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A Method for Conducting Multi-Parametric Analysis to Efficiently and Reliably Perform Vertical Handovers

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Abstract

WiMAX and WiFi are advanced high-speed network technologies facilitating wireless transmission in telecommunications. Each mobile user in these networks is managed by its respective base station. When a node moves beyond the coverage range of its base station, it undergoes a handover process. Maintaining uninterrupted communication between nodes during handover, particularly in vertical handovers, presents a significant challenge. To address this challenge effectively, proposed adjustments in parameters for selecting the base station aim to enhance the handover process. The results indicate that these proposed modifications have led to improved network throughput during vertical handovers.

Keywords: *Handover, Wimax, WiFi, Vertical Handover, Throughput.*

I. INTRODUCTION

WiMAX is a revolutionary wireless technology that has a rich set of technological improvements compare to the other broadband access technology. It gives a high speed data transmission over the network. It is capable to achieve the high data rate communication for different wireless applications such that the voice over transmission, video conferencing etc. Because of this WiMax has become one of the most promising technology that can be used for data communication effectively. The Wimax technology offers around 72 Mega Bits per second without any need for the cable infrastructure. Wimax technology is based on Standard that is IEEE 802.16, it usually also called as Broadband Wireless Access. WiMAX Forum created the name for Wimax technology that was formed in Mid June 2001 to encourage compliance and interoperability of the Wimax IEEE 802.16 standard. broadband access as a substitute to conventional. IEEE 802.16e clearly defined the mobility techniques in WiMAX network or handoff. Handoff means a mobile station (MS) can maintain continuous connectivity if it travels from a coverage area of one base station to the coverage area of another base station. Three types of handoffs are defined by the IEEE 802.16e, Hard handoff (HHO), Macro Diversity Handoff (MDHO) and Fast Base Station Switching (FBSS). Out of these three handoff types, HHO is mandatory and the other two are optional.

A) WiFi Networks

Wireless Fidelity (Wi-Fi) is a wireless technology which provides internet connectivity or connectivity among the users. In 1997 IEEE provide a set of specification and standards for Wi-Fi which is under the title 802.11 that explains the structure of the comparatively short range radio signal for Wi-Fi service. After that several specifications came and most commonly used specifications today are 802.11b, 802.11g and 802.11a. Out of these three, 802.11a can provide higher speeds within the various radio frequencies. IEEE is now working for a new standard 802.11n which is more reliable, secure and faster than the other standard. Originally Wi-Fi was created for wireless extension for the wired LAN. That’s why the distance between the Wi-Fi access point and user equipment is limited to around 100 feet indoor and up to 300 feet outdoors. So if a user moves its computer to a new location, he/she should find a new access point for continuing the communication.

B) Handover

Handover (HO) is one of the key requirements to embrace mobility and Quality of

Service (QoS) for the subscribers using a wireless service. HO refers to the process in which a mobile subscriber station (MS) migrates from the air interface provided by one Base Station (BS) to an air interface provided by another BS [2]. The impact of HOs between base stations is a serious problem in a mobile communication system and must be addressed. During HO, packets may be delayed and connections may be dropped [3]. Real-time applications are adversely affected by these delays and packet losses.

When the Handover process is between two different technology networks, this is called vertical handover. The vertical handover process requires more concern to reduce the data loss while selecting the base station.

In this work we have shown the Vertical handover process between the WiMax and WiFi Networks. We have suggested some parametric changes to improve the handover process and to reduce the data loss.

II REIVEW OF LITERATURE

Paul Boone performed a work," Author propose strategies that a mobile station can use to reduce the time required for scanning operations while attempting to establish network connectivity or perform a handover between neighboring base stations. Author model and simulate an area of WiMax coverage using real-world mobility trace data and show that there are strategies that reduce the time required for scanning operations significantly. Zdenek Becvar performed a work," Handovers in the Mobile WiMAX". This paper is focused on the description of full mobile WiMAX and presents an overview of the handover types and the procedures used during movement of users. Md. Imtiyaz Anwar performed a work," A Mobility Improvement Handover Scheme for Mobile-WiMAX". This paper presents a mobility improvement handover algorithm with less scan time implementation for Mobile WiMAX. Mobile WiMAX is a wireless technology based on IEEE802.16e for broadband wireless access. Mobile WiMAX introduces the most significant new feature, mobility to support for handovers, which can be considered as a basic requirement for mobile communication system. Zdenek BECVAR performed a work," Initialization of Handover Procedure in WiMAX Networks". This paper introduces a new approach in the triggering of handover procedure in WiMAX networks. Mobile WiMAX, based on the IEEE 802.16e standard, supports a several types of handovers and allows full mobility of users. The originating IEEE 802.16j standard introduces new network entities called relay stations. A relay station enables either throughput enhancement in the selected area or enlargement of a coverage area of base station. Jianlin Guo performed a work," Location Aware Fast Handover Between WiMax andWiFi Networks". This paper proposes a location aware fast handover technique for vertical handover between WiMAX and WiFi networks to minimize target network detection delay, select proper target network for handover and eliminate Ping-Pong effect. The proposed technique aims to reduce the total handover latency and can be applied to realize seamless handover between WiMAX and WiFi networks. Haidarali K. Ansari performed a work," Efficient Handover among WiMAX and WiFi". In this paper, Author propose the fast handover techniques between WiMAX and WiFi networks to speed up handover process. A link layer fast handover approach is proposed to realize fast link layer connectivity.An IP layer fast handover mechanism is proposed to achieve the high speed IP layer connectivity. Venkat Annadata performed a work," 802.16e & 3GPP Systems Network Handover Interworking". In this technical paper, intend to present a possible Mobile WIMAX□3GPP/2 Network Interworking architecture based on the 3GPP/2 standards and propose the seamless inter□system handover scheme which enables the service continuity with low handover latency and packet loss. Ejaz Ahmed performed a work," Handover Optimization for Real-Time Application in Mobile WiMAX / IEEE 802.16e". In Presented scheme minimum number of Base Stations will be scanned and MS should scan only those BSs which can fulfil the bandwidth requirement of MS. Priority should be given to real time flows in handover. Z. Becvar performed a work," COMPARISON OF HANDOVERS IN UMTS AND WIMAX". The WiMAX, or IEEE 802.16, is emerging broadband wireless technology. There are several versions of 802.16, which differ among other in the user mobility support. This paper analyzes the existing types of handover applied in the third generation mobile networks and compares them with handovers used in WiMAX technology. The study is based on the latest IEEE 802.16e version. Zahra Taheri Hanjani performed a work," A New Method for Handover Schemes in Mobile WiMAX". In this paper, concentration is on handover in WiMAX, in addition various type of handover and especially fast handover will be explained. Handover in WiMAX is significant due to effect on scanning time and latency.

Mohamad Salhani performed a work," Performance of WiMAX Networks using Horizontal Handover with Channel Reservation Mechanism". In this paper, Author consider a model of mobility for WiMAX network users introducing horizontal handover mechanism with channel reservation. Author take into account several approaches in order to carry out the reservation. Author evaluate the performance of the proposed model.

III. PROBLEM FORMULATION

To provide stable HO, the IEEE 802.16e BWA defines several steps. Before HO initiation, network topology acquisition, network topology advertisement, neighboring base station (BS) scanning, and the target BS association are carried. Then, cell reselection, HO decision, HO initiation, downlink synchronization with the target BS, initial ranging, termination service with the serving BS, authorization, and registration are performed during the actual HO. However some steps of HO process are still ambiguous and are not clearly defined [5]. Furthermore, unnecessary neighboring BS scanning and association are conducted before and during HO process. Once HO process is initiated, data transmission is paused until the establishment of the new connection. It causes service disruption. The disruption time (DT) of HO is still too long to overcome the maximum delay time of real-time services and this cause's packet loss [6].

IV. OPTIMIZED HO SCHEME

In the proposed HO scheme we will evaluate maximum effective capacity and idle capacity of a BS in a Point to Multipoint (PMP) WiMAX network. We will then add the effective idle capacity as the HO trigger and a decision factor for the selection of HO target cell. The algorithm steps are as follows:

A. **BS Maximum Capacity Evaluation:** To evaluate the BS capacity we will calculate total number of OFDM (Orthogonal Frequency Division Multiplexing) symbols and number of overhead symbols in WiMAX MAC (Medium Access Control) frame. Here we consider Time Division Duplexing (TDD) where every frame is divided into DL and UL sub frames. Fig. 1 shows the MAC frame structure [8] where the overheads are marked in bold and italic.

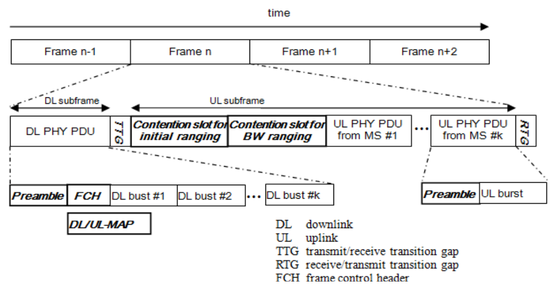

Fig. 1 WiMAX MAC Frame

To calculate total number of OFDM symbols transmitted per frame, first we have to calculate OFDM symbol duration which is given as:

TD_{OFDM} = useful symbol time + guard time

TD_{OFDM} = useful symbol time + G * useful symbol time

$$\mathbf{TD_{OFDM} = [1 / (f_s / N_{FTT})] * (1 + G)} \qquad - (1)$$

Where N_{FTT} is total number of subcarrier for OFDM PHY which is 256. G is Cyclic Prefix (CP) ratio=1/4. fs is Sampling factor = (Bandwidth * 144/125). Here we have taken 5MHz channel bandwidth. This gives TD_{OFDM} = 55.5 μs. We can compute total number of symbols as

$$\mathbf{N_{symbol} = T_{frame} / TD_{OFDM}} \qquad - (2)$$

Where T_{frame} is the frame duration and if assumed 20 ms gives N_{symbol} =360.

To calculate overhead symbols we start with preamble. Every preamble occupies first 2 OFDM symbols of DL sub frame. The FCH occupies 1 OFDM symbol. The size of DL-MAP and UL-MAP [9] is given as:

DL-MAP size = (64 + 32 * n) / 96,

UL-MAP size = (56 + 48 * n) / 96

Where n is number of active SSs that are served in the current frame. 96: represents the number of useful bits carried by an OFDM symbol for BPSK 1/2 scheme. 32 and 48: represent the number of bits carried by a DL-MAP Information Element (DL- MAP IE) and UL-MAP Information Element (UL- MAP IE), respectively.DCD/UCD overhead can be neglected as they are used for synchronization purpose only. Initial ranging message occupies 7 OFDM symbols and Bandwidth request slot 2 OFDM symbols. The TTG/RTG gap occupies 1 OFDM symbol. So, total overhead symbols can be given as [10]:

$$\text{Or, } \mathbf{N_{symbol\_overhead} = 13 + (120 + 80*n)/96} \quad - (3)$$

Assuming number of active MS at present = 5 gives $N_{symbol\_overhead}$ = 18. Now we can calculate effective capacity as:

$$\mathbf{C_{effective} = ((N_{symbol} - N_{symbol\_overhead}) * 96)/T_{frame}} \text{ -}\mathbf{(4)}$$

Using the values computed above gives

$C_{effective}$ =1.64 Mbps

B. **Idle Capacity Advertisement via MOB-NBR-ADV message:** The BSs periodically broadcast Mobile Neighbor Advertisement (MOB_NBR_ADV) control messages. These messages contain both physical layer and MAC address information. By means of such broadcasts, the MS becomes aware of the neighboring BSs. Each BS can also broadcast the idle capacity information of itself and of the neighbor BSs to the connected MSs via the MOB NBR-ADV messages, together with the DCD/UCD information [11]. To calculate idle capacity each BS can estimate its maximum effective capacity on a real-time basis. Through statistics a BS is also aware of the current data traffic throughput. Therefore, each BS could obtain the effective idle capacity as:

$$\mathbf{C_i = C_{effective} - C_{throughput}} \quad \mathbf{\text{-- (5)}}$$

C. **Target Cell Decision:** In our decision algorithm the decision factor for each candidate BS depends on both factors: idle capacity and signal strength. We have combined the two factors into a weighted target cell decision function.

Here P denotes the signal power. Based on the decision function, MS selects the candidate BS_K with the lowest value of D_k as the target cell to switch. W_1 and W_2 are the weights assigned to the two criteria.

D. Algorithm

The basic steps of this proposed approach is given in the form an algorithm

1. Define the Hybrid Network with N Number of Clusters. Some networks are Wifi networks and some are Wimax network
2. Define the initial parameter for each node of network such as bandwidth, transmission rate etc.
3. perform the random selection of source node and the cluster that will perform the handover call ClusterI and NodeJ
4. for i=1 to Length(Neigbours(ClusterI))
   {
   Calculate Distance(i)=
   DistanceBetween(Node(i),Cluster(i))
   Calculate
   Throughput=ThroughputOn(Cluster(i))
   Calculate IdleTime=IdleTimeOn(Cluster(i))
   }
5. find clusterN such that Distance(i) is Minimum, Throughput(i) is Maximum and IdleTime(i) is minimum
6. return clusterN
   }

V. CONCLUSION

The paper introduced an optimized handover scheme for WiMAX network. The method is based on effective capacity estimation of a BS and advertising idle capacity information through neighbor advertisement messages as per the IEEE 802.16 specifications. A detailed analysis is done to estimate maximum capacity of OFDM PHY layer. A conditional handover trigger for target cell selection that minimized data loss rate.

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