

Comparative Study of Various Handover Scenarios in WiMAX Network

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Abstract: Today in wireless network field Worldwide Interoperability for Microwave Access or WiMAX (IEEE 802.16 standard) has emerged out as one of the most promising networking technologies. But in order to compete with the present existing other wireless technologies like Wi-Fi (IEEE 802.11), 3GPP/UMTS, Bluetooth (IEEE 802.15); WiMAX has to promise better QoS & cost efficiency. Along with the QoS today's greatest network demand is mobility and mobility has to be supported by handover mechanism. So, this paper is focused upon the comparative study of various scenarios of handover technique in order to provide mobility to the WiMAX network along with enhanced QoS.

Keywords: WiMAX, Handover types, Handoff in WiMAX, QoS, Vertical Handover, Horizontal Handover, MDHO, FBSS, 802.15, 802.16, 802.11, 802.21, 802.16e, 802.16d.

I. INTRODUCTION

In order to provide omnipresent wireless network with more bandwidth, higher data rates, better QoS while considering overall system complexity; Institute of Electrical and Electronics Engineers (IEEE) introduced a LMDS (Local Multipoint Distribution services) standard 802.16 in 1999, which was released commercially in 2001 (named as WiMAX standard) to operate in the frequency range of 10-66 GHz for point to point links based on Line of Sight (LOS) transmission. Later several advancements and modifications were brought to 802.16 standards and improved versions like 802.16a, 802.16-2004 (also known as 802.16d), 802.16e, 802.16f, 802.16m etc. were gradually introduced. 802.16d and earlier versions of WiMAX standards were fixed and nomadic access types, but the later versions i.e. after 802.16e all were mobile accessible WiMAX standards and so better handover techniques were to be evolved in order to facilitate the mobility of WiMAX network without compensating with QoS. The upcoming topics of this paper will subsequently focus on the need and various techniques of handoff process in WiMAX network environment.

This paper is organized as follow: Section I presents the introduction to IEEE 802.16 standard and the need of handover mechanism. Section II is helpful to understand the background of WiMAX standard IEEE 802.16e. Section III discusses different scenarios of handover mechanism. Section IV presents different types of handoff mechanism. Section V compares Hard and Soft handover mechanisms, whereas Section VI presents the classification of handover on the basis of network diversity. Section VII classifies handover on the basis of architectural diversity and finally Section VIII concludes the paper followed by references.

II. BACKGROUND

In 2005, when IEEE introduced first Mobile WiMAX standard: 802.16e which added several enhancements to the existing WiMAX standards; some of the added features of 802.16e were:

- Enhanced mobility and portability capabilities.
- Improved NLOS coverage by using adaptive antenna system (AAS) with multiple inputs multiple output (MIMO) technology.
- Increased system gain and improved indoor penetration by adopting denser sub channelization.
- Handovers for portable and mobile access.

In nomadic WiMAX network access environment, the subscriber can change its BS but in order to do this it has to establish all new connection every time it changes BS of shift form one cell to another. But, IEEE 802.16e WiMAX standards allow

portability, simple mobility and full mobility for which is specified separate handover mechanism. So, 802.16e WiMAX network requires change in Base station(BS) to Mobile Subscriber station (MSS) connection, every time when the user move out of the range or area covered by a particular Base station it was initially connected to.

So, Handover can be understood as the technique to provide continuous connection between MSS and BS when BS moves from an air-interface of one BS to an air-interface of any other BS [1]. In fixed WiMAX network access environment, no movement is allowed and a particular BS for the subscriber is always fixed.

III. DIFFERENT SCENARIOS OF HANDOFF

- When the MSS is moving away from the area covered by on BS and entering into the area covered by another BS, then handover is needed to transfer the connection of MSS form current BS to other BS before the MSS moves out of the range of first BS, to avoid call termination.
- When the traffic handling capacity of any BS is exhausted then in order to accommodate more or new calls, loaded BS by means of handover transfers the ongoing or newly originated call to the neighboring BS with overlapping coverage area.
- Also my means of handover in case of interference (in non-CDMA environment) on any channel by different MSS from different cells (BS) using the same channel (but in different cells) then call is transferred to another channel in same cell or another cell, in order to avoid interference.
- In non-CDMA environment when an fast moving MSS connected to umbrella type cell, slows sown or stops then in order to shift the call from umbrella type (in order to efficiently use the umbrella cell capacity) to macro or micro type (whichever is needed) cell handover is needed.(Also applicable in reverse case).
- In order to avoid or reduce interference due to “near-far” effect in CDMA networks, soft handover is useful in such scenarios.

IV. TYPES OF HANDOFFS

As per IEEE 802.16e standards handover mechanism can be classified as: [2]

1. *Hard Handover*

- 1.1. *Intra Cell Handover.*
- 1.2. *Inter Cell Handover.*

2. *Soft Handover*

- 2.1. *Macro Diversity Handover (MDHO).*
- 2.2. *Fast Base Station Switching (FBSS).*

1. *Hard Handover:* Also known as “break before make”, means that in this type of handover mechanism the connection of MSS with source BS is first terminated before the establishment of connection with another i.e. target BS. In this manner the MSS is connected with only one BS at a given piece of time. The hard handover is so quick that it is not perceptible to the user of MSS, and also provided with a failure management system that in case if the connection establishment to the target BS is failed than the connection is reestablished back with the source BS. The mechanism of handover can be shown in figure No. 1, which clearly shows that hard handover is done when the signal strength of the source BS has dropped below that of the signal levels of target BS.

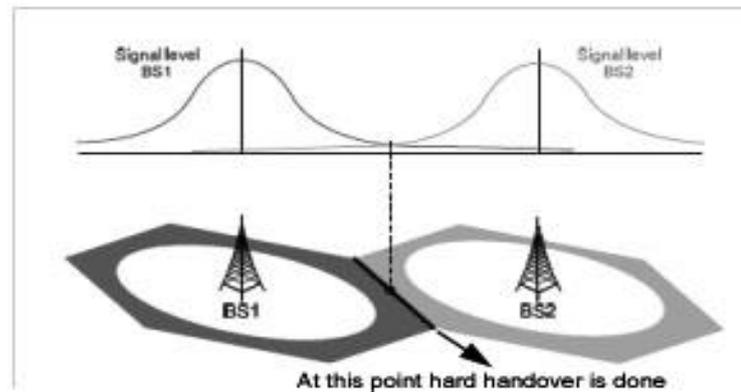


Fig. 1 Typical hard handover scenario

- 1.1. *Intra Cell Handover:* This type of hard handover is observed when MSS moves from one BS to another BS, but both the BS's of same backbone network or operator i.e. same MSC (Mobile/ Master switching center).(Referred as (A) in figure no. 2).
- 1.2. *Inter Cell Handover:* This type of hard handover is observed when MSS moves from one BS to another BS, but both the BS's of different backbone networks or operators i.e. different MSC's. (Referred as (B) in figure no. 2)

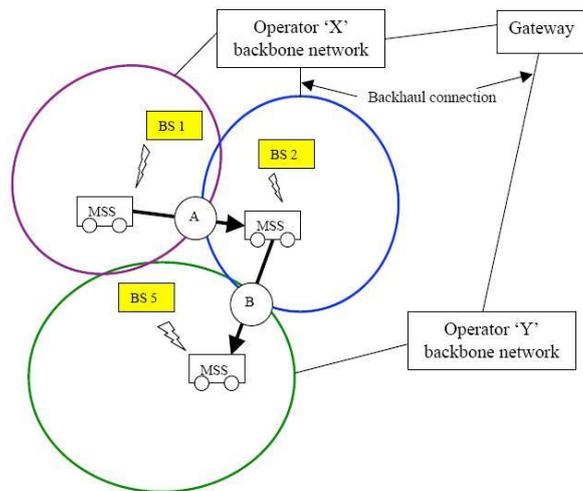


Fig. 2 Intra and Inter Cell Handover

2. *Soft Handover:* Also known as “make before break”, means that in this type of handover mechanism the connection of MSS with source BS is retained until the establishment of connection with another i.e. target BS. In this manner the MSS is connected with two (or may be more) BS at a given piece of time. The time for which both the connection run in parallel may be very small but also may grow large in some conditions.[5]
 - 2.1. *Macro Diversity Handover (MDHO):* [3] In order to understand this soft handover scheme. First we have to understand few concepts as follows:
 - *Diversity set:* Diversity set is the group of BS's selected by an MS such that all these BS's operate on same frequency channel and are synchronized on time and frame level. Diversity set is formed by sharing of MAC

context between BS and MSS. Also MSS select only those BS's as the member of diversity set whose CINR (Carrier to interference noise ratio).

- *Updating the Diversity set:* Diversity set may be updated under two situations: first when the CINR level of the serving BS falls below a predefined level known as H_Delete threshold, while the second case any BS is added into the diversity set if it has CINR levels above H_Add threshold.
- *Active BS:* All the BS's of the diversity set having all the information about the MSS including the MAC context.
- *Serving BS:* This is the BS to which the MS is recently handed over or registered with.
- *Neighbour BS:* This is the BS which is not the part of diversity set i.e., no traffic is exchanged with this BS but still MS can perform the signal strength measurement with this BS.

So, now we can describe the MDHO scheme in which the MSS communicate with all the active BS's in the diversity set for the exchange of uplink and downlink messages. In MDHO during downlink communication MSS receives data from all the active BS's and by the virtue of diversity combining MSS combines these multiple signals into a improved single data signal. And, during uplink communication in MDHO different active BS's receives data signal from MSS and after performing selection diversity the BS which receives the strongest data signal finally makes the transmission. [Refer figure no.3].

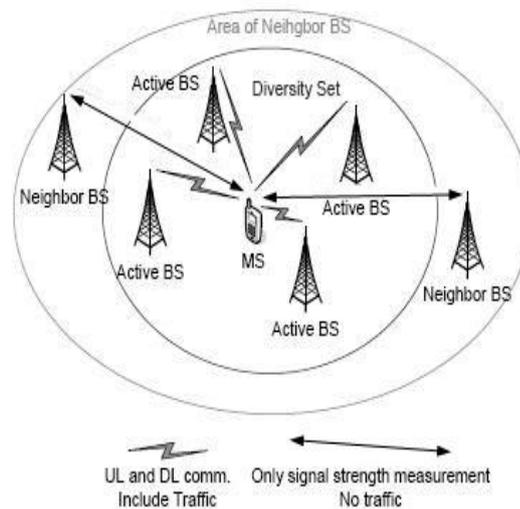


Fig. 3 Typical scenario of MDHO

2.2. *Fast Base Station Switching (FBSS):* During this type of handover mechanism the MSS receives signal from all the BS's of diversity set, out of these BS's MSS selects only one BS for exchanging uplink or downlink data, this BS is known as anchor BS. MSS gets registered and shares MAC context information with anchor BS only. MSS can update its anchor BS on the basis of CINR levels. [Refer figure no.4]

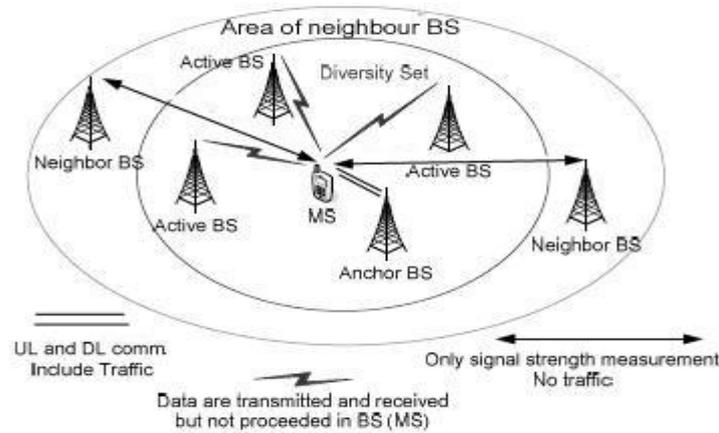


Fig. 4 Typical scenario of FBSS

V. HARD VS SOFT HANDOVER

1. IEEE 802.16e WiMAX standards specify hard handover as mandatory whereas the soft handover (MDHO and FBSS) as optional for BS and MSS both.
2. Hard handover has an advantage of using only one channel at a time during call whereas soft handover uses two or more than two, due to which the MSS's hardware has to be specific to handle more than one channel at a time, which is quite complex and expensive.
3. The handover time in hard handover is very small such that it is not perceptible to the user whereas it can be larger in case of soft handover.
4. Hard handover is possible only in case low speed mobility of about walking speed or low vehicular speed whereas at higher speed soft handover is needed.
5. Hard handover provides lesser connection reliability whereas the connection reliability is much higher in soft handover. The reason for this is, in case of hard handover another connection is established on the release of the current one so in case the targeted connection is failed the call is dropped, whereas in case of soft handover as source connection is not released up to the moment till the target connection is established so, the chances of call drops are minimal and only observed in case of interference or fading of the source channel, which is rare.
6. As, in during soft handover single MSS uses several channels for the single call so, due to this the overall capacity of the network is decreased as single node is involving more than one channel which in turn cannot be made available for other MSS's for new call.
7. Also, in soft handover the call rates are costlier as more than one channel are occupied for single call.

VI. CLASSIFICATION OF HANDOVER ON THE BASIS OF NETWORK DIVERSITY

The mechanism of handover can also be classified on the grounds of consideration that when a MSS connected to the source BS working on WiMAX standards, when move from one cell to another then whether the target BS is also working on same standards (i.e. WiMAX) or on some other standards like WiFi or UMTS.

So, in this manner the handover mechanism can be classified into two types as:

- A. *Horizontal handover:* When MSS moves from WiMAX network to WiMAX network, i.e. source and target BS's are both working on WiMAX standards.
- B. *Vertical handover:* When MSS moves from WiMAX to some other network [like WiFi or UMTS(3G/4G)], i.e. source BS is working on WiMAX standard but the target BS is working on WiFi (802.11) or UMTS (3G)/4G.

VII. CLASSIFICATION OF HANDOVER ON THE BASIS OF ARCHITECTURE DIVERSITY

[4] Handover mechanism is not architecture independent and depending upon the network at whose level the handover is taking place, handover mechanism can be further classified in to two types as follows:

- A. *Layer two handoff (L2HO)*: When a MSS moves from one cell to another without going under change in its IP (Internet Protocol) address, i.e. only air interface is changed but IP gateway serving the MSS is still same.
- B. *Layer three handoff (L3HO)*: When a MSS moves from one cell to another but also undergoes change in its IP address, i.e. along with the change in air interface the IP gateway initially serving the MSS is also changed.

VIII. CONCLUSION

Through out this paper we have gone through several scenarios and mechanisms of handover. Obviously, for every specific network environment specific handover mechanism is suitable and still this is the concern for researchers to give a stable and widely acceptable handover algorithm. Out of the presented technologies this can be concluded that rather hard handover is applicable for low speed mobile WiMAX networks but it is cheaper and simpler.

On the other hand need of high speed mobility demands soft handover despite of being complex and expensive. But, by minimizing the time duration of soft handover the cost can be minimized and being more reliable and compatibility with high speed moving network soft handover has wider scope.

Along with this it can also be concluded that importantly handover mechanism is not architecture independent, and both the basic types of handoffs, i.e. hard and soft both may incur at the level of layer 2 or layer 3 of the OSI network model.

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BIOGRAPHY



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