Development of Vertical Handover (VHO) Protocol Based on MIH (IEEE 802.21 standard) In UMTS-WIMAX Heterogeneous Network

Gurpartap Singh*, Garima Saini**

*UPG student NITTTR, Chandigarh, India
**Asst. Prof. NITTTR, Chandigarh, India
gurpartapjassal@gmail.com
garimasaini_18@rediffmail.com

ABSTRACT

The wireless industry has rapidly moving from the simple voice and text messaging to next generation of services, devices and applications. Voice, data and multimedia at high reliable speeds have become today’s norm and the user’s expectations on these services are higher than ever before. So, with increasing demand and popularity of the wireless communication, various mechanisms has been proposed and recently deployed to support data traffic over wireless media. Various device manufacturers are integrating more and more network interface to provide the level of services that the users requires. The network developed after integrating the various wireless technologies is called heterogeneous network. This growth of available broadband access technology has brought enormous challenges for operators wanting to ensure seamless mobility to its customer in heterogeneous environment. In this paper, we proposed a possible UMTS-WIMAX internetworking architecture and the VHO protocol based on MIH (IEEE 802.21 standard) for UMTS and WIMAX heterogeneous network for seamless intersystem handover, services continuity with low handover latency, system throughput and packet loss. The handover procedure is based on the media independent handover function (MIHF) which is guided by MIIS server.

Index terms - Vertical mobility, Heterogeneous networks, Mobility management Vertical handover, Media independent handover.

I. INTRODUCTION

Mobile broadband traffic has surpassed voice and is continuing to grow rapidly. This trend is set to continue, with global traffic figures expected to double annually over the next five years. By 2014, the average subscriber will consume about 1GB of data per month compared with today’s average figures that are around some hundred MB per month [1]. This traffic growth, driven by new services and terminal capabilities, is paralleled by user expectations for data rates similar to those of fixed broadband.

Long-Term Evolution (LTE) allows operators to use new and wider spectrum and complements 3G networks with higher data rates, lower latency and a flat, IP-based architecture [2]. To further improve the broadband user experience, 3GPP has been working on various aspects of the LTE Advanced standard. At the same time WLAN technology come in picture to be an ordinary way to realize mobile connection to the Internet, while companies all over the World realize wireless connections in particular locations (hot spots), like airports or hotels.

Recently, the Worldwide Interoperability for Microwave Access (WIMAX) IEEE 802.16 wireless MAN standard provides an air interface for fixed, portable and mobile broadband wireless access networks, which supported the mobile clients to go over the extended coverage area but not as cellular network. WIMAX is operating at a frequency band of 2.5-3.5 GHz which supports a maximum mobility at about 100km/h [3].
The most of the new individual wireless technologies are capable of providing these services. 3G network provide the wide-area coverage and strong support for mobility whereas WIMAX and WIFI (IEEE 802.16 and IEEE 802.11 standard) networks provide significantly higher data rate but limited mobility. So, by integrating the 3G and other IEEE standard (WIFI and WIMAX) networks, users will experience seamless and transparent wireless connectivity in more places and with better service than what can offered by single type of network. The network developed after integrating the various wireless technologies is called heterogeneous network. Heterogeneous Networks is about improving spectral efficiency per unit area. Based on different radio access techniques, cellular network, WIMAX and WLAN present distinct characteristics in terms of mobility management, security support, and quality of service (QoS) provisioning [4]. The vertical handoff process between different existing networks in the heterogeneous network has become the biggest challenge for the operator. So, in next generation heterogeneous wireless systems, one of the major challenges is seamless vertical handoff.

To address this issue, the IEEE group has been working on a standard IEEE802.21 Media Independent Handover (MIH) in order to optimize mobility procedures through different access technologies. The goal of this standard is to support and improve handovers by defining an abstraction layer called Media Independent Handover Function (MIHF) between Layer 3 and Layer 2 and below (MAC and PHY) [5]. This paper focuses on the performance of MIH and their framework by proposing a vertical handover protocol based on MIH capable of performing terminal and handover management.

This paper is organized as follow, section II present briefly introduction of heterogeneous network with their mobility challenges, section III discuss about the vertical handover and their various protocols, IV introduce the media independent handover (MIH) with their advantages, framework and reference model, V proposed the UMTS-WIMAX heterogeneous network, VI present the proposed vertical handover protocol based on MIH and VII present conclusion and future work possibilities.

II. HETEROGENEOUS NETWORK

Heterogeneous networks that contain overlapping coverage of several wireless access technologies enabling better spectrum efficiency and utilization are becoming common [6]. In heterogeneous network, a single technology or standard meet all the demands by integrating different technologies and standard to provide the level of service that users requires [7].

![Heterogeneous network](image)

**Fig.1 Heterogeneous network [6]**

II.1. Mobility management challenges in Heterogeneous networks

Mobility management is a critical aspect of heterogeneous networks. There are several challenges and issues regarding mobility in heterogeneous networks [8]:

- Choice of Technology
- Location Management
- Mobility Context Management
- Paging
- Moving Group Formations

There are various heterogeneous networks available like Heterogeneous network between GSM-UMTS, UMTS-WIFI, WIFI-WIMAX and UMTS-WIMAX. In all above networks, the aim is to provide the seamless services to the users. But major problem is to provide the seamless services during handover in heterogeneous network. The handover has been taken place between UMTS-GSM and UMTS-WIFI networks. The mobility between UMTS and WLAN can be referred to fully overlapping handover and immediately connect to other networks without need of PDP context re-activation.
On the contrary, the mobility between UMTS and WIMAX is referred to partially overlapping handover and handover should be done quickly to maintain the connection particularly when the speed of the mobile terminal is high [3]. This causes large drop of packet and data rate, while the handover take place between the UMTS and WIMAX network [9].

So, the aim is to provide an efficient handover management and seamless services to subscribers during vertical handover [10][11].

III. VERTICAL HANOVER

Handover is a process when a user switches to another channel without any interruption [11]. Handover is a process that requires careful consideration and understanding of the requirements in order to ensure the best QoS provided to the user. From a high level perspective handover provides the following:

- Continuity of call
- Optimum radio link selection
- Traffic distribution

III.1. Vertical Handover [12]

The vertical handover is opposite to horizontal handover. It is the transfer of data session or a call from one access technology to another access technology, for example from GSM to WCDMA or vice versa. Vertical handover is normally used when the user is using one access technology and during data session reaches the area of another access technology. Depending on different coupling scenario in UMTS-WIMAX network, we have different VHO protocol which is used to resolve several handover problems, such as packet loss, long handover latency and false fast retransmit [12].

The numbers of handover protocols are available to support mobility management during vertical handover. These are as follows:

- Inter-RAT Handover protocol [9]
- Multi-RAT Handover protocol [13]
- Seamless handover protocol [14]
- Predictive fast handover for mobile IP version 6 (PFMIPv6) with IQDE (Improved Quality Decision Engine) [15]

But there are no completely defined and referenced handover protocols for the mobile device to indentify the handling of handover between UMTS and WIMAX network efficiently. This is our motivation to propose the possible network architecture and VHO protocol for the mobile devices enabling the mobility and services and continuity during handover between these two emerging access technologies.

IV. MIH (MEDIA INDEPENDENT HANOVERS – IEEE 802.21)

IEEE has been developed a standard named Media Independent Handovers (MIH) – IEEE 802.21. IEEE 802.21 defines an abstract framework that optimizes and improves horizontal and vertical handovers by providing information about the link layer technologies to the higher layers [16]. This standard is expected to allow mobile users (and operators) to take full advantage of overlapping and diverse access networks.
It provides a framework for efficiently discovering networks in range and executing intelligent heterogeneous handovers, based on their respective capabilities and current link conditions.

IV.1. Need of Media independent handover (MIH) [17]

- Coverage Extension and Preferred Networks
- Load Balancing and Capacity Increase
- Flexible Network Architecture
- Longer Battery Life
- No Radio Access Network Modifications

IV.2. IEEE 802.21 Reference Model

The main design elements of IEEE 802.21 can be classified into three categories: a framework for enabling transparent service continuity while handing over between heterogeneous access technologies; a set of handover-enabling functions; and a set of Service Access Points (SAPs) [16].

![Fig.4 IEEE 802.21-2008 Reference Model [16]](image)

IV.3.1. Transparent Service Continuity

IEEE 802.21 specifies a framework that enables transparent service continuity while a mobile node switches between heterogeneous accesses technologies [16]. IEEE 802.21 specifies a mechanism to gather all necessary information required for an affiliation with a new access point before breaking up the currently used connection. Interactive applications, such as VoIP, are typically the most demanding in terms of handover delays, and high-quality VoIP calls can be served only by soft handovers. IEEE 802.21 allows the reception of dynamic information about the performance of the serving network and other networks in range, and IEEE 802.21 provides methods for continuous monitoring of available access conditions.

IV.3.2. Handover-Enabling Functions

IEEE 802.21 defines a set of handover-enabling functions, which are specified with respect to existing network elements in the protocol stack and introduces a new logical entity called Media-Independent Handover Function (MIHF). The MIHF logically resides between the link layer and the network layer. It provides abstract services to entities residing at the network layer and above called MIH Users (MIHUs). MIHUs are anticipated to make handover and link-selection decisions based on their internal policies, context, and the information received from the MIHF. The primary role of the MIHF is to assist in handovers and making handover decision by providing all necessary information to the network selector or mobility management entities. The MIHF is not meant to make any decisions with respect to network selection.

IV.3.3. Service Access Points

SAPs associated between the MIHF and MIHUs. MIH_SAP give MIHUs access to the following services that the MIHF provides [18]:

- **Media-Independent Event Service (MIES)** provides event reporting, for example, dynamic changes in link conditions, link status, and link quality. Events can be both local and remote. Remote events are obtained from a peer MIHF entity.
- **Media-Independent Command Service (MICS)** enables MIHUs to manage and control the parameters related to link behaviour and handovers. MICS provides a set of commands. Commands can be both local and remote. The information obtained with MICS is dynamic.
- **Media-Independent Information Service (MIIS)** allows MIHUs to receive static information about the characteristics and services of the serving network and other available networks in range. This information can be used to assist in making a decision about which handover target to choose and to make preliminary preparations for a handover.
V. PROPOSED UMTS-WIMAX HETEROGENEOUS NETWORK

The proposed architecture for UMTS-WIMAX interworking heterogeneous network shown in Fig. 5 is based on interworking model of 3GPP standards. The mobile subscriber (MS) or subscriber station node (SS) that can communicate with both UMTS and WIMAX network. The mobility inside WIMAX network is managed by WIMAX home agent located in WIMAX access service network gateway (WASNG).

VI. PROPOSED VERTICAL HANDOVER PROTOCOL BASED ON MIH (IEEE 802.21 Standard)

In this paper, to improve the QoS during the handover, a vertical handover protocol based on MIH has been proposed. In this handover, before leaving the serving network, the mobile prepares a new attachment in the target network. In order to reduce the packet loss during handover, the old network notifies the handover execution (HA) and the MS movement so that the HA can buffer the packets and forward them to the MS as soon as the HA receives the update from the MS. The handover procedure is based on the media independent handover function (MIHF). The MIHF exists in both the mobile node (MN) and the network node protocol stack. It provides three types of services: (1) Media independent event service (MIES); (2) Media independent command service (MICS); and (3) Media independent information service (MIIS).

VI.1. Vertical Handover protocol from WIMAX access network to UTRAN network

Fig. 6 shows three stages that handover procedure has to go through: initiation, preparation, and execution. In the initiation process, important changes in the link quality are reported. The handover procedure works as follows:
VI.1.1. The MIH mobile subscriber (MS) or subscriber station (SS) is pre-configured to generate triggers towards the network based on the degradation of current signal quality or on the necessity of switching between access technologies to support higher QoS requirement or low cost. The pre-configuration of these thresholds is usually set by the PoS (Point-of-Service) which is in this case is the WIMAX BS/PoS. When the connection is established, the PoS issue a configuration message to be sent to the mobile subscriber (MIH_configure_link_REQ). This message states the thresholds for the connection parameters under which the device generates a report and send a confirmation message to the WIMAX BS/PoS (MIH_configure_link_CNF).

VI.1.2. The mobile subscriber (MS) or SS send a periodic information messages stating signal strength measurements. The WIMAX BS/PoS will be aware of the MS status at all time. As far as QoS requirements and other significant parameters in case of crossing thresholds, the MS will generate a report to indicate changes to the PoS (MIH_linkparameters_report_IND). When deterioration in connection quality continues to reach unacceptable levels, the MS sends a message to the WiMAX BS/PoS indicates the need for a handover (MIH_link_going_down_IND). This message includes details about the time period at which the link will go down and the reason of this links weakness with a certain precision. Now the WIMAX BS/PoS is aware of the need of performing the handover and this is when the handover preparation stage starts.

VI.1.3. Now a query to the MIIS/HLR server might be sent requesting information regarding access networks around the MS. The MIIS/HLR server database includes information about different access networks present around the MS. This information includes: network status, availability, and signal strength.

VI.1.4. The MIIS server will send a message to the WiMAX BS/PoS indicating forcing the device to connect to a certain preset network instead of suggesting multiple networks to choose from. This step aims to optimize service in terms of network availability, cost, seamless mobility, and urgent traffic management and also will reduce the time consumed in the handover process. So the MS will not be required to perform additional scanning for networks in the surrounding and will be no need of resource availability check on candidate networks. Now, MS will skip all regular reporting actions and just report required measurements regarding to the target network i.e. UTRAN/GPRS and immediately starts establishing a connection with the new radio network.

VI.1.5. The WIMAX BS/PoS sends an information request (MIH_Get_Information_REQ) message to MIIS/HLR server. The MIIS/HLR server is then select the GGSN and GGSN then send the request to SGSN who serve the UMTS node in UTRAN/GPRS PoS. In order to be able to retrieve the address of SGSN that serves a UMTS node will be stored in MIIS/HLR server. MIIS/HLR server receives the request and then sends back a special message based on PoA (Point-of-Attachment) location where user zoning is applied.
containing the target/recommended network along with its characteristic. The MS now will only scan for this specific network rather than scanning for a list of available networks. MIIS will choose this network based on multiple aspects such as resources availability, QoS, signal strength within the zone, capability of maintain active sessions, and the types of services offered.

VI.1.6. The WIMAX BS/PoS will send an order to the MS for signal strength measurement and MS start scanning for the concerned PoA recommended by the MIIS/HLRserver(MIH_Scanned_concerend_PoS_REQ_parameters). The recommended UTRAN/GPRS network work on a cellular technology and will check the network layer parameter for MS and then MAC layer which is a cellular MAC will also check the availability of MS in cellular radio. Because our MS is MIH enabled (media independent) so MS will authorise in UTRAN/GPRS network. The recommended network PoS will send the MIH_Authorised_concerend_PoS_CNF_parameters message to MS. MS then sent back a signal strength measurement message to the WiMAX BS/PoS.

VI.1.7. The WIMAX BS/PoS sends a confirmation to the MIIS server stating the readiness of the wireless device to execute handover.

VI.1.8. The WIMAX BS/PoS communicates with UTRAN/GPRS PoS and send a (MIH_N2N_HO_Query_Resource) request and response. The UTRAN/GPRS PoS has to reserve required resources. Resources have to be guaranteed in both core and target networks. When the execution stage begins, the WIMAX BS/PoS orders the MS to start the handover by indicating the actions over the old and new link (MIH_Net_HO_commit_REQ). Old link resources are not needed anymore so it can be released and MS established the IP connection over the recommended UMTS node in UTRAN/GPRS network and reported back to the WIMAX BS/PoS (MIH_Net_HO_Commit_RSP). WiMAX BS/PoS then sent complete handover request to the UTRAN/GPRS PoS (MIH_N2N_HO_complete_REQ).

VI.1.9. The UTRAN/GPRS PoS has to respond WIMAX BS/PoS about complete the handover to recommended UMTS node (MIH_N2N_HO_complete.RSP). Then, WIMAX releases resources if not already done and MS starts data flowing through UMTS/GPRS Network. The vertical handover protocol based on MIH form UMTS to WIMAX is vice-versa.

VII. CONCLUSION AND FUTURE WORK

This paper aim to introduce UMTS-WIMAX heterogeneous network based on the 3GPP standard. The UMTS-WIMAX heterogeneous network has a generic problem of vertical handover. Various vertical handover protocols are present to improve the QoS during vertical handover. Among the three or four technique, the IQDE reduced the overhead and solving the services interruption for QoS improvement. But, no specific vertical handover protocol provides best solution for the UMTS-WIMAX heterogeneous network for various parameters like Throughput, delay, jitter time etc.

After study of above protocols, the vertical handover protocol based on MIH IEEE 802.21 standard with MIIS server is being proposed in this paper. The new technique aims to improve the throughput and reduce the overhead and time consumption while performing handover as well as allowing the MIIS server to optimize network utilization by balancing loads over available networks. This handover process will be guided by the MIIS server.

As a future work, further implementation, analysis and validation will be conducted to evaluate and confirm the performance of the proposed UMTS-WIMAX heterogeneous network and proposed vertical handover protocol.

REFERENCES


