END-TO-END QUALITY OF SERVICE SUPPORT OVER UMTS

By

MIOR RIDZUAN BIN CHE BAHARUN

FINAL PROJECT REPORT

Submitted to the Department of Electrical & Electronic Engineering
in Partial Fulfillment of the Requirements
for the Degree
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

END-TO-END QUALITY OF SERVICE SUPPORT OVER UMTS

by

Mior Ridzuan Bin Che Baharun

A project dissertation submitted to the
Department of Electrical & Electronic Engineering
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

Approved:

____

Dr. Mohd Zuki Bin Yusoff
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

May 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Mior Ridzuan Bin Che Baharun

ABSTRACT

End-to-end quality of service are very crucial in determine the quality of a certain network and can be seeing as a successful factor for every mobile network. This paper will discuss the end-to-end quality of service support over UMTS via DiffServ paradigm in achieving the end satisfactory for the customer. Telecommunications industries nowadays are rapidly growing from generation to generation advancement being making by the service provider. In order to tackle every customer, service provider will find a way to enhance their end-to-end quality of service over UMTS to satisfy their customer. In this paper, research for characteristic for UMTS network and DiffServ paradigm have been made in order to understand every criteria for achieving the best end-to-end quality of services for this UMTS network via DiffServ method. Mapping between DiffServ and UMTS network will be simulated and evaluated in OPNET software. Many scenarios will be simulated and will be compared in order to find the best result when using this DiffServ paradigm. Every result from each scenario will be shown in a graph which will be easier to see the differences between the variations of the end delay times for each scenarios mapping. As a solution, from the variations of the end delay time, it shows that DiffServ paradigm give a lower delay time and this means that end-to-end quality of services support over UMTS network via DiffServ paradigm can give the satisfactory services for the end user. In the future, as the advancement keep growing for UMTS network, others research can be done to find another paradigm that can give more end-to-end quality of services satisfactory for end users.

ACKNOWLEDGEMENTS

I would like to thank at my project supervisor, Dr. Mohd Zuki bin Yusoff for giving the opportunity to me to do this project. This project has given me a lot of new knowledge in communication cluster. I would also like to thank at my GA, Mr. Firas Ousta for teaching and guide me throughout this project. His patience and kindness to me in guiding me for this project a highly appreciated. Not forgotten my friend, Mohamad Alghafli who also contributing a lot in teaching me how to use the software for this project. Finally, I would like to thank to all the lecturers and students of Universiti Teknologi Petronas for supporting me and giving me opportunity to complete my bachelor degree of engineering here. I looking forward to pay back all the kindness I get here. Thanks you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 Project Background

Universal Mobile Telecommunication Systems also known as UMTS is the third generation of advancement in communications industry. This system has being developed for a wide range of services and applications for mobile user compare to the first and second generation. [1] This third generation technology basically can transport both voice and internet traffic more efficiently. However, every traffic that being convey on the same medium by this UMTS technology have to meet their different quality of service requirement. This is the main challenge whenever UMTS technology being employ in the mobile communications systems. Generally, quality of service can be defined as a standard measurement that needs to be passed by every service or application when delivering the voice and data traffic. Every service or application needs to be delivered in a quantitative and qualitative service level to the end user. This standard measurement can be quantified by packet loss probability, guaranteed bandwidth, end-to-end delay and jitter; will reflect how the traffic flows through a network. In other way, quality of service can be assuming as the degree of satisfaction of a user for a delivered service. As UMTS keep growing with real time and non-real time services, quality of service also keep higher expectation by the end user. To guarantees the satisfaction of end user, new UMTS mapping development need to be done. As for that, differentiate services or DiffServ mapping with UMTS network has being done in this project in order to meet the new expectation quality of service for the end user.

In this project, as there are two quality of service model that being proposed by the IETF, which is integrated service (IntServ) and differentiated service (DiffServ), DiffServ paradigm will be more emphasize and evaluated throughout the simulation. Apart from that, DiffServ paradigm is the new remedy as it can cope with the scalability and problem faced by the IntServ. In DiffServ, the traffic is classify and differentiated in different traffic class instead of explicit reservation that being introduce by other paradigm. In the other hand, it also provides priority based treatment according to these classes. [2] This UMTS mapping via DiffServ paradigm will be model and will be used to analyse the performance for the quality of service to the end user.

1.2 Problem Statement

Telecommunications industries nowadays are rapidly growing from generation to generation advancement being making by the service provider. Every end user needs to pay in order to get these services. However, for user who pay more to get better services and without affecting other user who pay less, quality of services scheme need to be realize. A priority service has to be given to the users who pay more and normal services still need to be given to the other user. Satisfactory for both user are very important. Quality of service need to differentiate the traffic based on the priority level. Every traffic classes will be evaluated and classes that need more attention will be given higher priority. Here effective quality of service has to be developed.

Other than that, undesirable situation such as call drop, data packet loss while browsing the internet, packet loss during Skype and etc. can affect the end user satisfaction. In order to tackle every customer, service provider will find a way to enhance their end-to-end quality of service over UMTS to satisfy their customer. Due to that, research based on this end-to-end quality of service support over UMTS network is very important in achieving a better quality of service for end user.

1.3 Objective

This project is a research based project on the end-to-end quality of service support over UMTS. The objectives of this project are listed as below:

- To study the guarantee end-to-end quality of service support over UMTS.
- To study the influence of the quality of service via DiffServ paradigm on network parameter such as packet loss, delay and throughput for different quality of service classes.
- To develop a UMTS network mapping via DiffServ paradigm on OPNET software.
- To draw a conclusion for quality of service based on the UMTS network mapping with and without the DiffServ paradigm.

1.4 Scope of Study

This project is study and research based that emphasize on improvement on end-to-end quality of service support over UMTS network. This study will be focus on quality of service architecture which can define the characteristics and functionalities of each layered that can be set up to meet the quality of service requirement. Apart from that, quality of service classes also being emphasized in determines how delay sensitive the traffic is. Each class which is conversational class, streaming class, interactive class and background class characteristics will be evaluated and will be study in this project. Performance requirement of the end-to-end quality of service also can be classified by bandwidth, the delay sensitivity, jitter sensitivity and packet loss sensitivity after we go through each of the quality of service class. Besides that, this project will focus on modelling the mapping between DiffServ paradigm and UMTS quality of service parameter. The DiffServ factor mainly the important thing in quality of service performance for this project. Simulation on mapping from DiffServ code point to UMTS quality of service classes will be focusing in this project in determined the end result of this project. All the simulation and evaluation of the result will be done in Optimize Network Engineering Tool (OPNET) software. Result from the simulation will be graphing systematically and will be comparing with each other to evaluate the effect of the DiffServ paradigm in the UMTS network. Then the result is predicted.

CHAPTER 2
LITERATURE REVIEW

2.1 UMTS Technology

International Mobile Telecommunication (IMT) 2000 is a program that will be establishing a wide range communication system that being proposed by International Telecommunication Union (ITU). In this program, UMTS has being developed that use wide code multiple access (WCDMA) as the radio access method. This UMTS technology basically is the advancement from the Global System for Mobile Communications (GSM) technology but it has more service capacity and many other features that can enhance the data traffic compare to GSM technology.

UMTS architecture basically consists of three components. The user equipment (UE), the UMTS terrestrial radio access network (UTRAN) and the core network (CN) are the basic component. [3] Each of these components has a different function and it will interact with each other to perform as a network.

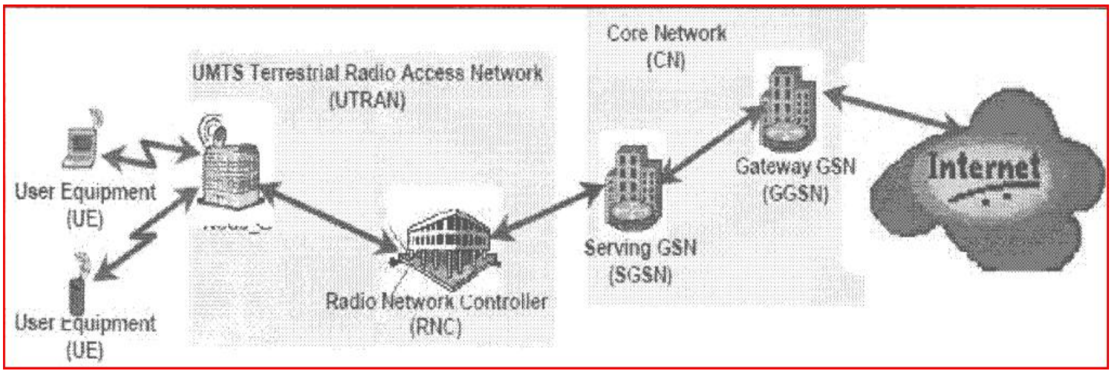


FIGURE 1: UMTS Architecture

2.2 Quality of Service

In communication industry, ‘Quality’ can be defined as a standard performance that need to be achieve by a certain data that go through a network. This performance will be measured by the delay, jitter, throughput and etc. For ‘Service’ term, it convey the meaning of the application that user can enjoy it such as web browsing, mail, video conference and etc. So, for this ‘Quality of Service’ term, we can conclude that it is a set of requirement that need to be achieving by a certain service to the end user. [3]

2.3 Quality of Service Architecture

Quality of service also can be defined as the ability of a certain system that provides a selective treatment in different services in a most cost effective management. This can be decomposed in the different domain and layers of the system. Functionalities of each layer are very different in treating each service according to their requirement. In quality of service, it has a signalling part, provisioning part, seamless mobility part and the overprovisioning part.

Signalling part, it will tell network element how to recognize the packet belonging to which flow by using the flow identifier. From there, network can received the signalling request and decide to admit it or not. Flow will be admitted when there are sufficient resources available. However, flow will be denied whenever it already crowded. In provisioning part, flow that admitted will be treating by each packet and will be configure properly. For seamless mobility, problem occurs whenever there a double reservation. It happen when old reservation remove before new reservation issue and resource occupied previously may assigned to somebody else. Last part which is overprovisioning; this part consists of dimensioning the network such that it can handle all possible traffic without congestion. [4] Every different layer in the subsystem is the combination of the service provisioning.

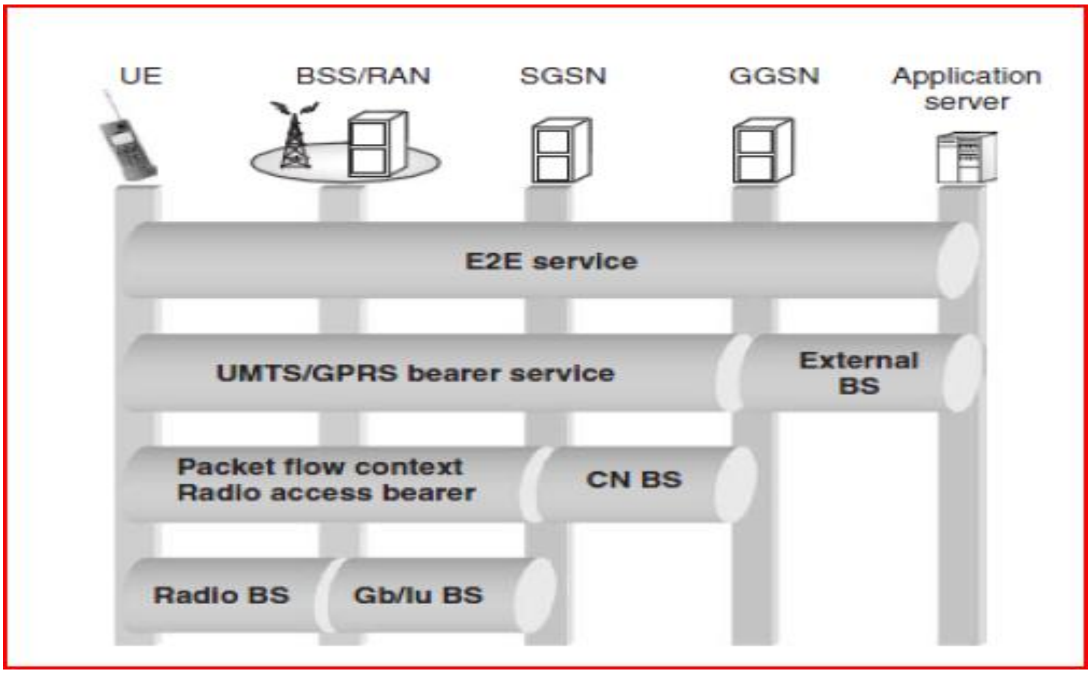


FIGURE 2: Quality of Service Architecture

From this architecture, topmost layer is the end-to-end service layer. Communication between UE to the other will be realizing in this layer. This layer is the important layer for this architecture. Bearer service have to part where there are transparent and non-transparent. For data transmission in bearer service, there are synchronous and asynchronous. In transparent bearer service, layer 1 of the physical layer will function in transmitting the data and have constant delay and throughput if no transmission error occurs. In order to increase the transmission quality in transparent bearer service, forward error correction (FEC) is used. For non-transparent bearer service, layer two and layer three protocols is use in implementing the error correction and flow control. High-level data link control (HDLC) will performing the retransmission of the data whenever erroneous is occurs. [5]

The radio access bearer service functions in providing the transport of signalling and user data between UE and SGSN. In the other hand, the core network bearer service of UMTS core network will connect with the SGSN and GGSN to external network. All this service control and utilize the backbone network efficiently. [6]

2.4 Quality of Service Classes

There are four classes that being introduce by UMTS, which is conversational, streaming, interactive and background class. From these classes, it being divided into two types of category which is real time and non-real time class. Conversational and streaming class categories under the real time class, while the other two, interactive and background class fall under non-real time class. Basically, real time class have more sensitivity on the delay time compare to the non-real time class. For non-real time class, it more sensitive to packet loss compare to real time class.

Firstly, conversational class has a characteristic that preserve time relation between information entities of the stream. It has a pattern that stringent to low delay. Constant bit rate also needed during the communication. Quality of service for this class may reduce when delay time increased due to transferring packet fail. Examples of application that use this class are voice over IP, video telephony, video conferencing and video gaming. Secondly, streaming class also categories in real time traffic class. It characterized by the time relation between sample packets within a flow shall be preserved. Example application is streaming audio and video over the internet. This class has a bit tolerant in delay time due to buffer play a very important role here.

Next, Interactive class has a characteristics that request response pattern by end user. It preserve payload content. Data integrity is highly demand for this class. Low error rate in the data transfer is very important. Example application is web browsing and database retrieval. Lastly, background class has a characteristics that data destination is not expecting the data within a certain time. This class basically is running in the background like when the laptop in the sleep mode. Thus this class is the most delay insensitive and low error data are demanding for this class. Data integrity is highly demanding here. Example applications are sending an email and file downloading. [6]

All of this quality of service classes easier for us to categorize the most important data transfer between end user to the other. From this, delay transfer time can be emphasizing in certain data transfer to achieve better quality of service support.

2.5 Performance Requirement for Quality of Service

Quality of service support over UMTS performance can be evaluate based on their bandwidth, end-to-end delay, packet loss and delay jitter. First, bandwidth is the sum of bits received from the user equipment to the radio network per second. This is very important parameter in the performance evaluation. Different value of bandwidth will be received by the user equipment in different environment. From this situation, gap of bandwidth and the average bandwidth received by user equipment will be varying and the differences give a varying quality of service to the end user.

Secondly, end-to-end delay is defined for time of packet transmission from user equipment to radio network before the handover take place. Lower delay will give a better quality of service to end user and this delay also related to the packet loss. Packet loss can be defined as number of packets lost during the handover while receiving the data from radio network. Lastly, delay jitter is a variable part of the end-to-end delay which is significant factor to evaluate the system performance especially in delay sensitive applications such as Voice over IP (VoIP). This is similar to handover latency just this delay jitter usually implies a stable transmission status. [7]

Performance Requirements Sensitivity				
Application	**Bandwidth**	**Delay**	**Jitter**	**Loss**
Video call	High	Low	Low	Med
Streaming	High	Med	Med	Med
Web browsing	Med	Med	High	Low
Email	Low	High	High	Low

TABLE 1: Performance Requirement

2.6 Differentiate Service (DiffServ)

Differentiated service (DiffServ) is a policy based approach to quality of service support in the internet. Here traffic that will flow in a network will be classified according to different classes and from those classes it will be assigned to different behaviour aggregates. [8]

In the IP packet header, DiffServ will use the DiffSerc code point (DSCP) field in it and from the DSCP it can determine the service type of data traffic by specifying a per hop behaviour (PHB) for that packet. Each packet that has the same PHB class marked on it will be experience forwarding behaviour in the core nodes similarly. It is implemented by means of buffer management and packet scheduling mechanism in the core nodes. For service differentiation for individual or aggregated flows ammeter measures the sending rate of a flows, and a market sets the DSCP fields of packet in the flow at the ages of the network. A dropper discards packets of different flows according to the DSCP fields and the current load with various dropping precedence policies in the core of the network. [9]

2.7 Mapping from DSCP to UMTS

PHB class selector introduces three forwarding priorities which are expedited forwarding PHB, assured forwarding PHB and best effort.

Expedited forwarding PHB (EF PHB) mainly being characterizes by the minimum service rate that can be configurable, independent of the aggregates within the router, and low delay and low loss services. The specified arrival rate will be dropped in advance. Traffic in the conversational class like VoIP matches this DiffServ class very well, the source traffic rate from a voice session is highly predictable, highly delay sensitive, but relatively loss insensitive.

Assured Forwarding per Hop Behaviour (AF PHB) recommend in [RFC2597] for 4 independent classes (AF1, AF2, AF3, AF4) although a DiffServ domain can provide a different number of AF classes. Within each AF class, traffic is differentiated into 3 ‘drop precedence’ categories. The packet marked with the highest drop precedence is dropped with lower probability than those characterized by the lowest drop precedence. AF PHB can support the streaming class, since that class has higher delay constraint than the interactive class, but less constraint than the conversational class. [10]

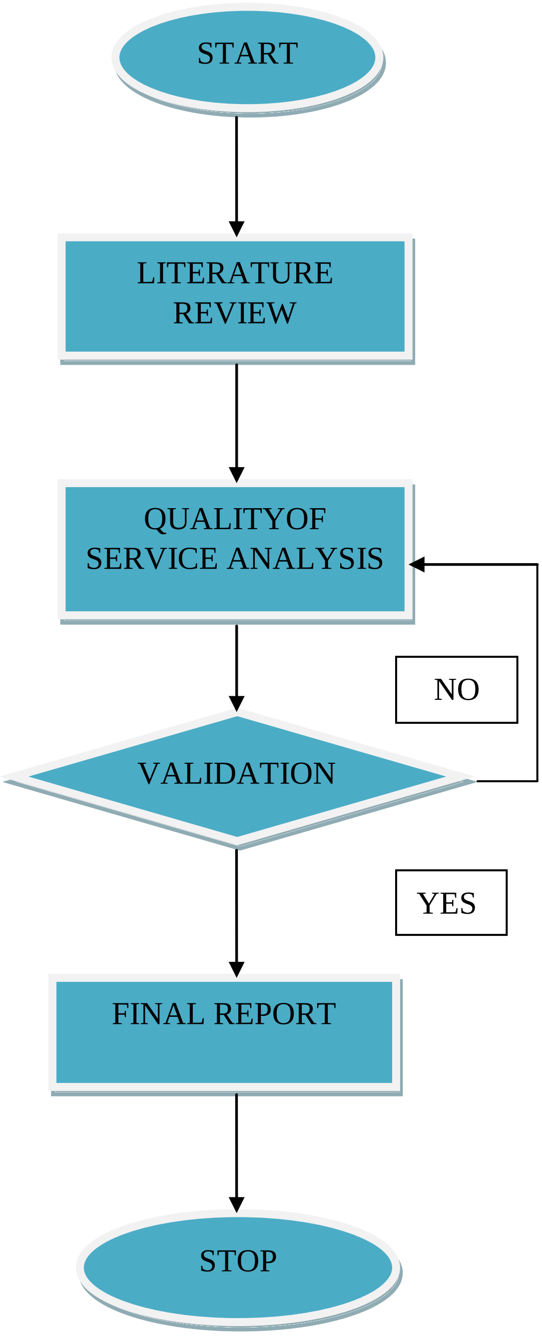
Lastly, Best Effort (BE), which does not provide any performance guarantee and does not define any Quality of Service level. Table below will showed a vertical mapping between the UMTS Quality of Service classes and the IP DiffServ classes.

UMTS Qos Classes	**DiffServ Classes**	**Reason**
Conversational	EF	As it is requires low delay and jitter and PF class guarantees a minimum service level.
Streaming	AF/Class 4	As it is required low variation of delay.
Interactive	AF/Class 3	As it requires low delay but not as low as in conversational class.
Background	AF/Class 2,3 or best effort	As there is no specific requirements for this class except reliability.

TABLE 2: Mapping UMTS Classes onto DiffServ Classes

CHAPTER 3

METHODOLOGY



- Preview and analysis problem
- Analysis problem of quality of service support over UMTS
- Fundamental studies from references and journal.

- Develop accommodation DiffServ to perform mapping procedure.
- Develop mapping of UMTS classes parameters to DiffServ paradigm.
- Develop mapping of UMTS messages to IP network counterparts.

- Simulation analysis using computer based software, OPNET.
- Interpretation of the results.

- Report on the analysis of end-to-end quality of service support over UMTS.

FIGURE 3: The Methodology of Project

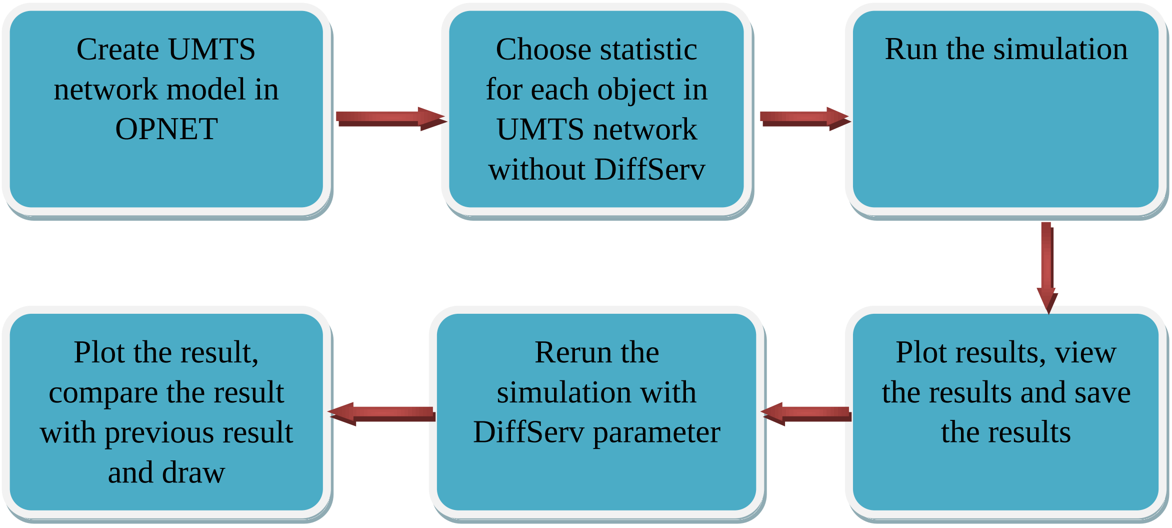


FIGURE 4: Simulation Flow

3.1 Data Gathering and Analysis

The project will begin with literature review on end-to-end quality of service support over UMTS. The literature review is firstly done by studying the quality of service architecture in understanding the function of each layer. Characteristic of each layer will be notified because each of the layers is related to each other.

After understanding each layer, the study can be further done on the quality of service classes. This is to categorize the delay sensitivity for data transfer in order to make prioritized which data need to be transfer first that can improve the quality of service support over UMTS. Then, the studies go further to radio access network (RAN) entities architecture. This is to find the connection between sending equipment with the receiver equipment of the radio frequency which can also affect the quality of services.

After that, developing accommodation of RAN function to perform mapping procedure can be determined after all the research had been done. Then mapping of UMTS classes of service (CoS) parameters to IP network quality of service parameters and mapping of UMTS messages to IP network counterpart also can be develop. From this scheme, suitable method in achieving better solution for quality of service can be implementing.

Then further research for differentiated service (DiffServ) need to perform. All the DiffServ parameters have to be categorized in order to perform a mapping between the Quality of Service UMTS via DiffServ. Project and scenario based on the mapping Quality of Service UMTS via DiffServ needs to be created for the simulation.

After all the research been considered, then simulation evaluation on OPNET can be performing. From this simulation evaluation, the best scheme for improving the Quality of Service support over UMTS can be determine. All the data that achieved will be interpret and documented for further research. Lastly, data result and discussion will be compiled in final report.

3.2 Simulation and Evaluation

The simulation and evaluation will be done after all the research and all the parameters have been taken into consideration. All the simulations in the paper are performed on a Network Simulator, OPNET. The optimization target in the simulation is to achieve end-to-end delay, better delay variation and link bandwidth utilization. So, the Key Performance Indicators (KPI) is:

- End-to-end delay
- End-to-end delay variation
- Bandwidth utilization
- Packet loss

For the simulation, developing the project and scenario is the best way in order to see variation of data whenever the simulation is run and rerun. From that, data collected can be evaluated based on the variation that can meet the best KPI. First scenario will investigates end-to-end Quality of Service provisioning approaches for UMTS networks in a DiffServ IP network environment. It maps from DiffServ to UMTS and measure the end-to-end delay and end-to-end delay variation. Secondly scenario that can be build is hybridize between two models which is DiffServ and RSVP to show the advantages and drawbacks from the hybridize technique.

3.3 Tool Required

The tool required for this modelling and simulation process is Optimized Network Engineering Tool (OPNET) simulator. OPNET is a high level event based network level simulation tool. Every simulation will be operates at packet level. It's originally built for the simulation of fixed networks. OPNET contains a huge library of accurate models of commercially available fixed network hardware and protocols. OPNET also consists of high level user interface, which is constructed from C and C++ source code blocks. Every modelling is divided to three main domain which is network domain, node domain and process domain. Each of the domains will function based on the project and scenario that will be built. Every change can be making easily based on the domain that affected to the project and scenarios.

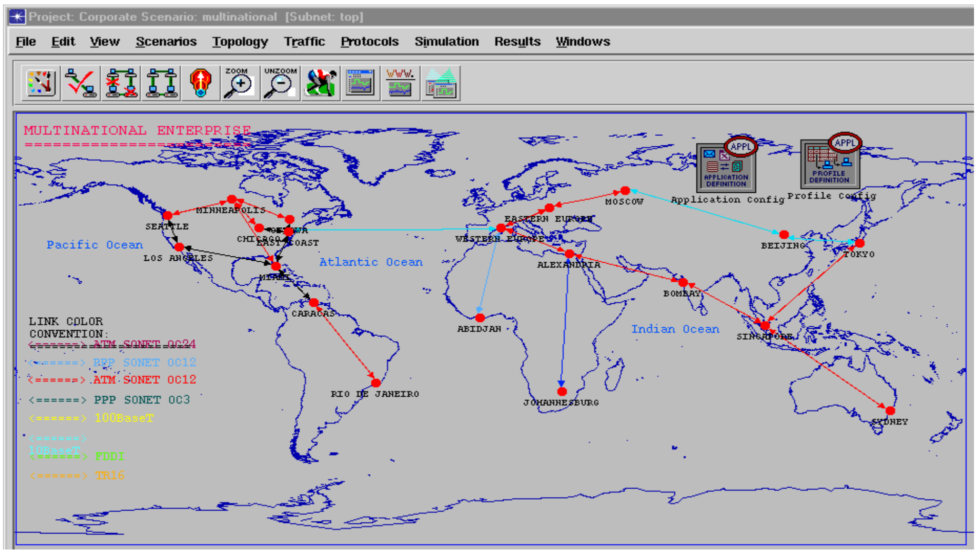


FIGURE 5: Network Domain

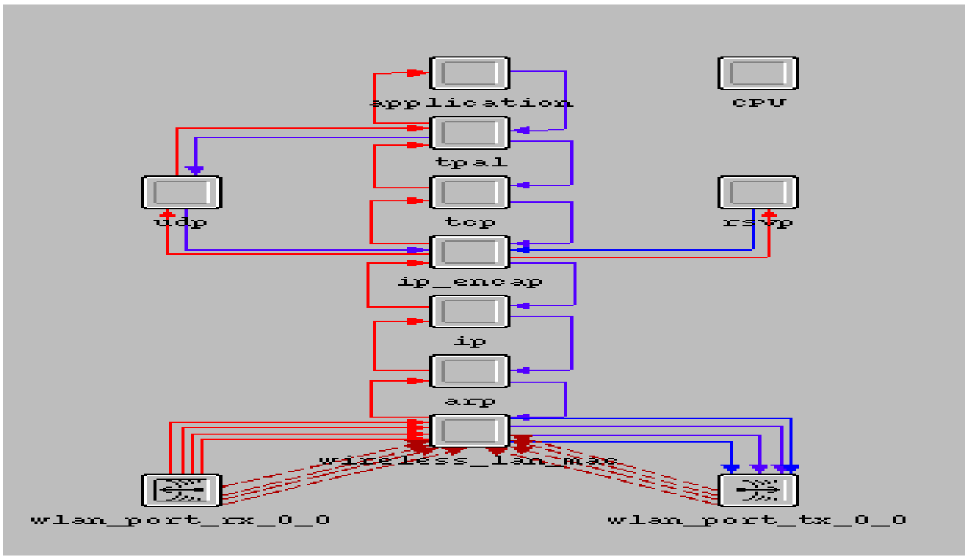


FIGURE 6: Node Domain

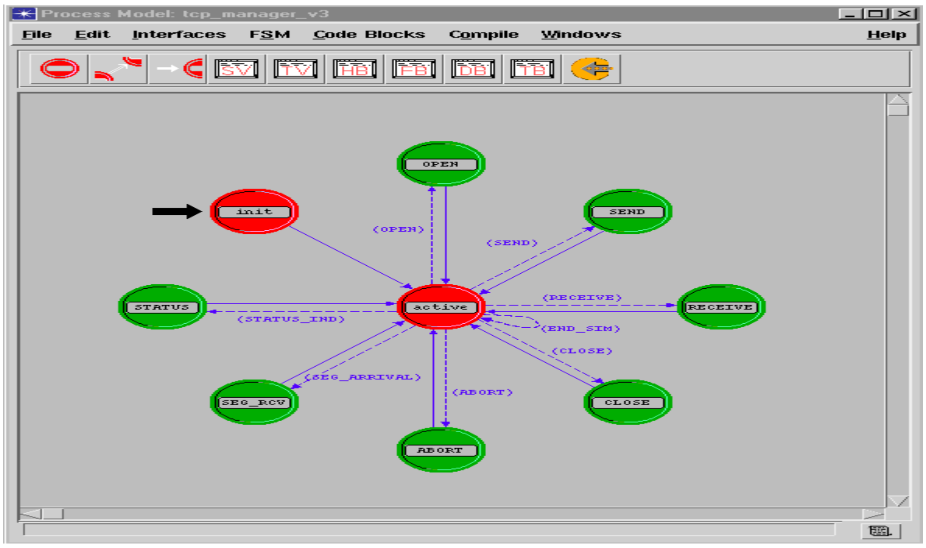


FIGURE 7: Process Domain

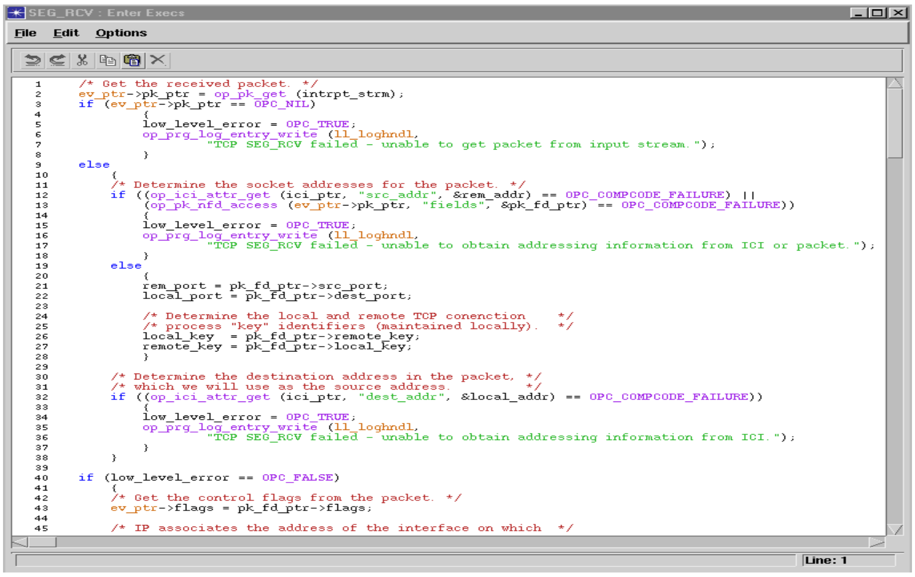


FIGURE 8: Code Level

3.4 Gantt chart

The Gantt Charts below show the timeline of the project for two semesters. The starting and finishing weeks for all activities are illustrated. The schedule for each activity can change from time to time depending on the works progress.

3.4.1 Gantt chart First Semester

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic: End-to-End Quality of Service Support over UMTS	■	■												
2	Preliminary Research Work: Research on literatures related to the topic		■	■	■	■	■								
3	Submission of Extended Proposal						●								
4	Project Work: Study on the research scope and method							■	■	■					
5	Viva: proposal defense and progress evaluation									●					
6	Project work continues: Further investigation on the project and do modification if necessary									■	■	■	■	■	
7	Draft for final report													●	
8	Submission of Interim Report Final														●

TABLE 3: Gantt chart First Semester

3.4.2 Gantt chart Second Semester

No	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Model Development and Modification Work	■	■	■	■	■	■								
2	Testing and Validation Work							■	■						
3	Submission of Progress Report								●						
4	Result Analysis and Discussion								■	■	■				
5	Pre-EDX										●				
6	Submission of Draft Report											●			
7	Submission of Dissertation (soft bound)												●		
8	Submission of Technical Paper													●	
9	Oral Presentation													●	
10	Submission of Project Dissertation (soft bound)														●

TABLE 4: Gantt chart Second Semester

3.5 Key Milestone

A key milestone is constructed to mark the end stage of a work or process of the project. It is an important element in order to monitor the progress and make sure that the project is on schedule. The key milestone for both first and second semesters is as shown in Table 5 below.

FIRST SEMESTER															
No.	**Detail/ Week**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	Completion of preliminary research work								■						
2	Completion of Interim Report (Draft and Final)													■	
SECOND SEMESTER															
No.	**Detail/ Week**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
3	Completion of model development						■								
4	Completion of testing and validation work								■						
5	Completion of results analysis and discussion										■				
6	Completion of final documentation												■		

TABLE 5: Key Milestone for First Semester and Second Semester

CHAPTER 4
RESULTS AND DISCUSSION

From the study above, result for the simulation already in a progress. Mapping between DiffServ and UMTS network have been develop. Figure below show the UMTS network that been create in OPNET based on the specific parameter.

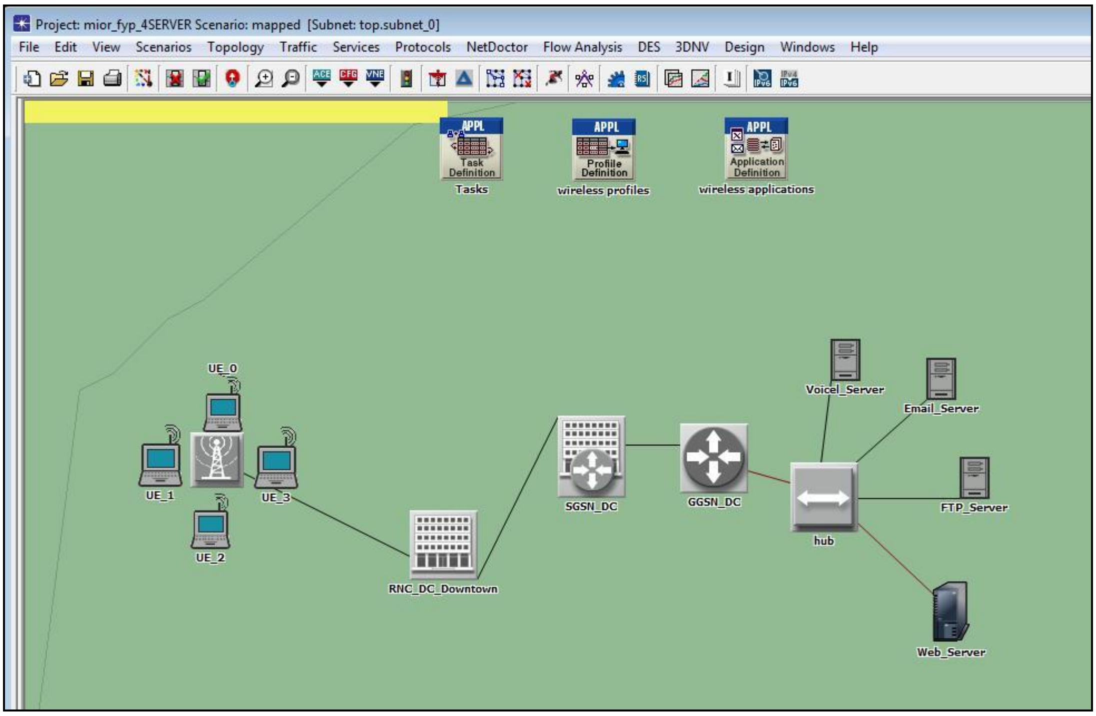


FIGURE 9: UMTS Network Base

This project start with analyzing the basic UMTS network based on the from the literature review. This UMTS network is calibrate with and without the DiffServ parameters in order to get the basic result first for comparing with the others results. Result from this network will be the based result in comparing the quality of service in performance requirement for others network. Result from this network is shown in a graphical way to easier see the varying in delay time with the others network.

4.1 Experiment 1

For experiment 1, we develop the mapping between UMTS network with the best DiffServ parameters. For this experiment highest drop precedence is apply to each class for DiffServ parameters. Figure 10 is calibrating according to this TOS parameters. The configuration is based on the table below:

COLOURS	QOS CLASSES	PARAMETERS
Blue	Conversational	Interactive Voice (6)
Red	Streaming	Streaming Multimedia (4)
Green	Interactive	Excellent Effort (3)
Light Green	Background	Best Effort (0)

TABLE 6: TOS Parameters

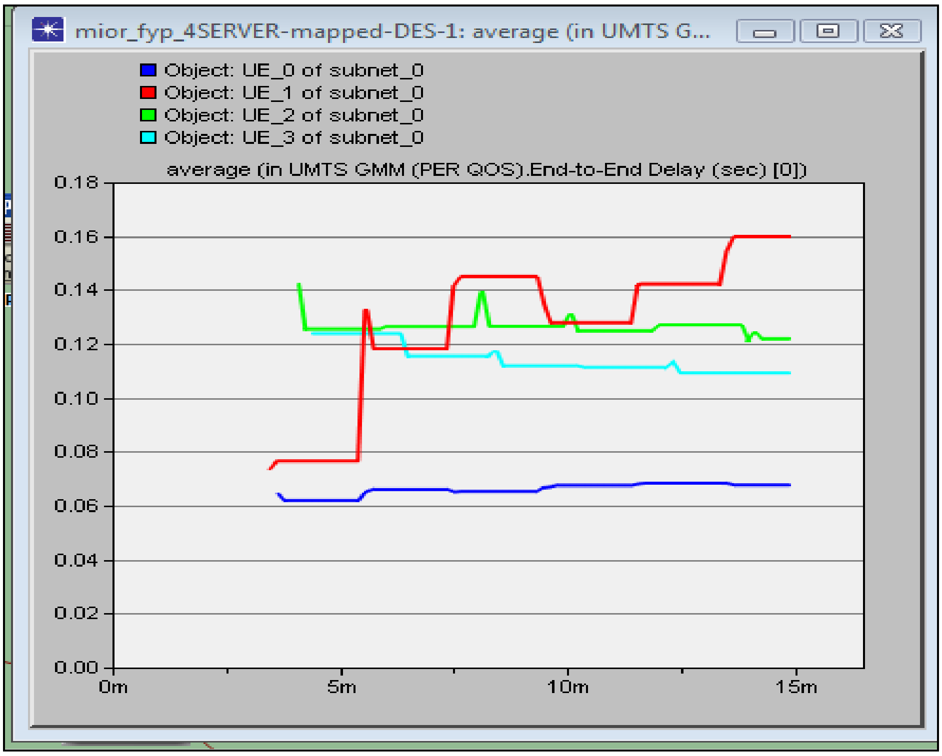


FIGURE 10: Graph without DiffServ Parameters (TOS Based)

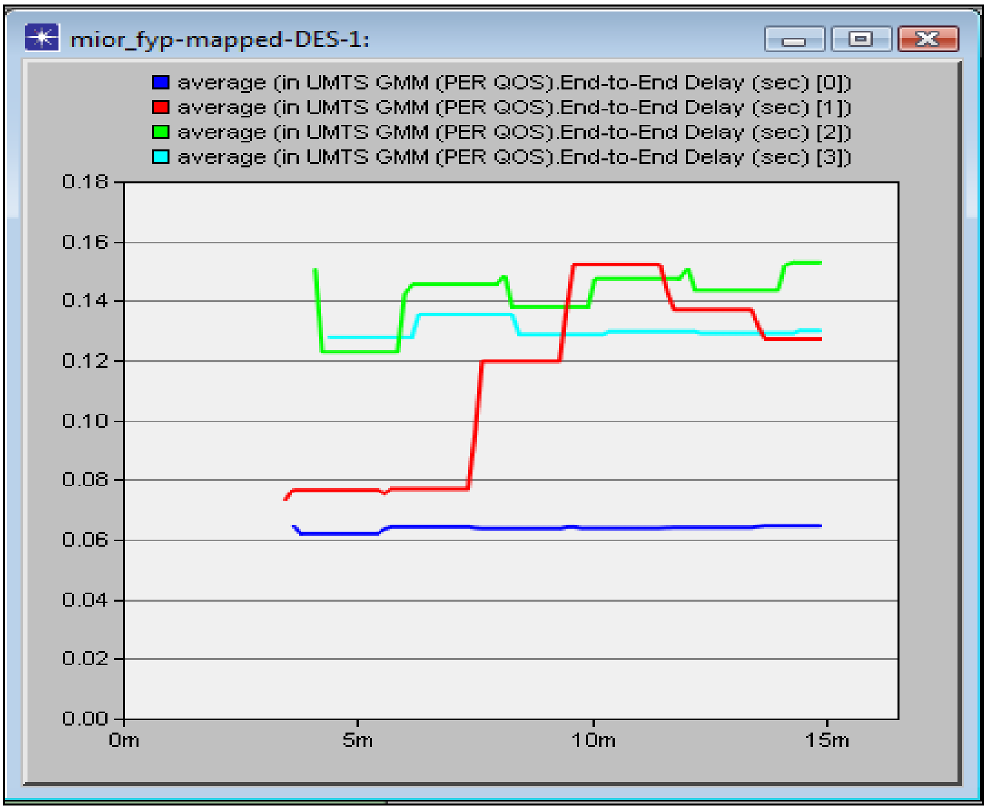


FIGURE 11: Graph with DiffServ Parameters

From the graph above there are 4 lines which represent each of the quality of service classes. This is the average end-to-end delay time graph. For figure 11, the calibration is adjusted to DiffServ parameters as follows:

COLOURS	QOS CLASSES	PARAMETERS
Blue	Conversational	EF
Red	Streaming	AF41
Green	Interactive	AF42
Light Green	Background	AF43

TABLE 7: DiffServ Parameters

From both of the graph above, Conversational class graph for figure 10 show a slightly higher around 0.070 at 15 minutes simulation compare to figure 11 that using DiffServ parameters that show around 0.063 at 15 minutes simulation. Both of the result is comparing at the end of time because from that the average delay time for voice or packet reach to the end user is calculated. Conversational class using the

DiffServ parameters has the lower delay time and it show that quality of service is at the better performance here compare to not using the DiffServ parameters.

Streaming class graph for figure 10 show a lots of increment around 0.160 at 15 minutes simulation compare to figure 11 that show only around 0.125 at 15 minutes simulation. This class also demanding lower delay time and it show here that using the DiffServ parameters quality of service it at the best performance here. Both conversational and streaming classes are the real time type of class which very demanding the lower delay time. Here shows that DiffServ parameters give a guarantee quality of service for a real time type of class.

While for interactive class and background class, the delay time for mapping using the DiffServ parameters shows a higher value compare to the mapping that not using the DiffServ parameters. This is happen due to DiffServ parameters given more priority to real time class in guarantee quality of service. It is not affected much for both of this class because both of these classes more demanding in packet loss requirement compare to delay time requirement.

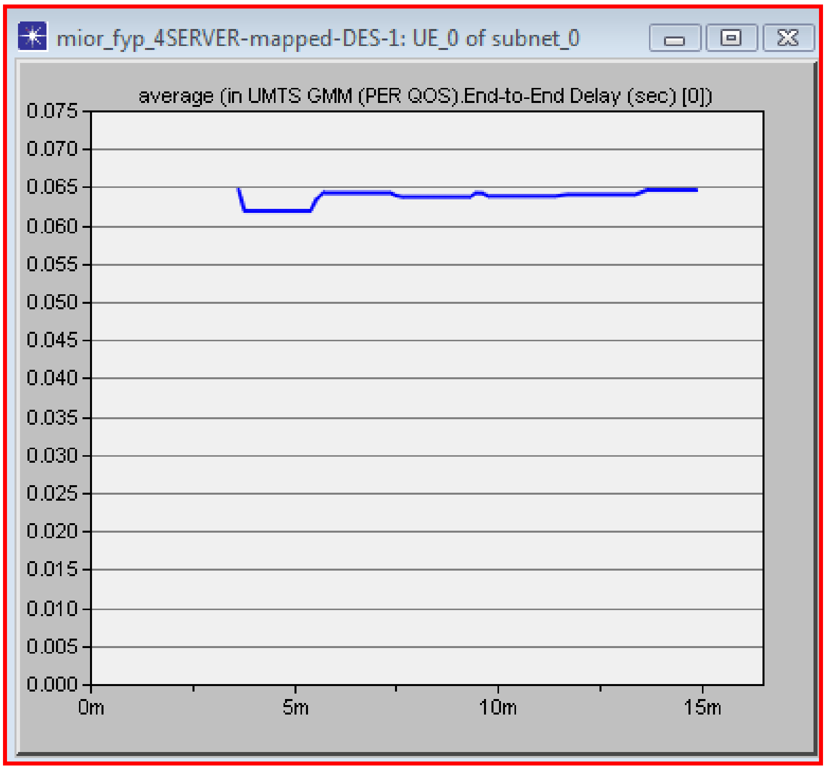


FIGURE 12: Conversational Class with DiffServ

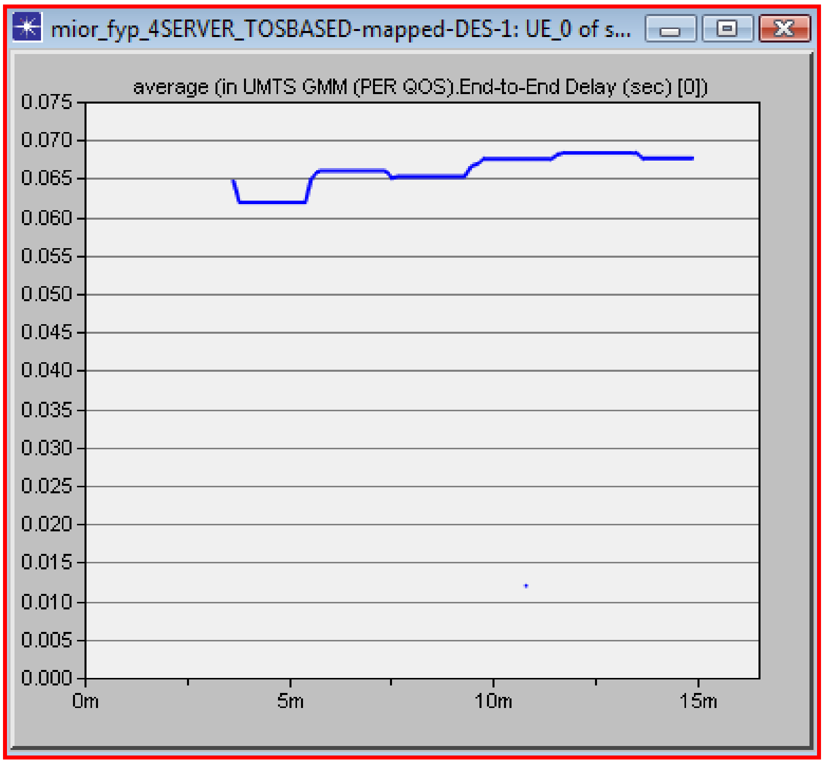


FIGURE 13: Conversational Class without DiffServ

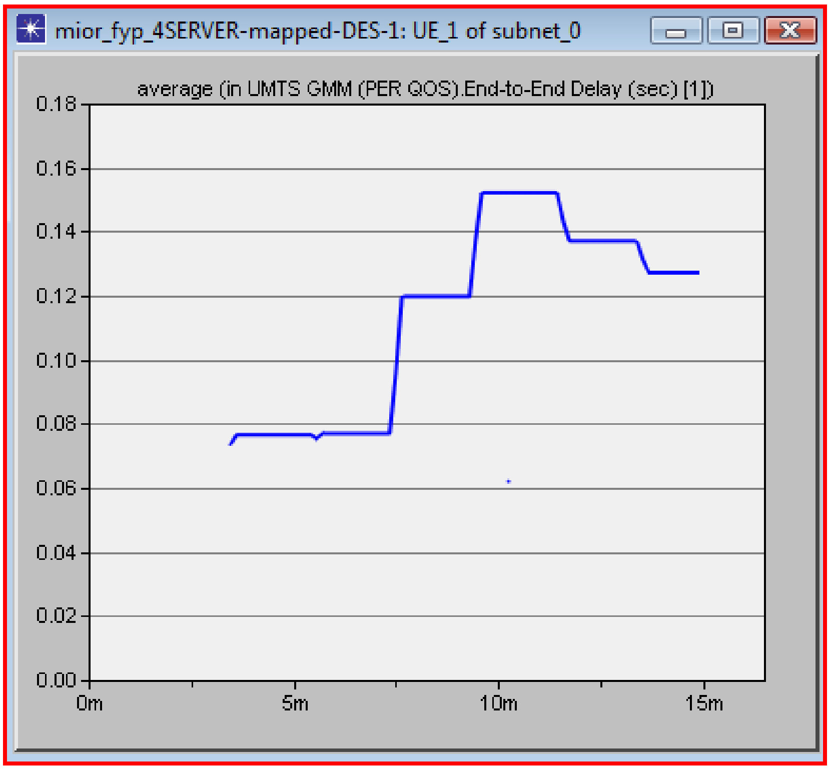


FIGURE 14: Streaming Class with DiffServ

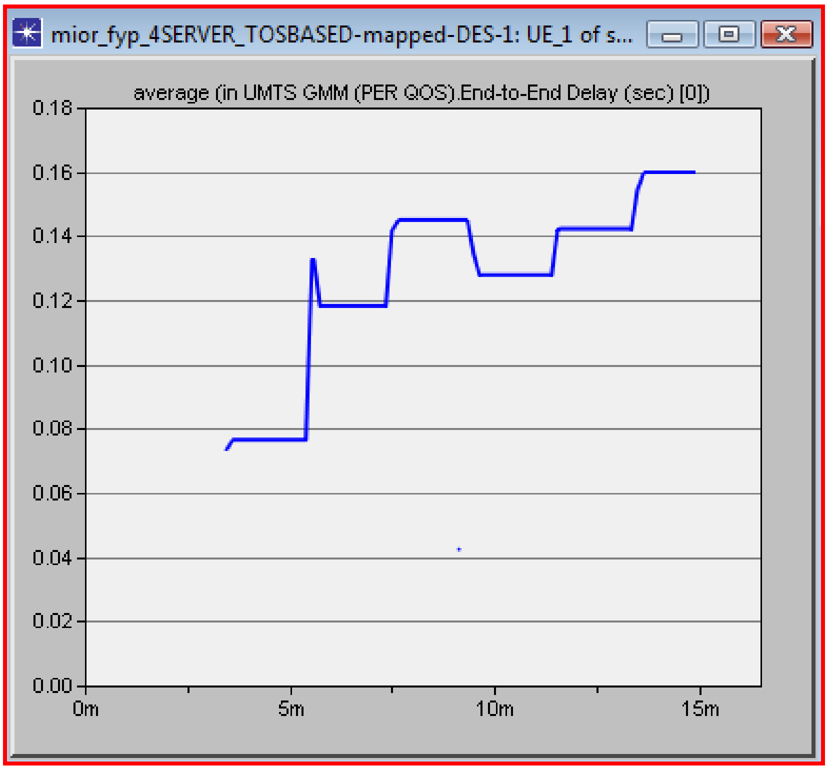


FIGURE 15: Streaming Class without DiffServ

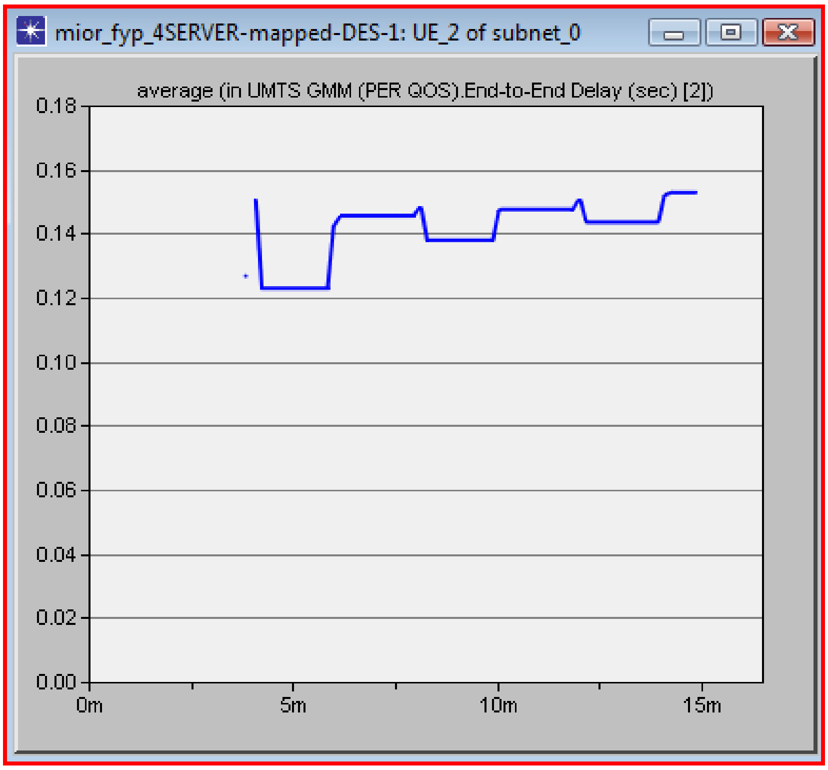


FIGURE 16: Interactive Class with DiffServ

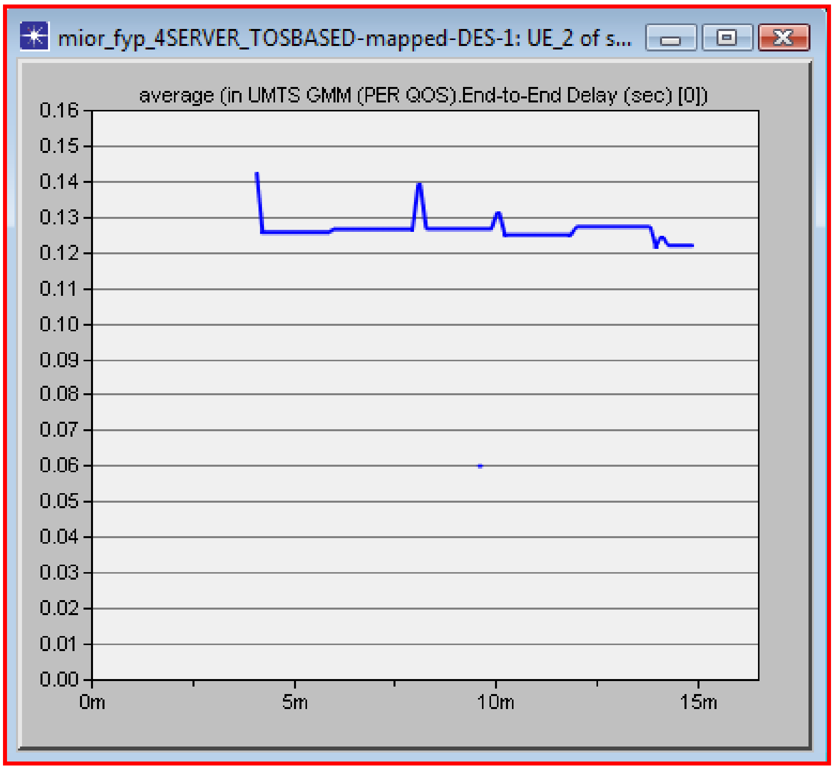


FIGURE 17: Interactive Class without DiffServ

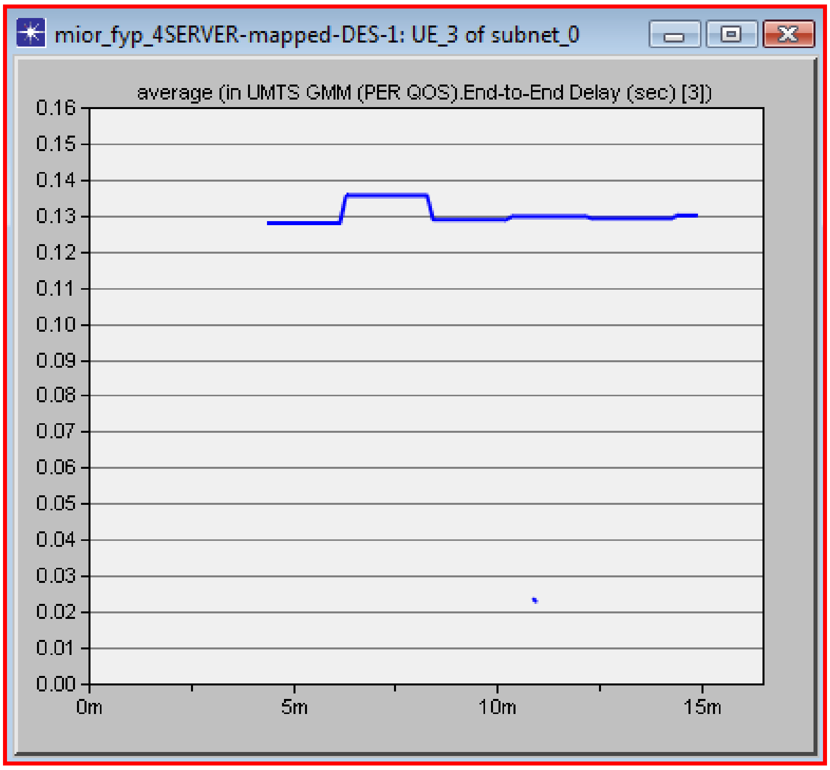


FIGURE 17: Background Class with DiffServ

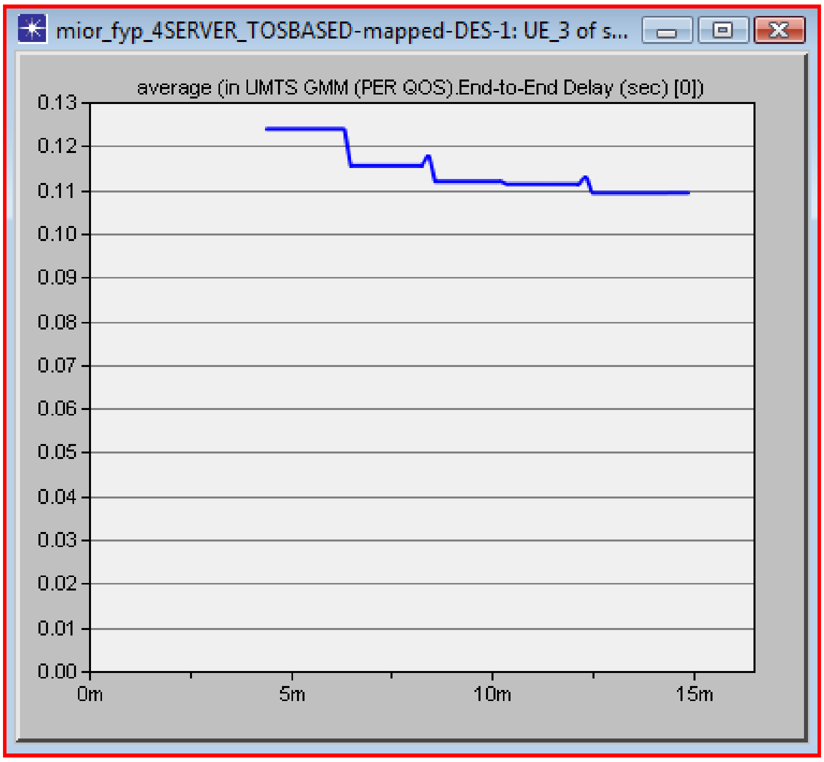


FIGURE 18: Background Class without DiffServ

Based on the graph above, the value for each of this graph is collected and put in this comparative table. From here we can evaluate the differences between network that use DiffServ parameters and not using it. By these differences, we can draw conclusion for each experiment.

	Conversational Class (Sec)	Streaming Class (Sec)	Interactive Class (Sec)	Background Class (Sec)
Without DiffServ	0.068	0.160	0.125	0.110
With DiffServ	0.064	0.130	0.150	0.130

TABLE 8: Comparative Output Result Between with and without DiffServ

4.2 Experiment 2

For experiment 2, we develop the mapping between UMTS network with the lowest DiffServ parameters. For this experiment lowest drop precedence is apply to each class for DiffServ parameters. The parameters for Tos based we use the same from the previous experiment. Table below show the parameters for the DiffServ network:

COLOURS	QOS CLASSES	PARAMETERS
Blue	Conversational	EF
Red	Streaming	AF13
Green	Interactive	AF13
Light Green	Background	AF13

TABLE 9: DiffServ Parameters for Lowest Drop Precedence

From the experiment, the results are shown in graph below. The result for this experiment also will be comparing with the Tos based mapping. Figure 19 and figure 20 show for average time for network end-to-end delay.

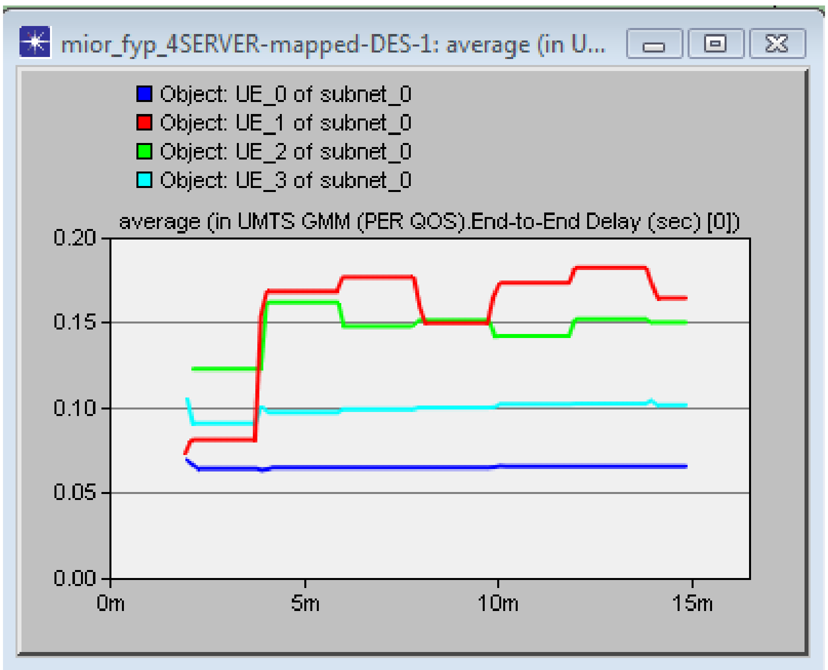


FIGURE 19: Graph with DiffServ Parameters (Lowest Drop Precedence)

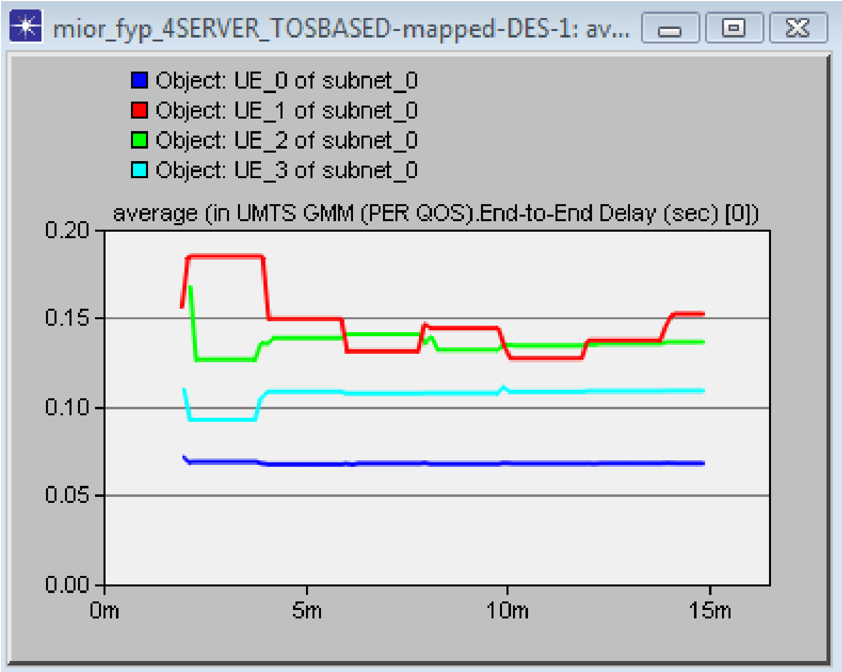


FIGURE 20: Graph without DiffServ Parameters (Lowest Drop Precedence)

Both graph doesn't show a lot of different for the end-to-end delay time for conversational class. However, for graph without DiffServ parameters, we can see a slightly different end-to-end delay for streaming class, interactive class and background class. It show that these class has much lower delay time graph compare to the graph that use DiffServ parameters. From here we can assume that lowest drop precedence DiffServ parameters is not the better solution for guarantee end-to-end quality of service for UMTS network.

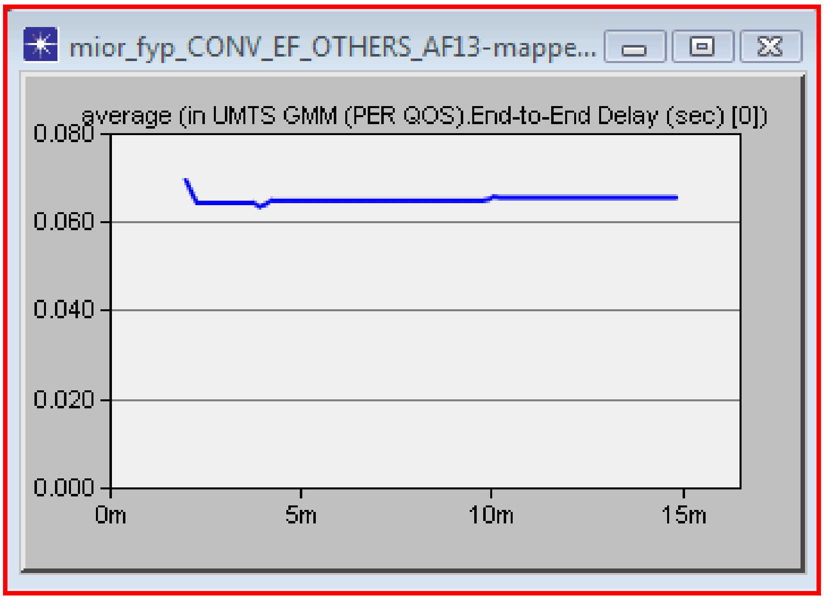


FIGURE 21: Conversational Class with DiffServ for Lowest Drop Precedence

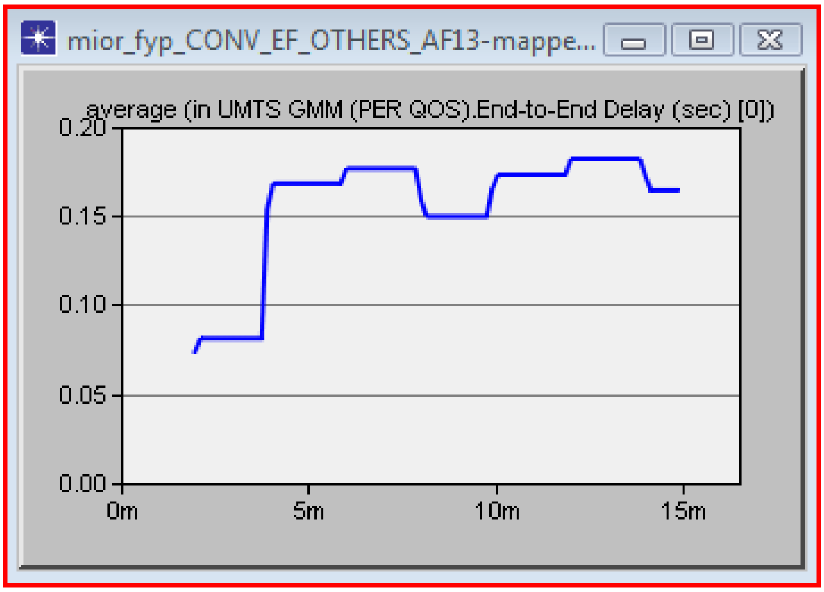


FIGURE 22: Streaming Class with DiffServ for Lowest Drop Precedence

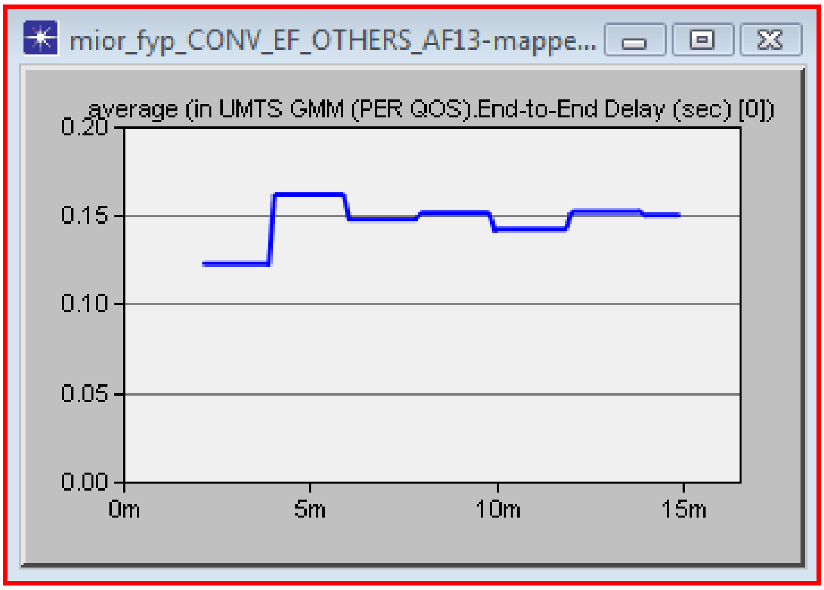


FIGURE 23: Interactive Class with DiffServ for Lowest Drop Precedence

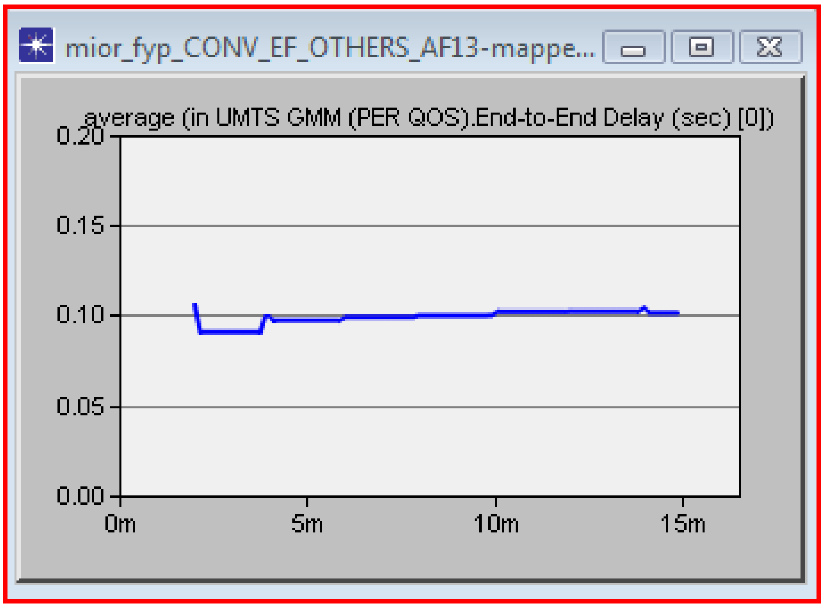


FIGURE 24: Background Class with DiffServ for Lowest Drop Precedence

Based on the graph above, the value for each of this graph is collected and put in this comparative table. From here we can evaluate the differences between network that use DiffServ parameters and not using it for experiment that use lowest drop precedence. By these differences, we can draw conclusion for each experiment.

	Conversational Class (Sec)	Streaming Class (Sec)	Interactive Class (Sec)	Background Class (Sec)
Without DiffServ	0.068	0.160	0.125	0.120
With DiffServ	0.068	0.175	0.150	0.110

TABLE 10: Comparative Output Result Between with and without DiffServ for Lowest Drop Precedence

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In a conclusion, this project is a comprehensive research study about end-to-end quality of service support over UMTS. The project is related to the study on quality of service support over UMTS which is improving the end-to-end quality of service for satisfaction for end users. The improvement on end-to-end of Quality of Service can be achieved by mapping from Quality of Service UMTS via DiffServ. All parameters will be evaluated in order to get the best result of Quality of Service from the simulation. This method has the ability to be success due to many research has been done by the other researcher.

From the studies, we also can find the characteristic in improving the quality of service and then we can develop the simulation evaluation for each of scheme. Besides that, performance factor in improving quality of service can be modifying in minimizing the delay and loss of data packet as lower as possible. Thus, all the connection related to quality of service can be improved from this researched based study.

5.2 Recommendation

For continuation of the project, the best project and scenario for the simulation model should be produced in many ways. The simulation should consist of the best network architecture and other parameters based on a few analyses. After that, the project and scenario for the simulation constructed will be tested and validated on its efficiency and accuracy. The simulation is considered successful if it meets all the objectives of the project.

It is recommended to start the simulation as soon as possible so that more time is available for testing and validation of the data. Therefore, more critical analysis on the data can be done such as to do variation on the end-to-end delay, probability packet loss and optimization of bandwidth for every class of Quality of Service over UMTS and also to every class of DiffServ. Moreover, further studies on Quality of Service and DiffServ are suggested in order to create more understanding on the project and to plan more analysis in the future.

REFERENCES

[1] M. Menth, M. Schmid, H. Heib and T. Reim, "*MEDF – A Simple Scheduling Algorithm for Two Real-Time Transport Service Classes with Application in the UTRAN*", 22nd Annual Joint Conference of the IEEE Computer and Communication with Societies (INFOCOM), Vol. 2. Pp 1116-1122, 2003.

[2] B. Moon and H. Aghvami, "*DiffServ Extensions For QoS Provisioning in IP Mobility Environments*" IEEE Wireless Communications (WPMC), 2005.

[3] Sikder Sunbeam Islam, 8-18, "*QoS Analyses for UMTS Cellular Network",*2008 .

[4] G. Gomez, R. Sanchez, 103-111, "*End-to-End Quality of Service over Cellular Network: Data Services Performance and Optimization in 2G/3G",* 2005.

[5] Jochen H. Schiller, 86, "*Mobile Communication, 1st Edition",* 2000.

[6] Dushyanth Balasubramaniam, 5-7, "*QoS in Cellular Networks",* 2006.

[7] L. Luo, 1470-1479, "*Computer Communications",* 2006.

[8] N. Nasser, "*DiffServ over UMTS*", MATH 884 Projects, Queen's University at Kingston, 2002.

[9] S. L. Shah, "*Bringing Comprehensive Quality of Service Capabilities to Next Generation Networks*", Motorola's White Papers, October 2001.

[10] Mario Marchese, 27-38, "*QoS over Heterogeneous Networks",* 2007.