Horizontal and Vertical Handoff between 802.16 and 802.11 Wireless Access Networks

Mr. Nilesh Sambhe
Department of Computer Technology
Yeshwantrao Chavan College of Engineering, Nagpur

Ms. Payal Thakare
Department Of Computer Engineering
Government College of Engineering, Pune

Mr. Vijay S. Masne
Department of Computer Technology
Yeshwantrao Chavan College of Engineering, Nagpur

***Abstract*— When the mobile node moves between different access network, one of the most important issues in wireless and mobile communication technologies is the mobility management. In this paper we discuss about horizontal and vertical handoffs between802.16 and 802.11 wireless access networks. Different scenarios of handoffs are discussed in the mesh backbone architecture. A handoff decision algorithm based on frame error rate ,RSS, and network traffic is given to decide between vertical and horizontal handoff. A Horizontal Handoff Management Unit (HMU) for horizontal handoff is presented. Separate algorithms for handoffs from WiMAX to Wi-Fi and Wi-Fi to WiMAX are also presented in detail. It implements Fast Binding Algorithm (FBA) which performs handoff based on priority resolution. The algorithm involves scanning, router discovery, setting up network link and updating routing information.**

***Keywords*--Handoff latency, Fast Handover MIPv6, Media Independent Handover Function, Fast Binding Acknowledgement Algorithm, Horizontal Handoff Management Unit, Wi-Fi, WiMAX, Received Signal Strength(RSS),Mobile Gateway, Wireless Mesh Router(WMR),**

1. INTRODUCTION

A major issue of mobility would be moving between networks and maintaining the connection alive but in an efficient way Mobility plays an important role in the present world.. This makes Handoff to come into action. Handoff is a process by which an ongoing call or data transfer is transferred from one access point to another.This can be achieved by identifying different networks and also maintaining exact Care of Address's (CoA's). Different networks here can be referred to as 3G, WLAN, GSM, CDMA, WiMAX, etc[2]. The most important terms associated with Handoff are handoff latency, association time and connection reestablishment time. Handoff latency is the time difference between any two data transfer taking place.

Handoff latency = Association time + Connection Reestablishment time

Connection establishment with the new network is known as association time. Connection reestablishment time is defined as the time taken to restore the previous data transmission. Any Handoff unit involves reducing of latency to make it more efficient. Handoffs are classified into two kinds: Horizontal and Vertical. Horizontal handoff occurs between identical network and vertical handoff between two different network topologies. A good deal of research is going on in proposing many schemes for handoff.

2. RELATED WORKS

Mobile IPv6 (MIPV6) [2] is used to provide a solution for the vertical handover's. The various latencies include: movement detection, care-of-address configuration, authorizing binding. These mentioned can considerably reduce the throughput of the applications. The solution for the above problems might be the standardization of the hierarchical MIPV6 (HMIPV6) [2] and fast handover MIPV6 (FMIPV6). The recent trend is to reduce the overall latency very much. Thus the introduction of a new area so called the Media Independent Handover Function (MIHF) [2] came as a standard of the IEEE 802.21. A unified service is provided for the upper layers during the process of the handoff between heterogeneous networks.

MIHF helps the mobile nodes with the following services: Continuous service, Discovery of new networks, Selection of links and Conservation of battery. This MIHF can also help the upper layers to combine services across the heterogeneous networks. MIHF has totally three different types of services, and in this paper mainly uses the Mobile Independent Information Service (MIIS)[2]. This unit is used to find and obtain the network information within a given a coverage area. The handover decisions are taken with the information provided from the layer 2 and layer 3

through the MIIS. To the already existing Information Element (IE) unit, we also define an extra unit in the name of Domain Prefix. This provides the list of layer 3 information namely the "domain prefix" of neighboring MAPs. The collected information of layer 2 and layer 3 is stored in the Information Service (IS) unit. This piece of information known as Vertical Handover Information (VHI) is also sent to the MN through the MIIS unit. Thus the MN will have the domain prefixes of the network area to which it might move to. This will be useful for the MN to formulate the on-link CoA (NLCoA) and the regional CoA (NRCoA), thus reducing the overall router discovery during the process of handoff. Many other signaling messages are directly handled by the MN as it has necessary information during the handoff initiation phase. By all this the overall anticipation and configuration latency are reduced.

3. SYSTEM DESIGN

Fig.1 shows two domains administered by two service providers A and B. The Wireless Mesh Routers (WMR) [10] in the same domain are called intra mesh routers and in different domains are called inter mesh routers. When the Mobile Node(MN) moves to another domain, the IP packets from Correspondent node(CN) can be routed to Home Agent(HA) and the HA can forward to the new location of the MN.

CASES IDENTIFIED

Case 1: Horizontal Handoff (2a, 2b of fig 1)

Case 2: Vertical Handoff between technologies under same WMR (1a of fig 1)

Case 3: Vertical handoff between technologies under different WMR but same HA (intra). (1c of fig 1)

Case 4: Vertical handoff between technologies under different WMR and different HA (inter). (1b of fig 1)

4. HANDOFF ALGORITHMS

The handoff algorithm consists of handoff trigger, handoff decision (Horizontal or Vertical) and handoff procedure. When the signal strength goes down the mobile node will initiate the handoff trigger. The handoff decision unit in WMR will decide whether it is horizontal or vertical handoff based on layer 2 information. Finally the respective handoff procedure is done.

4.1HANDOFF TRIGGER

A counter and threshold counter is maintained. When the value of RSS (cur) goes down below the value of RSS (threshold), the counter value is incremented by a value of 1. If this value exceeds the threshold counter value, a handoff trigger is initiated.

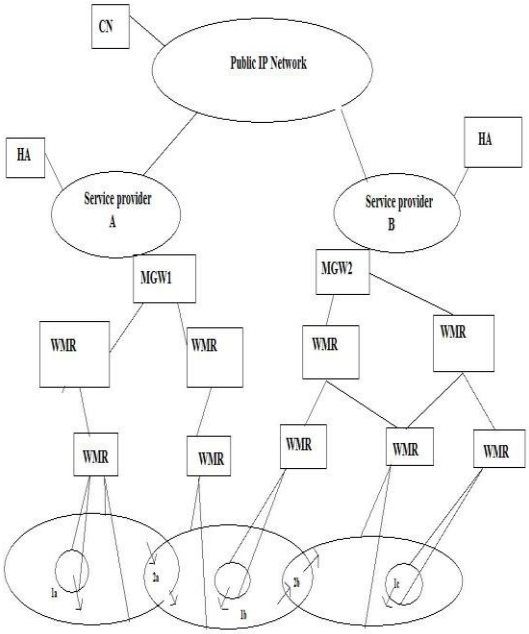

Fig 1. Reference Architecture

4.2HANDOFF DECISION

A status variable (STATUS) is maintained in WMR to identify the technology used in the MT. STATUS=0(WiMAX), STATUS=1(Wi-Fi).

During the scanning process, new WMR is selected based on the RSS value. The status variable of the current WMR is compared with the new WMR. If the status variable differs among them implies vertical handoff and same value among them implies horizontal handoff.

4.2.1 HORIZONTAL HANDOFF PROCEDURE

A Horizontal Handoff management Unit (HMU) is constructed for the handoff process as shown in fig 3

The HMU has three important units-Seamless Connectivity Manager (SCM) [1], the Interface Management System (IMS)[1], and the Policy Manager (PM)[1].

The priority resolution is done by PM using FBA algorithm. The timer of the PM is represented as Tpm and response time is Trpm. The steps of the algorithm are as follows:

1. Receive request for handoff from base station. **2.** Start timer of the PM-Tpm.

3. Obtain handoff response time from access point-Trpm.

4. Calculate Trpm-Tpm and find minimum among them.

5. Set the priority according to this difference in time.

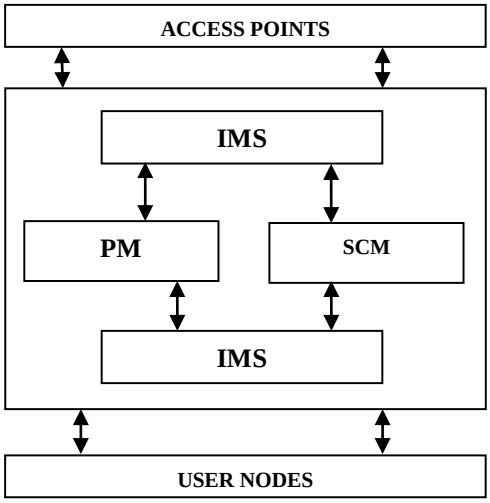

Fig 2. Handoff Management Unit

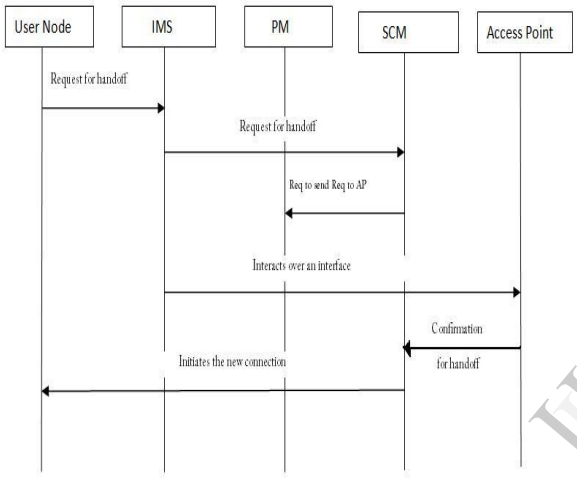

Fig. 3. Horizontal Handover procedure

The HMU receives the request in step 1 through IMS and sends request to SCM. After getting confirmation from a particular access point, SCM initiates a new connection. This is also known as proactive Handoff. The mobile node can also request for a particular access point for its handoff and connection with that access point is made if it's available which is done by SCM of HMU.

4.2.2 VERTICAL HANDOFF PROCEDURE

Vertical Handoff takes place whenever there is a change in the status variable of the current WMR and the new WMR. If the status changes from 0 to 1, handoff is performed from WiMAX to Wi-Fi is, otherwise the handoff is between Wi-Fi and WiMAX.

The vertical handoff involves four main stages-Network interface Scanning, New Access router discovery, New network entry and updating routing information.

Scanning involves identifying the available Access routers. Active scanning procedure is used in which probe messages are sent to scan the network. Handoff initial trigger takes place before the scanning stage so as to enhance the handoff performance. After the scanning process, with the new interface id, the MT requests the information about the new WMR.

Function RouterDiscovery:

Step 1: START
Step 2: MT sends an RtSolPr message to the Previous WMR (PWMR).
Step 3: PWMR send an advertisement message (PrRtAdv) with the NWMR IP address and its HAs IP address.
Step 4: If MT receives message with the same HAs IP address it is Intra Mesh Routing.
Step 5: Else if MT receives message with a different HAs IP address it is Inter Mesh Routing.
Step 6: Return

Setting up IEEE 802.11 link (WiMAX to Wi-Fi)

Function NetworkEntry:

Step 1: START
Step 2: Collect ranging information using RNG-REQ and RNG-RSP messages.
Step 3: MT sends SBC-REQ to the AP.
Step 4: AP sends SBC-RSP to the MT with requested capabilities set to 'on'.
Step 5: Registration process starts: MT sends REG-REQ to the AP and it replies with REG-RSP message.
Step 6: Return

This procedure is illustrated in Fig 4.

Setting up IEEE 802.16 link (Wi-Fi to WiMAX)

Function Network Entry:

Step 1: START
Step 2: Joins one of the APs scanned.
Step 3: MT requests authentication with the AP.
Step 4: On receiving authentication message the MT is authenticated.
Step 5: AP responds with association response message.
Step 6: MT considered to be authenticated when it receives a success response message.
Step 7: Return

This procedure is illustrated in Fig 5.

After updating information the L3 handoff is initiated using URI message.

Function Updation:

Step 1: START
Step 2: MT sends URI to the NWMR.

Step 3: NWMR updates or adds the routing information.

Step 4: NWMR sends URI message to PWMR for changing routing information.

Step 5: PWMR updates the routing information.

Step 6: PWMR might send L3 handoff finish message to the MT.

Step 7: Return

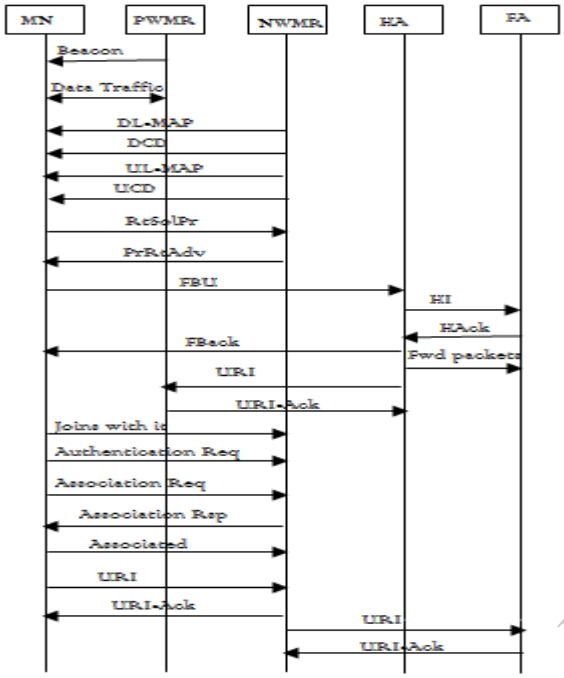

Fig. 4. Setting up link from WiMAX to Wi-Fi

5. CONCLUSION

Through this paper we have discussed horizontal and vertical handoff between 802.11 and 802.16 wireless access technologies. There are four scenarios identified: horizontal handoff, within same WMR, within different WMR but same HA, within different WMR and different HAs. Horizontal handoff is performed in HMU architecture using FBA algorithm and vertical handoff is performed between Wi-Fi and WiMAX using algorithm. The FBA algorithm employed for the horizontal handoff reduces the handoff latency to a larger extent and the ping pong effect in the handoff is avoided by introducing a counter variable. The overhead on the lower level WMRs caused by and decision unit and HMU is yet to be analyzed and resolved.

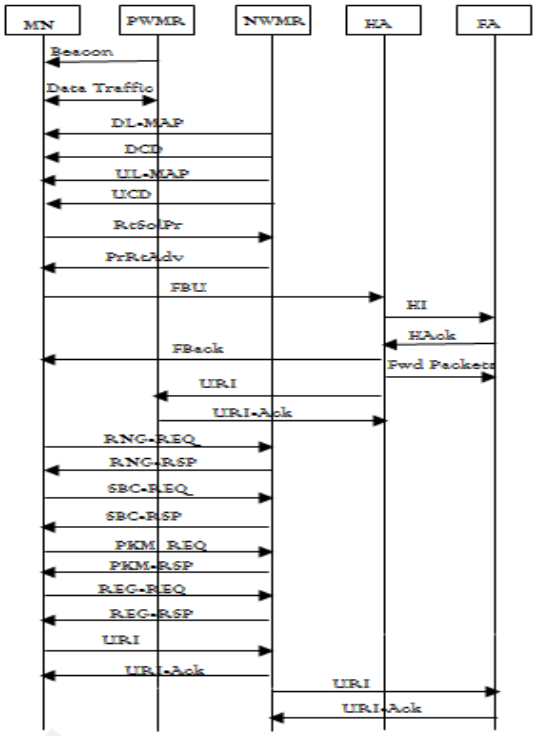

Fig. 5. Setting up link from Wi-Fi to WiMAX

6. REFERENCES

[1] Handoff Management Architecture for 4G Networks over Hierarchical MIPv6*Prakash.S, C.B.Akki , Kashyap Dhruve*

[2] Mobile IPv6 Based Fast Vertical Handover using IEEE 802.21 Media Independent Handover Function Pyung-Soo Kim1, and Yong Jin Kim2 *Department of Electronics Engineering, Korea Polytechnic University.*

[3] "Efficient Mobility Management for Vertical Handoff between WWAN and WLAN" *QianZhang,ChuanxiongGuo,ZihuaGuo, and WenwuZhu,Wireless andNetworking Group Microsoft Research Asia*, IEEE Communications Magazine, Speaker, QijinChen

[4] "Open Wireless Architecture - The Core to 4G Mobile Communications". Willie W. Lu , Jenny H.U, U.S Center for Wireless Communications. Stanford University.

[5] 3rd Generation Partnership Progect, "3GPP system to WLAN interworking: System description," TR 23.234, http://www.3gpp.com, June 2004.

[6] Chakravorty, R., Vidales, P., Subramanian, K., Pratt, I., Crowcroft, J., "Performance issues with vertical handovers Experiences from GPRS cellular and WLAN hot-spots integration," In: Proc. of the IEEE PerCom Cellular and WLAN hotspots Integration, pp. 155~164, 2004.

[7]"Enhanced vertical Handover in Mobile IPv6 with Media Independent Handover Services and Advance Duplicate Address Detection."Son Tran-Trong,Shahnaza Tursunova and Young-Tak Kim, Yeungnam University.

[8]"Vertical handover criteria and algorithm in IEEE 802.11 and 802.16 hybrid networks" Z. Daia, R. Fracchiaa, J. Gosteau, P. Pellati,France.