A Pre-authorization Algorithm for WiMAX Network to Reduce Handover Signaling

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Abstract. IEEE 802.16e is a platform capable of meeting those standards in modern wireless networks that demand broad bandwidth and high-speed mobility. One of the most significant problems with IEEE 802.16e is that although the handover technology provides smooth high volume data services at a high speed scale, it only specifies a mechanism without including precise methods or algorithms for handover that can be delegated. Another issue is handover signaling during the re-entry process when a mobile station requests access to the next possible base station. This paper proposes PAA (Pre-Authorization Algorithm) which accepts incoming requests quickly because it already has the incoming request’s information saved. PAA reduces call dropping for high speed users at the edge of cell and mitigates the ping-pong effect. Finally MATLAB was used to present the results that shows reducing in signaling time.

1. Introduction

WiMAX has emerged as one of the most competitive broadband wireless communications because of its data rate, low cost, wide coverage, and built-in mobility support [1]. However, there are a number of issues that could make mobile WiMAX network implementation difficult. Because of the affordability and mobility of the Mobile Station (MS), there are two type of handover vertical and horizontal. The vertical handoff occurs between the two cells with various technologies or when a node transfers between different wireless access networks [2]-[4], while horizontal takes place between the two cells with the same access technologies. Handover requests are becoming more common, necessitating the need for an efficient and quick authentication scheme [5]. The key change in IEEE 802.16e to allow mobility is support for handover (HO). When a MS moves across cell boundaries, the device performs HO to establish an ongoing data transmission service [6]. The HHO (hard handover) term in MWiMAX (mobile WiMAX) suffering from a prolonged “inter-handover” CDT (call disruption time), which can result in undesirable hazards such as packet losses, call delays, or even call falls when on the run. This happens during the actual handover process, when an MS disconnects from the SBS (serving BS) and attempts to bind to the selected TBS (Target BS). While a CDT of 200 ms is appropriate for real-time media streaming traffic [7], anything higher is disruptive [8].

The rest of this paper is organized as follows. Section 2 addresses the back ground. In Section 3, the PAA algorithm is discussed. Section 4 presents the network model and analysis result, and Section 5 concludes the paper.
2. Background

In IEEE 802.16e, the complete HHO process consists of two phases: NTAP (Network Topology Acquisition Phase) and AHOP (Actual Handover Phase), a detailed description of the whole process contains in [9]. This article focuses on reducing signaling in AHOP when the MS disconnects from the SBS and connects to the new BS (target BS). When the mobile station selects the next base station, it demands communication with the current base station as well as a number of other parameters [10]. When an MS tries to connect to a new BS in MWiMAX HHO, it must finish network re-entry procedure, which requires a set of protection and link re-establishment procedures. This takes a long time. As MS is passed from one cell to another but quickly returned to the original cell, a ping-pong effect occurs, as does when high-speed users pass the cell's edge. Ping-pong effects cause unnecessary network re-entry procedures, which cause delays, call disturbances, and handover overheads, which can impair overall system performance. To avoid this impact, the SBS informs the MS of the length of time that traffic for the MS will be buffered in the SBS [11]. In [12] suggested a link-layer quick handover scheme for the MWiMAX HHO scenario, which greatly reduces the chances of packet loss and transmission delay during handover. This scheme introduces the Quick DL- MAP- IE- MAC management message, which allows an MS to receive downlink traffic immediately following downlink synchronization with the TBS, even before the uplink is completed. A similar concept, known as Passport Handover, is addressed in [13], in which an MS could resume DL re-transmissions with the TBS prior to the completion of the authorization procedures by using the previous SBS's CIDs (Connection Identification). Though both of these methods improved overall handover efficiency, they did not account for the possibility of ineffective authorization activities when swapping domains. PPA proposed "base stations visitors" helps in handoff functions for users who are outside their coverage area and ensure effective authorization as explained in the following segment.

3. PAA

The PAA is based on the fact that the authorization process occurs in AHOP when the MS disconnects from the previous BS and connects to the current BS. According to IEEE 802.16e, the current BS requests information about the MS from the previous BS, as shown in figure 1 and the last one gathers this information with the aid of the backbone network. The network's re-entry can be seen here. Since transmitting the stored authorization messages from the SBS to the TBS can sometimes increase the overall load in the backhaul network, the proposed PAA/BV (Base station visitor) that provides information to TBS in advance that MS requires during visiting these base stations to perform pre-authorization and reduce signaling, thereby improving overall efficiency. Figure 2 describes re-entry phase in PAA/BV.

![Figure 1. Re-entry phase in HHO.](image-url)
the service interruption time of conventional scheme:

\[ T_{\text{CON}} = T_s + T_c + T_{\text{RNG}} + T_{\text{auth}} + T_{\text{reg}} \]  \hspace{1cm} (1)

While the service interruption time of PAA/BV is:

\[ T_{\text{PAA/BV}} = T_s + T_c + T_{\text{RNG}} \]  \hspace{1cm} (2)

Where \( T_s \): average time is takes to synchronize with new downlink.
\( T_c \): the average time needed for the contention resolution procedure during the contention based ranging phase.
\( T_{\text{RNG}} \): the average amount of time needed for ranging phase during HO.
\( T_{\text{auth}} \): the average time needed for re-authorization during HO.
\( T_{\text{reg}} \): the average time needed for registration process during HO.

The method of adding user information to base stations is influenced by two major factors: the capacity of the base station and the rate at which users visit these sites. It should be noted that maximum capacity varies from BS to BS depending on the nature of the coverage area, whether it has a high or low population density. Whereas in the first case, the capacity of the visitor list is high, and in the second case, it is smaller. The method for adding a consumer to the main list of BSs is depicted in figure 3.

PPA/BV prioritizes users who visit the BS often, regardless of the available capacity of the BS. In addition, the visitor rates for each user change on a regular basis, So the visitor list in BSs is continuously updated. The mechanism for updating is depicted in figure 4 below.
Figure 3. Flowchart of adding user.

Figure 4. Flowchart of update adding user.
4. NETWORK MODEL AND ANALYSIS RESULTS
The supposed network consists of seven base stations distributed in an area containing a set of streets, intersections, residential areas, and some buildings. Figure 5 explains the position of BSs.

Voronoi diagram is used to partition the area into cells as in Figure 6. A Voronoi diagram is a mathematical diagram that divides a plane into regions that are similar to each other for a given set of objects. In the most basic case, these objects are simply a finite number of points in the plane known as seeds, sites, or generators. For each site, there is a corresponding region known as a Voronoi cell, which consists of all points in the plane that are closer to that site than to any other [14]. This diagram helps us to know the closer BS with respect to the user and the boundaries of Voronoi cells represent the handover regions.

The result in Figure 7 shows the effect of capacity/load on the probability of adding information of MS to BV. Note that the highest probability of addition when there is high capacity. In Figure 8 when the visit per month is high, there is a high probability of addition too but Figure 9 displays that visit per month have a priority for addition regardless of available capacity of BV. Now look at the impact of PAA/BV on signaling time. As the MS located in cell 3 moves towards cell 4, the signal efficiency of the Serving BS degrades, resulting in a decrease in throughput. Since the HO is a break-
before-make one, the service is interrupted when it begins. However, the duration of disruption varies between traditional and proposed schemes. Simulated results show that PAA/BV minimize signaling time. In Fig. 10 the blue line reflects time signaling in the traditional scheme, after a certain number of visits to BS4, user information is applied to it, and the average time of the signaling time is measured (red line), and it progressively decreases before it stabilizes. Users moving on the street separating cell 3 and cell 4 usually experience ping-pong effect because the street is located on the edge of the two cells, repeated handover can occur due to fluctuation of signal strength and that involve frequent Re-entry process in traditional HO, but in PPA/BV there is no need to exchange message due to presence information in BSs in advance.

**Figure 7.** Effect of capacity on addition.

**Figure 8.** Effect of visit per month on addition.

**Figure 9.** Effect of capacity and visit per month.

**Figure 10.** Signaling reduction.
5. CONCLUSION

PAA is a satisfying adding users information for BV, hence pre-authorization is available. It does not require all BSs and sectors to use the same frequency, and it avoids the complexity of dealing with multiple transmitting BSs at the same time that SHO (soft handover) schemes do. The simulation results indicate that signaling has been substantially decreased by about 20%. As a result, overall handover time and efficiency are improved, and the ping-pong effect is minimized. Furthermore, we can use the user information stored in BV to facilitate the selection of the target BS, hence reduce the scan phase time (future work).

References

[1] Elhameen N M and Babiker A 2017 The Parameter Effect in Handover in the Mobile Wimax International Journal of Communication Research, 7 220-230.

[2] Hamza J B , Ng C K , Noordin N K , Rasid M F A and Ismail A 2010 Review of minimizing a vertical handover in a heterogeneous wireless network IETE technical review, 27 97-106.

[3] Hamza B J , Ng C K , Noordin N K , Rasid M F A and Ismail A 2010 The seamless vertical handover between (universal mobile telecommunications system) UMTS and (wireless local area network) WLAN by using hybrid scheme of Bi-mSCTP in Mobile IP. Scientific Research and Essays, 5 3474-3489.

[4] Hamza B J , Ng C K , Noordin N K , Rasid M F A , Ismail A and Tahir Y H 2010 Enhancement of packet reordering in a mobile stream control transmission protocol for a heterogeneous wireless network vertical handover Journal of High Speed Networks, 17 163-173.

[5] Fu A , Lan S , Huang B , Zhu Z and Zhang Y 2012 A novel group-based handover authentication scheme with privacy preservation for mobile WiMAX networks IEEE Communications Letters, 16 1744-1747.

[6] Mahajan P 2020 Analysis of back propagation and radial basis function neural networks for handover decisions in wireless communication International Journal of Electrical & Computer Engineering (2088-8708), 10.

[7] Banerjee N , Basu K and Das S K 2003 Hand-off delay analysis in SIP-based mobility management in wireless networks In Proceedings International Parallel and Distributed Processing Symposium pp. 8-pp IEEE.

[8] Jiao W , Jiang F and Ma Y 2007 Fast handover scheme for real-time applications in mobile WiMAX. In 2007 IEEE International Conference on Communications pp. 6038-6042 IEEE.

[9] Ray S K , Pawlikowski K and Sirisena H 2010 Handover in mobile WiMAX networks: The state of art and research issues IEEE Communications Surveys & Tutorials, 12 376-399.

[10] Kavitha V , Manimala G and Kannan R G 2019 AI-Based Enhancement of Base Station Handover Procedia Computer Science, 165 717-723.

[11] Kang H , Koo C and Son J 2004 Resource Retain Time for Handover or Ping Pong Call Recovery IEEE 802. 16 Broadband Wireless Access Working Group Project.

[12] Choi S , Hwang G H , Kwon T , Lim A R and Cho D H 2005 Fast handover scheme for real-time downlink services in IEEE 802.16 e BWA system In 2005 IEEE 61st Vehicular Technology Conference 3 2028-2032 IEEE.

[13] Jiao W , Jiang P and Ma Y 2007 Fast handover scheme for real-time applications in mobile WiMAX In 2007 IEEE International Conference on Communications 6038-6042 IEEE.

[14] Cui H , Wu L , Hu S and Lu R 2021 Measuring the Service Capacity of Public Facilities Based on a Dynamic Voronoi Diagram Remote Sensing, 13 1027.