

Implementation and Analysis of Wimax Module under Ns2 with Varying Mobility Model

Shanasa Rahel¹, Deepali Shukla²

¹M.E. (Electronics and Communication)

²Asst. Prof. Dept of E&C, MITM, Indore

Abstract

The network simulator 2 (ns-2) is a popular and powerful simulation tool for the simulation of packet-switched networks, which provides substantial support for simulation of TCP, routing, and MAC protocols over wired and wireless networks, such as wireless LANs, mobile ad hoc networks (MANETs), and satellite communications, etc, and is widely used in both academia and industry. Although many protocol modules have been implemented in the ns-2, the IEEE 802.16 broadband wireless access networks (BWANs) or WiMAX module has not been contributed yet. Thus, in this paper, we present our detailed design and implementation of the WiMAX module based on the IEEE 802.16 standard with the point-to-multipoint (PMP) mode for the ns-2. The implemented module comprises fundamental functions of the service-specific convergence sublayer (CS), the MAC common part sublayer (CPS), and the PHY layer. A simple call admission control (CAC) mechanism and the scheduler are also included in this module.

I. Introduction

The IEEE 802.16 standard forms the basis of Worldwide Interoperability for Microwave Access (WiMAX). It was developed by the WiMAX Forum with the objective of providing high speed data transfers over the air. The WiMAX Forum is an industry-led, non-profit organization that certifies and promotes the compatibility and interoperability of broadband wireless products based upon IEEE Standard 802.16 [1]. WiMAX has its origin in the computer industry and is an alternative to Third Generation Partnership Project (3GPP) and technologies like High Speed Packet Access (HSPA) and Long Term Evolution (LTE).

The most popular network simulator used by the academia and industry is the network simulator 2 (ns-2) [11], which has become the *de facto* standards for the simulation of packet-switched networks. Specifically, more and more published wireless network studies and investigations use ns-2 to evaluate and verify their work. Although there still another force investigates the IEEE 802.16-based simulator [8], this simulator is not public. The ns-2 is roughly composed of various traffic models, transport-layer protocols, network-layer protocols, and medium access control (MAC) layer protocols, etc. These components enable ns-2 to simulate different types of networks and their topologies. Researchers can benefit from these preliminary tests on their investigation and find out the drawbacks of their new design in efficient way.

Until today, as the best knowledge of the authors, no WiMAX/IEEE 802.16 module has been contributed to ns-2. Due to these reasons, we design and implement the WiMAX module for ns-2. The

developed WiMAX module is focused on MAC protocol development and inherited from the original MAC class in ns-2. This module is based on IEEE 802.16 point-to-multipoint (PMP) mode, which means that one BS can serve multiple subscriber stations (SSs) concurrently. We choose the orthogonal frequency-division multiple access (OFDMA) scheme for the physical (PHY) layer. Based on the OFDMA PHY specifications, it has been of major interest for both wireless applications due to its high data rate transmission capability and its robustness to multipath delay spread [9].

The IEEE 802.16 standard defines the specifications related to the service-specific convergence sublayer (CS), the MAC common part sublayer (CPS), the security sublayer, and the PHY layer. The MAC management messages, such as downlink/ uplink map (DL-MAP/UL-MAP), downlink/uplink channel descriptor (DCD/UCD), ranging request/response (RNGREQ/ RNG-RSP), and so forth are implemented following the 802.16 standard to operate the WiMAX networks. All operations between the base station (BS) and subscriber stations (SSs) over a *superframe* interval follow the compulsory procedures of the 802.16 standard.

II. An Overview of IEEE 802.16 Standards

The section briefly summarizes the operations of MAC and PHY layers in the IEEE 802.16 standard. Fig. 1 illustrates the architecture of IEEE 802.16. The CS provides any transformation or mapping of external network data that is received

through the CS service access point (SAP) and converts them into MAC service data units (MSDUs) received by the MAC layer through the MAC SAP. This sublayer includes classifying external network SDUs and associating them to the proper MAC service flow identifier (SFID) and connection ID (CID). In addition, it may also include the payload header suppression (PHS) function.

The MAC CPS provides the core MAC functionality of system access, bandwidth allocation, scheduling, contention mechanism, connection establishment, and connection maintenance. It receives data from various CSs through the MAC SAP, which is classified to particular MAC connections. The IEEE 802.16-2004 standard supports four quality-of-service scheduling types: unsolicited grant service (UGS) for the constant bit rate (CBR) service, real-time polling service (rtPS) for the variable bit rate (VBR) service, non-real-time polling service (nrtPS) for non-real-time VBR, and best effort service (BE) for service with no rate or delay requirements. In 802.16e standard, there is an additional service type called extended real-time polling service (ertPS) for voice over IP (VoIP) service with silence suppression.

These quality-of-service (QoS) classes are associated with certain predefined sets of QoS-related service flow parameters, and the MAC scheduler supports the appropriate data handling mechanisms for data transport according to each QoS classes. The upper-layer protocol data units (PDUs) are inserted into different levels of queues with an assigned CID in the MAC layer after the SFID-CID mapping. These data packets in these queues are treated as MSDUs and then will be fragmented or packed into various sizes according to the MAC scheduling operations. They will be processed by a selective repeat automatic repeat request (ARQ) block mechanism if the ARQ-enabled function is on.

For the UL traffic, each SS should range to the BS before entering the system. During the initial ranging period, the SS will request to be served in the DL via the particular burst profile by transmitting its choice of DL interval usage code (DIUC) to the BS. Afterwards, the BS will command the SS to use a particular uplink burst profile with the allocated UL interval usage code (UIUC) with the grant of SS in UL-MAP messages. The DL-MAP and UL-MAP contain the channel ID and the MAP information elements (IEs) which describes the PHY specification mapping in the UL and DL respectively. They are based on the different PHY specifications, such as single carrier (SC), single carrier access (SCa), OFDM, and OFDMA. The burst profile includes the DIUC, UIUC, and the type-length-value (TLV) encoded information. The TLV encoded information will notify the PHY layer of the modulation type, FEC code type, and encoding

parameters. The MAC data payload is packed by these encoding type.

The PHY layer requires equal radio link control (RLC), which is the capability of the PHY layer to transit from one burst profile to another. The RLC begins with the periodic BS broadcasting of the burst profiles which have been chosen for the downlink or the uplink connections. After the initial determination of downlink and uplink burst profiles between the BS and a particular SS, RLC continues to monitor and control the burst profiles. The SS can range with the RNGREQ message to request a change in the downlink burst profile. The channel measurements report request (REPREQ) message will be used by a BS to request signal-to-noise ratio (SNR) channel measurements reports. The channel measurement report response (REP-RSP) message is used by the SS to respond the channel measurements listed in the received REP-REQ.

The IEEE 802.16 uses the frame-based transmission architecture where the frame length is variable. Each frame is called a superframe and is divided into two subframes: the DL subframe and the UL subframe. In this paper, we are focusing the frame structure of the OFDMA-PHY in time division duplex (TDD) mode. A DL subframe consists of DL subframe prefix to specify the modulation and coding (in PHY mode), the length of the first DL burst, and the broadcasted MAC control messages, e.g., the downlink channel descriptor (DCD) and the uplink channel descriptor (UCD). Both of them define the characteristics of the physical channels by comprising the detail information of the DL burst profile and the UL burst profile.

Although IEEE 802.16 defines the connection signaling (connection requests and responses) between SS and BS, it does not define the admission control process. All packets from the application layer are classified by the connection classifier based on the CID and are forwarded to the appropriate queue. At the SS, the scheduler will retrieve the packets from the queues and transmit them to the network in the appropriate time slots as defined by the UL-MAP sent by the BS. The UL-MAP is determined by the scheduler module based on the BW-request messages. These messages report the current queue size of each connection in SS.

The IEEE 802.16 NS-2 Modules:

The developed 802.16-based WiMAX module named as the Mac802_16 class is in accordance with the specifications of the IEEE 802.16-2004 standard [1] and based on the ns-2 version 2.29 [11]. All modules are designed by using object oriented programming language C++ and modeled as several classes. The relationship between the WiMAX module and legacy ns-2 modules is based on the original network component stack of the ns-2 as shown in Fig 2. It illustrates the type of objects for the traffic generating agent (TGA), the

link layer (LL), the interface queue (IFQ), the designed MAC layer (WiMAX module), and the PHY layer (Channel).

First, the TGA is considered simply as an application level traffic generator that generates VoIP, MPEG, FTP, HTTP traffic, and so on. These traffic are classified into five different types of service, the UGS, rtPS, ertPS, nrtPS, and BE, each with its own priority. All packets will be transferred to different types of priority queues according to their service types by using CS layer SFID-CID mapping mechanism. The data packets in these queues are treated as MSDUs and will be selected to pass into the WiMAX module in a round robin manner.

While the WiMAX module in the SS receives the MSDUs from the Queue object, the MAC management component will initiate the ranging process to enter the WiMAX system or to transmit the MSDUs according to the scheduled time obtained from UL-MAP. Once the process has been successfully finished in the MAC layer, the Network Interface will add a propagation delay and broadcast in the air interface.

Simulation environment:

Simulation Tool	NS-2
No.Of Nodes	40
IEEE Standard	802.16
BS	1
Mobility Model	Random Way Point
Antenna Model	Omni Directional
Mobility Speed	20m/sec,250m/sec
Routing Protocol	AODV,DSR,DSDV
Simulation Area	2 Km
Simulation Time	200 sec.

III. Results & Analysis

Wimax with low mobility Model:

Parameter	AODV	DSR	DSDV
Delay(in ms)	146.73	413.15	139.44
Throughput(in kbps)	539.41	413.15	659.26
PDR (in %)	96.19	96.16	93.06

Wimax with high mobility Model:

Parameter	AODV	DSR	DSDV
Delay(in ms)	122.14	124.73	114.34
Throughput(in kbps)	666.76	651.69	680.68
PDR (in %)	98.45	99.32	96.34

End to End Delay Analysis: From Below Graphs in Fig1 and 2 it is clear that when node moves very rapidly than the delay is low as compare to the delay when the speed of nodes are slow.

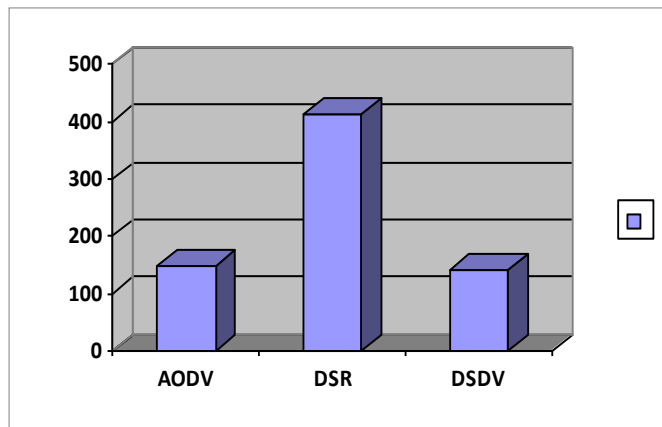


Figure-1

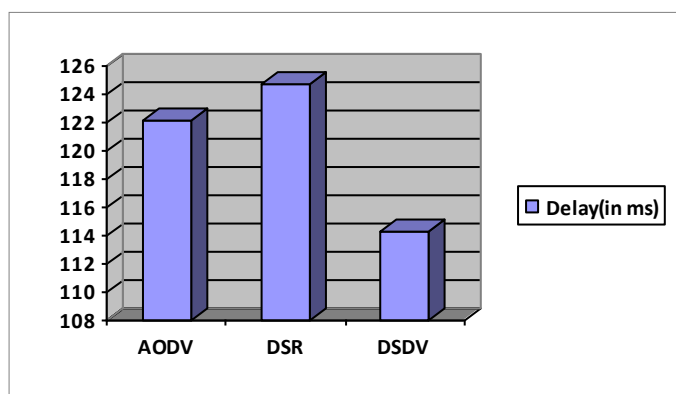


Figure-2

Throughput Analysis: In terms of throughput it is clear from below figure 3 & 4 that the wimax module with high mobility in fig-3 shows better Data transmission known as throughput in kbps. In low speed model throughput is less as compare with high speed model shown in fig-4.

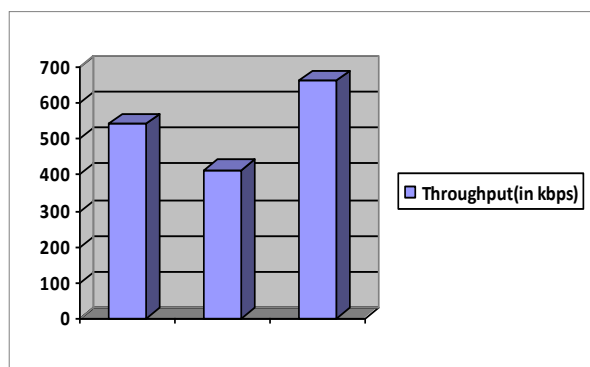


Figure-3

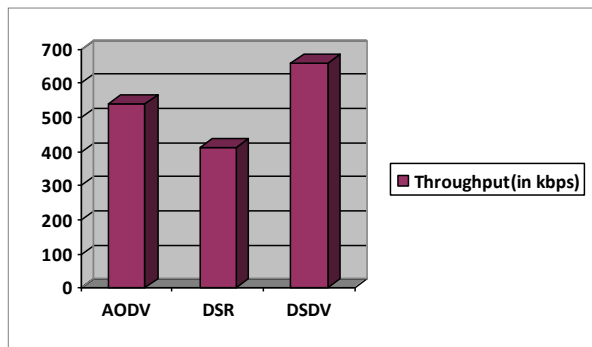


Figure-4

Packet Delivery Ratio Analysis: In terms of packet delivery ratio the wimax module with high mobility in figure 5 shows better performance than that of with low mobility model in figure-6 in our case we have taken low mobility scenario as 25m/sec and high mobility scenario as 250 m/sec

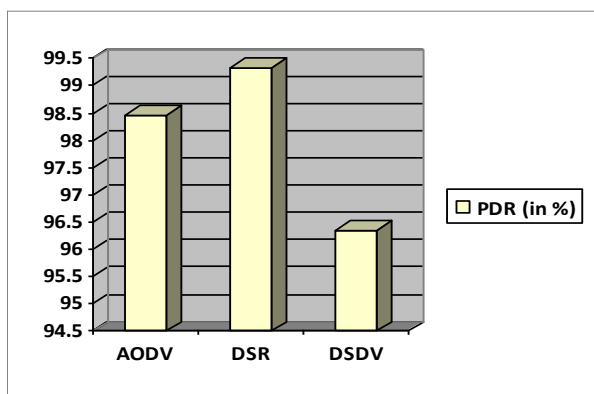


Figure-5

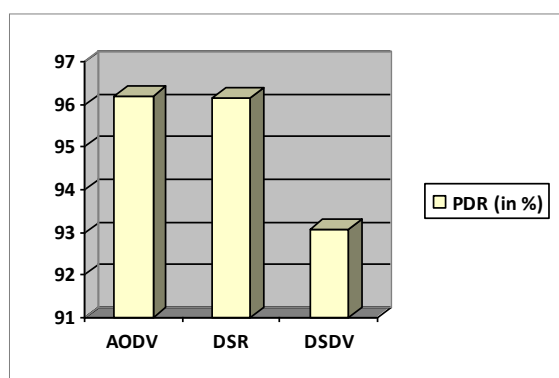


Figure-6

Conclusion: We have implemented Firstly Wimax Module under Ns-2 Simulator and then analyzed its performance under various routing protocols. From above results it is clear that when in a wimax scenario nodes move rapidly than the overall performance of network is good in terms of PDR and Throughput as Compare to the scenario having slow speed of node movement.

References:

- [1] Siva Ram Murthy, C., and Manoj, B.S. Second Edition, Low price Edition, Pearson Education, 2007. Ad-hoc Wireless Networks, Architectures and Protocols.
- [2] Feeney, L.M., and Nilsson, M., "Investigating the energy consumption of a wireless network interface in an Ad-hoc networking environment", In Proceedings of the IEEE INFOCOM, pp.1548 - 1557, 2001.
- [3] Ramanathan, R., and Rosales-Hain, R., "Topology control of multihop wireless networks using transmit power adjustment", In Proceedings of the IEEE INFOCOM, pp. 404-413, 2000.
- [4] Suchismita Chinara and Santanu Kumar Rath, "Topology Control by Transmission Range Adjustment Protocol for Clustered Mobile Ad Hoc Networks", ISRN Communications and Networking, 2011
- [5] Usop, N., Abdullah, A., and Abidin, A., "Performance Evaluation of AODV, DSDV and DSR routing Protocol in Grid Environment", International Journal of Computer and Network Security, vol. 9, no. 7, 2009.
- [6] Rahman, A., and Zukarnain, Z., "Performance Comparison of AODV, DSDV and I-DSDV Routing Protocols in Mobile Ad-hoc Networks", European Journal of Scientific Research, vol. 31, no. 4, pp. 566-576, 2009.
- [7] Harminder S. Bindra, Sunil K. Maakar and Sangal, A.L., "Performance Evaluation of Two Reactive Routing Protocols of MANET using Group Mobility Model", IJCSI International Journal of Computer Science Issues, vol. 7, no. 10, May 2010.
- [8] Anwar, F., Azad, M., Rahman, M., and Uddin, M., "Performance Analysis of Ad-hoc Routing Protocols in Mobile WiMAX Environment", IAENG International Journal of Computer Science, vol. 35, no. 3, pp. 353-359, 2008.
- [9] Vivek Thaper, Bindya Jain, and Varsha Sahni, "Performance analysis of adhoc routing protocols using random waypoint mobility model in wireless sensor networks", International Journal on Computer Science and Engineering (IJCSE), August 2011.
- [10] Sreerama Murty, M., and Venkat Das, M., "Performance Evaluation of MANET Routing Protocols using Reference Point Group Mobility and Random WayPoint Models", International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC) vol.2, no.1, March 2011
- [11] Nadesh, R. K., Sumathy, D., and Benjula Anbu Malar, M.B. "Performance Analysis of MANET (WLAN) Using Different Routing

- Protocols in Multi service Environments-An Quantitative Study”, *Advanced Networking and Applications* vol. 03, no.02, pp:1076-1079 ,2011.
- [12] Boomarani Malany,A.,Sarma Dhulipala, V.R., and Chandrasekaran, RM , “Throughput and Delay Comparison of MANET Routing Protocols” ,*Int. J. Open Problems Compt. Math.*,vol. 2, no. 3, September 2009.
- [13] Rajneesh Kumar Gujral, and Manpreet Singh, “Performance Analysis of Ad hoc Routing Protocols for Voice Communication Support over Hybrid MANETs”, *IJCA* vol. 22,no.3, May 2011.
- [14] Godder,T.K., Hossain,M.M., Rahman,M.M., Sipon Miah,Md and Mondal, S. K., “Performance comparison and analysis of mobile ad hoc routing Protocols” ,*Computer Science & Engineering: An International Journal (CSEIJ)*, vol.1, no.1, April 2011.
- [15] Charles Perkins, Elizabeth Royer, and Samir Das., “Ad-hoc on demand distance vector (AODV) routing”, July 2003.
- [16] David B. Johnson and David A. Maltz, “Dynamic source routing in Ad-hoc wireless networks”, Technical report, Carnegie Mellon University, 1996.
- [17] NETWORK SIMULATOR (ns2). <http://www.isi.edu/nsnam/ns/>.
- [18] Marc Geris' Tutorial for the UCB/LBNL/VINT Network Simulator "ns"