Impact of a Node mobility in two Mobile WiMAX Networks under different speeds

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***Abstract*— Mobility is important in wireless network because internet connectivity can only be effective if it is available during the movement of node. Several works have been carried out in performance analysis of node mobility in horizontal handover, but none of those is carried out in multiple networks within the same technology, So this paper analysis the performance of mobile nodes during handover in two WIMAX networks and to measure the performance there are number of parameters available like handover latency, end-to-end delay, MOS value, Throughput, Network Delay, etc. and we have used Network Throughput, Network Delay and MOS value which are involved in mobility management procedures**

Keywords-Mobile Network, WIMAX, Handover, Throughput, Delay, VoIP, OPNET

I. INTRODUCTION

The IEEE 802.16 technology (WiMAX) is one of the promising telecommunication technology alternative to 3G for providing last-mile connectivity by radio link due to its high speed data rates, low cost of deployment, and large coverage area. The standard specifies the air-interface between a Subscriber Station (SS) and a Base Station (BS). The IEEE 802.16-2004 standard, also known as the IEEE 802.16d, was published in October 2004. This was further developed into the mobile WiMAX standard referred to as the IEEE 802.16e-2005 or the IEEE 802.16e to support mobile users. The IEEE 802.16 can be used not only as DSL replacement for small business customers but also as a mobile internet access technology. [1]

Nowadays, one of killer applications for the IEEE 802.16 is Voice over IP (VoIP) service to support bidirectional voice conversation. Since its introduction, VoIP has been gaining more and more. [1]

II. RELATED WORK

Researchers have done lot of work in the field of WiMAX (IEEE802.16) and Mobile WiMAX (IEEE802.16e). A standard that specifies the air interface of fixed broadband wireless access (BWA) systems supporting multimedia services. The medium access control layer (MAC) supports a primarily point-to-multipoint architecture, with an optional mesh topology. Then enhancements to IEEE Standard 802.16 2004 was introduced in 2006 to support subscriber stations moving at vehicular speed [5] and thereby specified a system for combined fixed and mobile broadband wireless access. An overview of Mobile WiMAX and the performance for the basic minimal configuration based on the WiMAX Forum Release-1 system profiles.

III. QOS(QUALITY OF SERVICE)[2]

Originally, four different service types were supported in the
802.16 standard: UGS, rtPS, nrtPS and BE.

A. *The UGS (Unsolicited Grant Service)* :It is similar to the CBR (Constant Bit Rate) service in ATM, which generates a fixed size burst periodically. This service can be used to replace T1/E1 wired line or a constant rate service. It also can be used to support real time applications such as VoIP or streaming applications. Even though the UGS is simple, it may not be the best choice for the VoIP in that it can waste bandwidth during the off period of voice calls.

B. *The rtPS (real-time polling service):* It is for a variable bit rate real-time service such as VoIP. Every polling interval, BS polls a mobile and the polled mobile transmits bw-request (bandwidth request) if it has data to transmit. The BS grants the data burst using UL-MAP-IE upon its reception.

C. *The nrtPS (non-real-time polling service):* It is very similar to the rtPS except that it allows contention based polling.

D. *The BE (Best Effort)*: This service can be used for applications such as e-mail or FTP, in which there is no strict latency requirement. The allocation mechanism is contention based using the ranging channel.

E. *ertPS (Extended rtPS)* **:** Another service type called ertPS (Extended rtPS) was introduced to support variable rate real-time services such as VoIP and video streaming. It has an advantage over UGS and rtPS for VoIP applications because it carries lower overhead than UGS and rtPS

IV. PERFORMANCE METRICS

A. Throughput

Network throughput is the average data rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps) and sometimes in data packets per second or data packets per time slot. This parameter is essential inside the outlook through the device owner and it also measures the amount of user demands that are addressed with the machine. It is an approach to calculating the quantity of service that is provided. The response quantity of confirmed system increases because the system throughput increases. Once the maximum throughput within the technique is accomplished, the response time becomes infinite because the internal queuing delays become arbitrary large. Throughput was measured for the widely used transport protocols UDP and TCP, as well as for the popular application protocol FTP.[12]

B. Network Delay

Network delay is an important design and performance characteristic of a computer network or telecommunications network. The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. [12] There is a certain minimum level of delay that will be experienced due to the time it takes to transmit a packet, so this adds up more variable level of delay due to network congestion.

C. MOS in VoIP

A VoIP application typically works as follows, first, a voice signal is sampled, digitized, and encoded. The encoded data (called frames) is/are packetized and transmitted using RTP/UDP/IP. At the receiver's side, data is de-packetized and forwarded to a playout buffer, which smoothes out the delay incurred in the network. Finally, the data is decoded and voice signal is subjective and therefore is measured by mean opinion score (MOS). MOS is a subjective quality score that ranges from 1 (worst) to 5 (best) [5].

V. SIMULATION MODEL

Opnet Simulator is used to create the WiMAX Mobile environment and figure 1 represents the workflow of the OPNET Simulator.

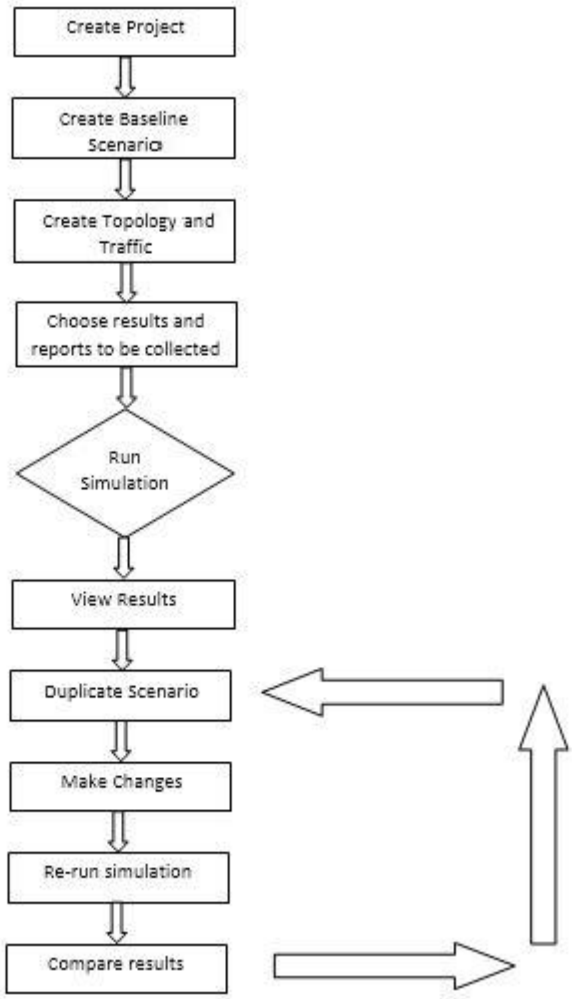

Figure 1. The Project/Scenario Workflow in OPNET

A. Network Model

The network consists of three cells in two different Networks and an IP backbone. Cell radius is set to 2 km. Each cell has 5 nodes. The green bidirectional dotted lines represent the generic routing encapsulation (GRE) tunnels and white arrow lines represents the trajectory set for mobile nodes to move around the network while simulation.[1][2] Figure 2 shows the implementation of Wimax mobile environment using OPNET Simulator.

B. ASN Gateway

The Access Service Network (ASN), which comprises one or more base stations and one or more ASN gateways that form the radio access network at the edge. The ASN gateway typically acts as a layer 2 traffic aggregation points within an ASN. Main functions that the ASN gateway include are intra-ASN location management and paging, radio resource management and admission control, caching of subscriber profiles and encryption keys, AAA client functionality, establishment and management of mobility tunnel with base stations, QoS and policy enforcement, and foreign agent functionality for mobile IP, and routing to the selected Network [1].

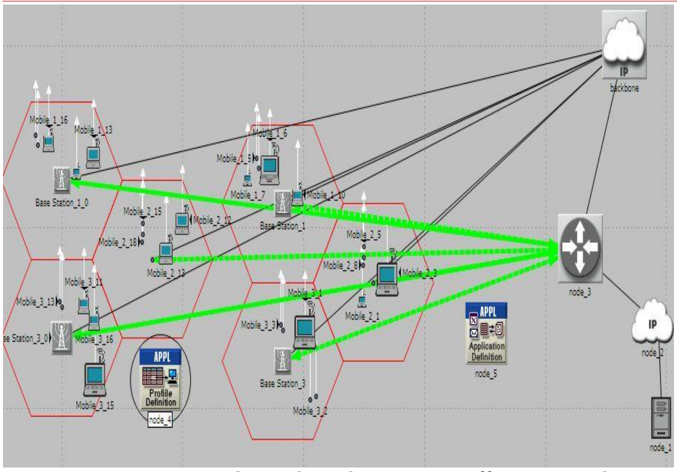

Figure 2. WiMAX Network Topology showing two Different Networks

C. Node Mobility Experimant Scenarios

Scenario 1: Scenario 1 is used to investigate the impact of handover on two same networks on the performance of VoIP application in a mobile WiMAX network at node speed of 20km/h.

Scenario 2: Scenario 2 is used to investigate the impact of handover on two same networks on the performance of VoIP application in a mobile WiMAX network at node speed of 40km/h.

Scenario 3: Scenario 3 is used to investigate the impact of handover on two same networks on the performance of VoIP application in a mobile WiMAX network at node speed of 60km/h.

VI. SIMULATION RESULTS

A. Throughput results

As seen from the Figure 3 it shows that network throughput is more at speed of 20 kmph but as the speed of mobile nodes increase the network throughput decreases, network throughput is less at speed of 40 kmph and constantly decreases as seen from the figure 3 that network throughput decreases a lot at speed of 60 kmph so this shows that the performance also degrades as throughput is inversely proportional to the speed of Mobile nodes.

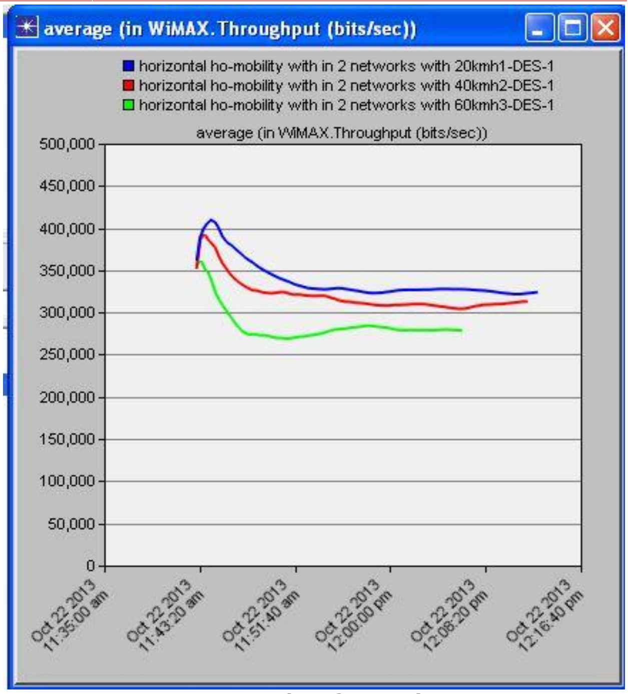

Figure 3. Throughput results

B. Network delay results

The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. As seen from the Figure 4 that Network delay seems less at 20 kmph speed but as the speed of mobile node increases the network delay increases.

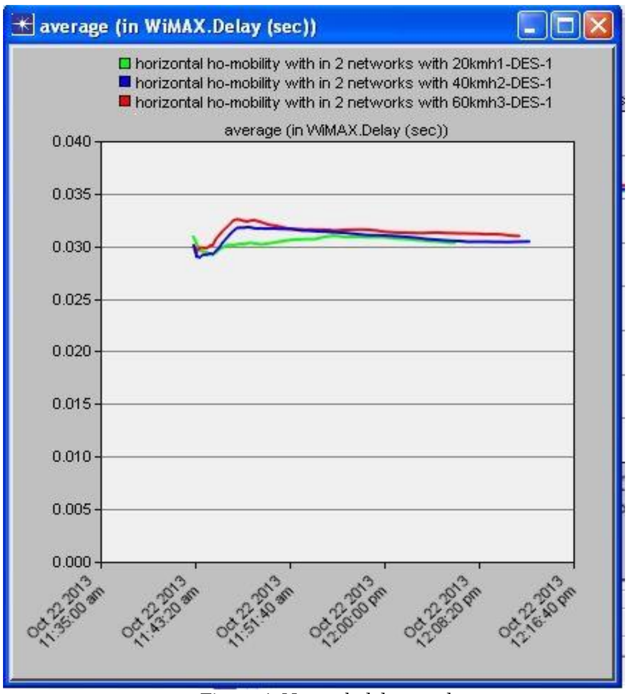

Figure 4. Network delay results

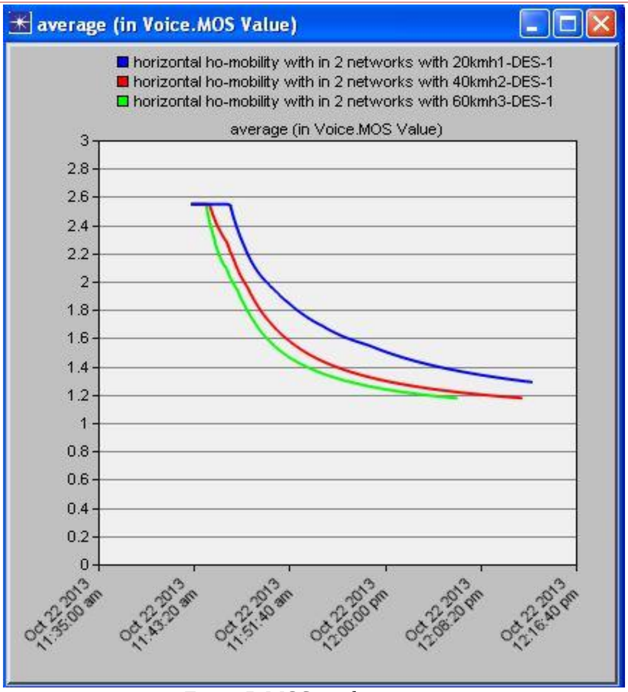

Figure 5. MOS results

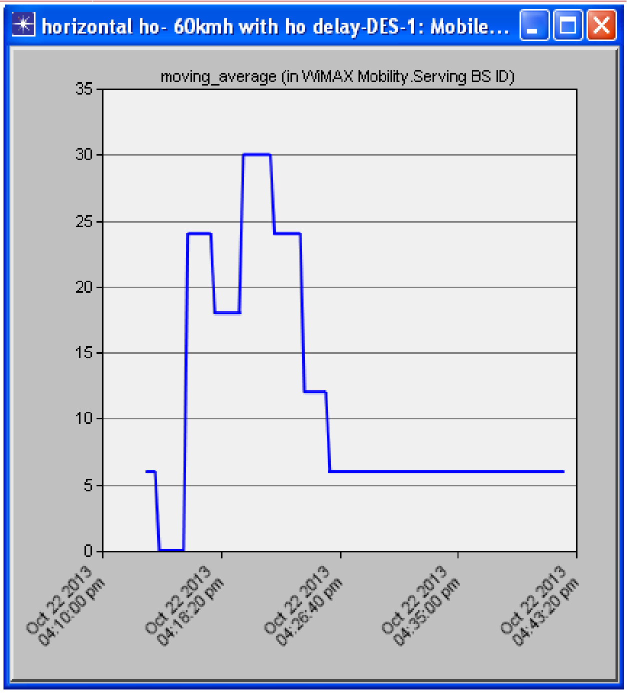

Figure 6. Serving Base ID

C. MOS results

Figure 5 shows that the MOS value is more at speed of 20 kmph and as the speed of mobile node increases to 40 kmph and further to 60 kmph the MOS value decreases. MOS value which describes the voice perception quality is illustrated in Fig. 5. The MOS value is quite high at the starting time of the simulation and the MOS value decreases to a value 1.3(approx.) in all cases. The MOS indicates that the quality of service is poor as the speed of mobile node increases.

D. Serving Base Station ID Analysis

From Figure 6, we can clearly depict that the mobile node is changing its Serving BS Id while it moves from one location to another i.e. it moves from the cell coverage of one base station to that of another base station. Whenever a mobile node exhibit handover, its base id is changed from the serving base station to the target base station. And as in two networks base ID changes rapidly to maximum of six different values as there are total six base stations in two networks so base Id changes as mobile node moves from one network to the other. Figure 6 also shows that the mobile node moves from one Cell to other and perform handover. This is the reason the serving base ID Changes as the mobile node enters the other cell. So Figure 6, Clearly Shows that Handover Actually Occurred.

CONCLUSION

In above results it has been shown that performance of node mobility during handover is higher when the speed of mobile node is less in the two WIMAX network. Above results has been analyzed using OPNET simulator and to measure the performance we took three parameters Network Throughput, Network Delay and MOS Value, and after examining the simulation in mobile environment , it shows that the performance of node mobility in two WIMAX network depends on speed of the mobile nodes. The performance of node mobility in two WIMAX networks varies due to the fact that End-to-End Delay increases while changing the network so performance degrades in handover of mobile nodes when speed increases ,And for future work different handover related WiMAX research issues need to be analyzed to support high-speed mobility in different scenarios.

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