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Analysis of BE and rtPS QoS in WiFi Network

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Abstract: Quality of Service (QoS) in networking is defined as the assurance or as a guarantee factor that the information is perfectly delivered in a communication link. As one of the promising novel in the next communication architecture is to have a coherence quality of service in a wireless hybrid network. However, these heterogeneous networks have various levels of QoS classes. WiFi, for example, has two classes of QoS, five classes in WiMAX while nine classes are in LTE. Since each system has a particular level of QoS classes, the motivation to have a persistent communication is a challenging task. In this paper, we investigate on details of the QoS in WiFi network first before proceed to the hybrid network. The QoS involve are real time polling service (rtPS) and Best Effort (BE). Thus, in this paper, we propose QoS table for WiFi network with the consideration of the user's application. We will evaluate the traffic outputs based on the application assigned to the end users. The propose structure will be analyzed using Opnet modeler simulation tool with the essential parameters which are throughput, delay and packet loss. The motive of this research is to have an optimize throughput, minimum amount of delay as well as zero tolerance on the packet loss. Therefore, a hybrid communication system benefited to all, especially for future user applications will be the significant from this research.

Keywords: Quality of Service; WiFi; real time polling service; Best Effort.

1. Introduction

QoS is an important factor in a communication system since its' determine the traffic and service prerequisite would be satisfied in terms of packet loss, delay, throughput and jitter. The original version of the IEEE 802.11 WLAN standard is designed to operate only with the best effort services; which means there is no QoS allocate on the assigned applications [1] [2]. However, a new protocol has been developed by the IEEE 802.11e for the allocation of QoS over priority mechanism which are the HCF Controlled Channel Access and Enhanced Distributed Channel Access. The applications are categorized into two QoS classes which based on guarantee bit rate or otherwise [3]. Details are shown in Table 1. Based on the characteristics and the similarity of the applications, the four applications have been categorized into 2 QoS classes; Voice and Video in the rtPS QoS meanwhile Web browsing and FTP in the BE QoS classes [4].

Table 1: WiFi QoS Classes [5]

Application	Description	QoS Classes
Voice	Bidirectional Voice calls with 64Kbps at 20ms. Talk spurt and silence spurt exponential with mean 0.35 seconds and 0.65 seconds.	Real Time Polling Service (rtPS)
Video	Downlink VBR stream with an average rate of 1Mbps and a peak rate of 5Mbps.	
Web	Inter-page request time exponentially distributed of mean 15 seconds.	Best Effort (BE)
FTP	FTP download of a 20MB file	

2. Simulation environment

In this network, we analyze the effect of the QoS classes and the effect in terms number of users and distance [6]. The two QoS classes involved are rtPS and BE. Using OPNET as the simulation tool, we investigate the QoS parameters; throughput, delay and data dropped involving different numbers of QoS users in the network [7] - [9]. We start with a small number of users and next we increase the distance to study the effect on the WiFi network [10], [11]. The simulation starts for 15 meter distance from the access point to the users. The users are assigned with the same QoS and later on we have a look the effect when the QoS is change. The applications appoint to the QoS; video conference to the rtPS QoS and web browsing to the BE QoS.

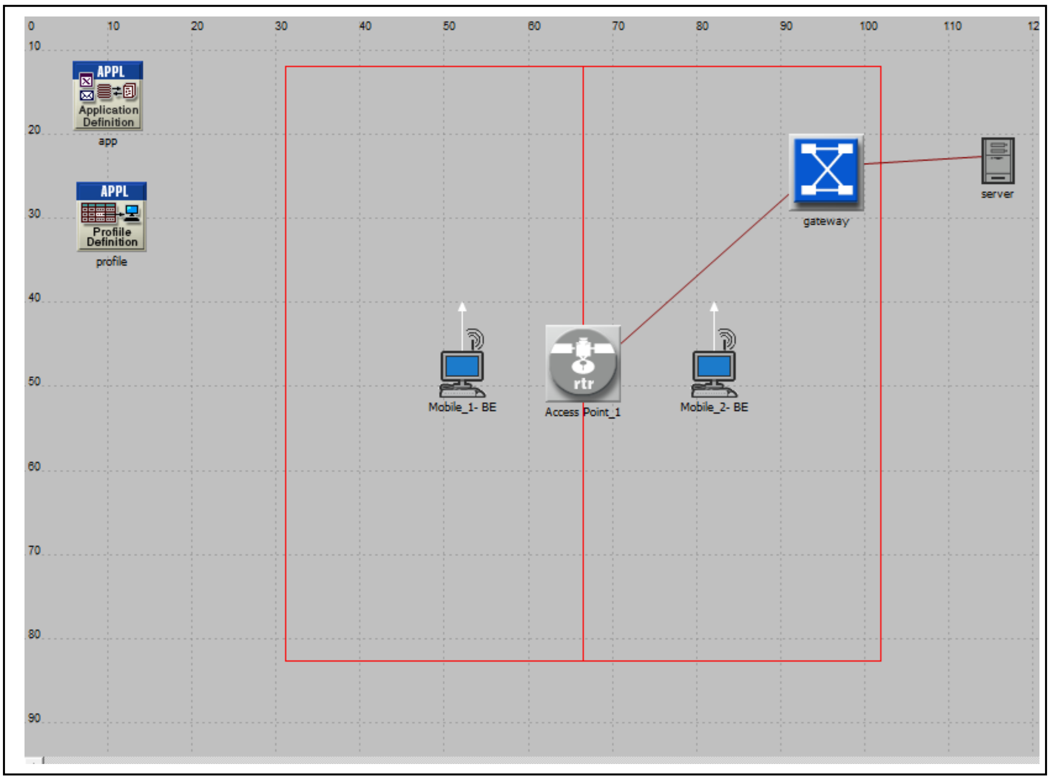

Fig.1 Network Model

The network model is the main staging region for creating a network simulation in which user can construct a network model the usage of fashions from the usual library, pick records about the community, run a simulation, and examine the results [12]. Except that, consumers can also create node and process models, build packet formats, and create filters and parameters, the usage of specialized editors that may be accessed from the assignment Editor.

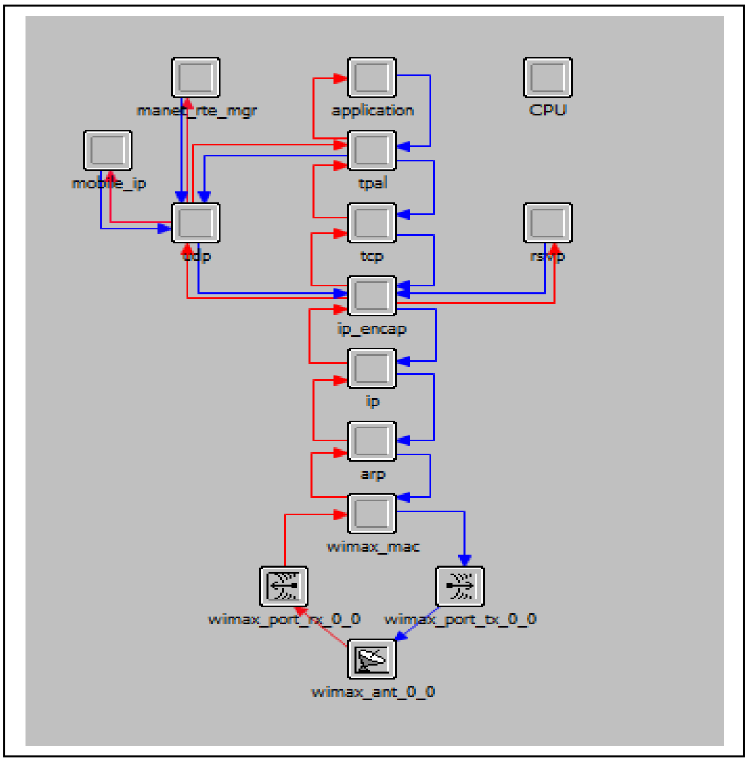

Fig.2 Node Model

The Node model is to define the action of every network object. The action is described using distinct modules, each of which defines some internal component of node action, for example data formation, data storage, and others. Modules are connected through packet streams or statistic wires. A network object is typically made up of a couple of modules that outline its behaviour [13]-[15].

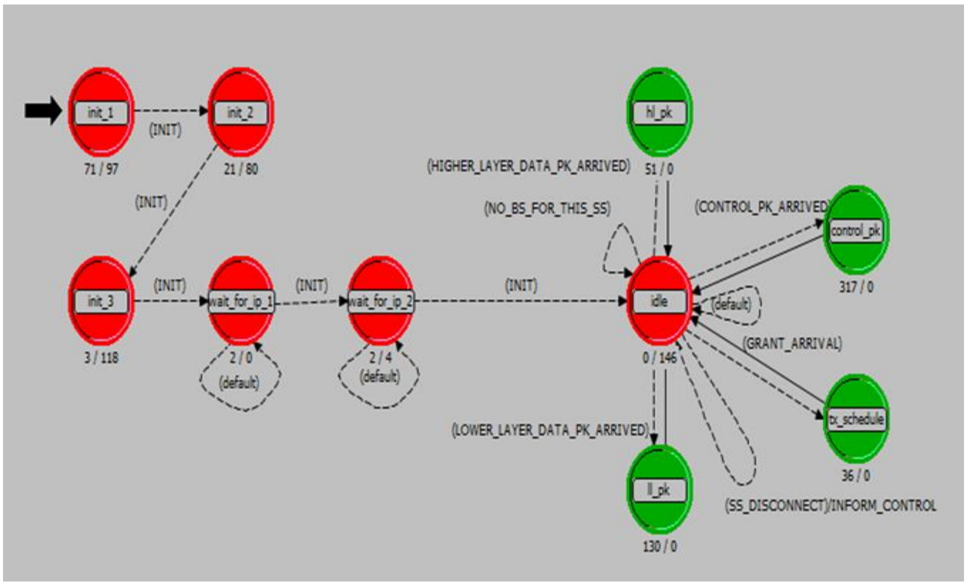

Fig.3 Process Model

The process model is used to create method fashions, which manage the underlying capability of the node fashions created within the Node Editor. Procedural models are represented via finite kingdom machines (FSMs), and are created with icons that constitute states and features that constitute transitions between states. Operations executed in every state or, for a transition are defined in embedded C or C++ code blocks.

3. Results and discussion

We conduct a few simulation scenarios to evaluate the proposed method. In this scenario, both users are set as BE QoS with the distance of 15 meters from the access point. Fig.4 shows the throughput for both users that shows almost the same reading. Throughput for user 1 and 2 are fluctuating with the highest point is between 6kbit/s and 8kbits/s since the application assigned to both users is web browsing. The signal will rise only when the user starts to browse a website and falls back when there is no activities.

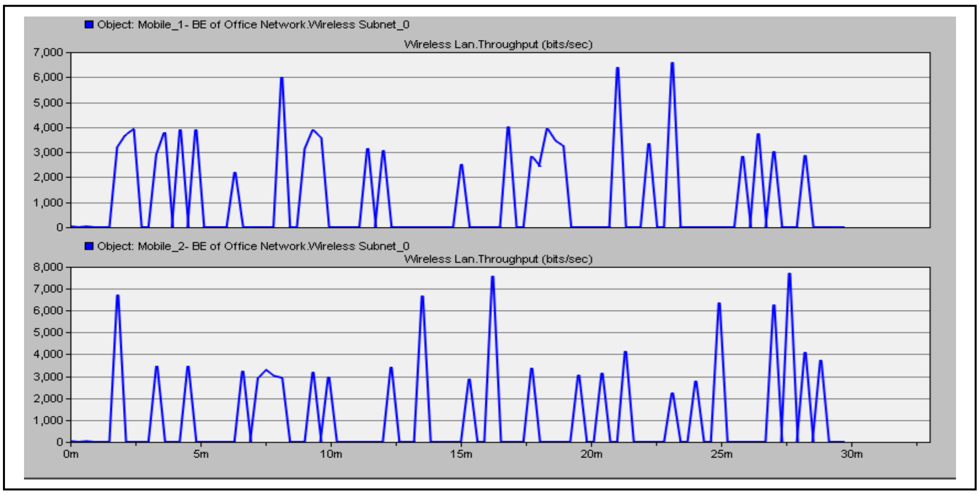

Fig.4 Throughput of BE user for 15 meter distance

In order to deeply understand the behavior of WiFi QoS, next we evaluate the delay and data dropped parameters. Fig. 5 demonstrates the average delay BE QoS for 2 users. There is not much difference between the users due to the same application settings.

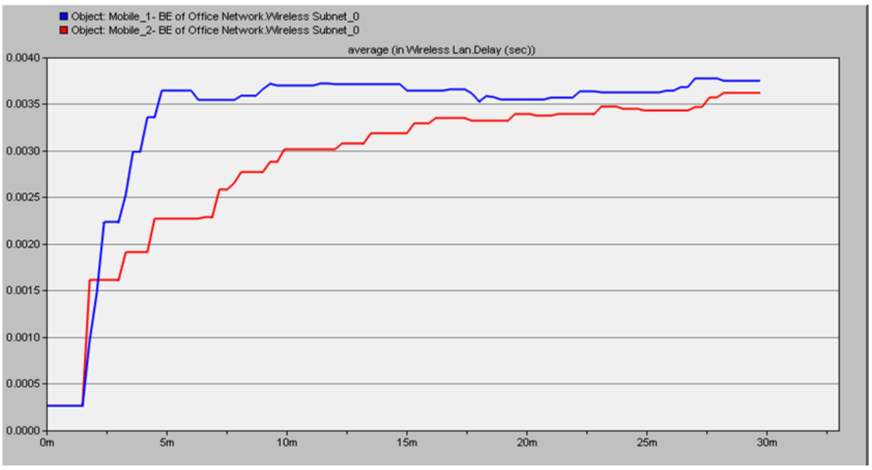

Fig.5 Average delay of BE user for 15 meter distance

Even though there is a delay reading, the data dropped for both BE QoS users are zero. This means that there is no data loss in the network. For both users, all the information is successfully transmitted and received as shown in Fig. 6.

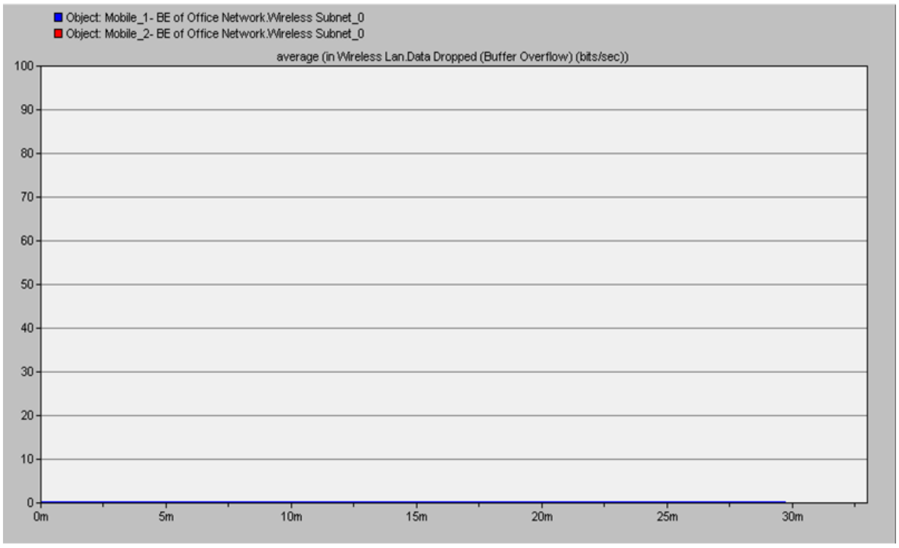

Fig. 6 Average data dropped of BE user for 15 meter distance

In this scenario, we changed the QoS to rtPS with video conferencing as the application. Fig.7, Fig.8 and Fig.9 explain the details based on the simulation outcomes. Throughput for both users remain stable till the end of the simulation time between 800 kbps and 1Mbps. However, delay for both users are utterly high that contributes to data dropped reading which is higher as well. Based on results, it shows that the rtPS QoS is truly sensitive even though it is a guaranteed bit rate QoS.

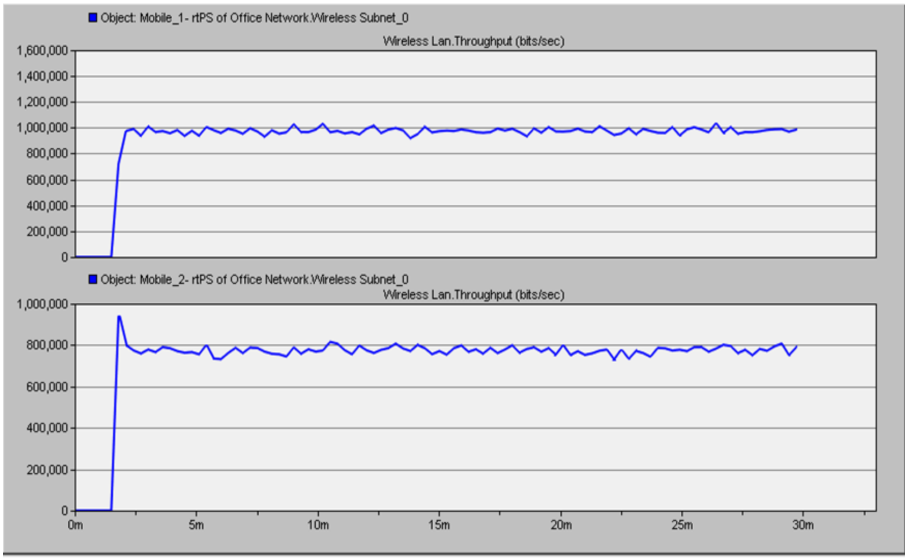

Fig.7 Throughput of rtPS user for 15 meter distance

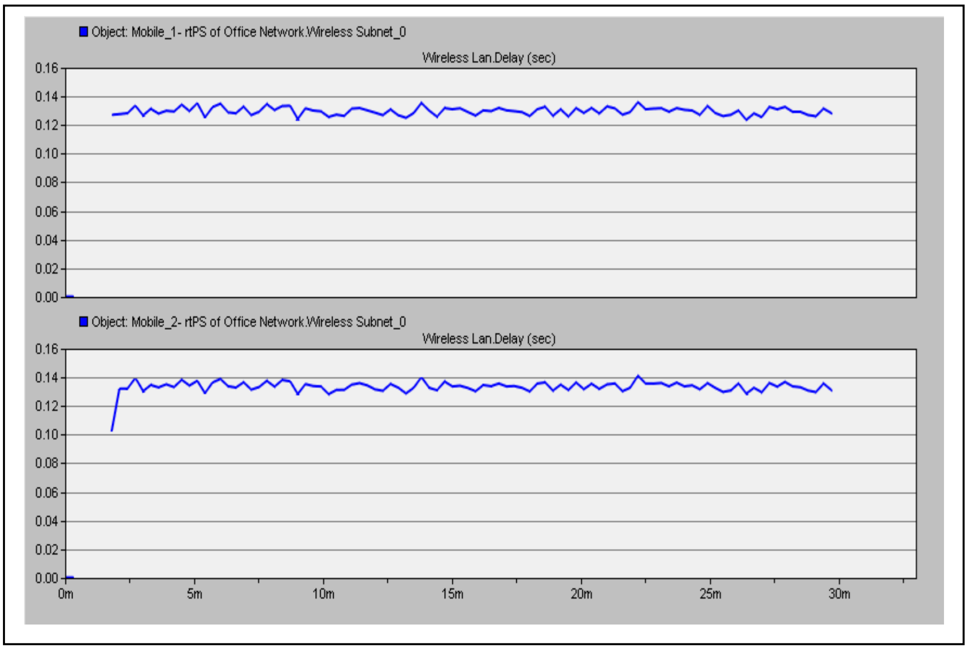

Fig.8 Average delay of rtPS user for 15 meter distance

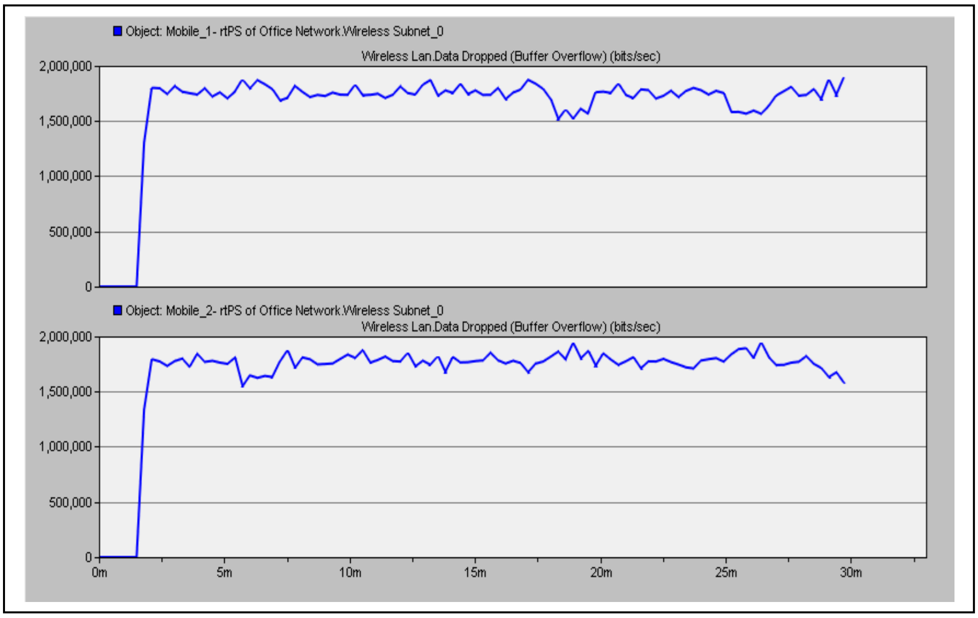

Fig.9 Data dropped of rtPS user for 15 meter distance

As for the further understanding, we assigned different QoS for each different user. User 1 is assigned with rtPS QoS and user 2 with the BE QoS. Fig.10, Fig.11 and Fig.12 demonstrates the simulation results. Both users produce throughput that is applicable to the application assigned which is 3 Mbps for the rtPS QoS and 8 kbps for the BE QoS. Delay for both users are showing the same reading at the end of the simulation time, which is lower than 0.06 seconds as illustrate in Fig. 11. The rtPS user shows a remarkably an increasing delay starting from the first point which affect the loss information. Fig 12 explains that there is a data dropped for the rtPS user compared to zero data dropped for the BE user.

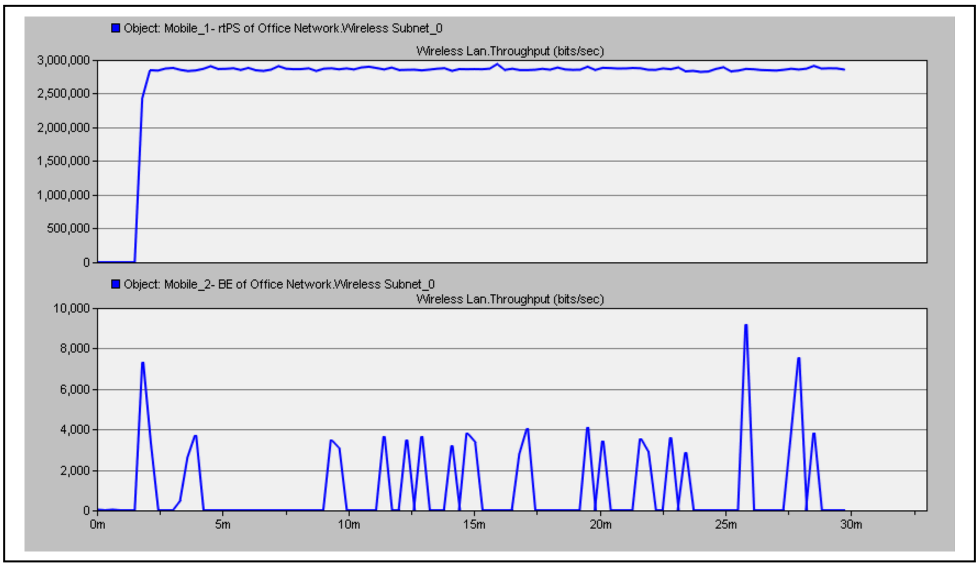

Fig.10 Throughput of rtPS and BE user for 15 meter distance

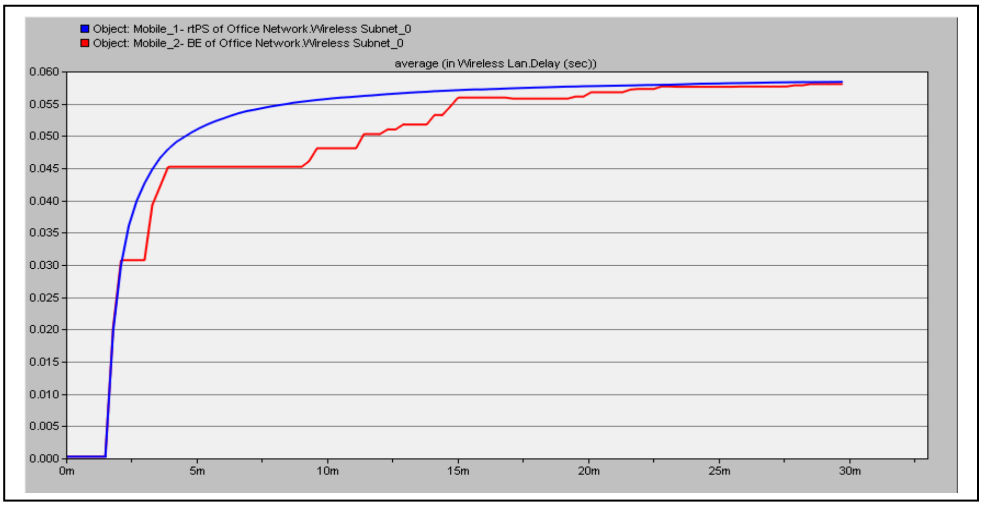

Fig.11 Average delay of rtPS and BE user for 15 meter distance

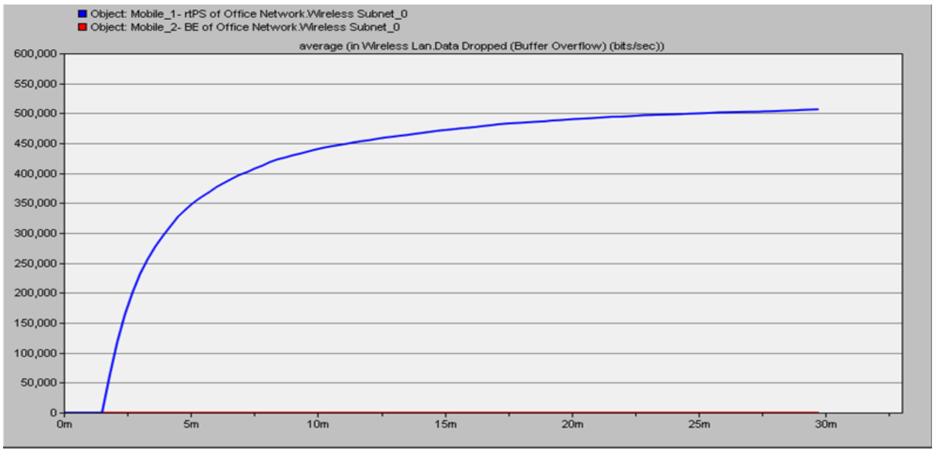

Fig.12 Data dropped of rtPS and BE user for 15 meter distance

4. Part B: Scenario 2

In this part, we expand the simulation environment into further detail to investigate the effect of QoS in WiFi network. We increase the number of WiFi users up to 20 and increase the distance up to 30 meters. The classes of QoS in WiFi network are still the same as previous settings. Also the QoS parameters such as throughput, delay and data dropped are the characteristics that determine the network performance are evaluated in this scenario. Fig. 13 shows the simulation setup in OPNET environment.

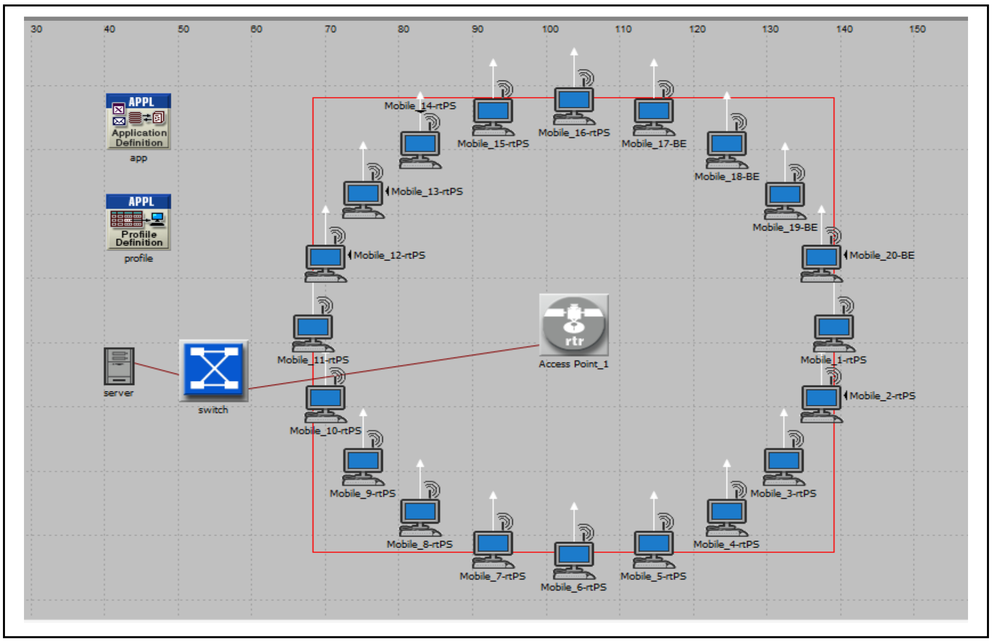

Fig.13: WiFi topology of 20 users for 30 meter distance

Fig.14, Fig.15 and Fig.16 reveal the simulation results when both the number of users are increasing and also the distances between the users and the access point. The users are all set with BE QoS and web browsing as the application. The throughput graph indicates that all 20 BE users are gaining throughput, however in a low range which is in between 400 kbps-160 Mbps. The throughput is all remain stable until the end of the simulation time. The average delay shows almost a same reading for all users, whereas zero data dropped for all the BE users. This explains that the QoS performance for all BE users are stable and all the users are producing throughput even though the quantity is limited.

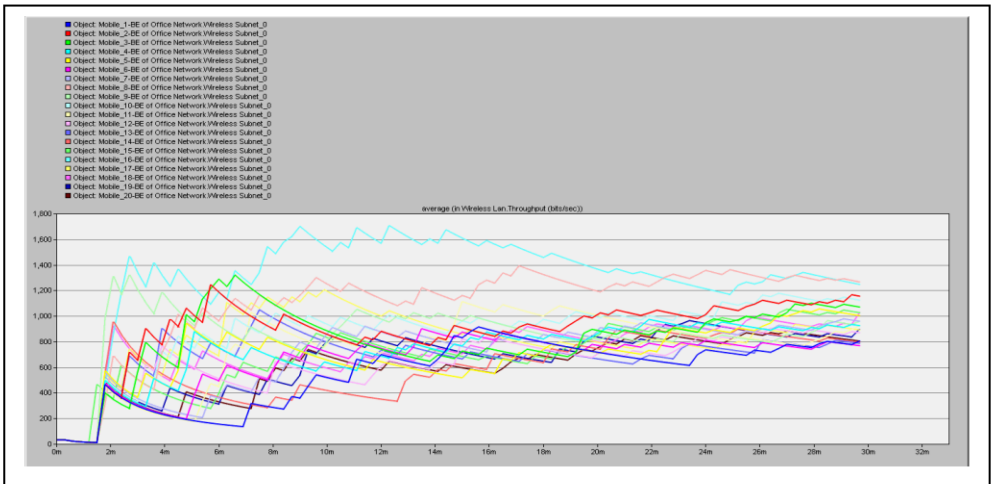

Fig.14 Throughput of 20 BE users for 30 meter distance

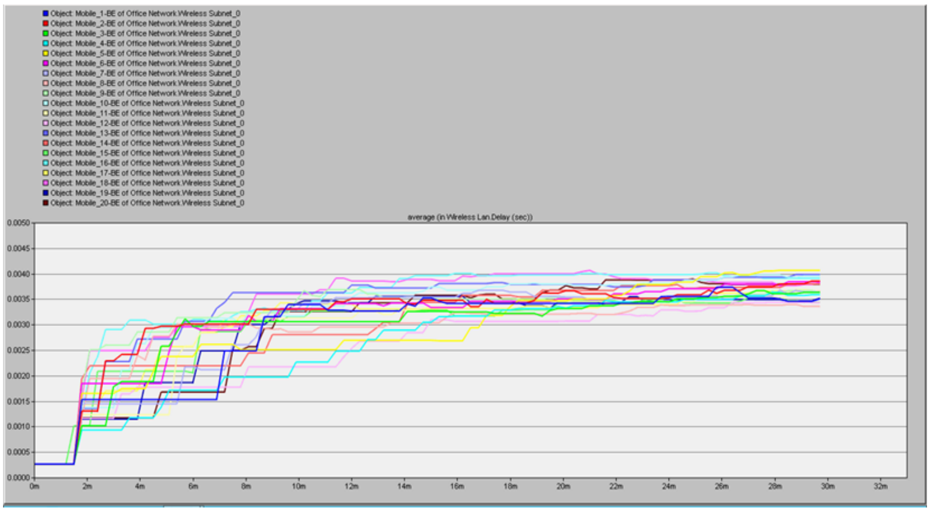

Fig.15 Average delay of 20 BE users for 30 meter distance

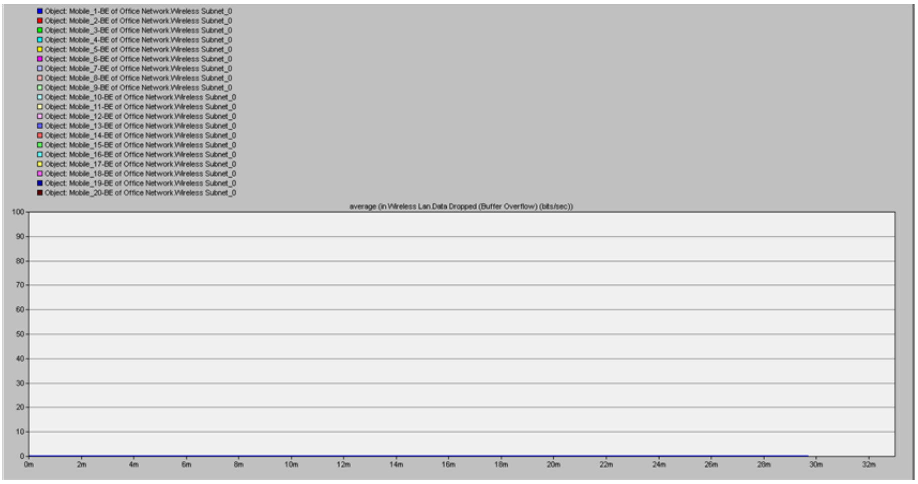

Fig.16 Data dropped of 20 BE users for 30 meter distance

Fig. 17 shows the average throughput for 20 rtps users. It shows that the throughput falls drastically from the starting point which then remain stable in a low range scale. The highest throughput will be around 15 kbps meanwhile the lowest is 5 kbps.

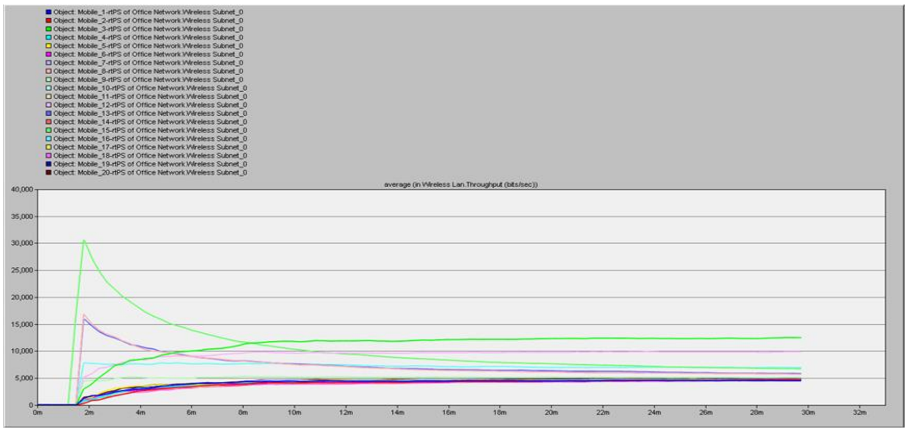

Fig.17 Throughput of 20 rtPS users for 30 meter distance

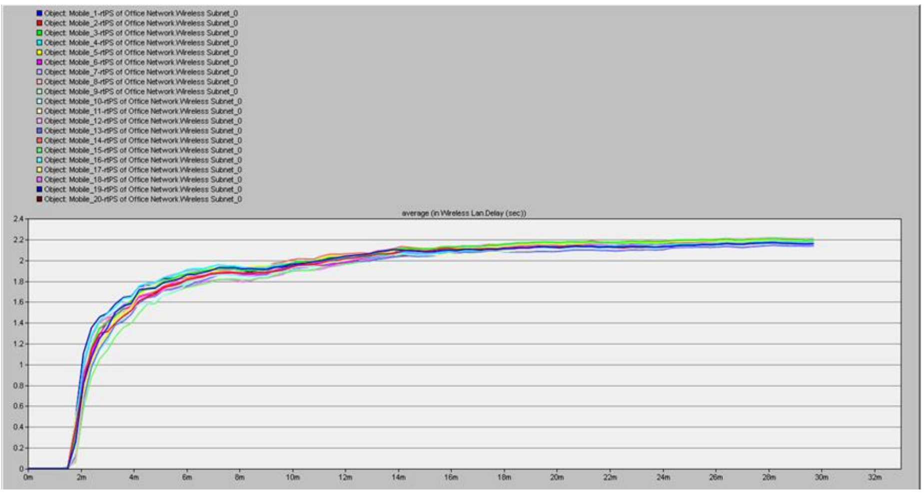

Fig.18 Average delay of 20 rtPS users for 30 meter distance

The delay measured in this scenario recaps a huge rising for this users with the video conferencing. The reading that shows a range in between 2 and 2.2 seconds, which classify as very high delay is degrading the cohesiveness of the video application. This eventually affected the data dropped performance as well. Fig. 19 shows the consequences of data dropped for the rtPS users, which is very high and summarize as unacceptable data loss ranges. The data dropped obtained from the simulation for all 20 users are 3.6 Mbps.

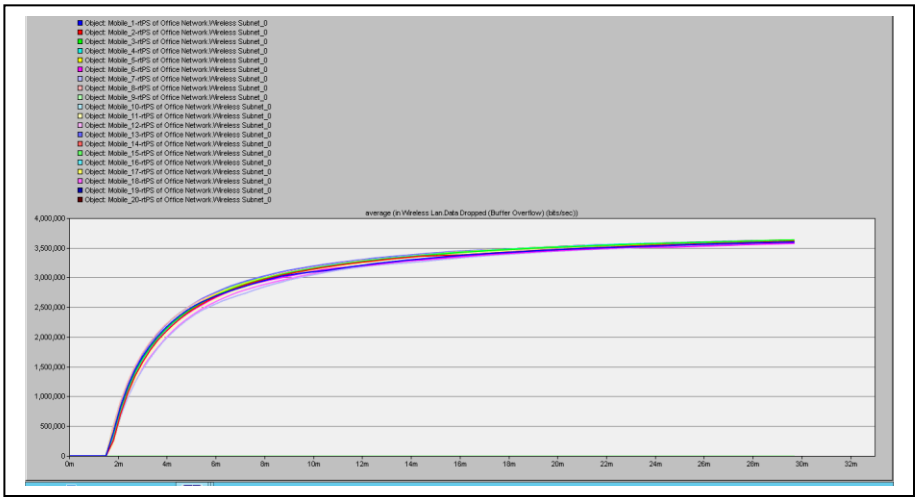

Fig. 19 Data dropped of 20 rtPS users for 30 meter distance

Next we investigate the output when the number of QoS users is equal. In this situation, we analyze the impact when the available bandwidth is given to a balance QoS number. Therefore, we set 10 users with BE QoS and remaining 10 users with the rtPS QoS users. Fig. 20 demonstrates that all the users in the network produce throughput even though some are in the low range and others in the higher range. Despite the limited bandwidth, all users still gaining throughput.

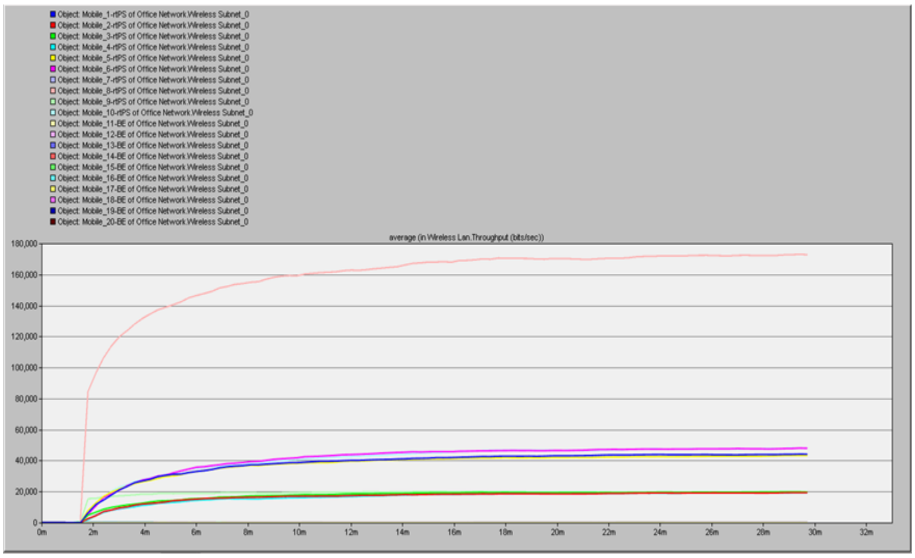

Fig.20 Throughput of 10 rtPS users and 10 BE users for 30 meter distance

In spite of that, delays for all users are considerably as high compare to the previous results. The average delay for the rtPS and BE QoS users' ranges from 0.48 seconds to 0.57 seconds. There is not much different between the rtps QoS and BE QoS since the number of users are equal.

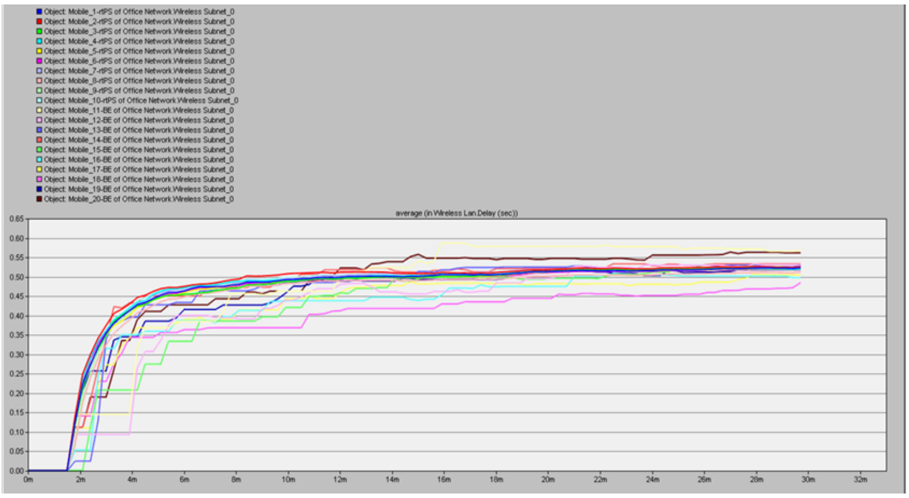

Fig.21: Average delay of 10 rtPS users and 10 BE users for 30 meter distance

Fig.22 shows the data dropped results indicates that there is no data loss for the BE QoS users, however rtPS users experienced a high data dropped which is around 3 Mbps.

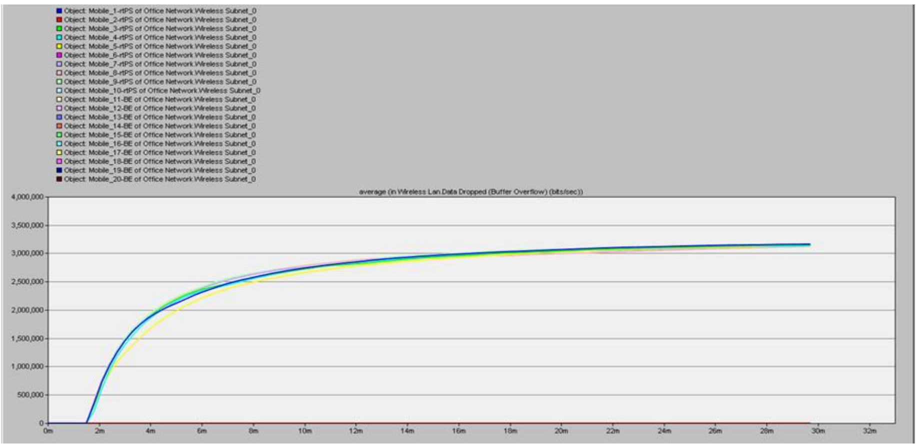

Fig.22: Data dropped of 10 rtPS users and 10 BE users for 30 meter distance

5. Conclusion

The table shows the summary based on the results obtained. Commonly known that BE QoS is the best available QoS which means the total bandwidth will be divided fairly among the users in the network. All the BE users will gain a throughput, with a slight delay, however no data loss. The Throughput for each BE users are quite small and likely the same which is the range of 8-9 kbps. When we changed the QoS of the users from BE to rtPS, total throughput for both users increasingly high. A higher data gain will make the users satisfied, however, it also causes the delay and data dropped reading to intensely high. Even though rtPS QoS is in the guarantee bit rate QoS classes, based on these results the data dropped value is outweigh the data achieved by the user. To discover the optimum result, we include the same number of QoS as an effort to a balanced output. Based on simulation results, total throughput in the network, increasing thoroughly which produces the highest throughput compared to the previous QoS allocation. For each QoS user, the throughput gain is adequate for the application assigned. For example, throughput 3 Mbps for video conferencing application and 9 kbps for web browsing that is sufficiently accepted. Delay for both users show almost the same reading and showing a raise value, however, it is still on a small-scale and under the acceptable delay for each application. For the rtPS user, there is still showing data loss during the transmission nonetheless it is very low because of the delay factor. As for the BE user, the data dropped shows a zero reading.

Table 2. Summarization of WiFi QoS

WiFi QoS	Parameter		
	Throughput	Delay	Data Dropped
All BE	Total : 15 kbit/s	0.004 s	0
All rtPS	Total : 1.8Mbit/s	0.14 s	2Mbit/s
BE=rtPS	Total : 3.8Mbit/s	0.055 s	500 kbit/s

When we include more users in the network, there is not much difference in the QoS behavior. The performance of each scenario is almost the same as before. Therefore the investigate reveals that the distance between the users and the access point does not affect much on the QoS parameter in WiFi network. However, the network performance of WiFi is degrading based on the fragmentation of the QoS in the network itself. This new discovery played an important factor in designing the optimization of WiFi network in terms of QoS parameter which are throughput, delay and data dropped.

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References

[1] Prinima, P. Joythi, "Evolution of Mobile Communication Network; 1G to 5G", International Journal of Innovative Research in Computer and Communication Engineering, vol.4, 2016.

[2] B. Ramia, B. Amin, A, Osman, "A Comparison between IEEE 802.11 a, b, g, n and ac Standards", International of Computer Engineering, vol.7, Issues 5, 2015.

[3] S. Surendra Tambe, "Wireless Technology in Networks", International Journal of Scientific and Research Publications, vol.5, Issues 7, pp 1-3, 2015.

[4] D. Zvikhachevskiy, J. M Sultan, K. Dimyati "Quality of Service Mapping Over WiFi+WiMAX and WiFi+LTE Networks,"Journal of Telecommunication, Electronic and Computer Engineering, vol.5, no. 2, pp. 1–10, 2013.

[5] D. Camps-Mur, et al, "Leveraging 802.11n frame aggregation to enhance QoS and power consumption in Wi-Fi networks," Computer Networks, vol. 56, no. 12, pp. 2896–2911, 2012.

[6] M. Meeran, P. Annus, M. Alam et al., "Evaluation of VoIP QoS Performance in Wireless Mesh Networks", vol.8, Issues 3, pp 1-26, 2017.

[7] (2016) Measuring Delay, Jitter, and Packet Loss with Cisco IOS SAA and RTTMON - Cisco. [Online]. Available: http://www.cisco.com

[8] (2014). Jitter. [Online]. Available: http://www.wikipedia.com.

[9] M.A Alawi, R.A. Alsaqour, E. Sundarajan and M. Ismail, "Prediction Model for Offloading in Vehicular Wi-Fi Network," International Journal on Advanced Science Engineering Information Technology, vol.6, No. 6, ISSN 2088-5534, 2016.

[10] E. Khaili, "Science & Technology WiFi and WiMAX QoS Performance Analysis on High-Level- Traffic using OPNET Modeler", Journal Science and Technology, vol. 25, issues 4, pp 1343-1356, 2017.

[11] (2014) Opnet Modeler. [Online]. Available: http: //www. mil3.com.

[12] J.M Sultan, G. Markarian, J. Jackson, "Hybrid WiFi and WiMAX in Disaster Management for PPDR Services", Journal of Telecommunication and Computer Engineering, vol. 9, No 3, 2017.

[13] J.M. Sultan, G. Markarian, P. Benachour, "Integration of WiFi and WiMAX Services: Bandwidth Optimization and Traffic Combination", International Journal Web Applications, vol.7, 95-108, 2015.

[14] W. Jiang., "OPNET-based WLAN Modeling and its Performance Testing", Chemical Transaction, vol. 51, pp 361-366, 2016.

[15] V. Singh, D. Rai, "Simulation of Network with Cloud Servers Using OPNET Modeler", International Journal of Advance Research and Innovation, vol. 5, pp 315-319, 2017.