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A QoE-Based Scheduling Algorithm in WiMAX Network Using Freeway Model

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***Abstract*—** Worldwide Interoperability for Microwave Access (WiMAX) networks were expected to be the main Broadband Wireless Access (BWA) technology that provided several services such as data, voice, and video services including different classes of Quality of Services (QoS), which in turn were defined by IEEE 802.16 standard. Scheduling in WiMAX became one of the most challenging issues. In the current cennario, the performances of wireless technologies have increased The QoS was introduced in WiMAX . It may satisfy QoS requirements for a wide range of services and data applications especially with the high speed connection, asymmetric capabilities , flexible mechanisms for resource allocation. Some services are very demanding, VoIP cannot tolerate delay in the transmission of data. The concept of QoS clearly depends on the service considered, its requirement of response time, which is its sensitivity to transmission errors... etc. For video streaming, we will need a near real-time transfer, with very low latency and low jitter, while VoIP traffic is intolerant of network delays and retransmission

Efficiently managing this, Quality of Experience (QoE) to end-users facing network resources limitation and heterogeneity of networks is a challenge. This paper first explores requirements to provide QoE assurance for multimedia applications. A new management framework, named QoE Real-time Multimedia Management (QoE2M), is introduced to provide end-to-end quality control on real-time multimedia applications over heterogeneous networks based on a combined control of video assessment, Quality of Service (QoS) and QoE-based mapping and adaptation procedures. Validation of the QoE2M framework is also discussed.

***Keywords*—** QoE, WiMAX , Qo**S** , VoIP ,QoE2M

1. INTRODUCTION

A day by day mobile user is demanding increased services provide by wireless network providers for day to day activities and entertainment. This demand requires increased network performance to provide similar services provided by fixed networks.

The network was examined objectively by evaluating a number of parameters to evaluate the quality of network service. This evaluation is known as the QoS of the network, it refers to the ability of the network to obtain a more deterministic performance, and therefore data can be transported with a minimum packet loss, minimum delay and maximum throughput. The QoS does not take into account the user's perception of the service provided. Another approach which takes into account the user's perception is known as QoE, it's a subjective evaluation that associates human dimensions; it groups together user perception, expectations, and experience of application and network performance. In order to understand the quality as perceived by end users, QoE has become a very active area of research. Many related works were published on analyzing and enhancing QoE in WiMAX network. The study in proposed an estimation method of QoE metrics based on QoS metrics in WiMAX network. The QoE was evaluated by using Free way model. The results show an efficient estimation of QoE metrics with respect to QoS parameters.

Other works like [8, 9and 10] also focus on the ANN method to adjust the input network parameters to get the ideal output to satisfy end users. Principally, the success of the ANN approach depends on the model's capacity to completely learn the nonlinear interactions between QoE and QoS. In , Muntean presents a learner QoE model that in addition to the user-related content adaptation, considers delivery performance-based content personalization in order to improve user experience when interacting with an online learning system. Simulation results demonstrate significant improvements in terms of learning achievement, learning performance, learner navigation and user QoE In [3], our study was focused on analyzing QoE performances of VoIP and Video traffic using different service classes with respect to QoS parameters such as throughput, jitter and delay. The simulation results show that A QoE-Based Scheduling Algorithm in WiMAX Network Using Freeway

Model is the best suited to handle VoIP traffic. This paper proposes a novel approach based on the user perception of Quality to provide best WiMAX network performances especially for the real-time traffic. The target of this improvement is to schedule traffic of UGS service class.

2.METHODOLOGY

QUALITY OF EXPERIENCE

Quality of Experience (QoE) is a subjective assessment of a customer's experiences with a service, it focuses on the entire service, and it involves subjective human perception. QoE is in part related to QoS and are two complementary concepts.

Quality of Experience vs Quality of Service assessment

QoS and QoE are rather unclear terms sometimes used interchangeably. It is good to redefine the terms of QoS and QoE. QoE is related to but differs from QoS, which attempts to objectively evaluate the service provided by the vendor, with QoS measurement is most of the time not related to customer, but to hardware and / or software. QoS ensure the good delivery of sensitive network traffic such as voice or applications. But with the rapid evolution of multimedia applications, the metrics of the QoS such as bandwidth, delay, jitter and packet loss fail to assess subjectivity associated with human perception and thus was born the QoE, which is a measure of personal judgment of the user according to his experience. Indeed, the notion of user experience has been introduced for the first time by Dr. Donald Norman, citing the importance of designing a user [18] centered service. Gulliver and Ghinea [11] decompose QoE into three components: assimilation, judgment and satisfaction. The assimilation is a quality measure of the clarity of the contents by an informative point of view. The judgment of quality reflects the quality of presentation. Satisfaction indicates the degree of overall assessment of the user.

A. Proposed QoE-based scheduling algorithm

The proposed QoE-based scheduling algorithm is based on two QoE requirements, each user has an initial maximum transmission rate and a minimum subjective rate requirement. The scheduler works as follows, each node starts sending traffic with a maximum rate. When a packet loss occurs with a given user then the system check on each user if the transmission rate is higher than the minimum subjective requirement, in this case the transmission rate is reduced, otherwise the transmission continues at the same rate. The rate returns to the original maximum value during the simulation, it's rested every 20 seconds, we observe that it takes 18 seconds to all users to reach the minimal transmission rate. Figure shows the activity diagram of the proposed scheduling algorithm.

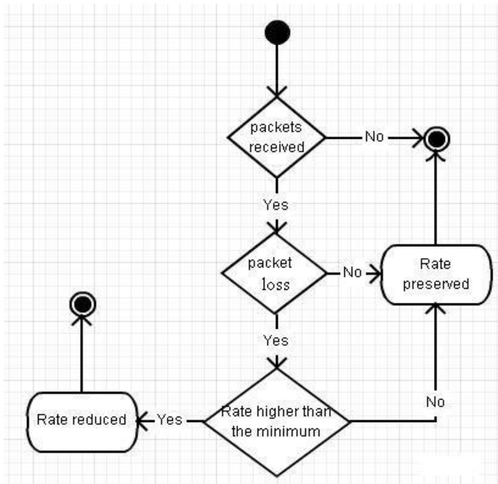

Figure 1: Activity diagram of the proposed QoE-based scheduling algorithm

3. SIMULATION ENVIRONNEMENT

A. Simulation Model

In this paper, we analyze the performances of the propose QoE-based scheduling algorithm, as we consider the Wireless-OFDM PHY layer, our QoE-based scheduling algorithm is compared with the famous WiMAX module developed by NIST (National Institute for Standards and Technologies), which is based on the IEEE 802.16 standard (802.16-2004) and the mobility extension (80216e-2005) , it provides a number of features including OFDM PHY layer. The Network Simulator (NS-2) is used. Our simulation scenario consists of creating five wireless nodes (SS, subscriber stations) and connecting them to a BS. A sink node is created and attached to the base station to accept incoming packets. A traffic agent is created and then attached to the source node. Finally, we set the traffic that produces each node. The first node has run with CBR (Constant Bit Rate) packet size of 200 bytes and interval of “0,0015”, the second node has run with CBR packet size of 200 bytes and interval of “0,001”, the third node has run with CBR packet size of 200 bytes and interval of “0,001”, the fourth node has run with CBR packets size of 200 bytes and interval of “0,001” and fifth node has run with CBR packet size of 200 bytes and interval of “0,0015”. The initial transmission rate that produces each node is about “133,3

Kbps", "200 Kbps", "200 Kbps", "200 Kbps" and "133,3 Kbps" respectively. All nodes have the same priority.

Each user has a minimum requirement, so the first user requires minimal traffic rate of "120 Kbps", the second "150 Kbps", the third "150 Kbps", the fourth "150 Kbps" and the fifth "120 Kbps".

TABLE 1: USER'S TRAFFIC PARAMETERS

Traffic rate / Users	Initial traffic rate (Kbps)	User minimum requirement (Kbps)
User 1	133,33 (200byte/0. 0015)	120
User 2	200 (200byte/0. 001)	150
User 3	200 (200byte/0. 001)	150
User 4	200 (200byte/0. 001)	150
User 5	133.33 (200byte/0. 0015)	120

To perform this simulation, the network simulator NS-2 was used, we have implemented the QoS-included WiMAX module within NS-2. This module is based on the NIST implementation of WiMAX , it consists of the addition of the QoS classes as well as the management of the QoS requirements. The resulted trace files are interpreted and filtered based on a PERL script, it's an interpretation script software used to extract datas from trace files in term of throughput, packet loss rate, jitter and delay. The extracted analysis results are plotted in graphs using EXCEL software.

B. Simulation Parameters

The same simulation parameters are used for both NIST and QOE-based scheduling algorithms

TABLE 2: SIMULATION PARAMETERS

Parameter	Value
Simulator	NS-2 (Version 2.29)
Network interface type	Phy/WirelessPhy/OFDM
Propagation model	Propagation/OFDM
MAC type	Mac/802_16/BS
Antenna model	Antenna/OmniAntenna
Service class	BE
packet size	200 bytes
Frequency bandwidth	5 MHz
Receive Power Threshold	2,025e-12
Carrier Sense Power Threshold	0,9 * Receive Power Threshold
channel	3,486e+9
Mobility Model	ManhattenGrid
Speed	15 m/s
Simulation time	200s

4. SIMULATION RESULTS AND ANALYSIS

In this section we present the results obtained through simulations, for both traffic scenarios considered, reflecting the performance of QoE-based scheduler algorithm and the NIST scheduler in term of average throughput, packet loss rate, average delay and average jitter in WiMAX network using BE service class. Figure 2 shows the values of the average throughput of the two modules considered in our simulations. We note that the values of the average throughput using the WiMAX module are higher than those of the module using the proposed mechanism for all the flows. Indeed, the mechanism based on QoE control the transmission rate for different users to adjust with subjective minimum requirements of each user in the main objective to reduce the network overhead and thus reduce delay, jitter and packet loss rate.

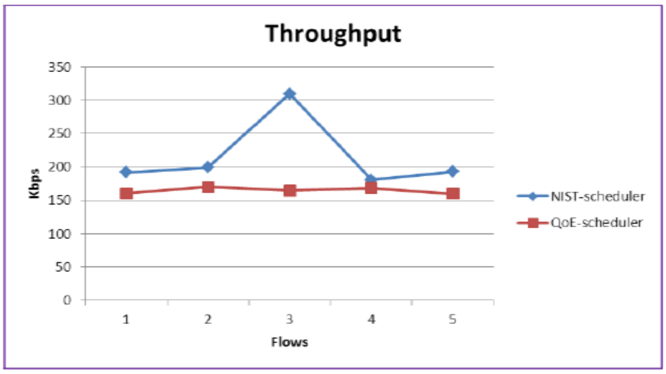

Figure 2. Average Throughput under Speed/fixed 15 m/s

Figure 3 illustrates the improvement obtained on packet loss rate by applying QoE-based scheduler algorithm for all flows. In general, the packet loss rate is reduced. In the case of flow 4, the values are similar

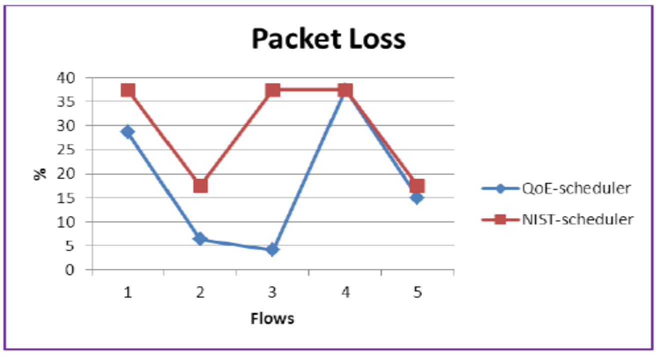

Figure 3. Packet loss rate under Speed/fixed 15 m/s

From figure 4, it can be noticed that the proposed mechanism based on the QoE is more efficient in terms of

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average jitter compared to the WiMAX module. Indeed, the average jitter values corresponding to the proposed mechanism are lowest compared to WiMAX module ones.

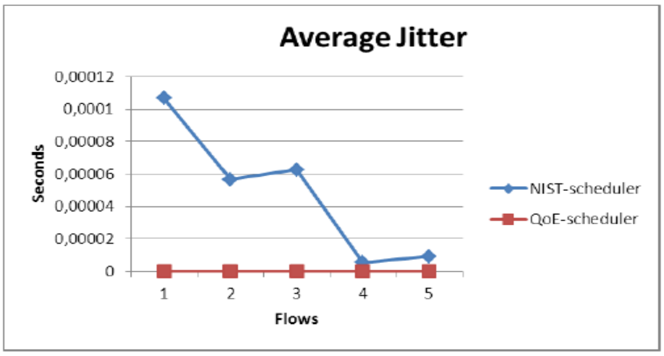

Figure 4. Average Jitter under Speed/fixed 15 m/s

As we can see on the figure 5, the average packet transmission delay is reduced using the mechanism based on QoE. In the case of flows 4 and 5, the two modules give similar average delay values.

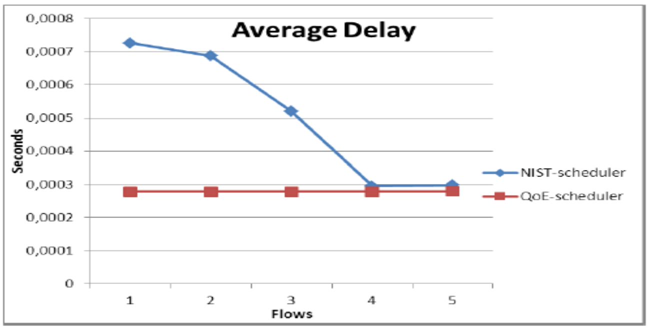

Figure5. Average Delay under Speed/fixed 15 m/s

5. CONCLUSION

In this paper, we have used a QoE-based scheduling algorithm in which depending on whether there is a packet loss, the system reduces the transmission rate of each connection in order to match with the minimum allowed requirement of transmission rate (minimum subjective requirement of the user). The simulations carried out show that the use of different levels of MOS enhances the QoE provided to users of WiMAX network. The proposed QoE-based scheduling algorithm significantly reduces packet loss, jitter and delay while using UGS service class. As a future work we may extend this study by taking in consideration other service class and other subjective parameters to handle VoIP traffic.

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