A QoS Analysis of UGS and ERTPS Scheduling Service Flows in video Conference over Worldwide Interoperability for Microwave Access (Wi-MAX)

Alkhatab Khalafalla Muslim Abdelhadi, Hala Eldaw Idris, Abdalla Abdalrahman Mohamed

Abstract: The IEEE 802.16e (published 2005) defined five different Quality of Service (QoS) classes including UGS, ertPS, rtPS, nrtPS and BE. It is well known that UGS and ertPS are designated to support QoS for voice applications with silence suppression. The other three classes have different applications. In this paper, we investigate the performance of UGS and ertPS QoS classes in terms of multimedia applications such as video conferencing over WiMAX network scenarios. The OPNET modeler 14.5 simulator is employed for simulation purposes in order to evaluate the performance of UGS and ertPS with a focus on video conferencing streaming and voice applications. The simulations show that the user with UGS QoS could provide higher throughput and lower delay, lower jitter, and lower queuing delay compared to the ertPS case. Consequently, we also evaluated the video conferencing/streaming application for the ertPS QoS case. Simulation results in this case show that for a defined two scenarios of network and a certain combination of users that are allocated a QoS and a selected application e.g., voice or video conferencing, UGS offers higher performance than ertPS.

Keywords: QoS, UGS, ertPS, throughput, delay, jitter, queuing delay.

I. INTRODUCTION

In the modern communications, WiMAX (IEEE 802.16) is the most evolution technique that enables everywhere delivery of broadband wireless access for mobile and fixed users. The IEEE 802.16 standard commonly known as Worldwide Interoperability for Microwave Access (WiMAX), that has been well-educated to speed up and introduce the broadband wireless access into the marketplace. Before the introduction of the IEEE 802.16 standard, the most effectual ways to get access to broadband internet service were at most through T1, cable modem, or Digital Subscriber Line (DSL). However, these infrastructures are more expensive, principally for deployment in developing countries and rural areas. The conventional wireless cellular networks the hierarchical architecture are centralized controllers to simplify management of resource and mobility support in a highly efficient way, identical to voice call services.

Manuscript published on 30 April 2017.
***** Correspondence Author (s)

Alkhatab Khalafalla Muslim Abdelhadi, Department of Communication, Faculty Post Graduate Studies, El Neelain University, Khartoum, Sudan.

Dr. Hala Eldaw Idris, Department of Communication, Faculty Post Graduate Studies, El Neelain University, Khartoum, Sudan.

Abdalla Abdalrahman Mohamed, Department of Communication, Faculty Post Graduate Studies, El Neelain University, Khartoum, Sudan.

It is one of the most evolution techniques which provide additional features to the existing broadband techniques. It can also be treated as a substitution to the existing cable and DSL technologies because it has minimum cost and easy to implement. It also support high data rate for applications with require level of Quality of Service (QoS). The common companies such as Samsung and Motorola are already developing WiMAX PDAs and phones and they have been used in Korea with WiMAX cousin technology, Wireless Broadband [1]. For the time being WiMAX is considered as one of the essential technologies for high speed wireless access and next generation networks (NGN). It covers large area comparison with Wi-Fi in addition to supporting quality of service (QoS) and security mechanism because of its optimized physical layer and too many flexible capabilities. The last improved technique of WiMAX is considered as one of the essential standards wireless networks for the upcoming time. WiMAX uses several technologies, such as Orthogonal Frequency-Division Multiple Access (OFDMA) and resource allocation methods with differentiated QoS are parts of Next Generation Networks (NGN) standards [2]. WiMAX can be suitable for Local Area Networks(LAN), Hybrid Networks and long range transmission gratitude to MAC relays defined in 802.16j [3]. The name WiMAX was suggested by the WiMAX Forum [4]. IEEE 802.16 defines the physical layer as layer (1) also referred as PHY and data link layer as layer (2) or Media Access Control – MAC layer of the OSI network model (Open Systems Interconnection) model. The standard includes details about the various flavors of PHY layers supported and countenance of the MAC layer such as scheduling services supported and the bandwidth request mechanisms. WiMAX forum is responsible for preparing profiles for systems that abide by the IEEE 802.16 standard and make interoperability tests to ensure that the implementation of different vendors can work both. The first IEEE 802.16 standard version was completed in October 2001 and since then many versions have come to light such as multiple traffic classes for QoS, mobility and Non-Line of Sight (NLOS) operation, operation in the licensed and unlicensed frequency bands [5].

II. MATERIALS AND METHODS

There is no specific definition of Quality of Service (QoS), in terms of telephony, was defined in 1994 in the International Telecommunication Union (ITU) Recommendation E.800.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

This definition contains broadly 6 major components such as Operability, Accessibility, Integrity, Retainability, Support, and Security. The ITU published a document discussing QoS in the field of data networking in 1998. The term Quality of Service (QoS) refers to the probability of the telecommunication.

Network meeting performance requirements and given traffic contract. Although the name suggests that it is a qualitative measure of how consistent and reliable network is, there are several parameters that can be used to measure it quantitatively. These include transmission delay or packet delay, throughput, jitter, packets lost ratio etc. The use of different type of applications in a network, results in heterogeneous traffic load. The traffic from different applications may require certain level of quality of service, for example, multimedia application is delay sensitive application, Voice over IP (VOIP) or IP telephony needs strict limits on delay and jitter. Video conferencing (VC) applications need very less time variation in delay while dedicated link emulation needs both timely delivery of packets and limit on maximum delay and jitter. A safety-critical application, which needs a guaranteed level of availability and accessibility within particular time and with accuracy such as remote surgery (this is also called hard quality of service QoS).

A. IEEE 802.16 Quality of Service Classes

To meet different QoS requirements such as throughput, packet error rate, jitter, data rate, system availability and delay; the WiMAX defined different scheduling mechanisms to allocate downlink and uplink transmission opportunities for different PDUs. The WiMAX defined five classes for QoS which are [6]:

1. **Unsolicited Grant Service (UGS):** This scheduling service is built to support applications that generate fixed-size data bouts periodically such as T1/E1 and VoIP without silence suppression. To support the real-time need of such applications and reduce over head by the bandwidth request-grant process, the BS allocates fixed size data grants or loans without acquiring explicit request from the SS. The size of the grants is dependent on the maximum rate that can be endured by the application and is negotiated at interconnection setup.
2. **Real-time Polling Service (rtPS)**: This scheduling service was created to support real-time applications that generate variable size packets on a regular basis such as MPEG video or VoIP with silence suppression. The BS allows the SS's to make periodic unicast demands and allows them to specify the size of the specified grant. Since a dedicated grant request is contention-free, the bandwidth get is going to be received by the SS in time. The SS's owed to this class are prohibited from using legislation request opportunities.
3. **Non real-time Polling Service (nrtPS):** nrtPS is designed to support non-real time applications that require variable size data grant bursts frequently. This scheduling service helps applications that are hold off tolerant but may need high throughput such as File Transfer Protocol (FTP) applications. The BS allows the SS to make periodic unicast grant demands, the same as the rtPS scheduling service, nevertheless the requests are granted at longer intervals. This kind of flow will ensure that the SS's receive request opportunities even during network congestion. SS's of the class are also permitted to use legislation request opportunities.
4. **Extended Real-time Polling Service (ertPS):** The extended real time polling service (ertPS) was introduced at the same time as mobile WiMAX and is a blend of UGS and rtPS. In this QoS class, unwanted unicast grants are provided by the BS, so this way the latencies induced by the bandwidth requests are removed. Applications backed offer real-time service goes that generate variable size data packets on a periodic basis such as voice with activity recognition (VoIP).
5. **Best Effort (BE):** This traffic class is made up of applications such as telnet or World Wide Internet access that do not require any QoS assurance. The bandwidth request by such applications is approved on space-available basis. The SS is allowed to use both contention-free and contention based bandwidth desires, although contention-free is not granted when the system load is high [6]

Table1. QoS Classes and Their Applications

S. No.	Quality of Service Class	QoS Specification	Application
1.	Unsolicited Grant Service (UGS)	Maximum sustained rate, Maximum latency tolerance, Jitter tolerance	Voice over IP (VoIP) without silence suppression, T1/E1
2.	Real-time Polling Services (rtPS)	Minimum reserved rate, Maximum sustained rate, Maximum latency tolerance, Traffic priority	MPEG video
3.	Non Real- time Polling Services (nrtPS)	Minimum reserved rate, Maximum sustained rate, Traffic priority	File Transfer Protocol (FTP)
4.	Best Effort (BE)	Maximum sustained rate, Traffic priority	Web browsing, data transfer
5.	Extended Real-time Polling Service (ertPS)	Minimum reserved rate, Maximum sustained rate, Maximum latency tolerance Jitter tolerance Traffic priority	Voice with activity detection (VOIP)

III. SIMULATION AND SCENARIO STEPS

Simulation tools are an essential part in the development and performance evaluation of communication networks. Among the available tools for networks simulation, OPNET 14.5 modeler is used in order to evaluate the performance of WiMAX scenario. The configuration of the WiMAX scenario is created as follows:

i. Components used are:
   a. base station BS,
   b. subscriber stations SSs
   c. And server.
ii. Two homogeneous networks are considered
iii. And one node of the network is assigned to act as a Base Station (BS) whereas all other nodes are assigned to act as a Subscriber Stations (SS) in addition to the applications server.

Two scenarios are investigated:

- First scenario is the WiMAX simulated for video conference application using ertPS service flow.
- Second scenario is simulated using UGS service flow for the same application type.
- The results achieved on these scenarios are discussed and compared between the two scenarios in terms of QoS parameters.

IV. RESULTS AND ANALYSIS

QoS provisioning encompasses providing Quality of Service to the end user in terms of several generic parameters. The perceived quality of service can be quantitatively measured in terms of several parameters. In the analysis, received throughput, packet loss, average end to end delay, and average jitter were considered. To run the comparison between UGS and ertPS effectively, results are presented on these configurations in an overlapped fashion. This makes it easier to see and compare the behavior of different QoS parameters for the same traffic over different type of service flow.

A. Comparative Results for Packet End-To-End Delay:

Fig. 1 shows a comparison of the packet end-to-end delay with respect to video conferencing. Packet end-to-end delay is main parameter of quality of service (QoS). So, it is very indispensable to be acceptable. This also affects the comprehend quality of the service. ertPS (results shown in blue) flow has maximum packet end-to-end delay out of the UGS service flow (results shown in red) and it performs worse in this performance parameter as it shows the maximum increase with respect to time. Subsequently, UGS service class performs better than ertPS service flow.

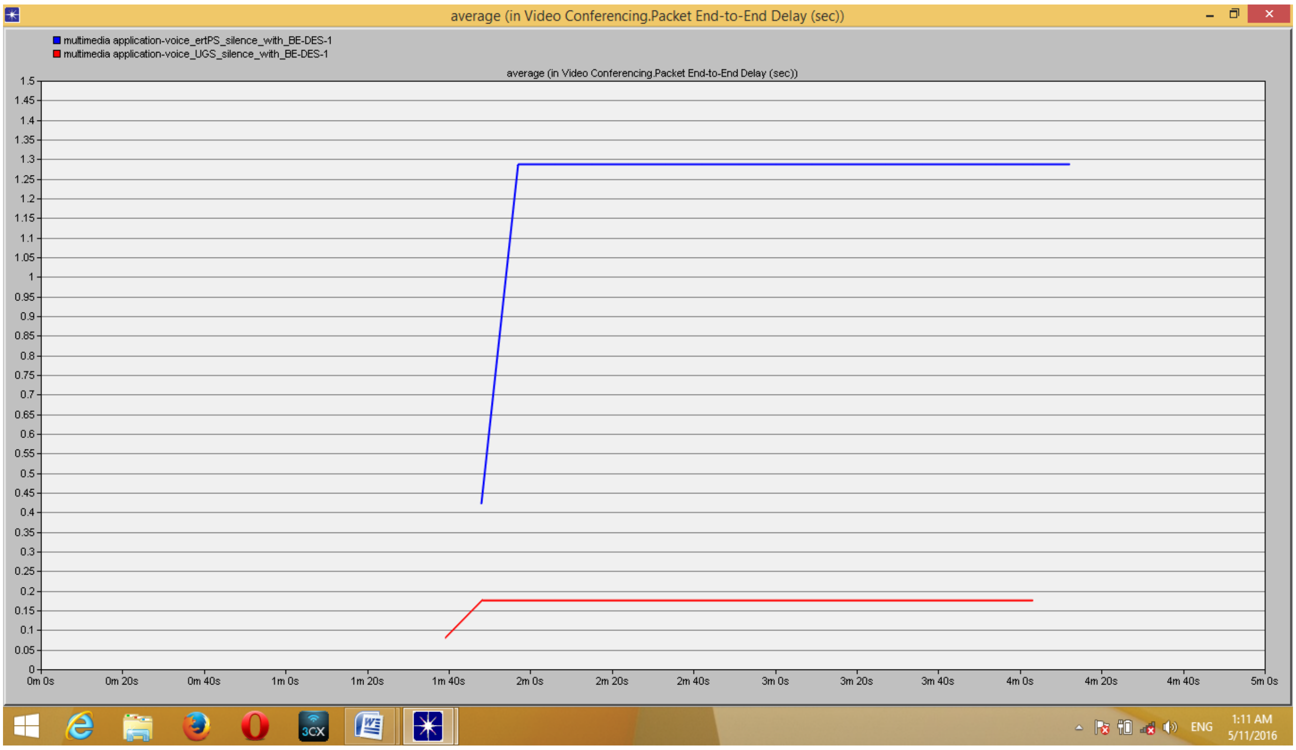

Fig. 1: Video Conferencing: Packet End to End Delay From ERTPS (shown in blue) and UGS (shown in red)

B. Comparative Results for Average Packet Delay Variation

Fig. 2 shows comparative graph of average packet delay variation with respect to the number of users for UGS and ertPS service flows. Jitter is the variation in the delay introduced by the components along the communication path. It is the variation in packet arriving time. Average jitter is the average of packet delay variations. In the ordinary situation, the packets should arrive to destination at the same delay. This will make the packet delay variation to be zero, which means no jitter. Jitter is commonly used as an indicator of stability and consistency of a network. As shown in Figure (2), UGS service flow has the lowest jitter compared to ertPS service flow. The value of jitter is very small in UGS which is desirable.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

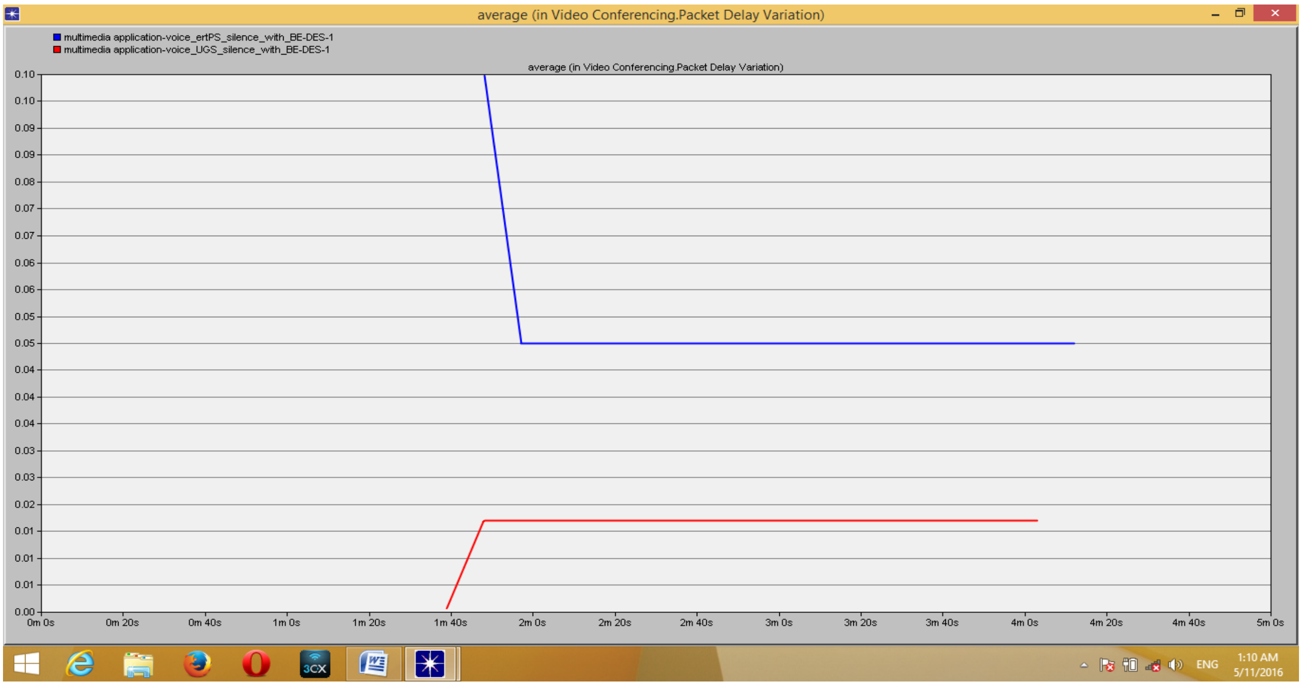

Fig. 2: Video Conferencing: Packet Delay Variation for ERTPS (shown in blue) and UGS (shown in red)

C. Comparative Results for Average Delay

Fig. 3 shows comparative graph of average delay with respect to network for the UGS and ertPS service flows. Delay or latency is the time taken by the packets to travel from the source to the destination [7]. As shown in Fig. 3 the delay is highest for the ertPS service flow. This is the expected result as this service flow has maximum packet end-to-end delay value as shown in Fig.1. The ertPS flow has the highest value of delay compared to UGS service flow. Hence, the UGS performs better than ertPS in terms of the average delay.

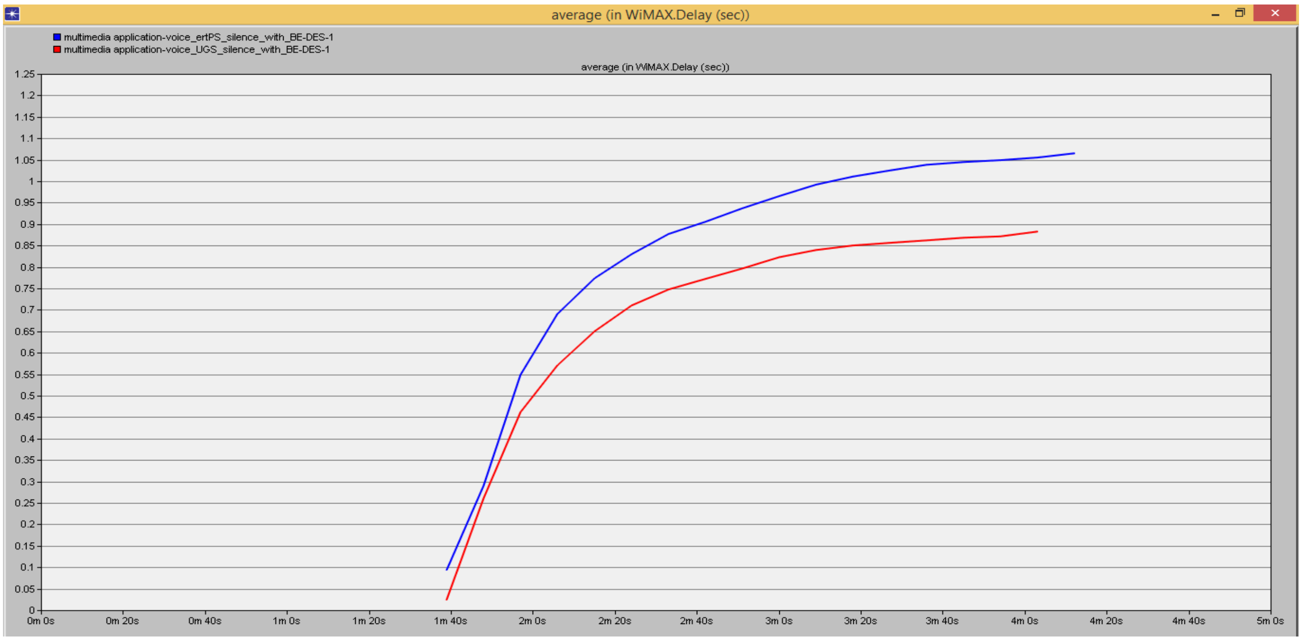

Fig. 3: Average WiMAX delay for ertPS (shown in blue) and UGS (shown in red)

D. Comparative Results for Throughput:

Fig. 4 shows comparative graph of the received throughput with respect to video conferencing for UGS and ertPS service flows. Throughput is a measure of the date rate (bits per second) generated by the application [7]. It is generally observed that UGS service flows have maximum received throughput values compared to ertPS service due to bandwidth starvation in congested environment with respect to video conferencing. Sine the simulation is configured with video conferencing traffic; hence the UGS performs better than ertPS in terms of throughput.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

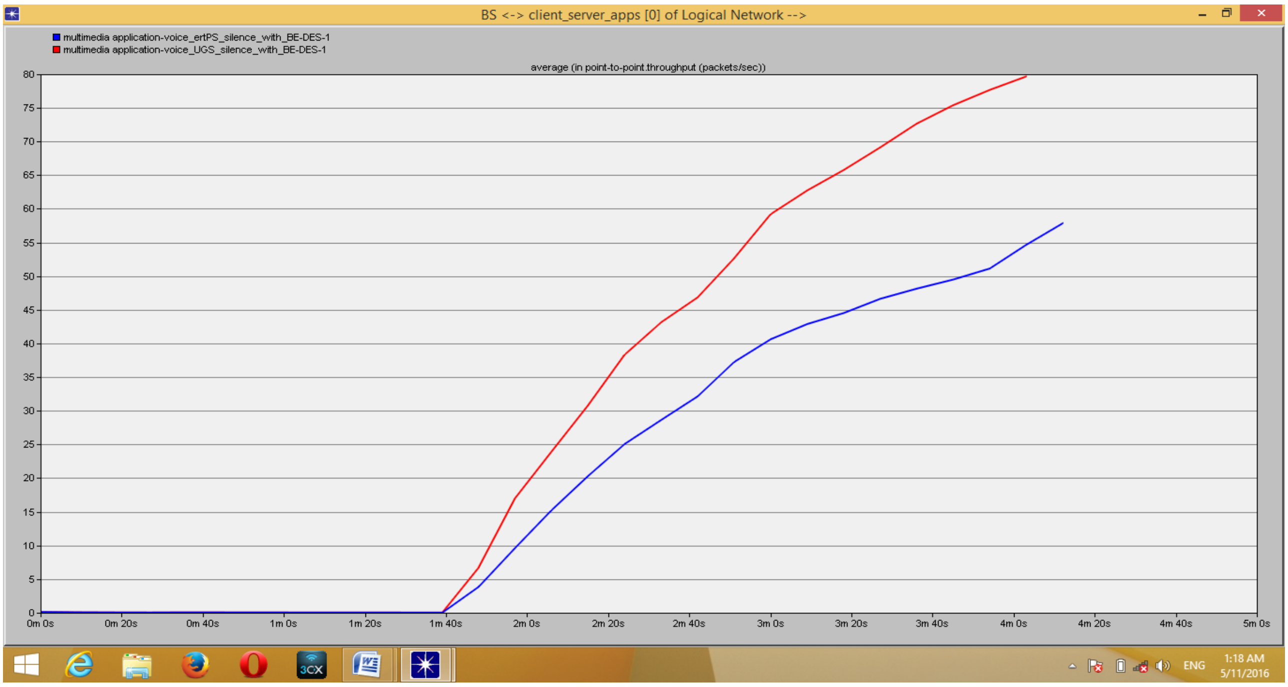

Fig (4): Video Conferencing: Average Point-To-Point Throughput for ERTPS (shown in blue) and UGS (shown in red)

E. Comparative Results for Average Queuing Delay

Fig. 5 shows comparative graph of average queuing delay UGS and ertPS service flows. Queuing delay is the time taken by the packets at nodes before processing [8]. The average queuing delay is highest for the ertPS service flow and the UGS performs better than ertPS in terms of the average queuing delay.

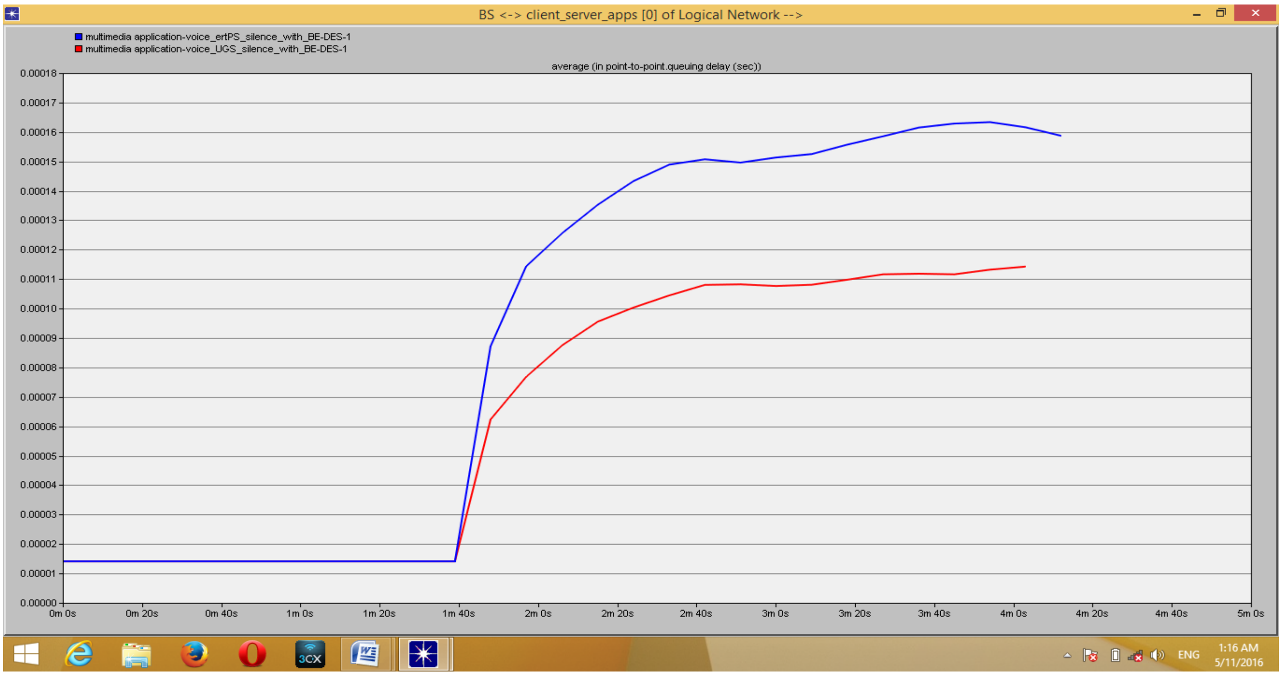

Fig (5): Average Point-To-Point Queuing Delay for ERTPS (shown in blue) and UGS (shown in red)

V. CONCLUSIONS AND RECOMMENDATIONS

In the paper, the general concepts of Quality of Service (QoS) in wireless networks were investigated through an extensive comparison of UGS and ertPS flows with the video conferencing application. Simulation results of packet delay variation, packet end-to-end delay, queuing delay and throughput as calculated from the total message received shows that the UGS flow outperform ertPS on all of the investigated quality of service (QoS) parameters. UGS flow shows minimum delay variation out of other service flow. UGS performs best with respect to average end-to-end delay performance parameter. Average jitter is the average of packet delay variations. The value of average jitter is highest in congestion with ertPS compared to UGS service flow.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

In conclusion the constant bit rate (CBR) traffic for video conference can be better served by Unsolicited Grant Service (UGS) flow as they serve the traffic in the most optimum way.

REFERENCES

1. Mark C. Wood, accessed May 24, 2016, "An Analysis of the Design and Implementation of QoS over IEEE 802.16", http://repository.mdp.ac.id/ebook/library-ref-eng/ref-eng-3/physical/wimax/wimax-qos/wimax_qos.pdf.
2. Qiang Ni, A. Vinel, Yang Xiao, A. Turlikov, Tao Jiang, 2007, IEEE Communications Magazine, "Wireless broadband access: WiMax and beyond- investigation of bandwidth request mechanisms under point-to-multipoint mode of WiMax networks1".
3. Genc, S. Murphy, Yang Yu, J. Murphy, 2008, IEEE Wireless Communications Magazine "IEEE 802.16J relay-based wireless access networks: an overview".
4. http://www.wimaxforum.org, Accessed May 24, 2016, WiMAX Forum.
5. IEEE Std 802.16-2009, May 2009, "IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Broadband Wireless Access Systems, " (Revision of IEEE Std 802.16-2004), IEEE Wireless Communications Magazine.
6. Bo Li, Yang Qin, Chor Ping Low, Choon Lim Gwee, December 2007, "A Survey on Mobile WiMAX", IEEE Communications Magazine.
7. Avni Khatkar, Yudhvir Singh, Vikas Nandal, July 2013," A QoS Oriented Analysis of ertPS, rtPS and nrtPS flows in WiMAX", International Journal of Advanced Research in Computer Science and Software Engineering, http://www.ijarcsse.com/docs/papers/Volume_3/7_July2013/V3I6-0680.pdf
8. ITU-T recommendation. (2001). Communications quality of service: A framework and definitions. G.1000, I.-T. R. (2001). ITU.