

WiMAX Mobile Network: Connection and Handover

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Abstract— In the present scenario, new and fast emerging technologies taking place frequently in the field of wireless network which allows high speed broad band access. Mobile WiMAX(Worldwide Interoperability for Microwave Access) based on 802.16e-2005[2] supports 4G, is an advanced next generation mobile broadband wireless network. IEEE 802.16e -2005[2] is amendment to IEEE 802.16 -2004[3] which is a fixed data transmission scheme for broadband connection to MAN. Wireless MAN-OFDMA specification to provide an advanced air interface for operation in licensed or unlicensed bands. This paper focus on the description and working of mobile WiMAX technology, various handover processes and the requirements of hand over processes and their working supported by the mobile WiMAX due to the mobility *Keywords- Wireless communication, Mobile WiMAX, Hand over.*

Introduction

WiMAX is the solution for Mobile broadband through which we can access faster data-transfer, this support the 4G. WiMAX is based on IEEE 802.16 standards. WiMAX is long range technology which covers number of kilometers, this technology uses licensed or unlicensed spectrum for delivering connections to a network, as in case of internet. If we are talking about classification then WLAN based on standard 802.11 (WiFi), WPAN based on standard 802.15(Bluetooth) and WiMAX is based on 802.16 known as WMAN operated at speed 30 to 40 Mbps but in 2011 it is up to 1Gbps it is a part of 4G. WiMAX comes under WMAN due to its long distance interoperability. The word WiMAX was introduced by WiMAX Forum[1] which was formed in June 2001 to promote conformity and interoperability of the standard. WiMAX provide fast data transfer as compare DSL and cable modem. Wimax can be setup in two forms Static and Mobile.

A fixed WiMAX WMAN based on the standard IEEE 802.16 -2004[3] in this big problem was that a user was not able to move during data transmission due to the lack of mobility. Mobile

WiMAX or 802.16e -2005[2] is newer version of 802.16 -2004 [3] which was a fixed Wimax. The network architecture of mobile WiMAX was defined by WiMAX Forum [1]. Due to the capability of moving in Mobile WiMAX network there would be the change in base station BS at the same time when the data is being transferred. Change in base station (BS) should be fast and without any data lose and without losing link to its MS. In this case the Handoff or some time known as handover technique is used ,this is a process which switch the network connection access point of the MS without data loss or disturbing the existing connections. There are three different technique for handoff which are supported by 802.16e 2005 specification : the Hard Handoff (HHO), the Fast Base Station Switching (FBSS), and the Macro Diversity Handover (MDHO). The first one is required while the others are optional ones. The WiMAX forum [1] has been working on the HHO designing enhanced techniques to achieve handoffs (layer 2) in less than 50 milliseconds .In this section we give a brief introduction about WiMAX and Hand over techniques, in the second section we will give the procedure of mobile WIMAX network and how it works with diagram .Third section would explain existing hand over methods and their working in detail and their advantages and disadvantages. Fourth section would contain performance matrices with different parameters and optimization techniques and applications .In Fifth section conclusion and references.

Handoff process in WiMAX

There is the requirement of handoff in mobile WiMAX which helps in achiving fast wireless broadband access to change the serving BS with another BS for providing better quality of service for MS and due to weak signals. Hand over in WiMAX is a process in which AP of MS is changed without data loss or without changing the existing connection, for maintaining continuity of connection when MS is moving from one base station to another base station. For handoff there will be requirement two BS and the handoff generally known as change of BS but it is not necessary because some time

handoff may occur with in the same BS with the help of different channels, this is known as intra-cell handoff, and second is inter-cell handoff. The handoff also may take place between two different technology, the handoff which take place between same network technology known as horizontal handoff, second is vertical handoff which take place between different type of networks. In WiMAX we have to use 802.16e-2005 because 802.16-2004 does not support handoff techniques.

Reasons for Handoff

Handoff may be due to many reasons some of them are as follows:

1. Weak signal at edge of any two adjacent BS range.
2. Due to slow service.
3. When the BS is full no more capacity.
4. Helps achieving fast access to wireless broadband access.
4. If faster or cheaper network is available.

Handoff Types

There are two types of handoff, soft handoff and hard handoff .In hard handoff the connection is broken from serving BS before new connection established with another BS. But in soft handoff first new connection is established with new BS and then old BS connection broken With continuing communications. The hard handover may be efficient as compare soft because in soft at a time two channels are occupied. The handoff should take place so fast that current IP connection should alive.

Basically 802.16e specification has support for three handoff methods: Hard Handoff (HHO), the Fast Base Station Switching (FBSS), Macro Diversity Handover(MDHO). HHO one is important and other is optional. There is also some other type handoff techniques such as intra-cell handoff, inter-cell handoff. HHO comes under hard handoff and other two comes under soft handoff.

Hard Handoff

In hard handoff the connection is broken from serving BS before new connection established with another BS. During handoff accessing data may be stopped. When MS is connected to BS it receives a message which is periodically broadcasted by SBS neighbor advertisement message (MOB_NBR-ADV).

This type of message is used for finding the networks and distributing their properties. The information presented by these messages is related to the signal strength from a neighbor BS. Figure .1 demonstrates the position where a moving user leaves a BS1 due to the weak signal and handover to BS2 with strong signals.

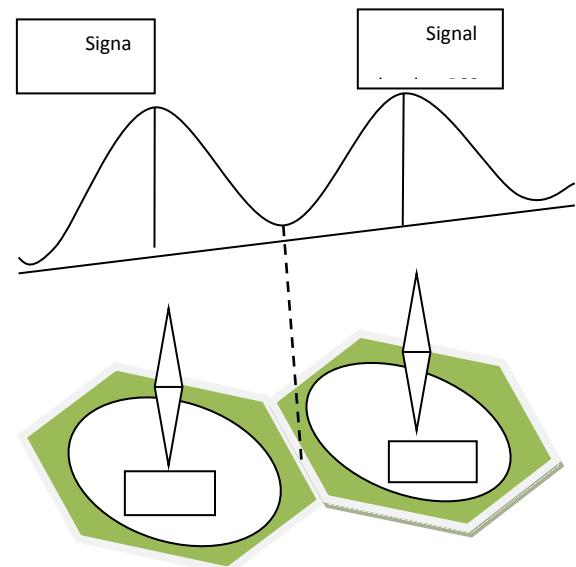


Figure 1. Hard Handoff Realization

Total procedure of HHO in IEEE 802-16e can be divided in two phase NTAP and AHOP [4].

Network Topology Acquisition Phase:

In this process before taking the decision of handoff MS and SBS both collect the information

BS advertises the network topology:

SBS periodically broadcast the knowledge about the position of NBSs with the help of a message MOB_NBR-ADV(Mobile Neighbor Advertisement) for handoff activities. The SBS collect these information about the NBSs with the help of backbone network.

Scanning of advertised neighboring BSs by MS:

MS scans the published BSs in a time slot to find right choice for handoff and maintain a list of TBSs this task is carried out with the help of a messages MOB_SCN-REQ and MOB_SCN-RSP respectively sent by the MS and SBS.

Ranging and Optional Association Activities:

The two messages are used for this Ranging Request(RNG_REQ) and Ranging Response (RNG_RSP) . Ranging can be followed by optional association act with the help of this MS would be associated with TBS.

MDHO and FBSS:

The MWiMAX HHO model is not very good for handling voice-centric applications with high speed mobility users. But MDHO and FBSS are the techniques which support seamless mobility at high speed up to 110 kph. With very low less than 1% packet loss very fast switching and and low handover latency (less than 50 ms). These two high potential techniques support to VoIP.

Macro Diversity Handoff (MDHO)

This MDHO method is achieved with the help of both MS and BS, when this is supported by both MS and BS. Each MS maintain a set of BSs who are in the range of MS. This set is known as diversity set or active set in which each BS is involved in handoff process. The BS nodes who are not in the range of MS or signal are weak for MS are kept out side this set ,these nodes kwon as neighbor BSs. Each MS has its diversity set. As shown in Fig. 3.

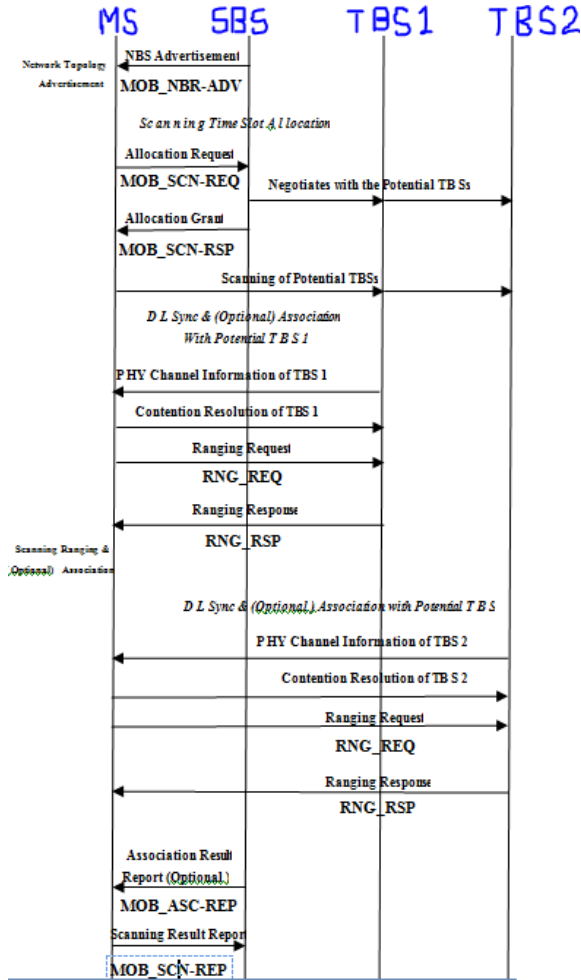
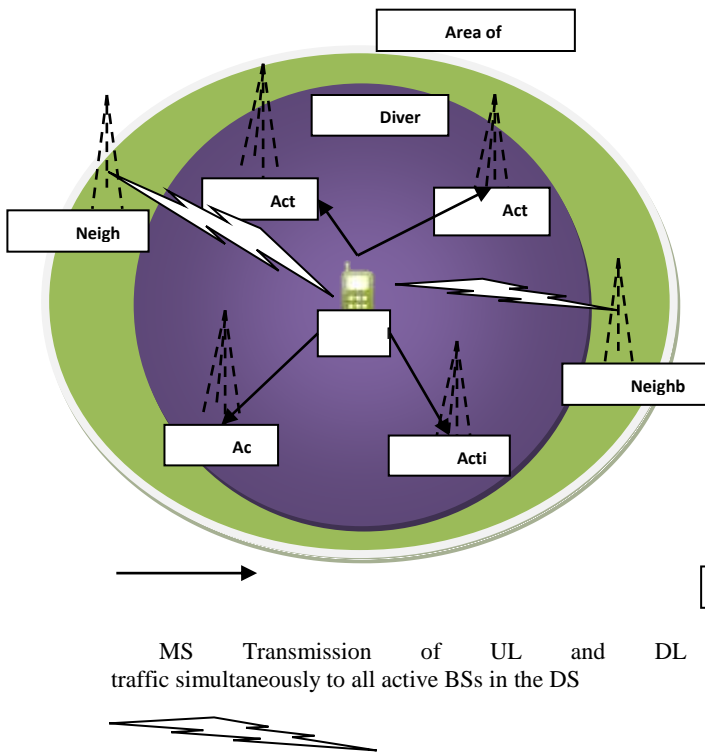


Figure.2 NTAP Message Sequence Chart

about the existing network topology with the help of backbone network. This is performed to find the list of NBSs, from which we can choose one particular TBS for the handoff activity

Figure 2. shows the message sequence chart for the procedure .The following steps describe the process:

When FBSS mode is on the MS would be responsible for monitoring the signal strength of the BSs belonging to the diversity set regularly. Then the MS will select a BS as an Anchor BS from diversity set and report the selected Anchor BS on MOB_MSHO-REQ message. As shown in figure -4.



MS Transmission of UL and DL traffic simultaneously to all active BSs in the DS



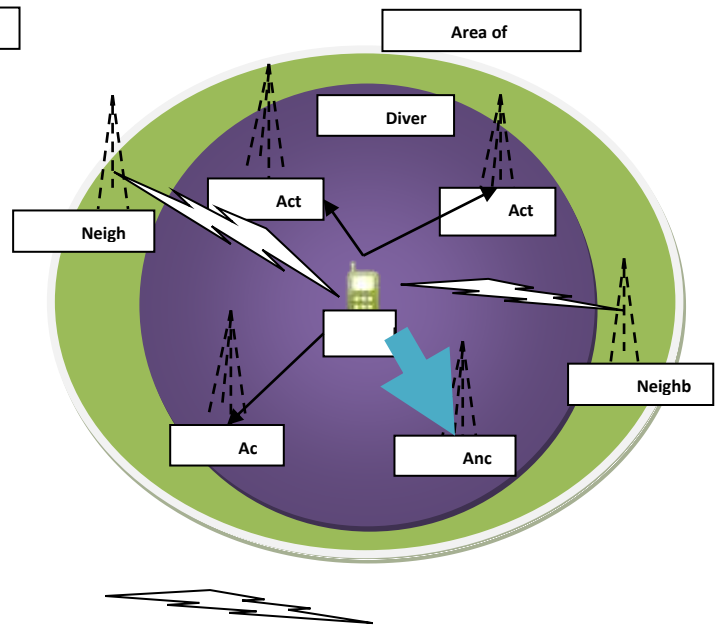
MS monitoring the signal strengths to update the DS

Figure 3. Macro Diversity Handover

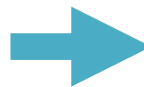
A MDHO begins with a message MOB_MSHO_REQ which enable an MS to transmit to and receive information from multiple BSs at the same time. In MDHO mode MS transfer a message to all BSs relate to Diversity set for DL and UL unicast message and traffic. For DL MDHO, two or more BSs provide synchronized transmission of data so that the MS performs the diversity combining..For UL MDHO the MS data transmission is received by multiple BSs so that they can perform selection diversity of the received information .

Fast Base Station Switching (FBSS HO)

FBSS HO begins with a message MOB-BSHO-REQ or MOB-MSHO-REQ message which allow an MS to receive and transfer data from/to the Anchor BS that may change in the diversity set.



MS monitoring the signal strengths to update the DS



MS Transmission of UL and DL traffic



MS monitoring the signal strengths to update the anchor DS

anchor DS

Figure 4. Fast Base Station Switching

Handoff performance analysis parameters

The performance of handoff process is the measurement of delay in data transmission during handoff and also involve delay in every step of handoff .The following parameters are used for measuring the delay, setting these values depend on particular system settings.

T1: time for one neighbor BS scanning

T2: time for initiating the network re-entry

T3: time for ranging

T4: time for channel capability negotiation

T5: time for re-authentication

T6: time for re-registration

Conclusion

Effective Seamless handoff management activity is the most important aspect required for communication technologies in the new next generation communication system. This paper analyze the current hand over problem in Mobile WiMAX network which were not supported in WiMAX 8002.16-2004 version but due to the requirement of mobility in the new version 802.16e-2005 this was possible to find new handoff techniques.

Hard hand over works with low speed mobility, for high speed mobility MWiMAX support FBSM and MDHO. Both MDHO and FBSS HO belong to soft handoff class. In both diversity set is maintain. The main difference between MDHO and FBSS is that in MDHO uses selection diversity and diversity combining in uplink and downlink. But in FBSS OH all data traffic is processed only in the anchor BS.

References

- [1] WiMAX forum ,<http://www.wimaxforum.org/>
- [2] 802.16e-2005,IEEE Standard for Local and metropolitan area networks-Part 16:Air Interface for Fixed and Mobile Broadband Wireless Access Systems-Amendment 2:Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Band and Corrigendum1, <http://standards.ieee.org/getieee802/download/802.16e-2005.pdf>
- [3] IEEE 802.16-2004, IEEE standard for local and metropolitan area networks-part 16:Air Interface for Broadband Wireless Access systems<http://standards.ieee.org/getieee802/download>
- [4] IEEE 802.16e-2005: IEEE Standard for Local and Metropolitan Area Networks-Part 16: Air Interface for Fixed and Broadband Wireless Access System.
- [5] Z. Becvar, J. Zelenka, "Handovers in Mobile WiMAX" Research in Telecommunication Technology, 2006.
- [6] N. Ekiz, T. Salih, Sibel, K. Fidanboyly, "An Overview of Handoff Techniques in Cellular Networks," World Academy of Science, Engineering and Technology 6,2005
- [7] Shian-Tsong Sheu, Chin-Chiang Wu, "Using Grey prediction theory to reduce handoff overhead in cellular communication systems, "The 11th IEEE International Symposium on Personal, Indoor and Mobile Radio Communications, vol. 2, pp. 782-786, 2000
- [8] G. Edwards, R. Sankar, "Handoff Using Fuzzy Logic," IEEE Globecom, pp. 38-44,1995.
- [9] H. Fattah, H. Alnuweiri, "A New Handover Mechanism for IEEE802.16e Wireless Networks," Wireless communications and Mobile Computing Conference, 2008. IWCMC'08. International, August 2008.
- [10] J. Choi, N. Hao, S. Yoo, "Fast groups canning scheme with dynamic neighbour base station list in IEEE802.16e networks,"8th Conference on Computer and Information Technology (CIT), July 2008.
- [11] M. Grine, A. Najid, R. Messoussi, "Performance Optimization of WiMAX Mobile Networks with a Predictive

- Handover Process,” International Journal of Distributed and Parallel Systems (IJDPDS) Vol.3, No.3, May 2012
- [12] Y. Han, H. Jang, J. Choi, B. Park and J. McNair, “A Cross-Layering Design for IPv6 Fast Handover Support in an IEEE 802.16e Wireless MAN,” IEEE Network , November/December 2007.
- [13] P. Marichamy, S. Chakrabati, S. L. Maskara, “Overview of handoff schemes in cellular mobile networks and their comparative performance evaluation,” IEEE VTC’99, vol.3, pp.1486-1490, 1999.
- [14] I. Papapanagiotou, D. Toumpakaris, J. Lee, M. Devetsikiotis, “A Survey on Next Generation Mobile WiMAX Networks: Objectives, Features and Technical Challenges” IEEE communications surveys & tutorials, vol. 11, no.4, fourth quarter of 2009.
- [15] L. Tian, J. Li, Yi Hang, J. Shi, J. Zhou, “Seamless Dual-Link Handover Scheme in Broadband Wireless Communication Systems for High-Speed Rail,” IEEE Journal on Selected Areas in Communications, Vol. 30, No. 4, May 2012.