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Various handover processes in Wi-Max

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Abstract

WiMAX is a broadband wireless access (BWA) scheme based on IEEE 802.16. This is an emerging technology that aims at providing last mile access internet and data services. Since 2001, WiMAX has evolved from 802.16 to 802.16d standard for fixed wireless access and to new IEEE 802.16e (Mobile WiMAX) standard with mobility support. Mobile WiMAX introduces the most significant feature that is support for handovers which can be considered as a basic requirement for mobile communication system. Since this standard support all type of data and applications like mobile Voice over Internet Protocol (VoIP), multimedia video stream (IPTV etc.) or multimedia gaming and other real time, non real time services, so the handover schemes must be fast and efficient should avoid any packet loss. This paper gives an overview of handover procedure and types of handover supported by mobile WiMAX.

Keyword: *Wi-MAX, handover, HHO, MDHO, FBSS*

I. INTRODUCTION

WiMAX stands for worldwide interoperability for microwave access. It is a trade name for the IEEE 802.16 international standards. WiMAX aims at providing a metropolitan area network (MAN) which will provide higher bandwidth and larger coverage than are currently available with existing wireless technologies such as Wi-Fi and 3G. Fixed WiMAX, based on IEEE 802.16d standard is a cost effective fixed wireless alternative to cable and DSL services. Mobile WiMAX (IEEE 802.16e) is a broadband wireless solution that covers mobile and fixed broadband networks. WiMAX coverage range is up to thirty mile radius and data rates between 1.5 Mbps to 75 Mbps theoretically [1].

Handover (HO) is one of the key requirements to embrace mobility and Quality of Service (QoS) for the subscribers using a wireless service. HO refers to the process in which an MS migrates from the air interface provided by one BS to an air interface provided by another BS .The impact of handovers between base stations is a serious problem in a mobile communication system that must be addressed. During a handover, packets may be delayed and connections may be dropped [2]. Real-time applications such as VoIP and streaming video can be adversely affected by these delays.

The IEEE 802.16e defines three basic types of HO: Hard Handover (HHO), Macro Diversity Handover (MDHO) and Fast Base Station Switching (FBSS). MDHO and FBSS are soft handovers and adopt the make-before-break scheme. HHO is mandatory in WiMAX system but MDHO and FBSS are optional. In this paper we present an analysis of Mobile WiMAX/802.16e standard handover procedure and types [3].

II. WIMAX ACCESS TYPES

The older version IEEE 802.16-2004 was defined only fixed and nomadic access. Fixed access allows no movement. The user device is assumed to be fixed in a single geographic location for the duration of the network subscription. Nomadic access provides movement among the cells, but there is no handover support. It means that moving user must establish a new network connection after each cell border crossed. IEEE 802.16e specifies handovers for portability, simple mobility and full mobility of the users. Portability and simple mobility fall into a hard handover group. The moving speed is in the range of walking speed and low vehicular speed for portability and simple mobility, respectively. Handover among Base Stations (BS) provide service continuity for all non real time applications. Full mobility comes under the group of a soft handover. Maximal supported speed matches high vehicular speed about 160 km/h [4].

III. WIMAX HANDOVER TYPES

WiMAX standard handover should provide continuous connection when a Mobile Station (MS) migrates from an air-interface of one BS to another air-interface provided by another BS. In the IEEE 802.16e are defined three types of handover [5]: Hard handover, Macro Diversity Handover (MDHO) and Fast Base Station Switching (FBSS).

A. Hard Handover: During hard handover the MS communicates with only one BS at a time. Connection with the old BS is broken before the new connection is established. Handover is executed after the signal strength from neighbor's cell is exceeding the signal strength from the current cell. HHO is a break before-make approach with each user device connected to only one BS at any given time, which is less complex than MDHO or FBSS but has a much poorer performance for long service interruption time [6]. In this handover process, the data transmissions will be paused, and the interruption will cause large delay to data transmission and even data loss.

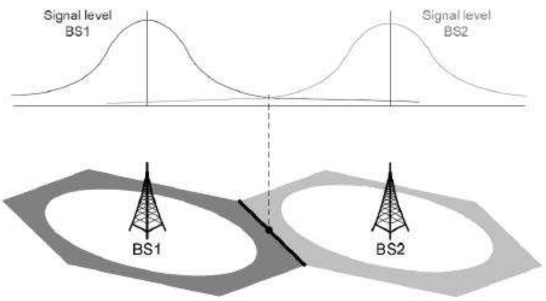

Fig. 1 Hard Handover

B. Macro Diversity Handover (MDHO): In MDHO a list of Diversity Set Base Stations is maintained by both MS and BS. These are the BS's, which are involved in the handover procedure. Diversity set is defined for each of MS's in network. MS communicates with all BS's in the diversity set (Fig. 2) [6]. For downlink in MDHO, two or more BS's transmit data to MS such that diversity combining can be performed at the MS. For uplink in MDHO, MS transmission is received by multiple BS's where selection diversity of the received information is performed. The BS, which can receive communication among MS's and other BS's, but the level of signal strength, is not sufficient come under Neighbor BS list. MDHO poses several constraints on the BS and network. Here both uplink and downlink require additional backhaul bandwidth to support forward link frame distribution and reverse link combining. For downlink data, tight timing is required for the arrival of packets at the BS in the active set, and the BS must coordinate scheduling so that packets are sent within the timing constraints acceptable for diversity combining at the MSS. For uplink data similar tight timing requirements are imposed on the backhaul network to ensure that packets from the BSs are received at the frame selector within the timing window required for performing selection diversity.

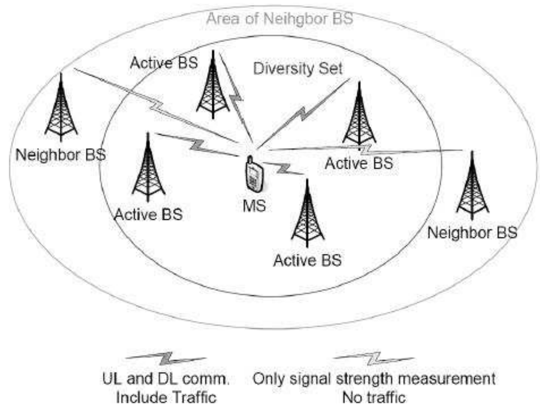

Fig. 2 Macro Diversity Handover

C. Fast Base Station Switching (FBSS)

In FBSS, the MS and BS diversity set is maintained similar as in MDHO. MS continuously monitors the base stations in the diversity set and defines an "Anchor BS". Anchor BS is only one base station of the diversity set that MS communicates with for all uplink and downlink traffic including management messages (Fig. 3.). This is the BS where MS is registered, synchronized, performs ranging and there is monitored downlink channel for control information. The anchor BS can be changed from frame to frame depending on BS selection scheme. This means every frame can be sent via different BS in diversity set [7]. FBSS relieves some, but not all of the network timing and configuration challenges met by MDHO. With FBSS, the MSS sends and receives bearer data to/from only one BS in any interval.

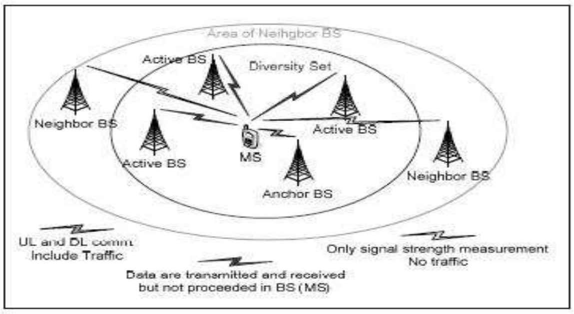

Fig. 3 Fast Base Station Switching Handover

IV. HANDOVER PROCEDURE

In the handover process, firstly, network topology acquisition is carried out before HO request. Then the actual HO process including HO decision, initiation, and ranging and network reentry process is performed. The overall handover process has the following steps [8]:

A. Network Topology Advertisement:

The BSs periodically broadcast Mobile Neighbor Advertisement (MOB_NBR_ADV) control messages. These messages contain both physical layer (i.e., radio channel) and link layer (e.g., MAC address) information. By means of such broadcasts, the MS becomes aware of the neighboring BSs. The MS then triggers the second-phase.

B. Scanning/ranging Procedure

In the second phase of HO, the MS scans and synchronizes with the neighboring BSs based on channel information from the neighbor advertisement. If the synchronization successes, it then starts the ranging procedure. The scanning and ranging processes are shown in Fig 4. The MS first sends a Mobile Scanning Request (MOB_SCNREQ) message to the neighboring BS with a potential target BS list (selected in the previous phase). The serving BS replies a Mobile Scanning Response (MOB_SCN-RSP) message to the MS to allocate a scanning duration. The serving BS may negotiate directly with the listed BSs the allocation of a unicast ranging opportunity [9]. If successful, the ranging procedure can be non-contention-based.

Else, the MS starts a contention-based CDMA procedure to be allocated a ranging slot by the neighboring BS. Then the MS starts a hand-shake ranging procedure with the neighboring BS for the OFDMA uplink synchronization and parameter adjustment. This process may contain multiple messages (Ranging Request (RNG-REQ) and Ranging Response (RNG-RSP) transmission and parameter adjustment transactions. This procedure ends after the MS has completed ranging with all its neighbors. In the ranging phase, a MS may switch to a new channel, thus temporally loosing connection with the serving BS.

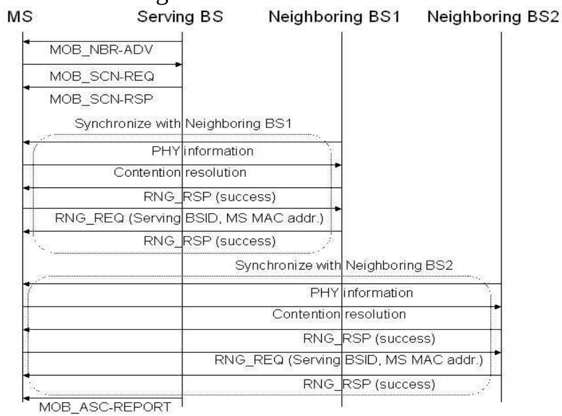

Fig. 4 Network Topology Acquisition

C. HO Decision and Initiation

The HO trigger decision and initiation can be originated by both the MS and the BS using a MS HO Request message (MOB_MSHO-REQ) or a BS HO Request message (MOB_BSHO-REQ) respectively. Fig. 5 shows the HO started by MS.

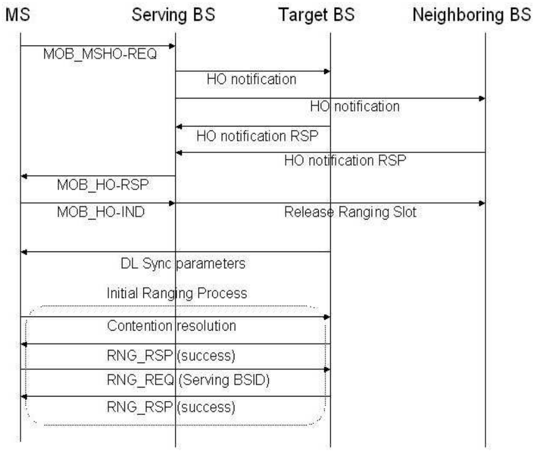

Fig. 5 HO decision, initiation, and ranging procedure.

The MS makes a decision about which BS(s) is (are) its target(s). A HO begins with when the MS sends a MOB_MSHO-REQ message to its serving BS indicating one or more possible target BSs. The serving BS may obtain directly from potential target BSs the expected MS performance at the target BSs through the exchange of HO indication and response messages. After receiving a response from a target BS (MOB_BSHORSP), the MS notifies the serving BS about its decision to perform a HO by means of a HO Indication (MOB_HO-IND) message [10]. The MS can also ask the serving BS to negotiate with the target BS the allocation of a ranging opportunity. If necessary, the MS may start ranging after HO initiation. The HO decision and initiation process does not provoke connectivity break-up nor does it add latency.

D. Network Re-entry

After all the physical parameter adjustments have been completed successfully, the network re-entry process is initiated to establish connectivity between the MS and the target BS. As defined in IEEE 802.16e, this procedure may include capability negotiation, authentication and registration transactions as shown in Fig. 6. Because the MS must wait until the re-entry procedure is completed successfully before it can restore communication, duration of this phase should be taken account into the entire HO latency.

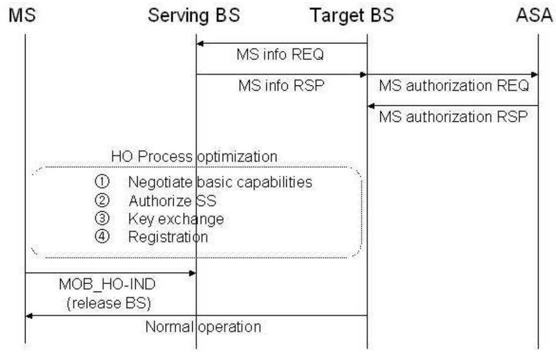

Fig 6. Authorization and registration procedure.

V. CONCLUSION

This paper analyzes the current handover situation in WiMAX networks**.** In the handover process before HO initiation, network topology acquisition including network topology advertisement, neighboring base station (BS) scanning, and the target BS association are carried out by backbone network. Then, cell reselection, HO decision, HO initiation, downlink synchronization with the target BS, initial ranging, termination service with the serving BS, authorization, and registration are performed during the actual HO.

Some parts such as HO initiation timing are still ambiguous and are not clearly defined yet. Furthermore, unnecessary neighboring BS scanning and association are conducted before and during HO process. Once HO process is initiated, data transmission is paused until the establishment of the new connection. It causes service disruption for some time. So, there is a need to propose some faster handover schemes that improve the overall efficiency of WiMAX networks.

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