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QoS Performances Evaluation for Mobile WIMAX Networks based on OPNET

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Abstract

WiMAX is believed as a last mile wireless connection tool to offer flexible broadband facilities for ending users. The limitations and performances of WiMAX network have been considered for designing and then simulated by using OPNET, which based in this paper on many quality of services QoS parameters such as voice-packet end to end delay, as well as throughput. A simulation concentrated on two applications Light video, and heavy video at a square area and simulation time of about five minutes depending on multiple scenarios of WiMAX. A comparison made between WiMAX PCM voice with light video and heavy video data transmissions based on voice delay and throughput and shows the voice with heavy video has a delay less than the delay of voice with light video and the heavy video has larger throughput than light video.

Keywords: *Mobile WiMAX, QoS, OPNET*, Light and Heavy Video.

INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) denotes to standards family of IEEE 802.16, it provides two forms of broadband access, fixed in addition to mobile access in telecommunications scenery. WiMAX runs in two band, licensed with 10GHz - 66GHz and unlicensed of 2 GHz - 11GHz frequencies for operation in Lines off Sight (LOS) plus Non-lines off Sight for each bands [1]. Originally, WiMAX was appointed by means of a solution for last miles broadband access, avoiding a major infrastructure estimations deal with arrangements of cables or DSL, Digital Subscriber Line. After that, Mobiles WiMAX qualified for fourth-generation (4G) requirements for data mobile networks challenging demands for subscribers that provides high data rates for Internet Protocol networks which is accomplished for proposing great Quality of Service (QoS) [2].

The technology of WiMAX considers as an Air Interface Standard which was quickly proved itself to show a key role for a fixed and mobile broadband for wireless MANs, and it's a development technology as an orthogonal frequency divisions multiplexing (OFDM) is applied which activates sending resist for vanish the effect of multipath and reduces it. A high data rates and a confirmation of Quality off Services (QoS) providing by IEEE 802.16 standards had commercially prepared it possible for multimedia applications backing such as video on demand (VoD), videos telephony, videos gaming, as well as mobiles TV broadcastings[3].

Mobile WiMAX is an explanation for broadband wireless which assists convergence of both broadband networks, mobile and fixed, over a common radio access wide-ranging broadband technology and architecture of flexible networks. Mobiles WiMAX Airs Interface approves (OFDMA) for upgraded performances of multi-path environments, while Scalable OFDMA (SOFDMA) is presented in the form of IEEE 802.16e Modification to backing scalable frequency band-widths from 1.25 to 200MHz[4].

In wireless communication systems, many factors influence the features of the received signal, namely path loss exponent, the range between base stations interfering and an in-demand user, log-usual shadowing, Rayleigh fading of short time in addition to noise. For improving capacity of the system, a peak data rate besides coverage reliability must be modified, also the transmitted signal from or to a specific operator is adapted [5].

ARCHITECTURE OF WIMAX

WiMAX System Description

The WiMAX is a wireless Metropolitan network established with standards of IEEE 802.16-2004 and IEEE 802.16e-2005 that improve the standards 802.16-2004 with an enhancement of new structures for the system especially the mobility. WiMAX have two standards express both physicals and MAC layers as follows [6]:

Physicals layers utilizes SOFDMA, with assigned frequency range of (2 - 11) GHz for NLOS and frequency band of (10 – 66) GHz for LOS. However most executed WiMAX networks can be found in the range of 3.5GHz and it backing channel bandwidth in the range (2 -20) MHz [7]. The base station (BS) of WiMAX may offer broadband wireless access of 30 - 100 miles (45 - 150 km) for mobiles stations and 300 miles (501 km) for fixed stations supported by maximum data rate of 70 Mbps for 20 MHz BW [8].

Then MAC layer is intended for backing packets transmission band both protocols ATM and IP. The structure of MAC's layer includes three subs- layers; the security, the common part, and MAC convergence sub-layer.

WiMAX abilities to direct a constantly increasing requests for wireless high speed data mobile within a networks of fourth-generation (4G). WiMAX planning to increase the growing rates of subscriber and intended carrier experiences worldwide [9].

Mobile WiMAX Features

Mobile WiMAX technology presents scalability for the most important things, RF access knowledge and network design, therefore to provide a big compact of flexibility deals with network arrangement choices and service assistances. The most important features maintained by Mobile WiMAX are [10]:

*Highs Data Rates: The presence of MIMOs antennas performances beside sophisticated Coding, elastic sub-channelization systems, and Modulation, totally support the technology of Mobiles WiMAX to backing highest download data rates about 630 M bps per sectors and peaks Upper load data rates to about 280 Mbps per sector in a 10 MHz channel.

*Quality of Services (QoS): It can be considered as a central foundation of MAC architecture to the IEEE 802.16. It explains Service Runs which give plan to DiffiServ code steps or MPLIS flow steps which enable end-to-end Internet Protocol established QoS.

*Scalability: the resources of spectrum for wireless broadband global as yet quite different with their allocations even with a progressively globalized budget, therefore technology of Mobile WiMAX is considered capable to activate in various channelization in the range 1.25 to 20 MHz to fulfill the various global requirements like forward efforts to reach spectrum synchronization, and also permits assorted economies for realizing the benefits of multifaceted technology of Mobiles WiMAX for their specifics geographic desires like supplying reasonable internet access at countryside sites against increasing ability accessible of mobiles broadband at metro and out-of-town zones.

*Security: The security aspects of Mobiles WiMAX had been provided greatest features at brand with message verification codes, like EAP, AES operating in CCM mode, CMACs and HMACs established controls messages protections schemes. The various group of user authorizations exists containing; Smart Cards, ISIM/USIMI, Digitals Documents, in addition to Usernames/Passwords outlines created at significant EAPs procedures for a certificate form.

*Mobility: Mobiles WiMAXs backings enhanced assignment systems within invisibilities not more than 500 msec for certifying reals time presentations such as Voice over IP performance without service decay. Flexible fundamental managing outlines promise that security will be sustained through handover.

The products of WiMAXs standards be definitely ford fixed band roaming facilities. The standards were revised for addressing all flexibility applications. Therefore, Mobiles WiMAXs backings total movement for roaming besides stationary arrangements. The next features can be addressed by WiMAX [11]: high data rates offering; backings fixed, roaming and movable applications thus congregating both mobiles and Fixed networks; have flexibles networking architectures; besides economical with simple for deploying. Furthermore, the supporting of point to point and point to multipoint connection, and supporting IP centered architecture; have optimizing assignment that backing all mobility applications like Voices cover Internets Protocols (VoIP). Finally, a power saving appliance that increasing a battery lifetime off portable devices [12].

EXPERIMENTAL METHODOLOGY

WiMAX simulation setup

WiMAX scenarios are based on the following considerations at table 1:

Table 1: WiMAX considerations

WiMAX		
	BS (Base Station)	SS (Subscriber Station)
Tx Power	20W	0.5W
Antenna Gain	15dBi	15dBi
Path Loss	Free Space	Free Space
Bandwidth	20MHz	20MHz

A fundamental structure for WiMAX is situated at subscriber station (SS), base station (BS), an ASN gateway and an ASN features.

- Base station (BS): can be either sectorizing or Omni-directional, fixed or mobile. The BS can assess quality of the channel constructed on quality for the receiving signals. A quality of channel response display advantages the mobile to offer the BS within quality response on the downlink channels. The timetable of BS may be considered for the channel quality for downlink and uplink of the user as well as to specify the modulation and coding systems which expands the throughput. In our simulation scenarios a fixed Omni-directional BS will be restricted.
- Subscriber station (SS): SS can be participate stations with server's implementations and SS with WLANs router operations in addition to SS with workstations functionalities.

With any connection of SS-BSs, MAC facilities form can be organized, OFDMAs physical outlines, modulation and an adaptation coding may be organized. The parameters of physical layer are arranged.

WiMAX scenario1

In the scenario one, all the links configure with the same setting and configuration for making the performance analysis simple yet comprehensive. However, in practical applications we could have different setting and configuration for each link and node in order to maximize the efficiency of the system. But while simulating a network in providing and considering various conditions as different and extreme as possible would make it appropriate and more comprehensive to study and research. In these scenarios, the behavior of QoS classes is observed by comparing the results where specified QoS classes were used with the scenario where all the traffic was managed on Best Effort basis. For studying how each of the QoS classes behave, a large number of simulations were conducted, by using each QoS class separately and with others, including all possible combinations and network conditions. The WiMAX senario1 seen in Figure 1.

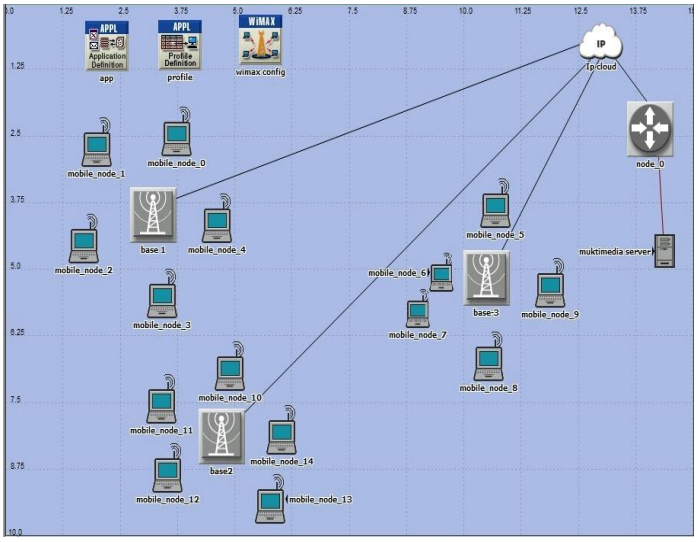

Figure 1: WiMAX networks scenario1

WiMAX scenario one has a three WiMAX –BS-Ethernet connected to router and WiMAX workstation SS Ethernet. We connect the WiMAX base station with the IP cloud by (PPP-link). The base station used to broadcast the WiMAX wave to the WiMAX work station every WiMAX BS coverage 30 km, the WiMAX arrangement seen in Figure 2.

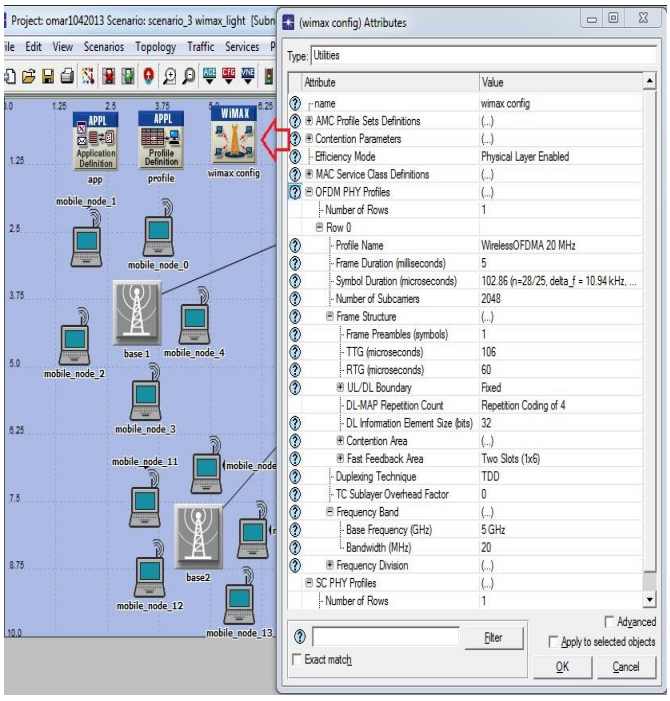

Figure 2: WiMAX scenarios1 arrangement

In this Scenario the parameters used to measure the network statistics in the video conferencing with low quality and voice with GSM quality, as in Figure 2 the WiMAX base station parameter configuration was shown in Figure 3, and WiMAX Mobile node parameter configuration was shown in Figure 4.

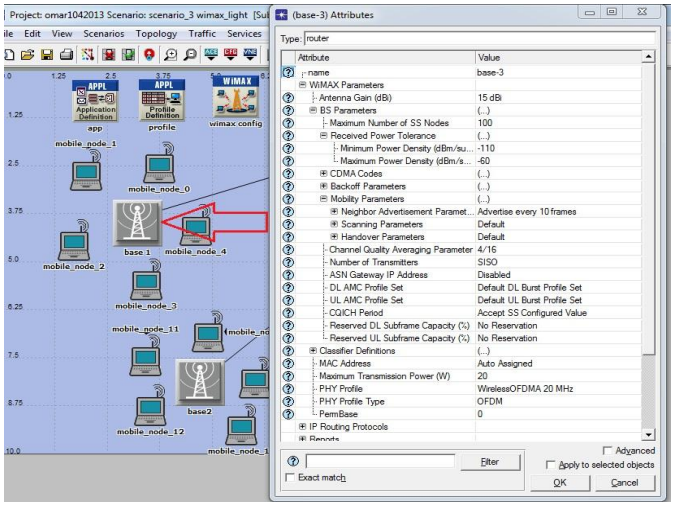

Figure 3: WiMAX bases stations configuration

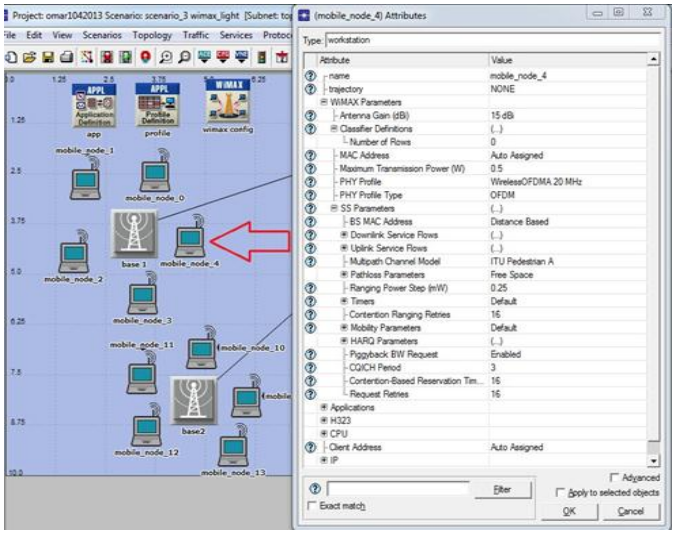

Figure 4: WiMAXs Mobile node configuration

WIMAX SIMULATION RESULTS AND DISCUSSION

WiMAX voice-packet end to end delay

A simulation results for WiMAX voice-packet end to end delay for the PCM voice and light video data transmission there are no connection until second 110 where the connection network established, and the communication system reach the steady state at the second 250 with maximum delay 115 ms, as shown in Figure 5.

The simulation results of the WiMAX voice-packets ends to ends delay ford the PCM voice and heavy video data transmission there are no connection until second 110 where the connection network established, and the communication system reach the steady state at the second 240 with maximum delay 110 ms, as shown in Figure 6.

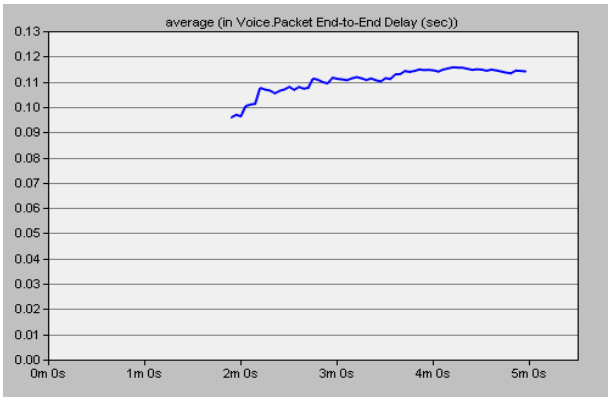

Figure 5: WiMAX voice pocket ends to ends delay with Light video delay

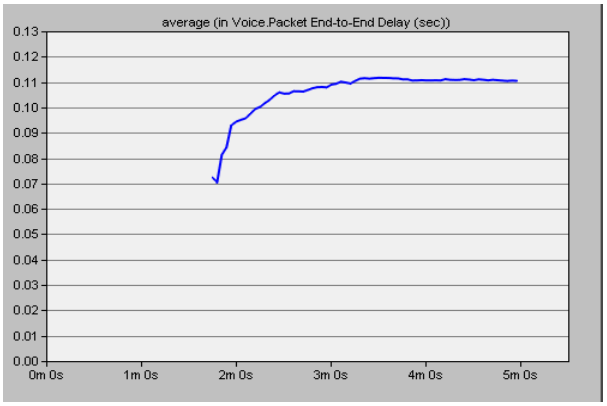

Figure 6: WiMAX voices pocket end to end with heavy video

When comparing between WiMAX voice-packets end to end delay for the PCM voice with light video and with heavy video data transmission connection is shown in Figure 7. From the simulation results at the second 240, the PCM voice with light video has 115 ms delay and the PCM voice with heavy video has 110 ms delay, then the voice with heavy video has a delay less than the delay of voice with light video.

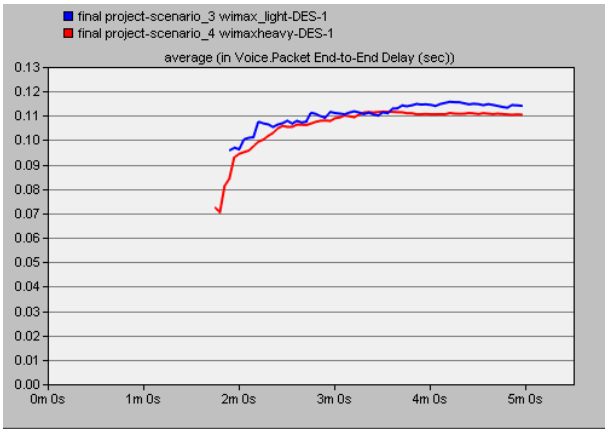

Figure 7: comparing delay of voice with light and heavy video of WIMAX.

WiMAX Light and Heavy video packets delay

The simulation results of the WiMAX light and heavy video packets delay data transmission there are no connection until second 110 where the connection network established, and the communication system reach the steady state at the second 300 with sent traffic 6.4 packet/sec, as shown in Figure 8.

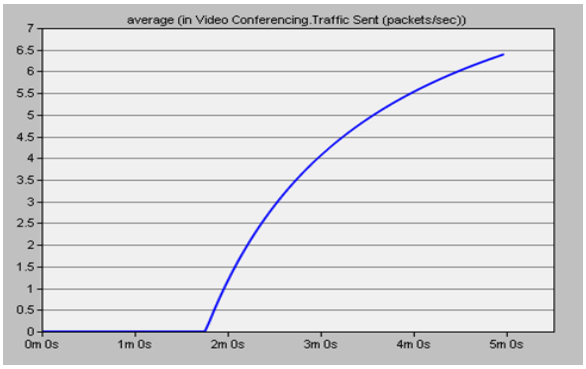

Figure 8: WiMAX light video traffic

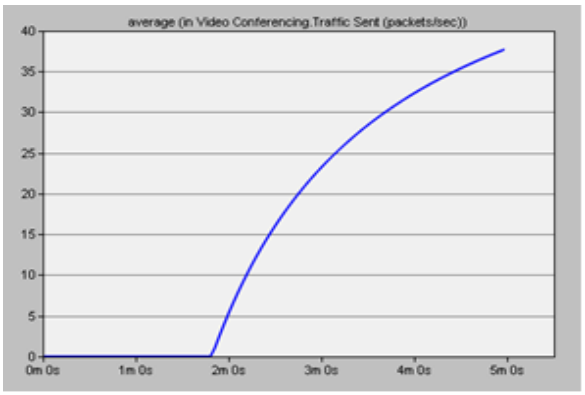

Figure 9: WiMAX heavy video traffic

A comparing between WiMAX light and heavy video traffic sent can be shown in Figure 10. From the simulation results at the second 300 the light video traffic sent has 6.4 packet/sec and heavy video traffic sent has 37 packet/sec, so the traffic sent of heavy video was larger than light video .

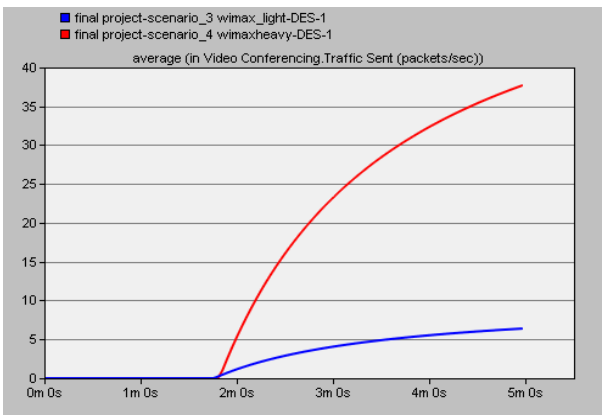

Figure 10: WiMAX comparing of light and heavy video traffic

Throughput

Networks in telecommunication, like Ethernet or packet radio have a network throughput which can be considered as a message or the amount of data, that has a successful move through the communication path between nodes, and this data can be delivered via a logical connection, or passed over a specific network node. It typically can be measured in bits per second (bps), and occasionally with data packets per second or time slot. WiMAX throughput considers the most dominant parameters which may impacts the quality of broadband access in flexible frameworks.

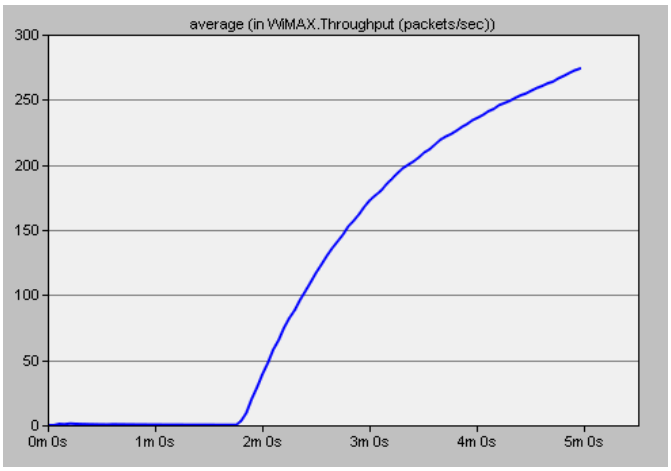

Figure 11: Throughput of WiMAX light video

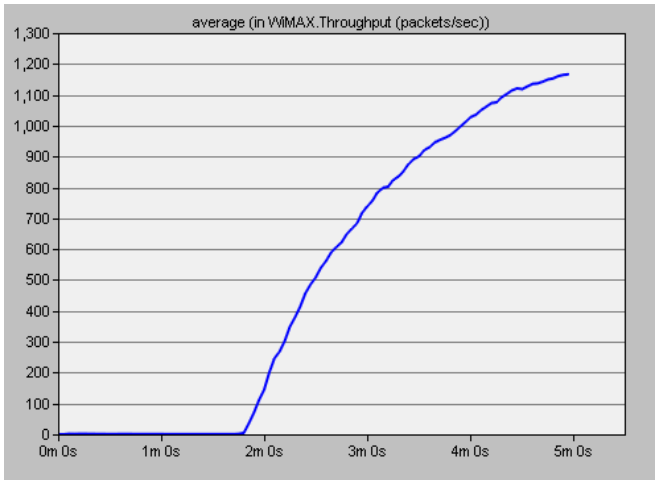

Figure 12: Throughput of WiMAX heavy video

when comparing between throughput of WiMAX with heavy video data transmission with light video data transmission, the simulation results, at the second 300 the light video has 275 packet/sec and the heavy video has 1180 packet/sec so the heavy video has larger throughput than light video as shown in Figure 13.

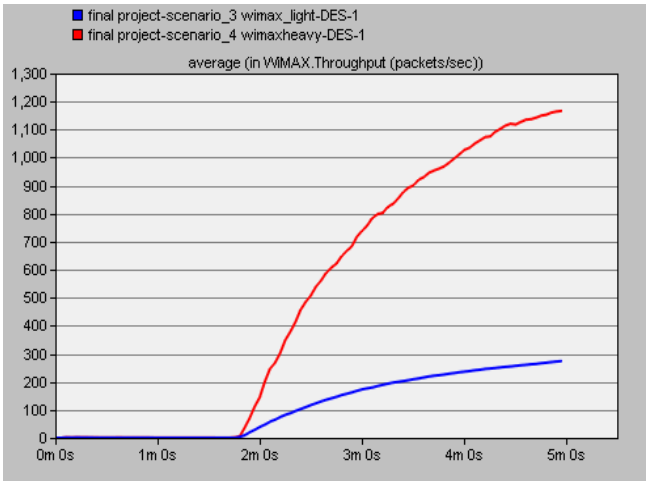

Figure 13: *Throughput comparing of WiMAX light and heavy video*

CONCLUSIONS

This paper had investigated practical information with performances of WiMAX technical broadband access. The concentration here for addressing if WiMAX access equipment may offer equivalent network performances for streaming's video, or voice presentations. The results of utilizing the OPNET Modeler are for designing and characterizing the performances of running a 300 ms movie to WiMAX video subscribers. Three performance parameters were specified for evaluating video performances over the access networks.

The confirmation scenarios established a complete designing for the research that executed well with the Modeler tool. Whereas the original work to combine MPEG-2 video contents verified to execute unwell and was subsequently unrestricted, the MPEG-4 video source showed a more faithful traffic load specified the bandwidth attentions of access networks.

From the simulations results, it concludes the following:

1. A comparing between WiMAX voice-packets end to end delay for the PCM voice with light video and PCM voice with heavy video data transmission, the voice with heavy video has a delay less than the delay of voice with light video by 5ms.
2. A comparing between WiMAX light and heavy video traffic sent, the traffic sent of heavy video was larger than light video by 30.6 packet/sec.
3. A comparing between throughput of WiMAX with heavy video data transmission and of WiMAX with light video data transmission, the heavy video has larger throughput than light video by 905 packet/sec.

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