A Performance comparison for QoS with different WiMAX environment for video application

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ABSTRACT
Future generation networks will be characterized by variable and high data rates, quality of services, seamless mobility both within a network and between networks of different technologies and service providers. An important aspect of components in a global next generation network is standardization to allow vendor independence and interoperability. A technology developed to fulfill these characteristics, standardized by IEEE, is 802.16, also referred to as WiMAX. This architecture aims to apply high data rates, quality of services, long range and low deployment costs to a wireless access technology on a metropolitan scale. This paper focuses on WiMAX since this wireless technology allows broadband communications. In particular, we provide here a preliminary study on MAC layer performance as well as a sensitivity study to its parameters. In this paper I have implemented the performance comparison with different WiMAX environment for video application under UGS (Voice over IP (VoIP) without silence suppression) with respect to Throughput, Load and Delay. A simulation approach has been adopted, based on a simulation tool known as OPNET Modeler 14.5.

Categories and Subject Descriptors
C.2.1 [Network Architecture and Design] : Wireless communication

General Terms
Measurement, , Design, Experimentation, verification

Keywords
WiMAX, Physical Layer, MAC Layer, OPNET Modeler, Video

1. INTRODUCTION TO WiMAX
WiMAX is an acronym for Worldwide Interoperability of Microwave Access. WiMAX is described in IEEE 802.16 Wireless Metropolitan Area Network (MAN) [1] standard. It is expected that WiMAX compliant systems will provide fixed wireless alternative to conventional DSL and Cable Internet. Typically, a WiMAX system consists of two parts:

- A WiMAX Base Station: Base station consists of indoor electronics and a WiMAX tower. Typically, a base station can cover up to 10 km radius (Theoretically, a base station can cover up to 50 kilometer radius or 30 miles, however practical considerations limit it to about 10 km or 6 miles). Any wireless node within the coverage area would be able to access the Internet.

- A WiMAX receiver - The receiver and antenna could be a stand-alone box or a PCMCIA card [2] that sits in your laptop or computer. Access to WiMAX base station is similar to accessing a Wireless Access Point in a Wi-Fi network, but the coverage is more.

Several base stations can be connected with one another by use of high-speed backhaul microwave links. This would allow for roaming by a WiMAX subscriber from one base station to another base station area, similar to roaming enabled by Cellular phone companies.

Important Wireless MAN IEEE 802.16 (WiMAX) Specifications:
- Range - 30-mile (50-km) radius from base station
- Speed - Up to 70 megabits per second
- Non-Line-of-sight (NLOS) between user and base station
- Frequency bands - 2 to 11 GHz and 10 to 66 GHz (licensed and unlicensed bands)
- Defines both the MAC and PHY layers and allows multiple PHY-layer specifications.

The simulation of WiMAX MAC Layer in this report is done on a networking tool known as OPNET (Optimized Network Engineering Tool) Modeler 14.5v [4]. OPNET Modeler provides a comprehensive development environment supporting the
modeling of communication networks and distributed systems. Both behavior and performance of modeled systems can be analyzed by performing discrete event simulations. The OPNET Modeler environment incorporates tools for all phases of a study, including model design, simulation, data collection, and data analysis.

2. WiMAX MAC LAYER
In a network, the purpose of the PHY layer is to reliably deliver information bits from the transmitter to the receiver, using the physical medium, such as radio frequency, light waves, or copper wires. Usually, the PHY layer is not informed of quality of service (QoS) requirements and is not aware of the nature of the application, such as VoIP, HTTP, or FTP.

The PHY layer can be viewed as a pipe responsible for information exchange over a single link between a transmitter and a receiver. The Media Access Control (MAC) layer, which resides above the PHY layer, is responsible for controlling and multiplexing various such links over the same physical medium.

Some of the important functions of the MAC layer in WiMAX are

- Segment or concatenate the service data units (SDUs) received from higher layers into the MAC PDU (protocol data units), the basic building block of MAC-layer payload.
- Select the appropriate burst profile and power level to be used for the transmission of MAC PDUs.
- Retransmission of MAC PDUs that were received erroneously by the receiver when automated repeat request (ARQ) is used.
- Provide QoS control and priority handling of MAC PDUs belonging to different data and signaling bearers.
- Schedule MAC PDUs over the PHY resources
- Provide support to the higher layers for mobility management.
- Provide security and key management.
- Provide power-saving mode and idle-mode operation.

The primary task of the WiMAX MAC layer is to provide an interface between the higher transport layers and the physical layer. The MAC layer takes packets from the upper layer these packets are called MAC service data units (MSDUs) and organizes them into MAC protocol data units (MPDUs) for transmission over the air. For received transmissions, the MAC layer does the reverse. The IEEE 802.16-2004 and IEEE 802.16e-2005 MAC design includes a convergence sub layer that can interface with a variety of higher-layer protocols, such as ATM, TDM Voice, Ethernet, IP, and any unknown future protocol.

2.1 WiMAX MAC Layer
The MAC layer of WiMAX, as shown in Figure 5-1, is divided into three distinct components: the service – specific convergence sub layer (CS), the common - part sub layer, and the security sub layer.

3. IMPLEMENTATION
In this report the implementation of WiMAX MAC layer supported by Quality of Service (QoS) is done. Support for QoS is a fundamental part of the WiMAX MAC-layer design. To support a wide variety of applications, WiMAX defines five scheduling services that should be supported by the base station MAC scheduler for data transport over a connection is given in Table: 1

<table>
<thead>
<tr>
<th>Service-Flow Designation</th>
<th>Defining QoS Parameters</th>
<th>Application Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsolicited-Grant Service</td>
<td>Maximum sustained rate</td>
<td>Voice over IP (VoIP) without silence</td>
</tr>
<tr>
<td>(UGS)</td>
<td>Maximum latency</td>
<td>suppression</td>
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<td></td>
<td>tolerance</td>
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<td></td>
<td>Jitter tolerance</td>
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<tr>
<td>Real-time Polling service</td>
<td>Minimum reserved rate</td>
<td>Streaming audio and video, MPEG</td>
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<td>(rtPS)</td>
<td>Maximum sustained rate</td>
<td>encoded</td>
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<td></td>
<td>Maximum-latency</td>
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<td>Traffic priority</td>
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<td>Non-real-time Polling</td>
<td>Minimum reserved rate</td>
<td>Streaming audio and video, MPEG</td>
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<td>service</td>
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<td>(nrtPS)</td>
<td>Traffic priority</td>
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<td>Non-real-time Polling</td>
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<td>File Transfer</td>
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<td>service</td>
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Before any data transmission happens, the BS and the MS establish a unidirectional logical link, called a connection, between the two MAC-layer peers. Each connection is identified by a connection identifier (CID), which serves as a temporary address for data transmissions over the particular link. In addition to connections for transferring user data, the WiMAX MAC defines three management connections—the basic, primary, and secondary connections—that are used for such functions as ranging.

WiMAX also defines a concept of a service flow. A service flow is a unidirectional flow of packets with a particular set of QoS parameters and is identified by a service flow identifier (SFID).

Parameter Involved in all scenario are given below. Parameter associated with WiMAX configuration is given in Figure: 2

Parameter associated with WiMAX base station is given in Figure: 3

Parameter associated with WiMAX configurations with efficiency mode is given in Figure: 4.
In this research, we have divided our work into three different scenarios with the help of OPNET Modeler.

**Scenario 1:** Here our network is encloses with WiMAX BS, Two Stations, and WiMAX Configuration with Application and Profile Communication. This scenario has been given in Figure 9.

**Scenario 2:** Here our network is encloses with WiMAX BS, Six Stations, and WiMAX Configuration with Application and Profile Communication. This scenario has been given in Figure 10.

**Scenario 3:** Here our network is encloses with WiMAX BS, Eight Stations, and WiMAX Configuration with Application and Profile Communication. This scenario has been given in Figure 11.

### 3.1 Performance Analysis of Delay and Throughput

Here an empty scenario is created with a network scale of campus having an area of 10 X 10 Kms as shown in figure 2.
The application configuration is configured to a video application for real time Polling Service (rtPS) of QoS. Also the WiMAX parameters are set according to the requirement.

In the first scenario we have taken two fixed nodes (WiMAX – SS). Now here we have made a second scenario by keeping all the application configuration, profile configuration and WiMAX configuration node parameters same and only changing the number of fixed nodes to six as shown in figure 3.

Similarly, third scenario is made by increasing the number of nodes to eight as shown in figure 4.

Here all the three scenarios are made with the same application but having different WiMAX fixed nodes. Now all the three scenarios are need to compare to analyze the delay and throughput performance, the results are shown in next section.

4. RESULTS
As discussed in the previous section the three scenarios are made having same application of video transfer but with different fixed nodes (SS nodes), have the throughput waveform as shown in Figure: 11. And the delay waveform as shown in Figure: 12. If the number of nodes in the network increases the throughput of the network becomes high and the delay of the network will reduces in proportionally and it is vice versa for the less number of nodes.
5. CONCLUSIONS

From the above analysis we can conclude that if the number of nodes in the network increases the throughput of the network becomes high and the delay of the network will reduces in proportionally and it is vice versa for the less number of nodes. It means that delay and throughput are reciprocal of each other in WiMAX also with WiMAX services. It also shows that WiMAX is really good replacement for existing networks. In this research I was taken fixed node because this research is totally dedicated to our rural area and we know that our 60 to 70% population still lived in rural area and with this research we can offered good QoS to that peoples.

We also observed and consider some works during this project they are given below:

This paper provides a preliminary MAC study for a WiMAX scenario. The following conclusions are made:

- WiMAX supports a number of advanced signal-processing techniques to improve overall system capacity. These techniques include adaptive modulation and coding, spatial multiplexing, and multiuser diversity.
- WiMAX has a very flexible MAC layer that can accommodate a variety of traffic types, including voice, video, and multimedia, and provide strong QoS.
- Robust security functions, such as strong encryption and mutual authentication, are built into the WiMAX standard.
- WiMAX defines a flexible all-IP-based network architecture that allows for the exploitation of all the benefits of IP.
- WiMAX offers very high spectral efficiency, particularly when using higher-order MIMO solutions.

6. FUTURE WORK

In the near future, the service providers' motivation is even more important than that of consumers since there is no application yet ready that consumes 10Mbps. The WiMAX service provider wants to increase monthly revenue and improve profitability because the voice revenue is declining. As a result, service providers want to offer advanced services. Since these services are heavy bandwidth consumers, they are uneconomical to deliver using current 3G technology. This is where WiMAX offers something that does not exist today – low cost/bit, high spectral efficiency which ultimately translates into solid and profitable business models. Recessions, such as the one we are witnessing, are not a supportive environment for new and emerging technologies to root, so is not going to be easy for WiMAX carriers and ecosystem vendors. The flip side of this is, however, that WiMAX has crossed a critical-mass maturity line while LTE is still behind, and is therefore in a position to entrench itself yet deeper before the pink color is back to investors’ cheeks and LTE could attempt to catch up. Besides, WiMAX has gained significant traction in geographies like Africa, the Middle East, and Southeast Asia, which are much less affected by the crisis than American, European, or Japanese markets, so the exposure for WiMAX in this environment is smaller. But WiMAX is good option for our country with technology because WiMAX have low latency then LTE and scenario is fitted also.

7. REFERENCES


