Performance Analysis of Quality of Service (QoS) in ATM Network using Opnet Modeler 14.5

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Abstract:- Quality of Service (QoS) is the description or measurement of the overall performance of a service, particularly the performance seen by the users of the network. Simulation experimentis applied in Asynchronous Transfer Mode or ATM network. ATM network is a network that integrated some traffic like voice, video, and data, refers to bandwidth allocation and data speed as the user request. The purpose of this research is to analyze QoS performance of ATM network. Experiment method by simulating OPNET Modeler 14.5. OPNET is simulator application which to design a network model and simulate it bygenerating a graph. The network service is Voice, Video, File Transfer Protocol (FTP), and Email. QoS parameter is Cell Transfer Delay (CTD), Cell Delay Variation (CDV), and Cell Loss Ratio (CLR). Experiment result shows that if the number of user is higher, resulting that the value of CTD, CDV, and CLS are higher. Refers to the theory that if the number of user is higher, so many cells is generated and transmitted by the network and make the network is traffic jam and full memory buffer, consequently make the cells need more time to destination. The imbalance traffic has an effect to network performance, the value of CTD, CDV, and CLR is higher. That is due to the single server has high congestion and the client request the service in single server, and for random server, client can request the service in any server.

Keywords:- ATM, QoS, CTD, CDV, CLR, OPNET Modeler 14.5.

I. INTRODUCTION

The development of telecommunication technology is growing rapidly nowadays. With the growing number of communication services, such as voice, video and data services, it takes a greater challenge to provide networks and develop the latest techniques to support an efficient and reliable communication. Various network technologies emerged with the aim to support the communication services that are more diverse so that the communication can run smoothly. One of network technologies is Asynchronous Transfer Mode (ATM).

This technology can fulfil the need of integration of several types such as voice, video, and data transfer. ATM works based on bandwidth allocation and data speed as per user demand. The ATM network is the appropriate network for sending large amounts of data where voice, video, and data will be divided into small, fixed-size packets called cells that are then transmitted over the network to their destination. Some of these ATM technology capabilities

ensure the required performance, support the services for various types of applications, transfer the large amount of data at high speed, and provide good utility for network resources.

The performance of network and good performance on ATM network technology are influenced by the parameter of QoS (Quality of Service). This research aims to determine the performance of ATM or QoS network on the ATM network. Whether the network supports some services such as voice, video conference, File Transfer Protocol (FTP), e-mail, and whether the network qualifies existing QoS network. This study also aims to determine how the influences of the number of users and the impact of imbalance traffic on ATM network performance are.

The QoS parameters that ATM specifies as network performance are Cell Transfer Delay (CTD), Cell Delay Variation (CDV), and Cell Loss Ratio (CLR). Cell Transfer Delay (CTD) is the delay time experienced by the cell between the first bit of the cell transmitted by the source and the last bit on the cell received by the receiver, Cell Delay Variation (CDV) is the difference between the maximum and minimum CTD values that occurs during connection, and Cell Loss Ratio (CLR) is the percentage of cell loss in the network caused by the error so that it cannot be received by the receiver. In the previous research, services used were remote login, video conference, FTP and e-mail by observing CTD, CDV, and CLR QoS parameters as a whole and were not based on each service. On the side of the scenario, it uses two scenarios to influence the number of users. The writer develops it by adding a service such as voice so on the side of services, the services used are voice, video conference, FTP, and e-mail by observing CTD, CDV, and CLR QoS on each service with service category consisting of Constant Bit Rate (CBR) Real Time Variable Bit Rate (RTVBR), Unspecified Bit Rate (UBR), and Available Bit Rate (ABR). On the side of the scenario, it uses five scenarios for the influence of the number of users.

The analysis used in this research is comparative analysis. The comparison is to compare the value of each parameter of the number of users variation and the use of imbalance traffic which refers to the standard value of voice, video conferencing, FTP, and e-mail service quality.

The analysis of the performance of a network is mostly done with the help of software. The software used to model ATM network is Optimization Network Engineering Tools (OPNET). The OPNET type used is OPNET Modeler 14.5.

	CBR, RTVBR	NRT VBR	ABR
CLR- *Cell Loss Ratio*	< 3% RTVBR < 1% CBR	< 3%	-
CDV- *Cell Delay Variation*	< 1 ms	-	-
Max CTD, *Maximum Cell Transfer Delay*	< 2 s	< 10 s	-

Table 1. Quality of Service Standardsin ATM Network

II. RESEARCH METHODOLOGY

A. Research Methodology

This research method uses experimental method. Simulating with simulation software, it is called OPNET Modeler Software and then analyzing the quality of service in ATM network. Output of this simulation process generates a graph. Parameter standards the each of services will be observed.

B. Research Parameter

The object ofthis experiment is Voice, Video Conference, File Transfer Protocol (FTP), and Email. Each of these services has QoS parameters. These parameters will be the research parameters.

The Quality of Service Standards, as follows:
- Cell Transfer Delay (CTD)
- Cell Delay Variation (CDV)
- Cell Loss Ratio (CLR)

C. Collecting Data Method

Data collection method used observation method. Observation method in this research is collecting the output simulation, it is a graph. OPNET Modeler generates a graph for each of scenarios.

D. Analysis Method

Analysis method used descriptive method. It means to describe the simulation results from OPNET Modeler software. Analyzing the output simulationsand knowing how the performance of the network is.

III. NETWORK DESIGN AND SIMULATION

A. Network Modelling

Based on Figure 1, there are 4 (four) subnet components. The subnet is used as a network simplifier in OPNET. Each of subnets has the same base network client server and connected to the central switch of each client server network.
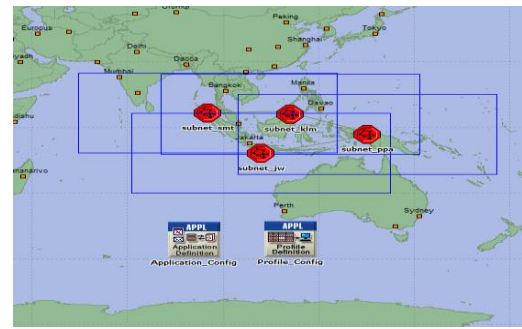

Fig 1:- Network Topology Model

Figure 1.showingthat the topology is suitable with the above planning. There are 4 (four) subnet, each of subnets has client server network.

B. Network Scenarios

Performance each of scenarios will be analyzed. The following scenarios for this research:

- *Scenario 1*

For scenario 1, the type of link is OC3; it has traffic capacity of 155.52 Mbps. This scenario aims to see the effect of the number of users. Initially the number of users in this network is 16 users. How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

- *Scenario 2*

For scenario 2, there is 1 (one) additional userfor each of subnet and switch, so the total of client nodes is 32 users. How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

- *Scenario 3*

For scenario 3, there is 2 (two) additional user for each of subnet and switch, so the total of client nodes is 64 users. How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

- *Scenario 4*

For scenario 4, there is 2 (two) additional user again for each of subnet and switch, so the total of client nodes is 96 users. How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

- *Scenario 5*

For scenario 5, there is 2 (two) additional user again for each of subnet and switch, so the total of client nodes is 128 users. How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

- *For scenario* 6, the type of link is OC3; it has traffic capacity of 155.52 Mbps. This scenario aims to see the effect of the imbalance traffic.How the effect of the number of users to QoS standards, there are Cell CTD, CDV, and CLR is.

C. OPNET Configurations

The configuration is configuration of application node, profile, client, switch, and server. Based on Figure 2

showing that the Application configuration for setting the types of services. In the application attributes, there is Application Definitions which aims to define the application, there are 4 (four) services such as voice, video conferencing, email, and FTP.
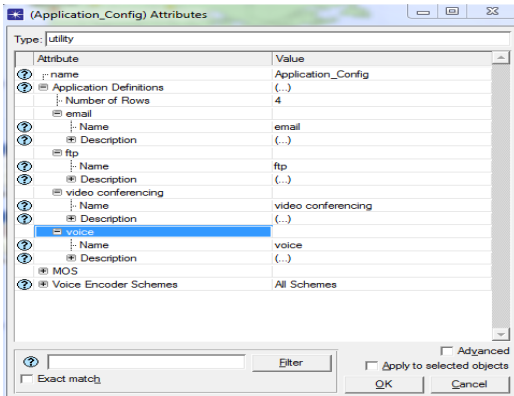

Fig 2. Application Attributes

Based on Figure 3 showing that the Profile configuration for setting the generated traffic and time duration. In the Profile Configuration re-input the type of service. There are 4 (four) services such as voice_p, videoconferencing_p, email_p, danftp_p.
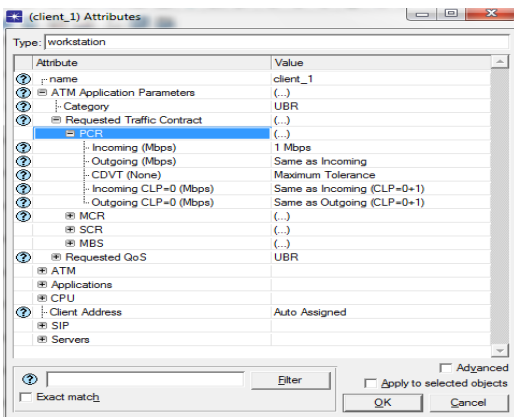

Fig 3. Profile Attributes

Based on Figure 4 showing the traffic parameter configuration. The parameter value is default. This traffic management aims to efficiently and optimize of resource on the network. The PCR value is default, 1 Mbps. The PCR is maximum speed of data that are sent by network users.
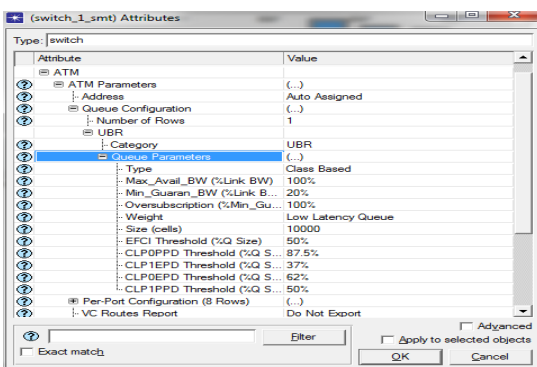

Fig 4:- Client Attributes

Based on Figure 5 showing that the switch configuration for setting category suitable with the type of service. UBR is for email service, ABR is for FTP service, RT-VBR is for voice service, and CBR is for video conferencing service. The parameter value is default. At Min_Guaran_BW(%Link BW) is set to 20%.
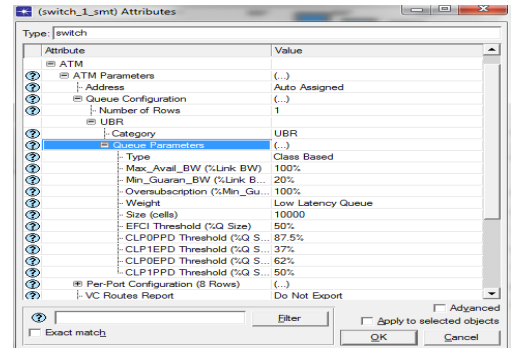

Fig 5:- Switch Attributes

Based on Figure 6 showing that the server configuration for setting Server Address. Server Address is the server address which is set to server_mt. All servers are set and given the server address.
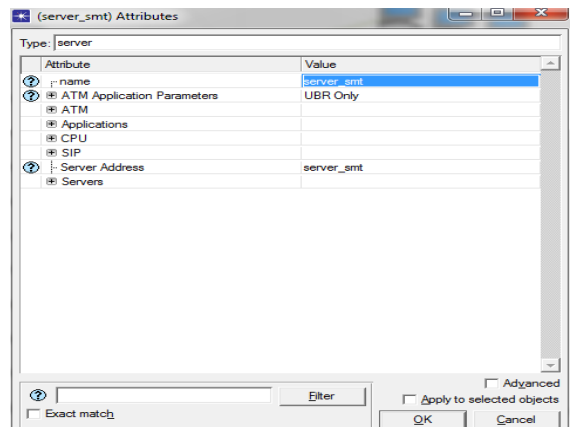

Fig 6:- Server Attributes

IV. RESULT AND ANALYSIS

A. Influence of Number of Node Client
- *QoS Standards for Voice Service*

Based on Figure 7 showing that the graphical comparison between scenario 1 and scenario 5 with the number of users consisting of 16 users, 32 users, 64 users, 96 users, and 128 users for Voice service. The graph is a simulation result for Cell Transfer Delay (CTD) parameter or it is called delay. Based on the graph, the scenario 1 has the least delay compared to another scenario. The value of CTD with 16 users is 0.017662 s, 32 users is 0.018278 s, 64 users is 0.018908 s, 96 users is 0.023255 s, and 128 users is 0.034885 s. This means that the more users, the more cells are generated and transmitted by the network so that the network is congested and buffer. Therefore, the cell needs more time to reach the destination. CTD for voice service comply with the QoS standards in ATM network, it is < 2 s.
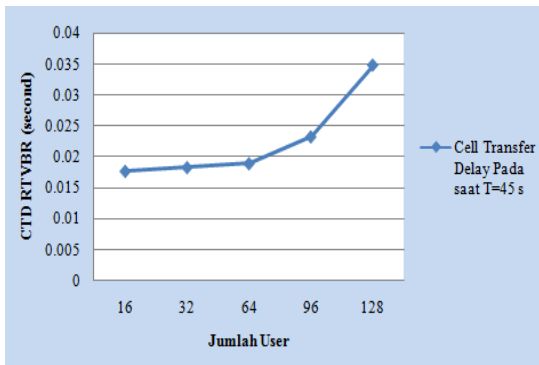
Fig 7:- CTD for Voice Service

Based on Figure 8 showing that the Cell Delay Variation (CDV) or it is called jitter result, the delay variation is greater. Based on the graph, the scenario 1 has smaller variation delay compared to another scenario. The value of CDV with 16 users is 6E-09 ms, 32 users is 9.4E-08 ms, 64 users is 1.2669E-04 ms, 96 users is 1.31215E-04 ms, and 128 users is 2.03552E-03 ms. This means that the more users, the more traffic loads in the network so that causing a congestion and then CDV is greater. The value of CDV in the ratio of number of users comply with the QoS standards in ATM network, it is < 1 ms.
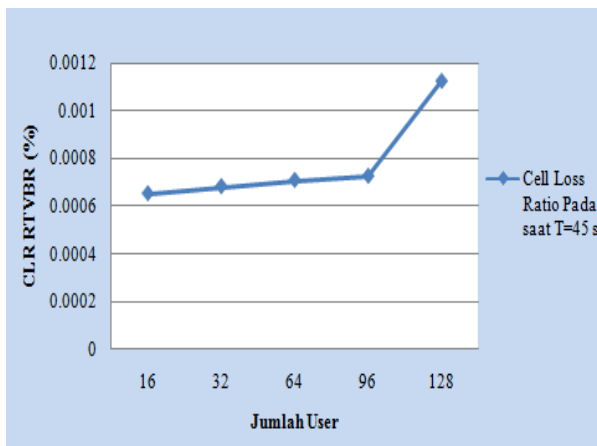

Fig 8:- CDV for Voice Service

Based on Figure 9 showing the graph of comparison resultof Cell Loss Ratio (CLR) or it is called Packet Loss. Packet Loss is used to find out how many packets are lost while transmitting data. The value of Packet Loss scenario 1 to scenario 5 is greater. The value of CLR with 16 users is 0.000652%, 32 users is 0.000682%, 64 users is 0.000709%, 96 users is 0.000726%, and 128 users is 0.001126%. Packet Loss is as a failure of data transmission on the network. In the scenario of the effect of the number of users, Packet Loss is influenced by over traffic and failure on the receiver, because the more users causing an overflow on the buffer so that many cells are lost. The value of CLR comply with the QoS standards in ATM network, it is< 3%.

The equation (1), formula for value of packet loss is:

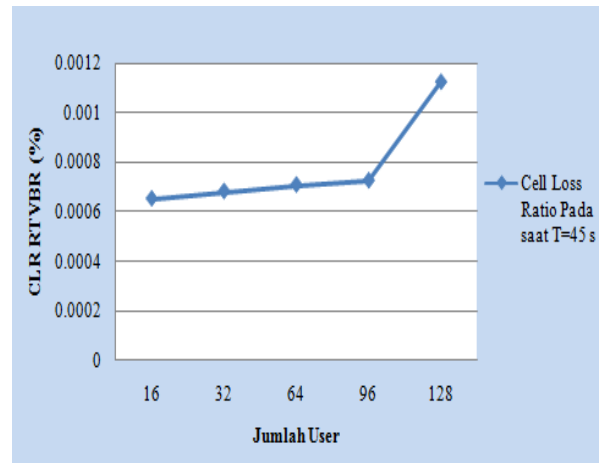$$Packet\ loss = \frac{(Packet\ transmitted - Packet\ received)}{Packet\ transmitted} \times 100\ \%$$

Fig 9:- CLR for Voice Service

Number of Users	Parameter			
	T=45 s CTD (< 2 s)	T=45 s CDV (< 1 ms)	T=45 s CLR (< 3%)	Description
16	0.017662	6E-09	0.000652	Good
32	0.018278	9.4E-08	0.000682	Good
64	0.018908	1.2669E-04	0.000709	Good
96	0.023255	1.31215E-04	0.000726	Good
128	0.034885	2.03552E-03	0.001126	Good

Table 2. Result for Voice Service

Number of Users	Parameter		
	T=45 s CTD (< 2 s)	T=45 s CDV (< 1 ms)	T=45 s CLR (< 1%)
16	0.019912 s	3.13669E-04 ms	0.000883 %
32	0.020728 s	3.80888E-04 ms	0.00103 %
64	0.022841 s	4.69951E-04 ms	0.001034 %
96	0.024789 s	1.0514E-03 ms	0.001048 %
128	0.030298 s	1.76471E-03 ms	0.001225 %

Table 3. Result for Video Conference Service

Number of Users	Parameter		
	T=45 s CTD (Not Specified)	T=45 s CDV (Not Specified)	T=45 s CLR (Not Specified)
16	0.015819 s	2.015E-06 ms	0%
32	0.017178 s	7.887E-06 ms	0%
64	0.0217 s	7.3966E-05 ms	0%
96	0.022006 s	1.52219E-04 ms	0%
128	0.025027 s	2.50436E-03 ms	0%

Table 4. Result for FTP Service

Number of Users	Parameter		
	T = 45 s CTD (Not Specified)	T= 45 s CDV (Not Specified)	T=45 s CLR (Not Specified)
16	0.021222 s	1.082E-06 ms	0%
32	0.021288 s	1.731E-06 ms	0%
64	0.022688 s	2.797E-06 ms	0%
96	0.033512 s	1.04281E-04 ms	0%
128	0.049405 s	1.54012E-04 ms	0%

Table 5.Result for Email Service

B. *Influenceof Imbalance Traffic*
- *QoS Standards for Voice Services*

Based on Figure 10 showing that the influenceof Imbalance Traffic for voice service. Based on the graph that the voice service with single server has high traffic level, it is caused by each of client request the service in the single server and different from the random server that each of client is free to access the voice service from any server randomly. The value of CTD is high on a single server because the delay of each client will need more time to reach the destination and different from the random server that delay is faster because each of client can access the nearest server so that need less time to reach the destination. The value of CTD for random server is 0.016509 s and single server is 0.018219 s. The value of CTD comply with the QoS standards in ATM network, it is< 2 s.
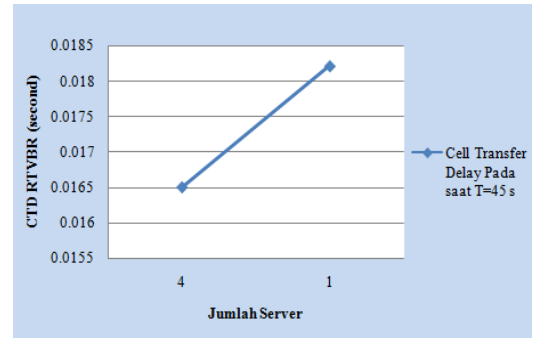

Fig 10:- CTD Imbalance Traffic for Voice Service

Based on Figure 11 showing that the result of CDV for voice service. Based on the graph, the value of CDV is different between single server and random server. The value of CDV for random server is 3E-09 ms and single server is 1.6071E-05 ms, thevalue of CDV comply with the QoS standards in ATM network, it is < 1 ms.This means that single server must serve all clients, so the traffic is overflow compared to the random server that each of client can access the server randomly, it means that distribution of traffic network equally.
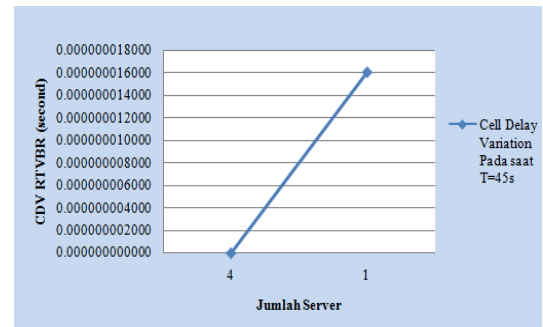

Fig 11:- CDV Imbalance Traffic for Voice Service

Based on Figure 12 showing the value of CLR is increasing on the Single Server. The value of CLR is 0.000615% and 0.000669%, the value of CLR comply with the QoS standards in ATM network, it is < 3 %.This means that the traffic load on the single server is greater than on the random server. However, Cell Loss on the single server and random server is small and comply with the QoS standards in ATM network.
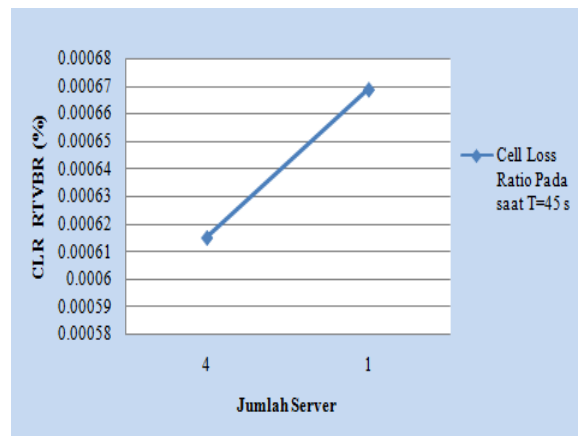

Fig 12:- CLR Imbalance Traffic for Voice Service

V. CONCLUSION AND RECOMMENDATION

A. Conclusion

Based on the result obtained, some conclusions are drawn as follows:

- Based on the overall results of ATM network simulation for the scenario of the number of users and imbalance traffic, it indicates that the generated QoS condition is good in accordance with the standardized QoS provision of the ATM network. Standardization of QoS CTD < 2 s, CDV < 1 ms, CLR < 3% for voice service and number of QoS CTD parameter < 2 s, CDV < 1 ms, CLR <; 1% for video conference service, while there is no providion for FTP and e-mail services.
- The performance of the ATM network can be reviewed from the value of CTD, CDV, and CLR based on the current number of users. This happens because the more users, the more cells are generated and sent over the network so that te network gets denser and buffer becomes full resulted in the cell becomes longer to reach the destination. Therefore, the values of CTD, CDV, and CLR become larger.
- CTD, CDV, and CLR values are for greater imbalance. This happens because with a single server, it will have a high traffic density where each client will request services on a single server, whereas with a random server each client is free to access services from any server.

B. Recommendation

Here are some suggestions that aim to develop this research.

- This research can be developed with other network simulators such as NS2 and OMNeT ++.
- Research can be developed using other variations of services.
- Research can be developed with a bigger variety of user numbers, with more users requiring longer simulation time.

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