International Journal of Advances in Engineering, 2015, 1(2), 51 - 59
ISSN: 2394-9260 (printed version); ISSN: 2394-9279 (online version)
url:http://www.venuspublications.com/ijae.html

REVIEW ARTICLE

A Survey of various Handover Techniques and Performance Analysis in Mobile WiMAX IEEE 802.16m Standard

M. Mayuranathan[1] and G. Akilandasowmya[2]
Dept. of Computer Science and Engineering, Valliammai Engineering College, India [1]
Dept. of Computer Technology, MIT-Anna University, Chennai[2]
manimayur@gmail.com

Received 19 January 2015 / Accepted 17 February 2015

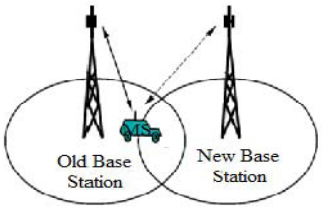
Abstract −The WiMAX is the Wireless inter-operability for microwave access (IEEE 802.16). It is known as broad –band wireless technology that is capable of delivering the voice, data and video services. Since it has key features of serving large coverage areas per base station and become a popular emerging technology for handling mobile clients and mobile subscriber station (MS) mobility through handover process. Generally handover process is classified into two categories namely soft handover and hard handover process. . However, serving a large number of Mobile Stations (MS) in practice requires an efficient handover scheme. Currently, mobile WiMAX has a long handover delay that contributes to the overall end-to-end communication delay. Recent research is focusing on increasing efficiency of handover schemes to reduce handover delay in WiMAX, various techniques are available. In this paper, we briefly describe about some of the recent techniques which is used for handover process and analysis their performance based on handover delay. Finally we conclude the best suited method to reduce hand over delay and we propose method for reducing handover delay in WiMAX.
Keywords − WiMAX, hand-over, hand-over techniques and performance analysis.

I. INTRODUCTION

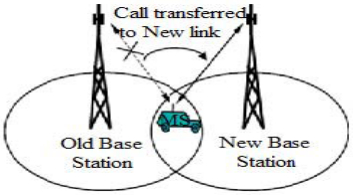
The mobile WiMAX defined in 802.16e standards addresses wireless broadband access for mobile users. It, basically built up ofThree main components: the subscriber station (SS), the access service network (ASN), and the connectivity service network (CSN). An ASN is typically built up of a set base solution (BSs) and one or more ASN gateways (ASN-GWs) interconnecting the ASN with the CSN. The ASN delivers MAC layer services to the subscriber station while the CSN provides layer 3 services [1]. Mobile IPV6 fast hand-over protocol in WiMAX is based on cross-layer approach. Generally cross-layer approaches have been designed to speed up hand over processes. These schemes aim to process both layer 2 and layer 3 HO procedures concurrently, thus save the total HO latency. Major goal of FMIPV6 is to reduce the latency by initiating steps for an impending HO in advance and by interleaving layer-2 and layer-3 HO procedures. Generally this kind of mobility-based hand –over mechanism are used to relieve ping-pong effect of hand-over which means in a short time, a single user handover back and forth for at least three times ASN-based network mobility is based on network-based hand-off management. There are two types of ASN-based network mobility is availed to solve the problems of host-based hand-over management [2, 4]. In MAP message techniques, message is used to perform the hand-off procedure which allocates resource to each frame. The persistent allocation scheme is a technique to solve the problems which is presented in MAP message scheme. In these techniques, resources are allocated only to the initial frame that solves the problems of MAP messages [3]. In this paper, we give details about these techniques and present the drawback of these techniques. Finally performance of these techniques is analyzed. This paper is organized is as follows: section 2 describes about hand-over techniques and their types, section 3 gives detail about the six hand-over techniques used in WiMAX network. In section 4, we analyze performance of these techniques. Section 5 and section 6 describe our proposal technique and conclusion.

II. HANDOVER OVERVIEW

Handover is defined as the process in which an MS migrates from the air interface provided by one BS to an air interface provided by another BS. It is one of the most fundamental features in homogeneous and heterogeneous network. Handover can be classified into two types. They are soft hand-over and hard hand-over. In soft hand-over, the connection to new base station (BS) is established before breaking the connection of current base station. Softer handover is defined as the user equipment combines more than one radio link to improve the reception quality. In hard hand-over, first it breaks the connection to its current base station before established connection to new base station. It can also be divided into two categories namely intercell technology and intracellular technology [1,5].



a. Before hard hand-over



b. After hard hand-over

Figure.1 Hard hand-over scenario

In inter cell technology type of hard hand-over, When a mobile node moves between one point of attachment (PoA) to another point of attachments (PoAs) in different networks technologies such as WLAN, WiMAX and UMTS etc. This type of handover is also termed as vertical handover, which may affect the quality of service (QoS) of different applications. Since different network access provides different bandwidth and delay profiles significantly [5]. In intracellular technology type of hard hand-over, Handover process of a mobile terminal takes place between base stations of same network technology such as between two WLAN access points. The mobile terminal may be equipped with a single interface thus may need to change its layer 3 identifier depending on the type of movement. It is also termed as horizontal handover. Intracellular technology type of hard handover in homogeneous network is not an important issue to mobile users. Three types of hand-over failures are too- late hand –over that is, the parameters are set too hard, so users do not have enough time to handover, which may cause call drop, too-early hand- over that is, the parameters are set too easy, so handover is executed when the quality of target cell is not so good, which may also cause call drop and finally ping-pong hand- over that is, in a short time, a single user handover back and forth for at least three times. The IEEE802.16e standard defines several main steps of the actual hand-over process as follows.

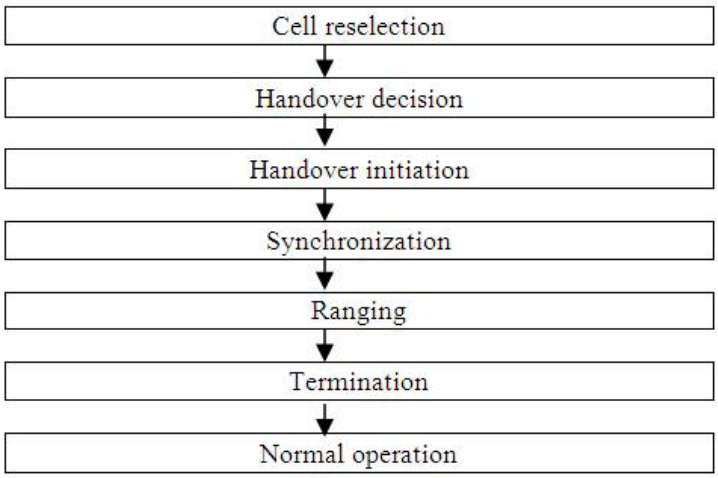


Figure.2 Hand over procedure phase in WiMAX

• Cell Reselection: mobile station (MS) selects the target BS according to either the signal strength of neighbor BS or other Quality of Service-level parameters. This information comes from the periodic mobile neighbor advertisement notification (MOB_NBR_ADV) or scanning requests.

• HO Decision and Initiation: MS (or BS) can make hand -over decision with mobile station hand –over request message (MOB_MSHO_REQ) or base station hand-over request message (MOB_BSHO_REQ). According to this decision, the MS begins hand-off from the serving BS to the target BS.

• *Synchronization*: MS needs to be synchronized to the target BS downlink and obtain UL (Up-Link) and DL (Down-Link) transmission parameters.
• Ranging: MS and target BS would perform initial ranging or hand -off ranging and uplink parameter adjustment.
• *T*ermination: The final serving BS terminates all contexts of the connections with the MS [2].

III. HAND OVER TECHNIQUES

a). Mobile internet protocol : Mobile internet protocol (mobile IP) is the standard internet protocol. It has host-based hand over management. . It maintains the permanent IP address for mobile users. The basic functionalities of mobile IP are mobile node, home agent and foreign agent. Mobile IP allows the mobile node to roam freely between different wireless zones. Home agent contains detail about mobile users and the permanent home address of mobile user is kept in home agent network. Foreign agent advertises care-of-address (CoA) to mobile IP and information about visiting network of mobile users. When mobile node wants to moving another network, it request foreign agent for CoA. After getting CoA, the mobile node inform to home agent about its CoA. This process is called Binding Update (BU). Fig3 shows detail view of this process. The signaling messages of BU process is binding address update and binding acknowledgement. The above BU process may incur long delays. Due to long delay of this process, packet from new network to mobile node will be lost. MIPv4, MIPv6, FMIPv6 and HMIPv6 are some of the versions of mobile IP[5].

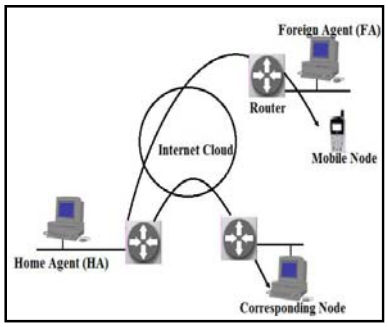


Figure.3 Mobile IP BU process architecture

Drawback: Handover management in mobile IP is host-based which always require mobile node. This process consumes more time. In MIPv4, the mobile node sends data directly to the host by using triangular routing. But mobile node receives data only via home agent or foreign agent. This will increase processing time and latency [5].

b) The FMIPv6-based Cross-Layer WiMAX: HO Scheme: FMIPV6-based cross-layer in WiMAX hand-over scheme Combines and interleaves the WiMAX HO procedures (layer 2) with the FMIPv6 HO procedures (layer 3). FMIPv6-based on cross layer supports session continuity in network-layer HO when a MS moves to a different IP network. It aims to enable HO between different IP networks without affecting upper layer connections. It reduces HO delay through prediction of HO and preparation beforehand. In FMIPV6-based on cross layer approach, the mobile terminal scans to find the available target BS and among them selects one candidate BS .More specifically, there are four HO stages: network topology acquisition, HO preparation, HO execution, and HO completion. In each stage, the cross-layered HO procedure includes one interaction message between FMIPv6 and IEEE802.16e entities. In FMIPV6, the terminal and the current access router (AR) exchange the router solicitation for proxy (RtSolPr) and proxy router advertisement (PrRtAdv) messages. In network topology acquisition stage of FMIPV6-based cross layer approach in WiMAX combines the above FMIPV6 procedure with cell reselection hand –over step of WiMAX. In hand-over preparation stage, the mobile station configure its new IP address, referred to as the care-of-address (CoA) from router advertisement message. In hand-over execution stage, the mobile terminal send fast binding update message to current access router (AR). This activates the current AR to send to the target AR handover initiation (HI) message. When the target AR receives HI, it confirms the procedure and sends the HO acknowledgement (Hack) message to the current AR. At this time, packet tunneling starts and data packets are buffered at the target AR. Fast binding acknowledgement (F-BACK) message is sent from target AR.HO decision and Initiation and synchronization hand-over process steps of WiMAX also performed in this hand-over execution stage. In hand –over completion stage, fast neighbor advertisement (FNA) message is sent from the terminal to target access-router. This FNA message informs the target AR the new link and allows the release of buffered packets from the target AR [2].

C.MAP messages: In MAP message techniques, the mobile WiMAX system allocates frequency-time resources on a per –frame basis. In these techniques, at the beginning of each frame, the resource allocation information is delivered as message to frame. Therefore, the resource allocation can be changed frame by frame. Moreover, the amount of resources in each allocation can range from one slot to the entire frame. Particularly, this resource allocation for each frame is well suited for busty data traffic, even in rapidly varying channel conditions. for that, the MAP message of this

mobile WiMAX system yields better performance than the High Speed Packet Access (HSPA) and Evolution Data Optimized (EV-DO) systems under a constraint of full buffer traffic and ten active downlink (DL) sessions[3].
Drawback: Generally MAP massage indicate the detailed about resources allocation information for all multiplexed users. Also it should robustly be encoded to ensure that all the mobile stations (MSs) in the system can decode them. For this reasons, the MAP message techniques yields the large signaling overhead when data for many users are multiplexed in a Frame. When we accommodate a large amount of low-data-rate and voice over internet protocol in the system, this problem becomes obvious. Therefore, performance of MAP message shrinks to up to 44%. Therefore, it is crucial to reduce the signaling overhead to increase system performance [3].

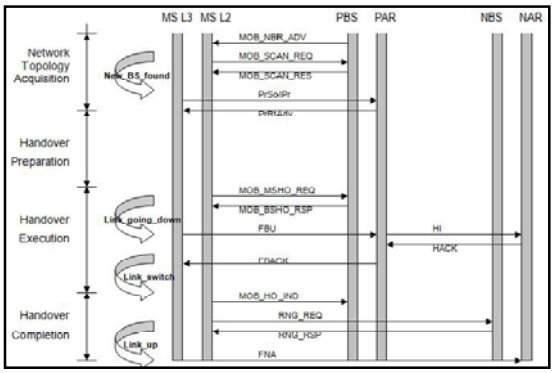


Figure.4 The FMIPv6-based cross-layer WiMAX handover procedure

d) Persistent allocation scheme: This PA scheme is particularly designed for periodical packet arrival traffic and mainly focused on VoIP traffic. In this scheme, the resource is not allocated to every frame (unlike MAP message).instead of that, this scheme persistently allocates resource for a VoIP user over multiple Frames. In other words, the allocation information is signaled to the user when the user is initially allocated and need not be repeated in subsequent frames. As a result, signaling overhead is reduced and makes more resources available in the frame. In addition, the PA scheme yields a large capacity gain compared to conventional dynamic scheduling (DS) scheme [3].
Drawback: The practical implementation of PA scheme is the major problem. When the inter arrival time is not periodic, the PA scheme does not work according to its original purpose. Second, the PA scheme is hard to adapt to the dynamically varying channel states, because it allocates the same modulation coding scheme (MCS) for a long period. To avoid this problem, the PA scheme has to use frequent reallocation, or use the robust MCS level to meet any channel state. At the results, this also increases overhead. In PA scheme, it is still difficult to solve the network delay jitter issue, which occurs in the practical system, in spite of the basic assumption of "periodic inter arrival time [3]."

e. Access service network: Access service network has been developed for Mobile WiMAX is based on network-based hand-over management technique. Generally network-based hand –over was developed by IETF to solve many of problems of Host-based hand-over management technique like mobile IP. Network-based hand-over is completely has been different from host-based technique. Access service network has their own hand-over protocol and network mobility version. It provides radio resource management, network discovery and authentication services. ASN-based network mobility has many base station (BS) and ASN-gateways, home agent and mobile station. Each Mobile station is associated with ASN-gateways which are acted as a foreign agent for that Mobile station to inform Care of address to home agent. ASN-based network mobility performs hand-over procedure without changing the home agent where the target base station may belong to the same network or not. Two different types of ASN based hand-over are presented. They are intra-ASN hand over and inter-ASN hand-over. Intra-ASN hand over is also known as R6 hand-over. R6 is the wired interface between Base stations to ASN-gateways. R3 is the wired interface between ASN to core network. The combination of R6 and R3 wired interface provides the transfer of packets between home agents to mobile station. Inter ASN hand-over is also called as R4 hand over. In this type, the mobile station moves between different networks. R4 is also the wired interface between different ASN-networks.

Figure.5 Network-Based handover procedure

These are the steps for hand-over procedure in ASN-based network,
1) The state of the MS is shown before the handover.
2) The Serving network sends an HO-Req message to
one or more target ASNs establishing the potential
target BSs for handover. This message contains a timer TR-HO-Req. The message also includes an authenticator ID that points to the authenticator distributor function at the authenticator ASN and the anchor ASN-GW.
3) The target network(s) sends an application context retrieval message to the ASN authenticator (AAA server).
4) The target network(s) may initiate a data tunneling path for the MS with the Anchor ASN after receiving the HO-Req message.
5) The target network(s) sends an HO-Rsp message to the serving network to acknowledge the handover request and starts timer TR-HO-Rsp. Upon receipt ofthe HO-Rsp message, the Serving network stops timerTR-HO-Req.
6) The Serving network sends a MOB-BSHO-REQ message to the MS containing one or more potential target BSs selected by the network for the MS to handover.
7) The Serving network sends an HO-Ack message to the target network(s) controllingthe candidate targetBS(s) selected for the MS. Upon receipt of the HO-Ack message, the target ASN(s) stops timer TR-HO-Rsp[4].

f) hand-over self optimization mechanism based on velocity: Many hand-over techniques does not considered about velocity. But hand-over self optimization mechanism based on velocity (HSMV) takes velocity into account and also it maintains the hand-off stability without human intervention. HSMV is based on monitoring, analyzing, planning and executing stages [6]. In monitoring stage, the key performance indicator (KPI) is monitored which is used to measure the quality of hand-over. In analyzing stage, the success rate of hand-over is measured and this rate is compared with threshold value of hand-over. If success rate is greater than threshold value within a given buffer time, again we perform monitoring stage until we get lesser value of success rate than threshold value. Adjustment of hand-over parameters based on velocity is performed in planning stage. The velocity is found by using novel based mechanism. Adjusted hand-over parameters are executed in execution stage. Finally this process again moves into monitoring stage [6].

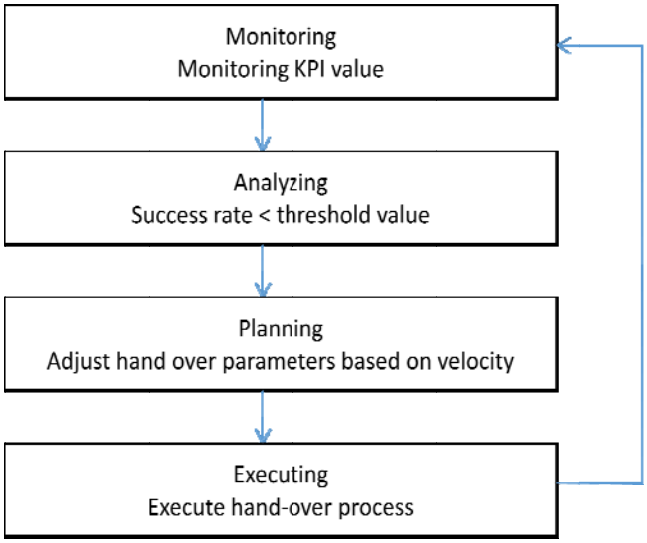


Figure.7 Flowchart for hand-over self optimization based on velocity

g. Mobile station movement direction prediction based hand-over scanning: In neighboring base station may delay MAC overhead. This will increase overall hand over delay in wimax. To solve this problem mobile station movement direction prediction (MMDP) based hand- over scanning scheme is introduced. It based on dividing the BS the handover process, scanning is one of the required phases to find the target BS. During the handover scanning process, the MS must synchronize with the entire advertised neighbor BSs (nBSs) to select the best BS candidate for perform handover action. The redundant or unnecessary scanning of coverage area is into zones and sectors. This scheme reduces the number of neighboring base stations. Only two base stations becomes candidate. Hence, the handover scanning process repetition will be reduced with these two shortlisted BS candidates instead of scanning all nBSs. Thus, MMDP will reduce scanning delay and the number of exchange messages during the handover scanning [7].

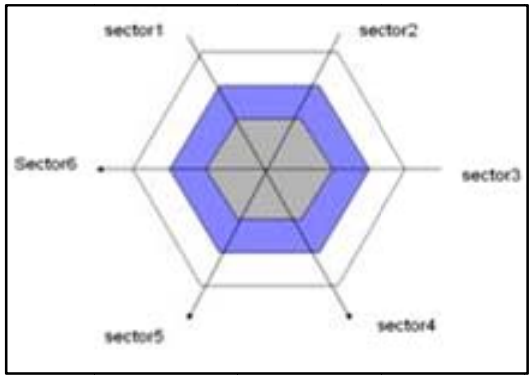


Figure.7 Phases of MMDP scanning procedure. (Hexagonal shape represents zone divisions).

Zone division: The base station structure is divided into three zones based on signal quality. They are no hand-over (no HO), low hand –over (low HO) and high hand-over (high HO). In no hand-over zone, the mobile station has high signal quality which has no hand-over probability. In low hand-over zone the mobile station receives good signal quality but that is less strong than no hand-over zone. But MMDP-based hand-over scanning process predicted the MS direction movement in this zone. The high hand-over zone has weak signal quality, so the MS must perform hand-over process as quick as possible [7].

Sector division: The coverage of base station structure is divided into six sectors. The SBS select mobile station location sector based on Θ angel which is the angel that MS made it with the SBS axis. This angel can be calculated by taking the inverse cosine of equation.

$$\cos(\theta) = a2 + b2 - c2/2ab \quad (1)$$

To simplify the SBS distance calculation complexity, the SBS will only keep calculating the distance in interval time between the MS positions and the nBSs, those are neighboring to the MS location sector[7].

Direction estimation: As an example, assume that the MS is located in sector 1 as shown in Fig 7 and thus only the nBSs of B, C and D are considered. When the MS is located in the Low-HO zone, the SBS will start to predict the MS movement direction. It calculates the distance between MS and nBSa of B, C and D based on co-ordinate distance formula which is given as

$$d = \_(x2 - x1)2 + (y2 - y1)2 \quad (2)$$

Where x1 and y1 are the x and y coordinates for the MS position and, x2 and y2 are coordinates for the BS position, and d is the distance between them. Then the forward or backward movement of MS is calculated by using following expression,

$$DBji = DBj - Dbi \quad (3)$$

$$DCji = DCj - Dci \quad (4)$$

$$DDij = DDj - DDi \quad (5)$$

Where DBi, DCi and DDi are the distance between the MS position and the nBSs of B, C and D respectively when the MS is located at point i. while, DBj, DCj and DDj are the distances between the MS position and the nBSs of B, C and D respectively when the MS is located at point j. The DBji, DCji and DDji are calculated between two points of i and j, which may be forward or backward movement. The nBSs of E, F and G can be ignored because they are not in the same or neighboring sectors. In a similar way, we can calculate the distances of DBkj, DCkj, DDlkj, DBlk, DClk and DDlk when MS is located at k and l points. The accumulative distance (AD) function during T time is the main indictor that estimates the MS moving toward respective BSs. The AD function is calculated as the following equations.

$$ADb = DBji + DBkj + DBlk \quad (6)$$

$$ADc = DCji + DCkj + DClk \quad (7)$$

$$ADd = DDji + DDkj + DDlk \quad (8)$$

Where the ADb is theADfunction of the BS B, ADc is theADfunction of the BS C, and ADdis the AD function of the BS D. Unlike monitoring with multiple BS, two BSs that have the highest AD function values will be considered as the two potential TBSs to be scanned. Therefore in MMDP scheme, the handover scanning will only need to perform on BS B and BS C. By this way, the scanning time and the MOB_SCN-RSP/REP messages size will be reduced [7].

IV. PERFORMANCE ANALYSIS

Qualnet 5.0 simulation tool has been used to evaluate the performance of the MMDP handover scanning scheme. the other conventional hand-over schemes which scans more than two neighbor base station for finding target base station takes 330ms for scanning process. In the proposed MMDP scanning scheme, the number of scanned nBSs is reduced to two, thus, theMS will scan the first nBS in the first iteration within only two frames scanning duration, and the scan second nBS in the second iteration with two frames length duration. This leads to the property that the proposed scheme (MMDP) reduce the scanning time 245 ms. Therefore, it reduces the total scanning delay by 25%, and also the scanning interval duration by 50%, which enhances the overall handover operation in terms of reduced overhead signaling, message exchanges and message size to satisfy the network and user requirements. We perform simulation consist of 100 macro cells in UMTS to analysis the performance of HSMV. The estimated error which represents the difference between actual velocity and estimated velocity is presented in this method. But the value of estimated error is small. So this method is useful to reduce call drop rate. In HSMV, Call drop caused by too early hand-over and too-late hand over is decreases as three times than hand-over schemes without based on velocity. The following equation describes about hand-over delay of mobile IP protocol. The hand-over delay of mobile IP protocol is based on router solicitation advertisement and response, binding message and acknowledgement and authentication message from target station.

HD mobile IP = TBU+TBA+ TAUTH+TRSOL +TRADV +TDAD (9)

Where, DAD message is used to check whether an IP address is original or duplicate. Normally hand –over delay time is in the range of 40-70ms to avoid call drop. But mobile IP delay time is 1.2 seconds .this is very high delay time compare to others. Using opnet software, the hand-over delay of ABNM is calculated. The following equation describes the hand-over delay of ABNM,

HDASN = TBU + TBA + TAUTH (10)

Where, TBU is the time duration for sending binding message, TBA is the time duration for binding acknowledgement message. TAUTH is the delay involved in authenticating the MS Profile within the network. The hand-over delay at various speeds is calculated for ABNM. The max, min, mean and standard deviation value of hand-over delay at various speeds is minimum to ABNM compared with mobile internet protocols[4,5,6 & 7).

Table.1 Result of performance analysis of various hand–over techniques

Hand-over techniques	**Based on hand-over delay**
Mobile IP protocol	1.2 seconds
ABNM	0.31 seconds
HSMV	0.42 seconds
MMDP	0.28seconds
FMIPV6 CROSS LAYER	0.166seconds

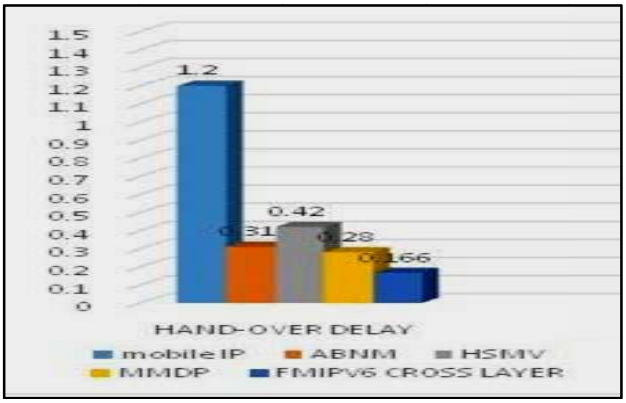


Figure.8 The Graph shows the hand-over delay time of various hand-over techniques

V. FUTURE WORK

FMIPV6-cross layer approach combine with MMDP scanning hand-over: The FMIPV6-cross layer approach combines layer 2 and layer 3 hand-over processes. If the hand-over process of layer 2 produces some delay and layer3 hand-over process also produce some delay. So total delay time of layer2 and layer is high. But FMIPV6-cross layer method combines these two layer hand-over process which reduces total time delay. In network acquisition stage of FMIPV6-cross layer approach, the mobile station send advertisement message to find its neighbors base station and send hand-over request message to all its neighboring base stations. This increases hand –over delay time. To avoid this problem, we combine MMDP scanning hand-over to FMIPV6 –cross layer approach. In MMDP method only two of its neighboring station receives hand-over request message. Based on accumulative distance function, that two neighboring stations are indentified. The time required to calculate this AD function is minimum compared with passing hand –over request message to all its neighboring stations.

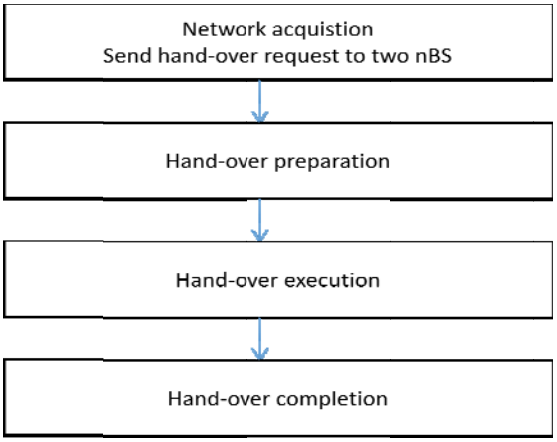


Figure.9 Flow chart representation of FMIPV6-cross layer combines with MMDP scanning hand-over.

VI. CONCLUSION

In this paper, we analysis various hand-over techniques which is used in WiMAX. We introduce one new hand-over techniques for WiMAX which reduce hand-over delay time considerably. In our future work, we implement and analyze performance of the FMIPV6-cross layer approach combine with MMDP scanning based hand-over.

REFERENCES

1. On Handover performance analysis in Mobile Wimax networks, Yazan A Alqudah, Senior Member,IEEE, Huiqin yan,2009
2. Performance of FMIPV6 based Cross layer handover for supporting Mobile VoIP in Wimax networks, Heejung Kim, Melody Moh,2009.
3. Virtually dedicated resource allocation for VoIP traffic in the downlink mobile Wi max system with hybrid ARQ,Young Il seo, Member, IEEE and Dan keun Sung, Senior Member, IEEE,2009.
4. Handover Delay in Mobile Wimax : A Simulation Study,BhaskarAshoka, David Eyers and Zhiyi Huang,2011.
5. An Optimized Vertical handover strategy for heterogeneous wireless access networks based on IEEE 802.21 media independent handover standard ,Ms.R.Tamijetchelvy, Dr.R.Sivaradje,2012.
6. Handover Self optimization mechanism based on velocity for Cellular Networks,YangYang,PengYu,Wenjing Li,2012.
7. Fast-Handover Mechanism between 802.11 WLAN and 802.16 WiMax with MIH in PMIPv6, Cheol-Joong Kim · Seok-Cheon Park · Myung-Kyu Yi,2013
8. WiMAX Forum, www.wimaxforum.org.
9. Kyung-ah K, Chong-Kwon K, Tongsok K, "A seamless handover Mechanism for IEEE 802.16e Broadband Wireless Access"[C]. ISPC 2004
10. Lee D.H., Kyamakya K., Umondi J.P. "Fast handover algorithm for IEEE 802.16e Broad band wireless access system". ISWPC 2006
11. H. Fathi, S. Chakraborty, and R. Prasad, "Optimizationof Mobile IPv6-Based Handovers to Support VoIP Servicesin Wireless Heterogeneous Networks," 2007
12. Haghani, E. and Ansari, N, "VoIP Traffic Scheduling in WiMAX Networks," Proc. of IEEE GlobalTelecommunicationsConf(Globecom), Nov. 2008.
13. K. Sambale and K. Klagges, "Increasing the VoIP capacity of WiMAX systems through persistent resource allocation," in Proc. Eur. Wireless,2009
14. S. Shrivastava and R. Vannithamby, "Performance analysis of persistent scheduling for VoIP in WiMAX networks," in Proc.IEEE 10 thAnnu Wireless Microw.Technology,2009.
15. C. Nie, V.M., and X. Yang, "Adaptive Polling Service for Next-Generation IEEE 802.16 WiMAXNetworks",IEEE Global Telecommunications Conf, (Globecom),2007.
16. WiMAX Forum: Mobile WiMAX – Part I: A Technical Overview and Performance Evaluation, February 2006.
17. Y. Chen and F. Hsieh, "A Cross Layer Design for Handoff in 802.16e Network with IPv6 Mobility," Wireless Communications and Networking Conference, 2007, pp.3844-3849.
18. R. Koodli, "Fast Handovers for Mobile IPv6," IETF RFC 4068, July 2005.

19. R. Srinivasan, J. Zhuang, L. Jalloul, R. Novak, and J. H. Park, IEEE Std 802.16m EvaluationMethodologyDocument, IEEE 802.16m-08/004r3,Mar. 2008.
20. C. Perkins, "Mobile ip," Communications Magazine, IEEE, vol. 35, no. 5, pp. 84–99, 1997.
21. Ashutosh Dutta, David Famolari, Andsubir Das, TelcordiaTechnologies Yoshihiroohba, Victor Fajardo, KenichiTaniuchi, Rafaellopez, "Media-independent preauthenticationsupporting secure interdomain handoveroptimization" IEEE Communication Magazine, April 2008.
22. J.R.Damhuis, "Seamless handover within WiMAX andbetween WiMAX and WLAN," 8th Twenty StudentConference on IT, Enscheda, January 25th, 2008.
23. Xiaohuan Yan, Y.AhmetSekercioglu, and Sathya Narayanan, "A Survey of Vertical Handover Decision Algorithms in Fourth Generation Heterogeneous Wireless Networks", Computer Networks, Vol. 54, pp. 1848-1863, 2010.
24. HongLin Hu, Jian Zhang, XiaoyingZheng, Yang Yang, et al. "Self-Configuration and Self-Optimization for LTE Networks," Communications Magazine, Vol. 48, Issue.2.2010.