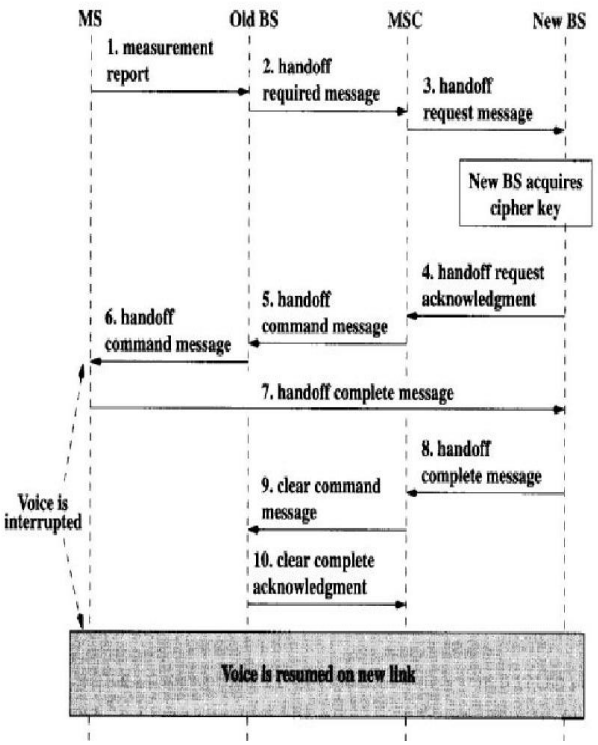

Figure 16 : MAHO inter BS hadoff message flow

For MCHO, NCHO and MAHO, handoff failure can occur for a number of reasons. Some of them are listed below:

a) The network takes too long to set the handoff after the handoff has been initiated.

b) There is no available channel on the target base stations.

c) The target link fails in some way during the execution of handoff.

d) Handoff is denied by the network, either for lack of resources or because the portable has exceeded some limit on the number of handoffs which may be attempted in some period of time.

e) In some other systems, handoffs can fail due to resource blocking (e.g. DECT).

Summary

Method	Measurement	Decision	Systems
MCHO	Mobile	Mobile	DECT, PACS, 802.11
NCHO	Network	Network	GSM, UMTS
MAHO	Mobile & Network	Network	AMPS,TACS, NMT

IX. Conclusion

Future generation wireless networks should ensure the best connectivity service to mobile subscriber anywhere at any-time. One way to improve the performance of wireless network is to use efficient handoff schemes when user is switching from one cell to another. In this paper we present an overview about the issues related to 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.

References Références Referencias

1. http://en.wikipedia.org/wiki/Handover
2. http://en.wikipedia.org/wiki/Soft_handover
3. Jahangir khan, (October 2010). Handover management in GSM cellular system. *International Journal of Computer Applications (0975 – 8887), Volume 8– No.12.*
4. http://wireless.agilent.com/rfcomms/refdocs/cdma2k/c2kla_gen_bse_sft_concept.html
5. Krishna B Rao, Lakshmi Narayan Mishra. SOFT HANDOFF IN CDMA SYSTEMS. Department Of Electrical Engineering, University of Texas at Dallas, 2601 N. Floyd Rd, Richardson, Texas, USA.
6. Claudia Linnhoff-Popien, Peter Ruppel, Mobile Communications. Mobility Management .v7.0 .1/5.
7. Farahd E. Mahmood, Member of IEEE, (2010). Investigation of Horizontal and Vertical Handoff in Mobile Networks. Mosharaka International conference on Communication, Propagation and Electronics.
8. NasıfEkiz, Tara Salih, SibelKüçüköner and Kemal Fidanboylu, (2006) —An Overview of Handoff Techniques in Cellular Networksǁ International Journal of Information Technology Volume 2 Number 6.
9. M. Gudmundson, (May 1991). Analysis of handover algorithms, Proc. IEEE VTC '91, pp. 537–542.
10. G. P. Pollini, (March 1996). Trends in handover design, IEEE Commun. Magazine, pp. 82–90.
11. J. D. Wells, (May 1984). Cellular system design using the expansion cell layout method, IEEE Trans. Veh. Technol., Vol. VT-33.
12. Dr. S. A. Mawjoud, Electrical Engineering Department, University of Mosul, (2007) Simulation of Handoff Techniques in Mobile Cellular Networks. Al-Rafidain Engineering Vol.15 No.4.
13. S Alagu, Meyyappan, (November 2011). Analysis of handoff schemes in wireless mobile network. International Journal of Computer Engineering Science. Volume1 Issue2, ISSN : 2250:3439.
14. Mahboubeh Lohi, DilshanWeerakoon, A. H. Aghvami, (1999). Key issues in Handover Design and Multi-Layer Cellular System Design. Centre for Telecommunication Research. King's College London Strand, London WC2R 2LS, England.
15. Ezio Biglieri, Luigi Fratta, BijanJabbari. (1999). Multiaccess, Mobility and Teletraffic in Wireless Communications.Volume 4, Kluwer Academic Publishers.
16. Noerpel, Y. Lin, (December 1997). Handover Management for a PCS Network, IEEE Personal Communications.
17. Amer Tawfeeq Abed, (April 2013). Handoff-Handover Technique Improved the Mobility in Cellular Phone Communications. Canadian Journal on Electrical and Electronics Engineering Vol. 4, No. 2.

This page is intentionally left blank