

## Research Article

## Comparative Analysis of Mobile Wimax Performance through Mobility Model using Qualnet Simulator 6.1

Ashish Shukla<sup>A\*</sup>, Rajeev Paulus<sup>A</sup>, A.K.Jaiswal<sup>A</sup> and Mayur Kumar<sup>A</sup>

<sup>A</sup>ECE, SHIATS Allahabad, India.com

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### Abstract

*In this paper we provide a performance analysis for real-time services with a limited bandwidth in a Mobile WiMAX network. Mobile WiMAX can be efficiently used for real-time services with a theoretical maximum bandwidth of 120 Mbps and maximum transmission range of 50 km. The IEEE802.16e standard, also bring multiple antenna support through multiple input multiple output communication. This bring potential benefits in terms of coverage, power consumption, frequency reuse and bandwidth efficiency by addition of full mobility support. The main contribution of this paper is that we could use different users with different speed by using different mobility model such as random waypoint model and flag mobility model. All the simulation are carried out by scalable network simulator through QualNet simulator 6.1. The changes in various speed will bring result in the form of total received messages, received throughput, average jitter, average end to end delay and energy consumption in mobile WiMAX cell.*

**Keywords:** Performance Evaluation, WiMAX, Wireless Access Networks

### 1. Introduction

The global demand for multimedia data services has grown at a remarkable rate in recent years. The increase in demand is likely to grow at an even faster pace in the future due to advances in multimedia distribution services. Network scalability thus becomes an important consideration for both equipment manufacturers and service providers. The overall system capacity has to be made expandable in terms of the number of subscribers supported, data rate, and geographical coverage. There are many factors that influence the scalability of a network (K. Santhi et al, 2006). The 802.16 Medium Access Control (MAC) layer uses a scheduling algorithm for which the subscriber stations need compete once, i.e. for initial entry into the network. After that it is allocated an access slot by the base station. The time slot can enlarge and contract, but remains assigned to the subscriber station, which means that other subscribers cannot use it. In addition to being stable under overload and over-subscription (unlike 802.11), the 802.16 scheduling algorithm can also be more bandwidth efficient. The scheduling algorithm also allows the base station to control QoS parameters by balancing the time-slot assignments among the application needs of the subscriber stations (K. Santhi et al, 2006). We study and assess the coexistence and interoperability solutions between WiMAX and other wireless access networks, such as WLAN (IEEE 802.11) in Beyond 3G (B3G) networks. We also evaluate the special features of the WiMAX technology, such as the improved coverage in

Non-Line of Sight (NLOS) environments, in order to examine the applicability of well-known localization techniques. It can provide high-speed mobile data and telecommunications services comparable to the emerging 4G technologies. It offers a wireless alternative to cable and digital subscriber line

(DSL) for last mile broadband access. It can also be used to connect Wi-Fi hotspots with each other and to the Internet. With the introduction of mobile WiMAX raises the question of coverage and throughput that can be provided to the end users. In general, using WiMAX Base Stations (BS) to provide wide coverage for an entire region can still be economically infeasible due to the high cost of setup and maintenance of infrastructure (K. Santhi et al, 2006). The IEEE 802.16j Working Group aims to solve these issues through the use of multihop relay stations in an attempt to extend the coverage area and improve throughput at a feasible economical level. Communication networks support a wide range of services, from voice over IP for consumers to critical life-saving telemedicine applications. It is vital to ensure that a given network is capable of providing adequate network resources for future growth in demand (G. Zaggoulos et al, 2007). The data rate can be effectively doubled by doubling the number of sectors while maintaining an Omni-directional coverage. The network can be further expanded by another sectorization. With an increased number of hubs to cover the same geographical area, less bandwidth will be required for each hub, and hence equipment costs can be reduced. WiMAX Provides fixed, nomadic, portable, and soon, mobile wireless broadband

\*Corresponding author: Ashish Shukla

connectivity without the need for a direct line-of-sight with a base station (K. Kim et al, 2005).The WiMAX forum developed requirement guidelines for the several applications that can be run over WiMAX. In (F. Bernard et al, 2004). The authors proposed a performance evaluation study of a WiMAX system (802.16 2004) when using directional antennas to improve its general performance. The 802.16e standard has been developed for speeds of up to 120 km/h at 3.8 GHz. WiMAX 802.16e also examines the possibility of using directional antennas to reduce the impact of Doppler spread, and hence improve the performance of a mobile WiMAX communications link. The use of directional antennas improves performance without the need for increased digital signal processing at the receiver (Fong et al, 2004).There are several advantages of the systems with wireless broadband access such as fast start-up implementation of the system, dynamic allocation of radio resources, lower costs (when compared to 3G mobile networks), efficient use of radio spectrum, large throughput in uplink and downlink directions, wide range of QoS, etc.

This broadband access is standardized by the IEEE 802.16 Working Group and the WiMAX Forum. However, the IEEE 802.16 Working Group developed the standards for the physical and MAC level (Richard et al, 2005; Fong et al, 2004).WiMAX is IP native (as all other standards from IEEE), the telephony is represented by Voice over IP (VoIP). However, if one wants to provide real-time services over Mobile WiMAX, such as VoIP, then we need to provide whether the QoS requirements for these services are met or not. Accordingly in this paper we conducted the performance analysis of Mobile WiMAX regarding the VoIP service by using simulation technologies (Chen et al, 2005; Chong et al, 2005).

This paper is organized as follows. Section 2 describes important aspects of the physical layer relevant to our analysis that is the Simulation setup. Section 3 introduces the Scenario description and environment used and results are given in Section 4. Finally, Section 5 and section 6 concludes the findings and references respectively.

## 2 Simulation Setup

We have created the WiMAX scenario using Qualnet 6.1 network simulator to simulate the comparative analysis of mobile WiMAX performance through mobility model and focusing on total received messages, received throughput, average jitter, average end to end delay and energy consumption in mobile WiMAX cell.

### 2.1 WiMAX Scenario in Qualnet

The main scenario consist of two base station (BSs) and 102 subscriber stations (SSs). For one WiMAX cell, node1 act as the base station. On the other hand, node 6 act as the base station. To the node 1, 60 subscriber stations are attached with a frequency band of 2.4 GHZ while to the node 6, 42 subscriber stations are attached with a frequency band of 2.43 GHZ. CBR traffic application is

used to provide constant data transmission from source to destination.

The architecture of WiMAX scenario is designed as shown in figure 1 for Comparative Analysis of Mobile WiMAX Performance

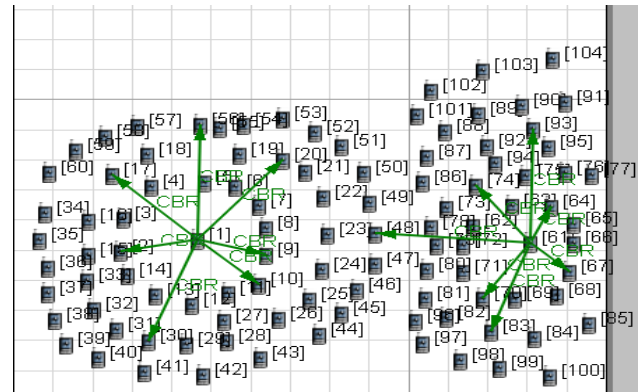


Fig. 1 WiMAX scenario in QUALNET

In this scenario we are using AODV routing protocol which is a reactive routing protocol that contains route table. Moreover, IPV4 network protocol is used.

### 2.2 Simulation Parameters

Table I shows the parameters for new simulation design of the scenario for the comparative analysis of mobile WiMAX performance through mobility model.

Table 1 Simulation Parameters

Parameters	Values
Terrain-Dimensions (m)	1500*1500
Mobility Model	Random Waypoint, Flag mobility
Frequency Band (GHZ)	2.4,2.43
Channel Bandwidth (MHZ)	20
Frame Duration (ms)	16
FFT Size	2048
MS Velocity (MS <sup>-1</sup> )	20
BS Transmitted Power (dbm)	30
SS Transmitted Power (dbm)	20
Simulation Time (s)	600
Traffic	CBR
Antenna Type	Omni-directional
No. Of Packet Sent	500
Pause Time (s)	30
Radio Type	802.16e

## 3 Scenario Description

In this paper we have designed two scenario with two different mobility model, one is random waypoint mobility and other is flag mobility. For this, we have used Qualnet simulator 6.1 to design and analyze the scenario over an area of 1500m\*1500m. For both the Scenarios simulation time is 600sec. The results analyzed are compared to each

other and different performance metrics are evaluated such as total received messages, received throughput, average jitter, average end to end delay and energy consumption.

3.1 Scenario 1:

In this scenario, there are 2 base station and 102 subscribers' stations in which 14 CBR application are used. Flag mobility model is considered for this scenario which provide a constant speed with a time interval of 30 sec for each flag. The scenario designed is shown in figure2.

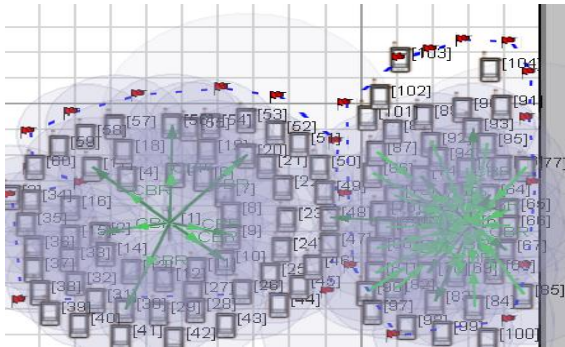


Fig.2 Mobility with flag

3.2 Scenario 2:

In this scenario, there are 2 base stations and 102 subscribers' stations in which 14 CBR application are used. Nodes are made mobile by using random waypoint mobility model. Minimum speed is 0 mps and maximum speed is 20 mps. Pause time is 30 sec. The scenario designed is shown in figure 3.

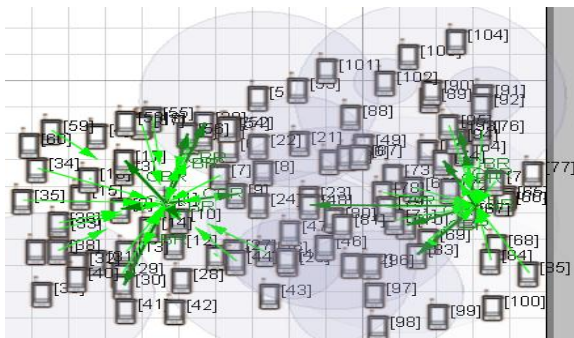


Fig. 3 Mobility with Random waypoint Model

The comparative analysis is done to evaluate the different performance metrics so as to observe which mobility model gives the best network performance.

4 Results and Discussion

4.1 Received Throughput

Unicast throughput refers to total amount of data a receiver receives from the sender divided by the time it takes for the receiver to get the last packet. The throughput

is measured in bits per second (bit/s or bps). Figure 4 shows Unicast received throughput of WiMAX cell in flag mobility is more than random waypoint mobility model. Performance of flag mobility is higher due to movement of nodes in a trajectory path of WiMAX cell. While in the case of random waypoint model nodes start moving away from the WiMAX cell. Therefore, its performance is degraded.

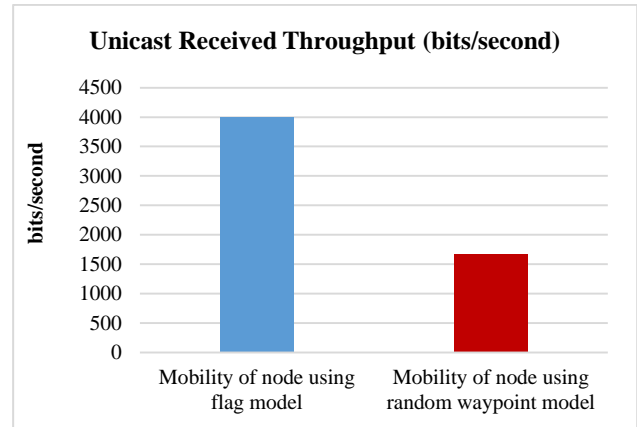


Fig. 4 Received Throughput

4.2 Average Unicast End To End Delay

End-to-end delay indicates how long it took for a packet to travel from the CBR source to the application layer of the destination. It represents the average data delay an application or a user experiences when transmitting data. Figure 5 shows that end to end delay experienced more in case of random waypoint model because data in WiMAX cell moving from one point to another point and it will take more time to reach to the destination. In case of mobility with flag, data will takes same time to transmit and receive.

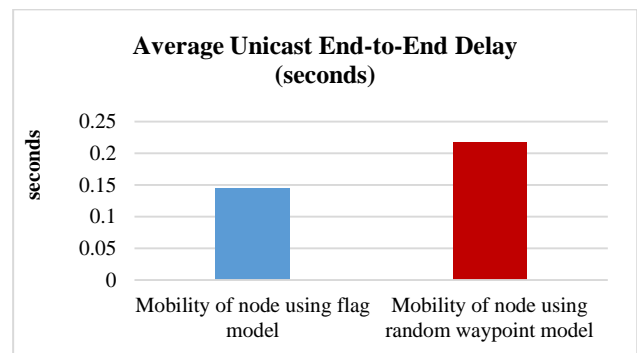


Fig. 5 Average Unicast End To End Delay

4.3 Average Unicast Jitter

Jitter is the variation in delay by different data packets that reach the destination and can seriously affect the quality of audio/vedio and thus an unwanted parameter. Figure 6 shows that jitter is the variation in the time between packets arriving, caused by network congestion, timing

drift, or route changes. Jitter should be small for mobility with flag because the packet of arriving in all nodes of Wimax cell will takes less time to their destination nodes. In case of random waypoint packets start moving in all direction with a speed of 20 mps that will take the nodes away from the cell area and leads to drop packet in large ammount. This happens only because nodes in wimax cell will move without any specific trajectory therefore maximum time were taken by the nodes which is moving in case of random waypoint model and experienced more jitter.

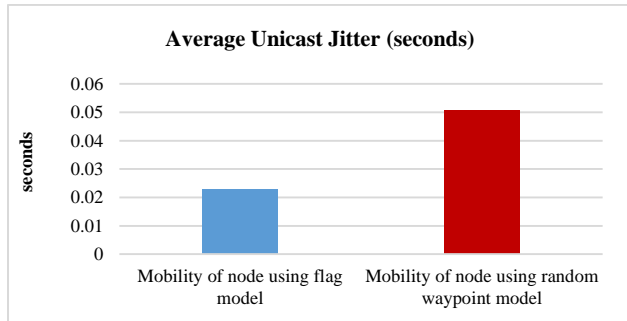


Fig. 6 Average Unicast Jitter

4.4 Total Unicast Fragments Sent

Total unicast data sent refers to the total no of data sent from a signal source to single destination that shown in figure 7.

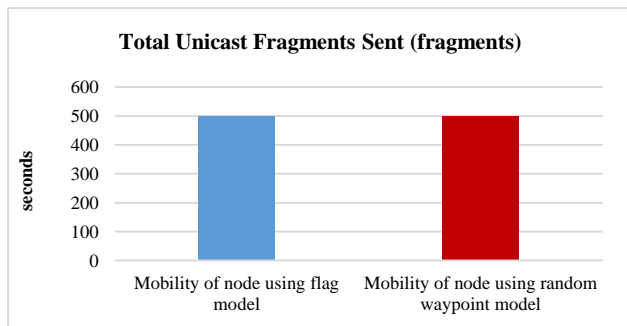


Fig. 7 Total Unicast Fragments Sent

4.5 Total Unicast Fragments Received

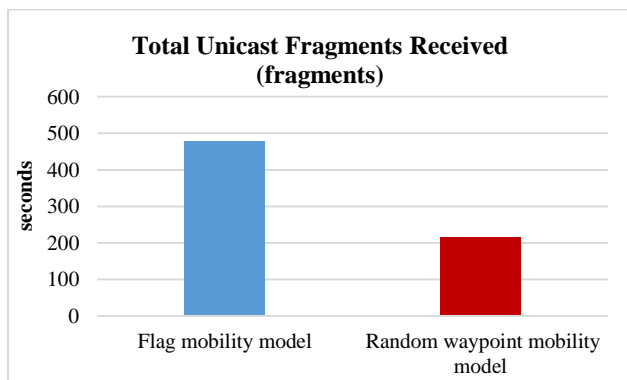


Fig. 8 Total Unicast Fragments Received

Total unicast data received refers to the total no of data received from a signal source to single destination that shown in figure 8.

Conclusions

The results show that the performance metrics such as total transmit messages, total received messages, received throughput, average jitter and average end to end delay indicates that flag mobility model is more efficient than random waypoint model. It is concluded that in the case of flag mobility model, a fixed trajectory path established according to the user needs that provide maximum throughput and minimum delay. While in the case of random waypoint model, all the nodes in WiMAX cell moving with different speed from the circumference of the WiMAX cell. Therefore maximum packets are being lost during the transmission process. The future work will focus on base station mobility through flag mobility model and random waypoint model for WiMAX cell performance.

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