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Implementation of Vertical Handover in Heterogeneous Networks

*Hoshang Karanjekar, **Asst. Prof. Manisha Kamble
*M.tech. (CSE)
Wainganga College of Engineering &
Management, Nagpur karanjekar.hoshang@gmail.com
**Computer Science & Engineering Wainganga College of Engineering &*
Management, Nagpur manisha.thool@gmail.com

ABSTRACT
One of the major design issues in heterogeneous wireless networks is the support of vertical handover. Vertical handover occurs when a mobile terminal switches from one network to another (e.g., from WLAN to CDMA 1xRTT). Seamless handover between different access technologies is a great challenge as it needs to obey different performance of QoS and security constraints. Subscribers are becoming more demanding regarding roaming capabilities across different networking technologies such as WiFi, WiMAX, and CDMA as they claim service continuity with QoS requirement and good security features.Vertical Handover Decision (VHD) algorithms need to be designed to provide the required Quality of Service (QoS) to a wide range of applications while allowing seamless roaming among a multitude of access network technologies. This paper is about a survey of the VHD algorithms designed to satisfy these requirements.. In this project, a QoS based vertical handover mechanism between heterogeneous networks is proposed by applying the Signal to Interference and Noise Ratio (SINR) in combination with Received Signal Strength (RSS). A combination of 3 parameters i.e. Data Rate, SINR and RSS are evaluated to take decision of the best network among available. The Media Independent Handover MIH (IEEE 802.21) protocol is adopted to assist in the handover decisions by providing a suitable platform for vertical handovers. The performance of the proposed SINR based vertical handover algorithm and RSS based vertical handover algorithm have been evaluated in terms of the maximum downlink throughputs.
Keywords - MIH; SINR; vertical handover; WiMAX;

I. INTRODUCTION

Future mobile devices will need to roam seamlessly across heterogeneous access technologies such as 802.l1, WiMAX, CDMA, and GSM, between wired networks such as xDSL and cable, as well as between packet switched and circuit switched (PSTN) networks. Fig 1 shows an example wireless internet roaming scenario across heterogeneous access networks that involves intra-subnet, inter-subnet and inter-domain mobility. Supporting seamless roaming between heterogeneous networks is a challenging task since each access network may have different mobility, QoS and security requirements. Moreover, interactive applications such as VoIP and streaming media have stringent performance requirements on end-to-end delay and packet loss. The handover process stresses these performance bounds by introducing delays due to discovery, , authentication configuration and binding update procedures associated with a mobility event [6]. The ability to change access link for better QoS in different wireless communication networks is known as seamless vertical handover [9].To achieve this objective, the Media Independent Handover (MIH) IEEE 802.21

standard has been proposed to permit the exchange of entities belonging to different access networks and assists the handover decisions by defining the set of functional components to be executed [8].

The vertical handover process involves three main phases, namely system discovery, vertical handover decision, and vertical handover execution. During the system discovery phase, the mobile terminal gathers the various parameters of different networks which are available to it and in which mobile node is moving. These networks may also advertise the supported data rates and Quality of Service (QoS) parameters. Since the users are mobile, this phase may invoke periodically. In vertical handover decision phase, the mobile terminal decides whether the connections should continue using the existing selected network or be switched to another network. The decision depends on various parameters including the type of the application (e.g., conversational, streaming), minimum bandwidth and delay required by the application, transmit power, access cost; and the user□s preferences. During the vertical handover execution phase, the connections of the mobile terminal are re-routed to the best network among the available in a seamless manner.

Authentication, authorization, and transfer of a user□s context information is also done in this phase.

Handover is the process of maintaining a user□s active sessions when a mobile terminal changes its connection point to the access network (called „„point of attachment"), for example, a base station or an access point. Depending on the access network that each point of attachment belongs to, the handover can be either horizontal or vertical. A horizontal handover takes place between points of attachment supporting the same network technology, for example, between two neighbouring base stations of a same cellular network. On the other hand, a vertical handover occurs between points of attachment supporting different network technologies, for example, between an IEEE 802.11 access point and a cellular network base station. A handover process can be split into three stages: handover decision, radio link transfer and channel assignment. Handover decision involves the selection of the target point of attachment and the time of the handover. Radio link transfer is the task of forming links to the new point of attachment, and channel assignment deals with the allocation of channel resources.VHD algorithms help mobile terminals to choose best network to connect to among all the available networks.

II.   WIFI AND WIMAX NETWORKS

Wireless Fidelity (WiFi) is a wireless local area network over limited range. It is known also under IEEE 802.11, and aims to connect devices such as Personal Computers, PDAs, laptops, printers, etc. IEEE 802.11 allows connectivity in infrastructure mode or ad-hoc mode. In infrastructure mode, the WiFi stations communicate through the access point (AP). In this mode, the 802.ll network architecture, illustrated in Fig.2, is its hierarchical representation. Its basic element is the Basic Service Set (BSS), which is the red on the area covered by one AP.

A BSS may also be part of larger network element called Extended Service Set (ESS). The ESS consists of one or more BSSs connected to the same wired LAN so called Distribution System (DS).In ad hoc mode, devices can communicate directly with each other without Access Point support. In our paper, we focus on infrastructure mode.
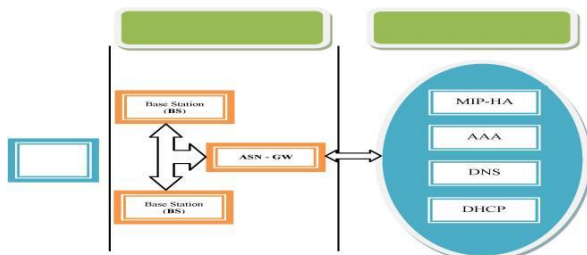

Figure1. Wireless internet roaming scenario in heterogeneous networks.

Network (CSN) is the core of WiMAX Network. It provides IP connectivity to the MS.

In order to provide mobility, 802.16e supports handover mechanisms. The IEEE 802.16e defines three different types of handover: Hard Handover (RHO), Fast Base Station Switching (FBSS) and Macro Diversity Handover (MDHO). The RHO is often referred to as a break-before-make handover: fast the MS disconnects from the serving BS and then connects to the target BS. In FBSS and MDHO, the MS maintains a diversity set which includes numerous active BSs in its range. The BS, to which the MS has the connection, is called the anchor BS. In FBSS, the MS transmits to and receives data from a single serving BS. The transition from the serving anchor BS to the target anchor BS in FBSS is done without invocation of the normal handover procedure, only the anchor BS update procedure is needed. In MDHO, the MS maintains a connection to one or more BSS in the diversity set simultaneously [6].
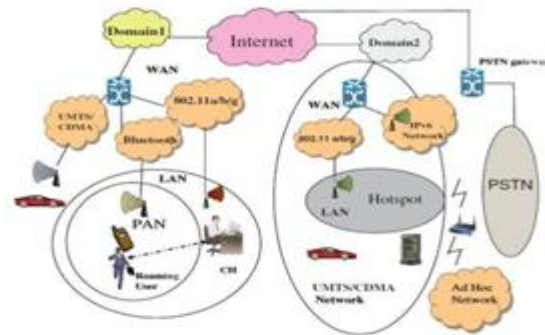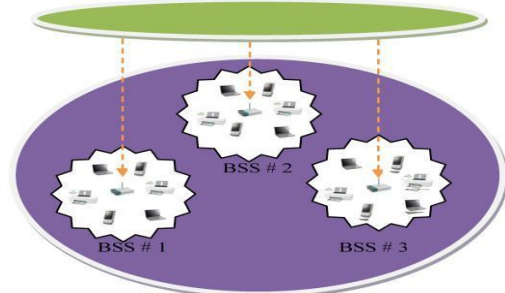

Figure .2. WiFi infrastructure mode

Figure 3. WiMAX architecture

Worldwide Interoperability for Microwave Access (WiMAX) is a Wireless Metropolitan Access Network (WMAN). It is used generically to describe wireless systems based on IEEE 802.16.WiMAX offers high data rates and large area coverage. It supports fixed and mobile broadband access. In our work we focus on Mobile WiMAX (IEEE 802.16e). The Mobile WiMAX Network, described in Fig. 3, is divided into three parts: the Mobile Station (MS) which is the user's device, the Access Service Network (ASN) is the radio access and includes one or more

Base Stations (BS) and one or more ASN Gateways (ASN GW). The Connectivity Service

III. SYSTEM METHODOLOGY

A. *Handover Management Process*

Handover management process in a mobility scenario is the procedure to maintain continuous connection in active mobile terminal while moving from one access link (base station or access router) to another. Handover management process has been described in several works [6] which involve three phases as shown in Fig. 4.

- Handover Information Gathering: In this phase mobile node collects all information required to initiate the handover. Also known as system discovery or handover initiation phase.

- Handover Decision: This phase determine when and how to perform the handover by selecting the best access link available and by giving instructions to the next phase, (i.e. handover execution). Also known as system or network selection.

- Handover Execution: In this, mobile node changes channels conforming to the details resolved during the decision phase.
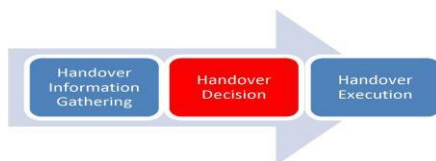

Figure 4. Handover Management Process

B. *MIH Overview*

MIH defines a logical entity, MIHF, located on layer 2.5 between link layer and network layer of the OSI model. It provides a framework that allows interaction between higher layers and lower layers. The MIHF supports three types of services: Media Independent Event Services (MIES), Media Independent Command Service (MICS, and Media Independent Information Service (MIIS). The MIES aims to provide and to predict link changes such as LINK UP, LINK DOWN, LINK GOING DOWN, etc. These events are propagated from lower layers to upper layers through the MIH layer. MIES is divided into two categories, link events and MIH events. Link events are generated from the lower layer and transmitted to MIH layer [4].

The MIH events are the events forwarded from MIH to upper layers. MICS refers to the commands, such as initiate In this project, a SINR based scenario

similar to that handover and complete handover, sent from higher layers to proposed by Kemeng et al is proposed instead of RSS as the lower layers. It allows enabling handover mechanism. MICS handover criteria for WIFI and WiMAX integration network includes MIH command and LINK command. MIH [6]. The Shannon capacity determines the maximum Commands originate from the upper layers down to the MIHF. achievable data rate for a given Signal to Interference and Link Commands are specific to the lower layers. MIIS Noise Ratio SINR and carrier bandwidth as:

provides a framework by which MIHF can discover homogenous and heterogeneous network information existing within a geographical area to facilitate seamless handover when roaming across these networks. The MIIS provides a bidirectional way for the two layers to share information such as current QoS, performance information and availability of service. Fig. 5 illustrates the MIH architecture.
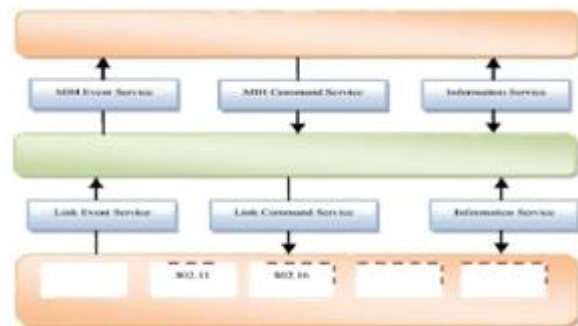

Figure 5. MIH architecture

At the transmitter, the data source is composed of sequences of binary bits with equal probability. After LDPC encoding, the codeword□s are interleaved and modulated to symbols. The sequence of symbols is then converted to Ns parallel sub streams and choose the Ns to be equal to the number of transmit antennas Nt, and do not consider space time coding in our current system. At each transmit antenna, the OFDM modulator performs inverse FFT (IFFT) and adds CP. At the receiver side, after CP removal and FFT operation in OFDM demodulators, the signals at frequency domain are fed into a soft MIMO detector and then use an iterative receiver scheme with MAP MIMO soft detector to achieve optimal or near-optimal performance. Such approach is different from the non-optimal receiver in, which has a non-iterative structure with the fixed sphere decoding algorithm. Although the MIMO MAP method suffers an exponentially growing complexity as the number of antennas and constellation point□s increases, it may be feasible to implement for systems with BPSK and/or QPSK modulations. Within each

iteration of the receiver, the MAP detector generates extrinsic soft information, i.e. log likelihood ratio (LLR), based on the received signal and the priori information interleaved from the LDPC channel decoder output. The inter leaved LLR from MIMO detector are then sent to LDPC decoder to extract the redundancy across coded bits. After a number of iterations, the hard decision is made at the output of channel decoder [7].

C. *SINR BASED VERTICAL HANDOVER STRATEGY*

$$R = w\, log_2\left(1 + \frac{\gamma}{\Gamma}\right)$$

Where:

• R is the maximum achievable data rate • w represents the bandwidth of the carrier • is the received SINR at a MT
• is the gap in decibel between channel capacity and encoded QAM, minus the gain caused by coding.
Let RBs be the maximum data rate from WiMAX base station, RAP be the maximum data rate from WiFi access point. Shannon formula becomes:

$$R_{BS}\quad W_{BS}\, Log_2\left(1 + \frac{\gamma_{BS}}{\Gamma_{BS}}\right)$$
$$R_{AP}\quad W_{AP}\, Log_2\left(1 + \frac{\gamma_{AP}}{\Gamma_{AP}}\right)$$

Where, Y_{BS} and Y_{AP} represent the receiving SINR from WiMAX and WiFi respectively. By letting $R_{BS} = R_{AP}$. We can find the relationship between required Y_{BS} and Y_{AP} in case of MT receiving the same data rate from WiMAX and WiFi:

$$\gamma_{AP}\quad \Gamma_{AP}\left[\left(1 + \frac{\gamma_{BS}}{\Gamma_{BS}}\right)^{\frac{W_{BS}}{W_{AP}}} - 1\right]$$

$$\gamma_{BS}$$

$$\gamma_{AP}$$

The SINR-based VHD algorithm becomes applicable by having the relationship between the receiving SINR and the maximum data rate from both WiMAX and WIFI. which represents the SINR received from WiMAX has been converted to an equivalent required to achieve the same data rate in WiFi.

i) *Utilization of Access Network:*
        Whenever the MN moves within the signal

coverage of WLAN, it□s possible for the MN to handover to an AP for better service. Normally, the MN will select a target AP with the highest RSS. Without considering the utilization of the AP, an MN connects to a busy AP, which may cause service degradation due to the possible congestion. To avoid this problem, we take the back-haul bandwidth of each AP as another handover decision factor because the back-haul bandwidth might be a bottleneck for the access network.

To determine the available back-haul bandwidth, each AP estimates its available back-haul bandwidth ( ) with utilization ( ) and back-haul bandwidth ( ). The available back-haul bandwidth ( ) can be estimated by = (1 −) ×

The value of will be broadcast periodically by each AP. Let be the array of available back-haul bandwidth for APs, = [1,   2,   3...   ],

is an available back-haul bandwidth of all candidate APs. The higher the utilization value is, the lower the available backhaul bandwidth can be offered. The lower available back-haul bandwidth results in the increase of transmission delay. With the use of , utilization of all candidate APs is also included in a handover determination. Therefore, the received will be taken as another handover decision factor in the proposed scheme.

ii)*Pre-active Handover Support :*
        For most pre-active handover schemes, handover decision algorithms were proposed to select a best target network, and some handover processes will take place before handover execution, for example, the authentication in layer two and MIP registration and binding processes in layer three. The decision algorithms enable the MN to select a best target network with different decision factors [1] [2], but it takes a lot of time to collect. The Media Independent Information Service (MIIS) component of Media Independent Handover (MIH) protocol [7] may provide necessary information for handover timing determination.

IV. RESULT

After successfully running the project code, obtained results are as shown below.
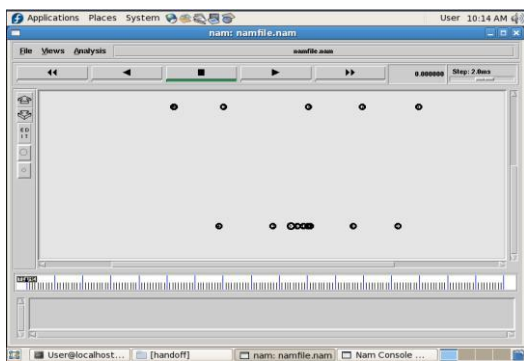
Figure 6. Two Heterogeneous networks with mobile nodes

Above figure 6 shows the variable number of mobile nodes forming clusters representing different networks. These networks will have different characteristics like different data rate, different SINR ratio and many more.
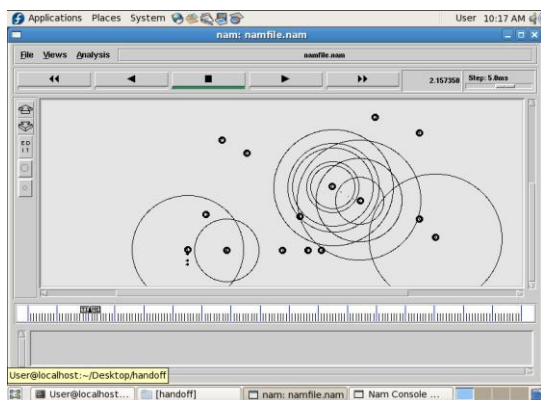

Fig 7. Broadcasting mobile nodes and moving among different networks.

Above figure 7 shows that mobile nodes moving across the different networks while accessing the services.
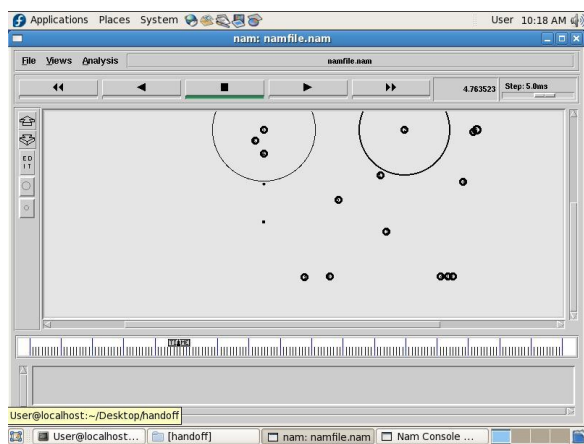

Fig 8.Mobile nodes switched services after the handover execution.

Figure 8 above shows that mobile nodes have switched the use of service after taking a proper handover decision by calculating various parameters like RSS and SINR.

V.   CONCLUSION

The given SINR and RSS based Media Independent Handover mechanism with QoS support for coexist heterogeneous WiMAX and WiFi networks.

● Besides supporting QoS for different traffic flow, the proposed combined approach based VHD algorithm will also promote maximum achievable data rate.

● The performance of the proposed SINR based VH algorithm and RSS based VH algorithm have been evaluated in terms of the maximum downlink throughputs.

Sometime when a mobile node is using the service, full network strength is shown but still the speed is very low. So taking RSS alone for handover will not be suitable.

Sometimes a network having maximum data rate among the different available networks but it may having very high SINR ratio. So SINR only can☐t be taken into consideration. Hence, both RSS and the SINR are counted for the decision in determining the handover. Specifically, the maximum data rate is evaluated for handover for uninterrupted use of service.

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