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Abstract:-

Currently using wireless networks is at a point of high demand due to its flexibility and low costs in implementing them. From the construction of the IEEE 802.16 (WiMAX) standard and the current needs in health, education and other fields, for accessing information and in general for establishing reliable communications it enables industry and research institutes to strengthen the implementation of these technologies.

To meet these needs it is important to provide a service that meets the requested requirements in, along this line of thought it is important to analyze the performance of these technologies through performance evaluation including parameters for quality of service (QoS) based on the IEEE 802.16 standard.

EVALUATION OF THE SERVICE QUALITY IN WIRELESS NETWORKS BASED ON WIMAX TECHNOLOGY

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The paper aims to present to the scientific community the features and benefits that come with the IEEE 802.16 standard.

Specifically, the research focused on analyzing variables as the traffic received, delays, and the performance provided by the network for different types of scheduler supported by the IEEE 802.16 by using the OPNET software, finding that levels of throughput may be decreased when mobility is present in receiving equipment.

Keywords:

WiMAX, QoS, wireless networks, broadband, service types, Scheduler.

INTRODUCTION

Wireless networks are at their peak; with the implementation of Wi-Fi Internet access is becoming easier, reaching speeds of 11, 54 and 300 Mbps and coverage of up to 100 meters. However, the implementation of the IEEE 802.16 (WiMAX) standard, achieves a speed of 1Gbps while idle and 100Mbps while moving, and has coverage of up to 40km while in line of sight with the antenna, operating in the band from 2.5-11 GHz [1].

Imax is a robust broadband protocol, that has different types of reservation or Qi's and modulation, important in the transmission of real-time services such as voice over IP, video, telephony, among others, and the transmission of burst traffic such as video conferencing or web traffic at high speed.

This article describes the operation of the IEEE 802.16 standard in transmission applications sensitive to delay. The paper is divided as follows:

In the second part it shows the development of the standard and the 802.16 standard over time, subsequently we review the different service classes and applications, important to understand the service quality of the WiMAX technology, section four shows the simulations performed to analyze them based on the results found. Section 6 presents the conclusions and finally the references.

2. EVOLUTION OF THE IEEE 802.16. STANDARD

Initially, the developers of broadband technologies designed and worked separately, which caused hardware and software incompatibilities, high prices and low acceptance.

In July 1999, the IEEE formed a committee consisting of research centers that were given the task of creating a working group that was given the name of 802.16 in order to develop standards and recommend practices to support the development and optimization of fixed wireless broad band systems [2].

The final standard was approved in April 2002 and was known as WiMAX (Worldwide Interoperability for Microwave Access).

In March 2003 was ratified the new version, the 802.16a [3] which made wireless broadband technology important and relevant, and established the operation in the range of 2-11 GHz.

By December 2005, the IEEE approved the 802.16e Mobile standard WiMAX, which allows using the communication system with moving terminals, which started its boom in research and production.

From 2007 until now the technology has been slowly introduced into the daily life penetrating in industrialized countries and is planning major changes in lifestyle.

The WiMAX Forum makes a prediction of the penetration of WiMAX worldwide as seen in figure 1. This graph shows the importance that WiMAX will have in the near future, growing exponentially especially in the areas of the world where it has already been implemented and to a lesser extent but still high in developing areas.

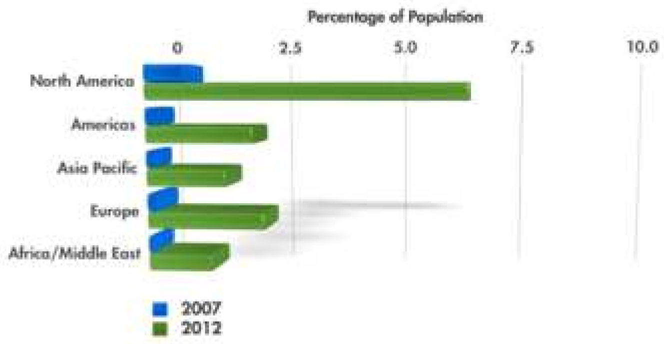

Figure 1: Percentage of population with access to WiMAX [4].

In 2011 the 802.16m [5] standard is adopted, known as WiMAX 2 [6], which reaches speeds up to 360 Mbps, competing with its rival LTE (Long Term Evolution) [16].

By the year 2012 is expected to certify the hardware that will implement the WiMAX 2 so that suppliers can provide this sustainable broadband connectivity able to cover a 50 km radius, consistent with the demand for mobile connections.

3.THEORETICAL FRAMEWORK

WiMAX (Worldwide Interoperability for Microwave access) is defined as a technology, a data transmission standard that uses radio waves (Figure 2). It is characterized because it can cover distances up to 48 km and speeds of up to 75Mbps. With line of sight (LOS) it can reach 10Mbps in 10KM and without line of sight (NLOS) it can reach 10Mbps in 2km [8].

In the WiMAX technology there are several ways of reserve or class of service (CoS), these provide QoS values including Throughput, latency, delay, etc. Distinguishing features of flows from what is called scheduler service types:

In the 802.16 5 standard 5 kinds of QoS can be differentiated:

- ❖ Unsolicited Grant Service (UGS): A service guaranteed without request, is the highest quality of service, it is used for real-time services that generate fixed size periodic packets, it is fast and there is no prior negotiation [8].
- ❖ Real Time Polling Service (rtPS): real-time service by vote is a real-time service that generates variable length packets, the terminals with this traffic, make a requests indicating the data volume, it is the second in efficiency [8].
- ❖ Extended Real Time Polling Service (ertPS): Real-time Service extended by polling, it is included in the 802.16e standard, it supports packets of variable size, is a sort of hybrid between UGS and rtPS [8].
- ❖ Non Real Time Polling Service (nrtPS): polling service for applications in non-real time, is a service that generates variable packages with a minimum amount of data to transmit, are applications with non-real-time, it has a maximum amount of time between requests [8].
- ❖ Best Effort Service (BE): best effort, the terminals send requests and wait until the base stations enable them to transmit, use the remaining resources [8].

WiMAX uses multiplexing orthogonal frequency division (OFDM) modulation schemes with QPSK and 64-QAM. When a robust scheme such as QPSK, WiMAX can be used to provide high throughput with long range, while the low-order modulation (16QAM) offers a lower throughput than the highest range of the same base station [9].

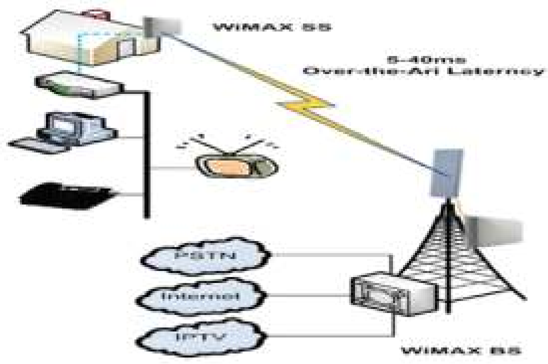

Figure 2: services supported by Wimax [11]

4. TOPOLOGIES AND SIMULATIONS.

In the simulation process is to evaluate the performance Scheduler for 3 types of service in terms of throughput and delay over topologies raised. For the simulation will differentiate traffic: interactive voice, video streaming and best effort. This type of traffic was chosen because each has different characteristics, and may be granted special treatment depending on the service being used. The research was focused on the projection of two scenarios in which One involved fixed mobile hosts, while the other, moving mobile equipment.

4.1. First proposed topology. In the first proposed scenario (figure 3) there are 5 fixed transmitting users (wireless) and 5 receiver (wired computers), such equipment is connected to the base station by Ethernet (1000 BaseX) interface duplex which is supported a transmission capacity to 1Gbit / s but the near intrinsic delay 100 ms the transmission medium is incorporated; The characteristics of traffic sent via the base station is observed in table 1. When transmitting users are sending data simultaneously they saturate the communication channel because the existing bandwidth is less than that required by the multiple generating data applications and data loss occurs, however, the aim of this paper is to give a greater priority to the transmitter of voice traffic (interactive voice) and to evaluate the IEEE 802.16 standard. It should be noted that the analysis will focus on transmitters 3, 4 and 5. The transmitter 1 and 2 were created with the intent to overload the environment and make transmission conditions more critical.

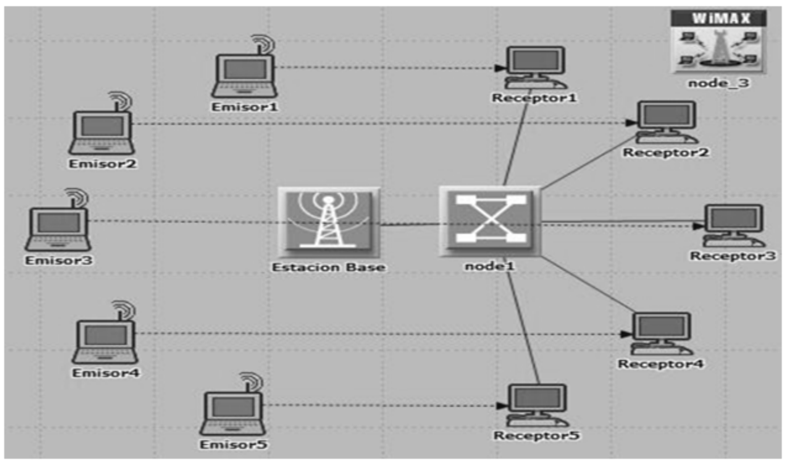

Figure 3: First scenario raised.

Table1. Traffic generated on scenario

Origin - Destination	Traffic Type	Transmission Rate
Transmitter 1 - Receiver 1	Silver (streaming video)	300 Mbps
Transmitter 1 - Receiver 1	Silver (streaming video)	500 Mbps
Transmitter 1 - Receiver 1	Bronze (Email)	300 Mbps
Transmitter 2 - Receiver 2	Gold (Interactive voice)	500 Mbps
Transmitter 2 - Receiver 2	Silver (streaming video)	150 Mbps
Transmitter 2 - Receiver 2	Bronze (Email)	200 Mbps
Transmitter 3 - Receiver 3	Gold (Interactive voice)	300 Mbps
Transmitter 4 - Receiver 4	Silver (streaming video)	300 Mbps
Transmitter 5 - Receiver 5	Bronze (Email)	300 Mbps

The simulation is generated over a period of one hour, in the first instant transmits the Transmitter 5, after 700 sec transmits the Transmitter 5, at time 1500 sec starts generating traffic the transmitter 3, at time 2200 sec the Transmitter 2 transmits, and finally at 3000 sec the Transmitter 1 sends data (this can be reflected in Figure 4).

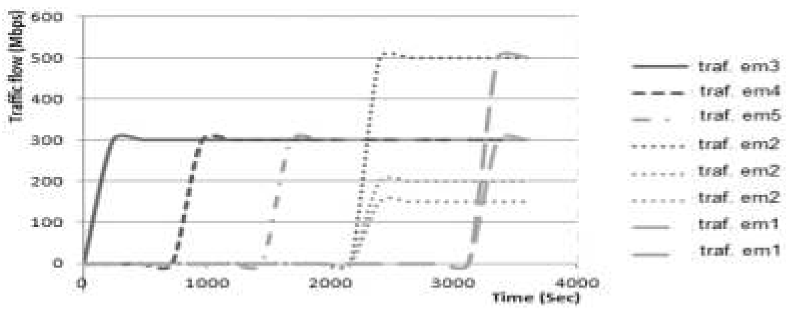

Figure4: Traffic sent by the transmitting equipment (scenario 1).

For the second scenario we used the same topology proposed above, however mobile nodes are added, which are indicated in figure 5 with a particular trajectory; these generate traffic associated with video streaming "RTPs" and email traffic associated with "best effort". In this case the effect of the mobility of the nodes on the traffic sent and received will be analyzed.

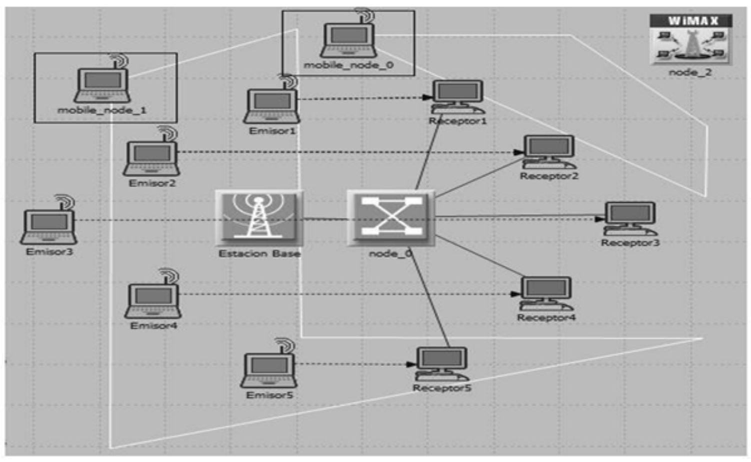

Figure 5: Second scenario raised.

In figure 6, the flows sent by the emitters in order to analyze the network throughput variables and estimate the QoS delay observed. The mobile transmitter that transmits the video streaming starts to 700 sec, while the emitter type best effort traffic to 1500 sec.

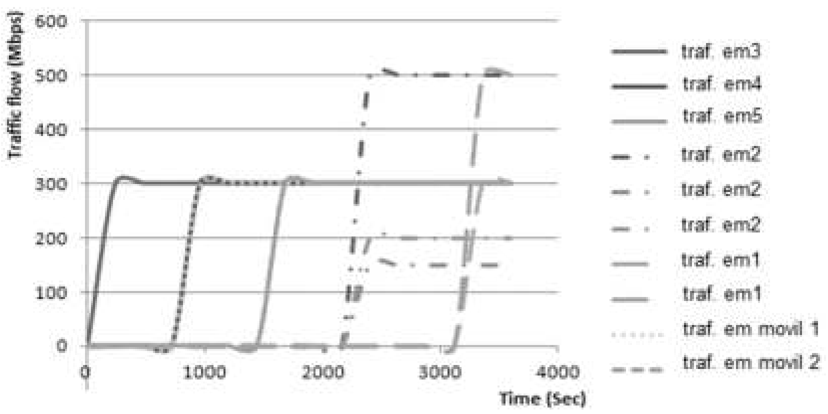

Figure 6: Traffic generated by transmitters for scenario 2.

The most relevant physical conditions such as antenna transmission power, modulation type, etc. work area, are summarized in table 2.

Table 2: Physical conditions of transmission

Workspace	15 km
Antenna gain	-1 dBi
Modulation type	16 QAM
Access Technology	OFDMA
Speed of the mobile nodes	1 km/ s
Central frequency	5Ghz
Bandwidth	20 MHz.

However, as we will work with 3 types of traffic, it will be convenient to associate them with 3 types of Scheduler for assigning QoS in this case they will be UGS, nrtPS and BE (Best effort). In the simulation UGS must be associated with a Gold service, rtPS with a Silver Service and BE with a Bronze service.

Service characteristics are shown in table 3:

Table. 3 Configuration of the Scheduler

Service	Maximum sustained capacity	Minimum sustained capacity	Maximum delay
Gold (Interactive voice)	10 Mbps	5 Mbps	30ms
Silver (streaming video)	1 Mbps	0.5 Mbps	50ms
Bronze (best effort)	378 Kbps	378 Kbps	50ms

5.RESULTS ANALYSIS

In Figure 7 the behavior of scenario 1 was evident in terms of traffic received by the receivers 3,4 and 5.

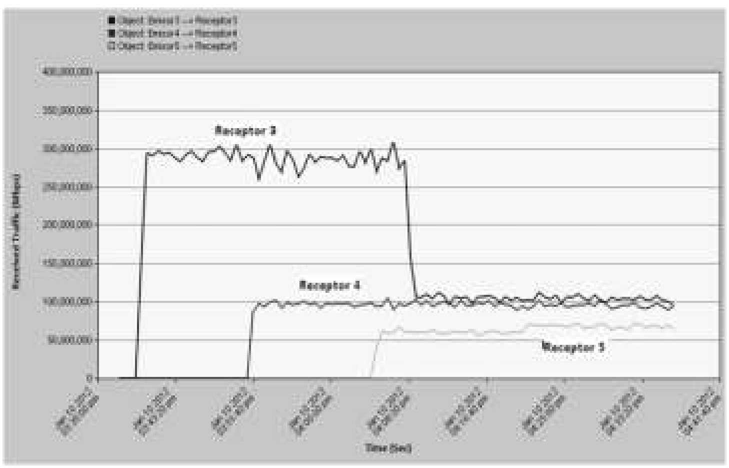

Figure 7: Traffic received in scenario 1.

As clarified above at time 0.0 the transmitter 3 (UGS service) sends information at a rate of 300 Mbps and the channel has no saturation so that information is completely sent, then the emitter 4 (rtPS service) sends traffic to the same rate, however saturation and thus presented in the respective base station packet classification depending on the type of priority is made. The emitter 3 has a higher priority so that lower-priority packets are discarded in this case the emitter 4 with a single throughput of about 100 Mbps. Then the emitter 5 (BE service) sends data at a rate of 300 Mbps but as the channel is saturated and a smaller amount of the previous traffic packets are processed by having the lowest priority reaching close to 60 Mbps throughput . Finally when the six sources (including the transmitter 1 and 2) intentionally created to produce congestion in the media, sent simultaneously, a decrease in the throughput of the transmitter 3 is observed. In the emitters 4 and 5 no deterioration is observed, due to the configuration that was given to the processing capabilities of each service established minimum transmission.

In Figure 8, the delay in transmission of data on the network implemented for the 3 most common types of flow is observed; Hence the delay of all the packets that are sent from the emitters to the base station and are then directed to the respective receptors are displayed. The delay value for best effort packets is between 58mseg and 80mseg with an average value of 62mseg, video streaming traffic to the packet delay is an average value of 50 ms. In the case of voice transmission, it was sought that the maximum packet delay was 30ms, while for other data types this range was greater, by not being a factor so critical.

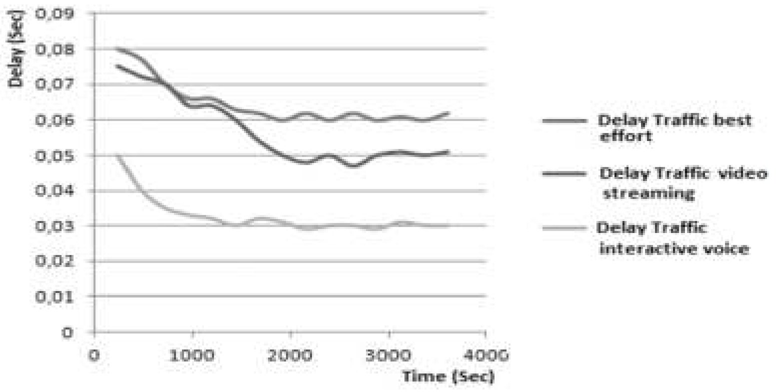

Figure 8: Delay in Scenario 1.

Figure 9 shows the traffic received by mobile transmitters' receivers (receivers 1 and 2) more traffic from transmitters 3, 4& 5 in scenario 2 is shown. As it was stated initially rtPS and BE data were sent by mobile issuers; in the first instance the bandwidth required to transmit voice traffic is secured, and as in the previous case, the throughput of the sources 4 and 5 is smaller because saturation occurs. Analyzing the traffic received by the receivers of mobile devices, is smaller than Sources 4 (40% less than the fixed emitter traffic streaming video) and 5 (15% less than the fixed emitter BE traffic) even though the rate transmission of all issuers is 300Mbps, this means that the throughput is related to the mobility of the team, in fact, it is clear that when the mobile device moves away beyond the range of the base station it is impossible to achieve transmission, however the computer simulation trajectory stays within that coverage.

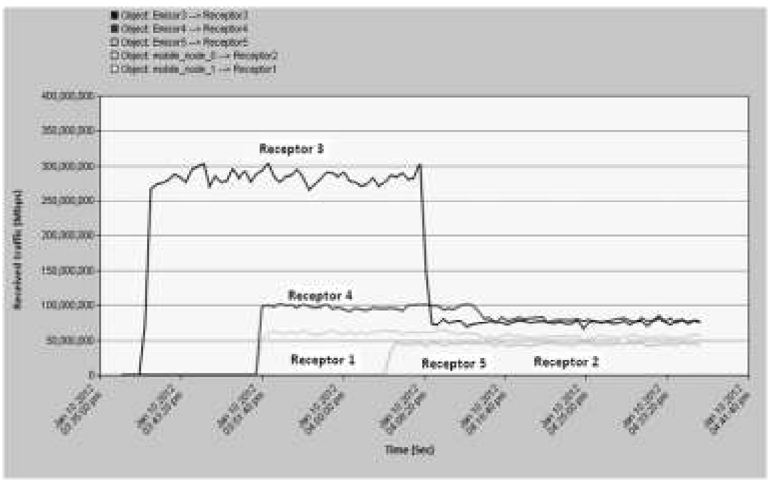

Figure 9: Traffic received in scenario 2.

From figure 10, we sensed that the delay is greater on the scenario with mobile devices, in this case the average value is 80 msec for the best effort data source type and 66mseg for video streaming, and this means that mobility is a factor affecting the number of packets sent as the delay thereof. However the fact of providing quality of service preserves higher priority packets and attempts to meet the transmission requirements, in spite of adverse circumstances and channel saturation, or movement of the equipment.

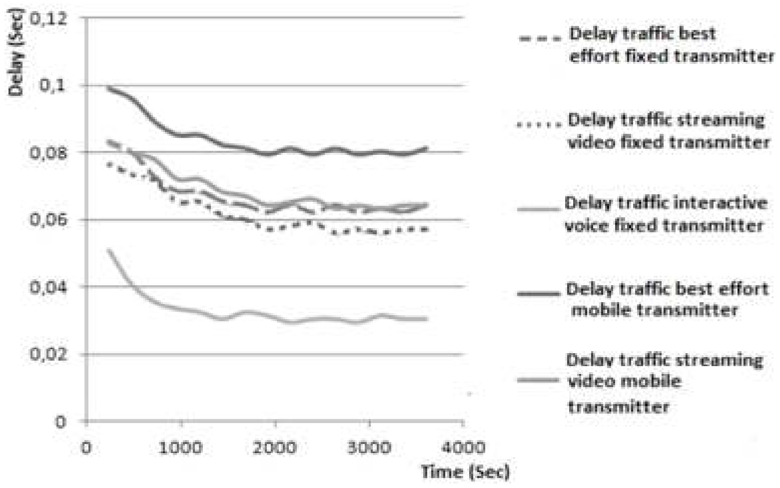

Figure 10. Delay in Scenario 2.

In table 4 and 5 the results obtained in both scenarios are synthesized. As expected the packets with higher priority are those that are more efficient in terms of delivery delay and throughput depending on the settings you have made to the assigned scheduler. In scenario 2 conditions were more critical which is reflected in lower throughput for certain types of service and a greater delay.

However, according to the IEEE 802.16 [2] standard, theoretical transmission capacity is established from 150 Mbps to 350 Mbps which is in line to cast in the simulation; shows that from the total traffic sent over 400 Mbps are beginning to experience packet losses. In terms of delays the IEEE 802.16 and manages a range of tolerance for these. For example for UGS scheduler (usually allocated for voice traffic) specifies to not exceed 50ms. In the case of streaming we sought to handle traffic delays on the same order.

Table 4. Throughput results

Variable	Scenario 1	Scenario 2
Throughput -Gold	300 Mbps	300 Mbps
Throughput-Silver	100 Mbps	90 Mbps
Throughput-Bronze	50Mbps	50 Mbps
Throughput -Silver (mobile)	-------	60Mbps
Throughput -Bronze (mobile)	-------	40Mbps

Table 5. Throughput results

Variable	Scenario 1	Scenario 2
Delay - Gold	30ms	30ms
Delay - Silver	50ms	55ms
Delay - Bronze	60ms	67ms
Delay - Silver (Mobile)	-------	67ms
Delay - Bronze (mobile)	-------	80ms

6. CONCLUSIONS

The implementation of QoS on traffic sent through wimax networks, allows proper classification of packets and if necessary dismiss some, and preserve others who have medium and high priority as in the case of voice traffic and services real-time multimedia which are quite sensitive to delay.

It is clear that assigning a type of scheduler to a given traffic allowed working on each particular form, in order to meet the requirements of delay, use of bandwidth among others as noted by software Simulation and proper configuration for each priority. However, the IEEE 802.16 standard does not establish a specific treatment for each Scheduler which identifies each traffic, but gives some leeway to manufacturers on the use of bandwidth, tolerable delays including among other variables

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