A Study and Proposed Approach for the Improvement of QoS in WiMAX

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Abstract
WiMAX (Worldwide Interoperability for Microwave Access) is an emerging broadband wireless. Technology which provides many of the same fundamental principles as Wi-Fi networks, it also provides a greater signal range more than the 100 feet provided by most usual Wi-Fi modems are used. Instead, WiMAX boasts a 30 mile radius, large enough to cover portions of major cities. In addition, this standard is intended to provide 30 to 40 megabits per second as a transfer rate, with a 2011 update to the standard yielding up to 1 gigabit per second at fixed points. It should be noted, however, that bandwidth on a WiMAX network is not exclusive to users and instead must be split, meaning that while higher speeds may be advertised, the number of users can lower transfer rates in practice. In this paper the focus is to improve the QoS in WiMAX and also a study of WiAMX, its basics, application and about its network architecture.

Keywords
WiMAX, IEEE 802.16, QoS

I. Introduction
WiMAX uses IEEE 802.16 wireless network standards that are interoperable, as compared to the IEEE 802.11 standards used by wireless LANs. The original standard, as mentioned above, was developed in 2001 and borrowed some of its technology from a service known as WiBro, used in South Korea. The IEEE standards for WiMAX in 2004 and 2005 have defined a convergence sub layer, common part sublayers and the security sub layer as part of the MAC layer. The Convergence sub layer maps the transport layer traffic to a MAC according to the type of traffic to be scheduled and handled according to its quality of service requirement like ATM, TDM Voice, Ethernet, IP, and any other. Convergence sub layer is also responsible for MSDU header suppression that reduces upper layer overheads. Common Part Sub layer performs regular MAC layer functions; it uses TDM multiplexing on the Downlink and allows sharing the uplink between SSs in TDMA fashion. Common part sub layer also maps all services, including upper layers connectionless services, to a unique connection identifier (CID). Common part sub layer is the layer to provide, Grant/request mechanism, associates QoS parameters, and routing data to the correct convergence sub layer and provides downlink scheduling services. The MAC security sub layer is responsible for access authentication, connection setup and providing key exchange during the network entry procedure and encryption for data privacy.

WiMAX is an IP based, wireless broadband access technology that provides performance similar to 802.11/Wi-Fi networks with the coverage and QOS (Quality of Service) of cellular networks. WiMAX is also an acronym meaning “Worldwide Interoperability for Microwave Access (WiMAX). It is defined as: “WiMAX is defined as a telecommunications technology that provides wireless transmission of data using a variety of transmission modes, from point-to-multipoint links to portable and fully mobile internet access. WiMAX ormed in june 2001 to promote conformity and interoperability of the standard” WiMAX is a wireless digital communications system, also known as IEEE 802.16 that is intended for wireless “metropolitan area networks”. WiMAX can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed stations, and 3 - 10 miles (5 - 15 km) for mobile stations. In contrast, the WiFi/802.11 wireless local area network standard is limited in most cases to only 100 - 300 feet (30 - 100m). With WiMAX, WiFi-like data rates are easily supported, but the issue of interference is lessened. WiMAX operates on both licensed and non-licensed frequencies, providing a regulated environment and viable economic model for wireless carriers. At its heart, however, WiMAX is a standards initiative. Its purpose is to ensure that the broadband wireless radios manufactured for customer use interoperate from vendor to vendor. The primary advantages of the WiMAX standard are to enable the adoption of advanced radio features in a uniform fashion and reduce costs for all of the radios made by companies, who are part of the WiMAX Forum - a standards body formed to ensure interoperability via testing. The more recent Long Term Evolution (LTE) standard is a similar term describing a parallel technology to WiMAX that is being developed by vendors and carriers as a counterpoint to WiMAX.

The Mobile Wi-Max quality of service (QoS) depends heavily on the 802.16e physical (PHY) and medium access control layers (MAC), as these layers deal with the base-station (BS) and mobile station (MS) access. It is designed to support and manage different kinds of traffic and applications through five defined service classes: Unsolicited Grant Service (UGS); Extended Real Time Polling Service (ertPS); Real Time Polling Service (rtPS); Non Real Time Polling Service (nrtPS) and Best Effort (BE). The MAC Packet Data Unit (MPDU) is the data unit used to transfer data between MAC layers of BS and SS. The standard defines two types of MAC header namely Generic MAC (GM) header and Bandwidth Request (BR) header. The generic header is used to transfer data or MAC messages while BR header is used to send bandwidth requests packets to BS. SSs send their bandwidth request in either bandwidth contention period or in allotted unicast uplink slots or piggybacked with data packets. The standard also defines a number of MAC management messages, which has to be transmitted between the SS and BS before actual data transfer take place.

A. IEEE 802.16 QoS
IEEE 802.16 is a series of Wireless Broadband standards authored by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE Standards Board established a working group in 1999 to develop standards for broadband for Wireless Metropolitan Area Networks. The Workgroup is a unit of the IEEE 802 local area network and metropolitan area network standards committee. Although the 802.16 family of standards is officially called Wireless MAN in IEEE, it has been commercialized under the name “WiMAX” (from “Worldwide Interoperability for Microwave Access”) by the WiMAX Forum industry alliance. The Forum promotes and certifies compatibility and interoperability of products based on the IEEE 802.16 standards. The 802.16e-2005 amendment version was announced as being deployed around the
world in 2009.[1] The version IEEE 802.16-2009 was amended by IEEE 802.16e-2009

B. 802.16E-2005 Technology
The 802.16 standard essentially standardizes two aspects of the air interface - the physical layer (PHY) and the Media Access controller (MAC). This section provides an overview of the technology employed in these two layers in the mobile 802.16e specification.

1. PHY
802.16e uses Scalable OFDMA to carry data, supporting channel bandwidths of between 1.25 MHz and 20 MHz, with up to 2048 sub-carriers. It supports adaptive modulation and coding, so that in conditions of good signal, a highly efficient 64 QAM coding scheme is used, whereas when the signal is poorer, a more robust BPSK coding mechanism is used. In intermediate conditions, 16 QAM and QPSK can also be employed. Other PHY features include support for Multiple-in Multiple-out (MIMO) antennas in order to provide good non-line-of-sight (NLOS) characteristics or a hybrid automatic repeat request (HARQ) for good error correction performance. Although the standards allow operation in any band from 2 to 66 GHz, mobile operation is best in the lower bands which are also the most crowded, and therefore most expensive.[3]

2. MAC
The 802.16 MAC describes a number of Convergence Sub layers which describe how wire line technologies such as Ethernet, Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) are encapsulated on the air interface, and how data is classified, etc. It also describes how secure communications are delivered, by using secure key exchange during authentication, and encryption using Advanced Encryption Standard (AES) or Data Encryption Standard (DES) during data transfer. Further features of the MAC layer include power saving mechanisms (using Sleep Mode and Idle Mode) and handover mechanisms. A key feature of 802.16 is that it is a connection oriented technology. The subscriber station (SS) cannot transmit data until it has been allocated a channel by the Base Station (BS). This allows 802.16e to provide strong support for Quality of Service (QoS).

C. WiMAX QoS Basics
In an ideal world it would be possible to send data over a network and gain the same performance as that achieved by a circuit switched network. However the nature of packet data means that the same channels are used for data travelling to and from a variety of different sources and end points. Within a packet data network, there are three main parameters that are key to the performance of the network, and the WiMAX QoS. These three parameters are:

1. Jitter
In the context of computer networks and in the case of the WiMAX system, jitter is a measure of the variability over time of the packet latency across a network. A network with constant latency has no variation and hence no jitter. However as the levels of data are constantly varying, it takes a variable amount of time for a packet to arrive at its destination. Packet jitter is expressed as an average of the deviation from the network mean latency. Although the term jitter is often used, it is actually imprecise and a standards-based term, packet delay variation, PDV, is more correctly used. PDV is an important quality of service factor in assessment of network performance.

2. Throughput
Throughput is the amount of number of packets effectively transferred in a network, in other words throughput is data transfer rate that are delivered to all terminals in a network. It is measured in terms of packets per second or per time slot.

3. Average Delay
Delay or latency represents the time taken by a bit of data to travel from source to destination across the network. The main sources of delay can be categorized into: propagation delay, source processing delay, Queuing delay, transmission delay and destination processing delay. Here we have calculated end to end delay which is a measure of elapsed time taken during modulation of the signal and the time taken by the packets to reach from source to destination.

4. Jitter or Delay Variation
Jitter can be observed as the end-to-end delay variation between two consecutive packets. The value of jitter is calculated from the end to end delay. Jitter reveals the variations in latency in the network caused by congestion, route changes, queuing, etc. It determines the performance of network and indicates how much consistency and stable the network is.

5. Packet Loss
Packet loss is the term used to indicate the loss of data packets during transmission over a network. Packet loss may occur for a variety of reasons but normally occurs as a result of high network latency or overloading of switches or routers that are unable to process or route all the incoming data.

D. WiMAX Network Architecture’s Major Element
The WiMAX architecture developed by the WiMAX forum supports a unified network architecture to support fixed, nomadic and mobile operation. The WiMAX network architecture is based upon an all-IP model. The WiMAX network architecture comprises three major elements or areas.

1. Remote or Mobile Stations
These are the user equipments that may be mobile or fixed and may be located in the premises of the user.

(i). Access Service Network (ASN)
This is the area of the WiMAX network that forms the radio access network at the edge and it comprises one or more base stations and one or more ASN gateways.

(ii). Connectivity Service Network (CSN)
This part of the WiMAX network provides the IP connectivity and all the IP core network functions. It is what may be termed the core network in cellular parlance.

E. WiMAX Network Architecture
The overall WiMAX network comprises a number of different entities that make up the different major areas described above. These include the following entities

1. Subscriber Station (SS) / Mobile Station (MS)
The Subscriber station, SS may often be referred to as the Customer
Premises Equipment, CPE. These take a variety of forms and these may be termed “indoor CPE” or “outdoor CPE” the terminology is self-explanatory. The outdoor CPE has the advantage that it provides better performance as a result of the better position of the antenna, whereas the indoor CPE can be installed by the user. Mobile Stations may also be used. These are often in the form of a dongle for a laptop, etc.

Fig. 1: WIMAX Architecture

2. Base Station (BS)
The base-station forms an essential element of the WiMAX network. It is responsible for providing the air interface to the subscriber and mobile stations. It provides additional functionality in terms of micro-mobility management functions, such as handoff triggering and tunnel establishment, radio resource management, QoS policy enforcement, traffic classification, DHCP (Dynamic Host Control Protocol) proxy, key management, session management, and multicast group management.

3. ASN Gateway (ASN GW)
The ASN gateway within the WiMAX network architecture typically acts as a layer 2 traffic aggregation point within the overall ASN. The ASN-GW may also provide additional functions that include: intra-ASN location management and paging, radio resource management and admission control, caching of subscriber profiles and encryption keys. The ASN-GW may also include the AAA client functionality (see below), establishment and management of mobility tunnel with base stations, QoS and policy enforcement, foreign agent functionality for mobile IP, and routing to the selected CSN.

4. Authentication, Authorization and Accounting Server (AAA)
As with any communications or wireless system requiring subscription services, an authentication, authorization and accounting server is used.

5. Home Agent (HA)
The Home Agent within the WiMAX network is located within the CSN. With Mobile-IP forming a key element within WiMAX technology, the Home Agent works in conjunction with a “Foreign Agent”, such as the ASN Gateway, to provide an efficient end-to-end Mobile IP solution. The Home Agent serves as an anchor point for subscribers, providing secure roaming with QOS capabilities.

F. WIMAX Applications
WiMAX network provides the ability for service provider to deploy new era broadband service. WiMAX applications are most effective than today. It provides a broad customer base, while adding up a mobility feature to those services. WiMAX technology applications are a mean of service providers to present data, video, voice, mobile and internet access. There are various benefits of WiMAX technology such as it provides simple based prospective cost saving and service efficiency but to be capable to allow VoIP calling, mobile devices, video making and high speed data transfer in

G. Proposed Work
In proposed work the quality features of all parameters has been implemented through OPNET simulation and producing good results, these parameters are discussed in WiMAX QoS basics, just like priority queue algorithm produces less delay than FIFO (First In First Out) algorithm so we will consider priority queue algorithm and in another case an algorithm namely round robin gives time to every packet which is ready for transmission but in this case important packet can have loss, now as compared to round robin algorithm WRR (Weighted Round Robin) is better than round robin because this approach assign weight to important packets and these packets will be delivered on priority basis.

III. Simulation Results
As networking systems have become more complex and expensive, hands-on experiments based on networking simulation have become essential for research and teaching the key computer networking to students. The simulation approach is the most cost effective and highly useful because it provides a virtual environment for an assortment of desirable features such as modeling a network based on specific criteria and analyzing its performance under different scenarios with less cost. In this thesis, we present our approach which is developing on OPNET simulation. The simulated results of this proposed approach is shown in following figures, these figures are showing different results like WiMAX connection delay, voice packet delay variation, packets end-to-end delay for the three different traffic distributions, shows traffic sent and received by the three distributions considered in the simulation, throughput, voice jitter, WiMAX throughput, voice packet received, voice packet delay variation, WiMAX load, voice traffic sent, WiMAX delay, voice packet delay.

Fig. 1: Voice Jitter
Fig. 2: WIMAX Throughput

Fig. 3: Voice Packet Delay Variation

Fig. 4: Voice Packet End to End Delay

Fig. 5: Voice Traffic Received

Fig. 6: WIMAX Load

Fig. 7: Voice Traffic Sent
IV. Conclusions and Future Scope

Due to fast development of technology, future communication and transmission are totally dependent upon wireless network and quality of service (QoS) provision is a bigger challenge for wireless communications. In this paper we conducted a broad study of WiMAX. We started by describing the introduction of WiMAX then IEEE 802.16 QoS, 802.16E-2005 TECHNOLOGY, WiMAX QoS BASICS, WiMAX NETWORK architecture’s major element and in last WIMAX network architecture. The study of WiMAX QoS basics (jitter, throughput, average delay, jitter or delay variation and packet loss) help to improve the quality in services in these major fields, few results of this study has been shown in this paper. In future we can continue this work and can take a better quality results with these parameters jitter, throughput and delay.
References


