

# Development of Emulation Network Analyzer Tool for Computer Network Planning

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## Abstract

*This paper describes the development of Emulation Network Analyzer (ENA) for heterogeneous services in campus environment. The purpose of this paper is to inform this ENA able to plan and predict network performance. For this purpose, our ENA development is differ from others system such as application and hardware network analyzer. This study focuses on the design of emulation network analyzer, user interface design, characteristics, model description, implementation and evaluation. This ENA can provide a useful network architectural solutions and optimization of network resources during preparation, proposal and planning phases. Finally, ENA tool is a good emulation analyzer that can be used in small to medium size networks for campus environment purposes with minimum cost.*

**Keywords:** maximum 5 keywords from paper

## 1. Introduction

Now days there are a lot new technologies and services have been introduced for examples VoIP, Video conferencing, SMS over Internet and Voice conference. The functionality and accuracy of the Emulation Network Analyzer (ENA) has proven in the lab and real network experiments. We have implemented this tool and based on our experiment results show that ENA tool has produced minimum relative error rate compare with hardware network analyzer [1] [2] [3] [4] [5]. Therefore, it contribute significant productivity to campus IT environment for managing their resources management without using any high cost hardware network analyzer or simulation tool. This paper is organized as follow, in section 2, we discuss on tools for network planning and monitoring. In section 3, it will cover on design of ENA. In section 4, we concentrate on implementation of ENA. Finally, in section 5, we discuss briefly on evaluation of ENA tool.

## 2. Tools for Network Planning and Monitoring

Tools for network planning and monitoring can be divided into two types: i) hardware tools; and ii) software tools. One of the examples using hardware tool for monitoring is Fluke Optiview Network Analyzer (refer to Figure 1). This tool can monitor and analyzer network performance based on real time [6], [7]. In addition, this tool able to test and generate traffic into a real network. One of the examples, software tool that can be used to monitor and analyzer network performance is ColaSoft Capsa. This software is developed based on real time. The famous network planning today is Opnet, this tool already used by many institutions but need to invest a lot of money (refer to Figure 2) [8], [9], [10], [11]. Most of the network monitoring development focuses on real time and less of development focus on network planning.

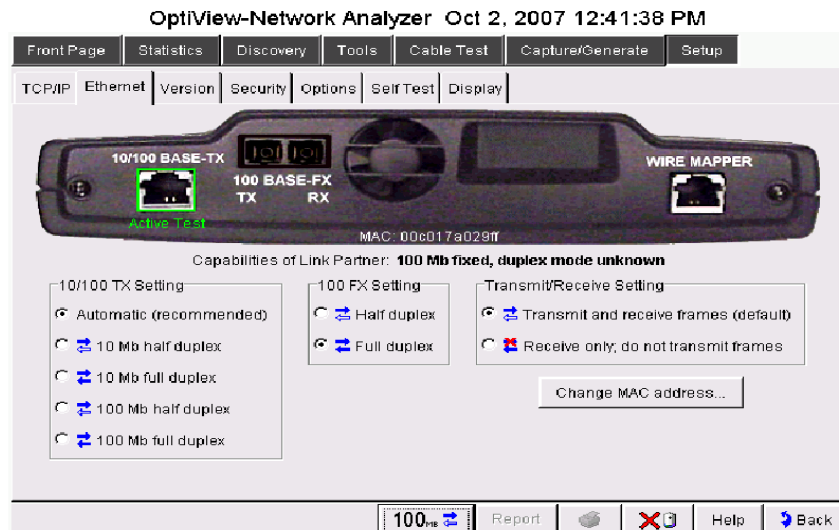


Figure 1. Fluke Optiview Network Analyzer Layout

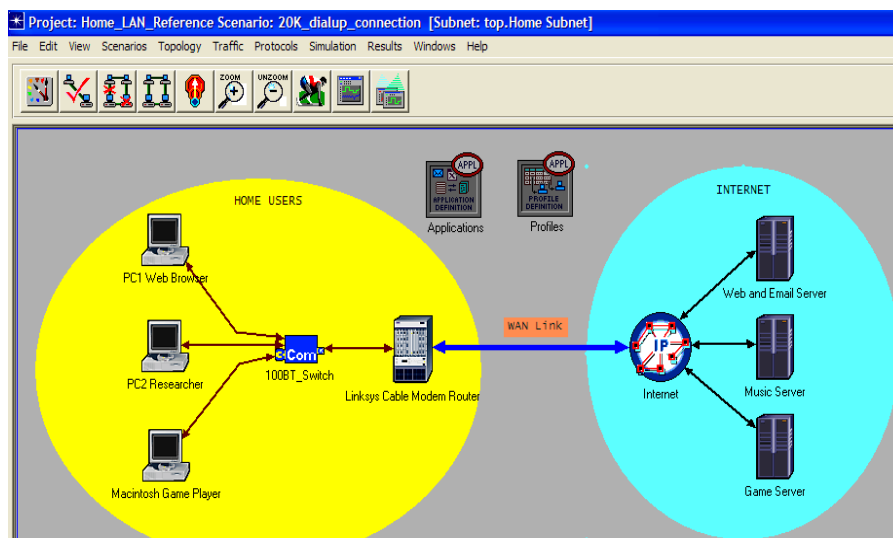


Figure 2. Sample of Network Planning Using OPNET

### 3. Design of Emulation Network Analyzer

Figure 3 shows the model has been formulated from real network environment to simulation model. A successful simulation model that is able to provide a sufficiently credible solution that can be used for prediction.

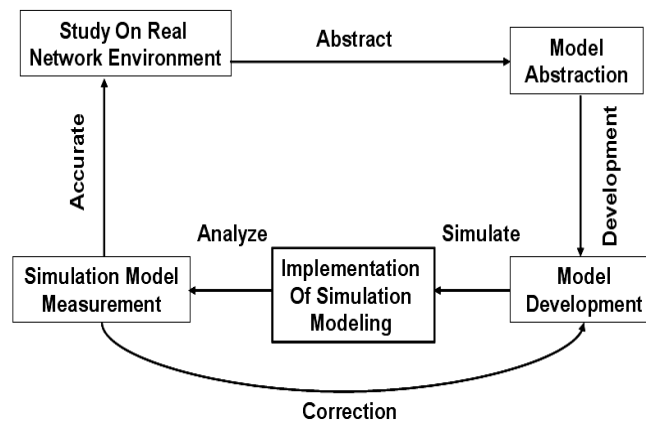


Figure 3. Model and Simulation Development Phases

### 3.1 User Interface Design

Figure 4 and Figure 5 show the measurement of: i) ENA menu without constraint; and ii) ENA services menu with constraint. The administrators are given an option to define which network medium should be analyzed the network performance.

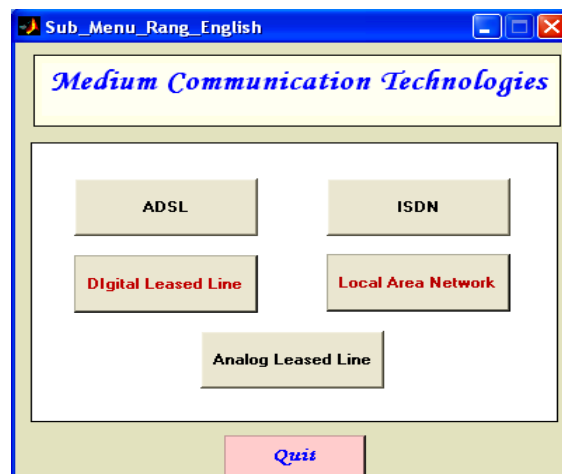


Figure 4. Measurement of New Service Menu (Without Constraint)

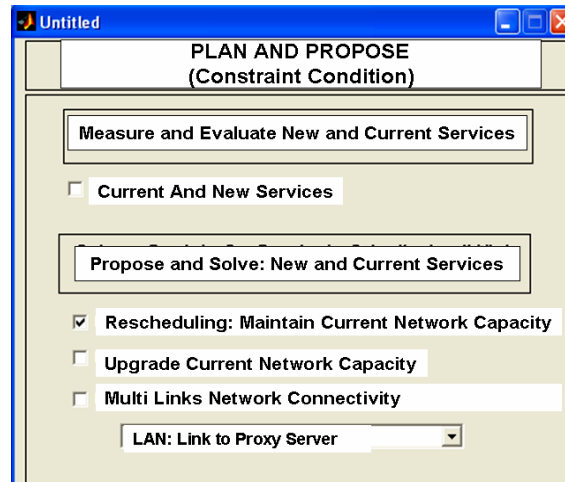


Figure 5. Measurement of New and Current Services Menu (With Constraint)

ENA tool consists of seven modules: upgrading network, rescheduling network services, multi- links network, minimum bandwidth requirement, utilization, network traffic and delay. ENA tool can use to help and understand network behavior and traffic patterns generated by multi-links and services (refer to Figure 6 and Figure 7). Through analyzing and monitoring network utilization rate, we will get an idea whether the network is idle, normal or busy.

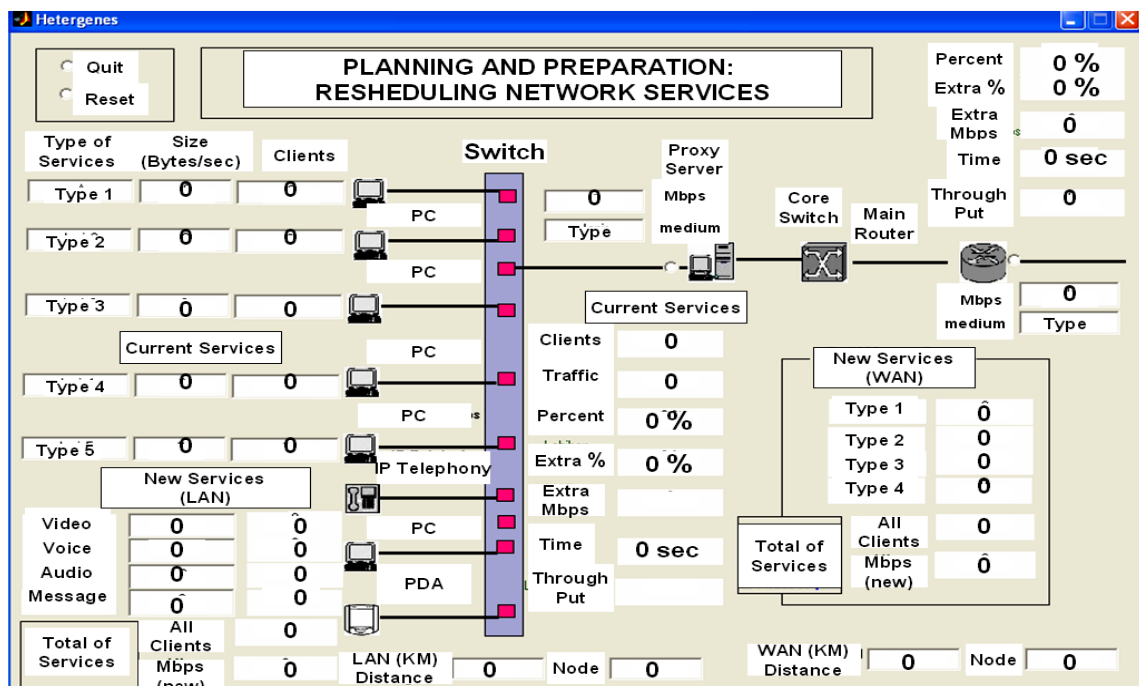


Figure 6. Sample of Rescheduling Network Services and Multi-Links in Text Interface for Heterogeneous Services

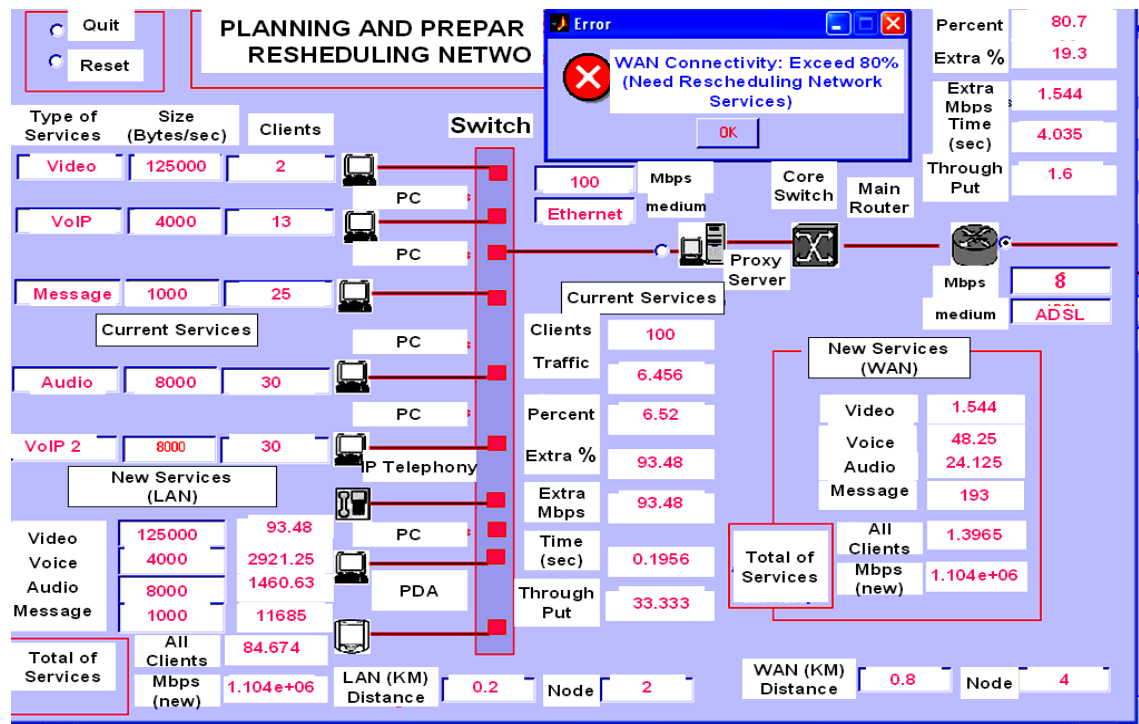


Figure 7. Sample of Network Services Output in Text Interface for Heterogeneous Services

### 3.2 General Architecture

The general architecture of the software tools is shown in Figure 8.

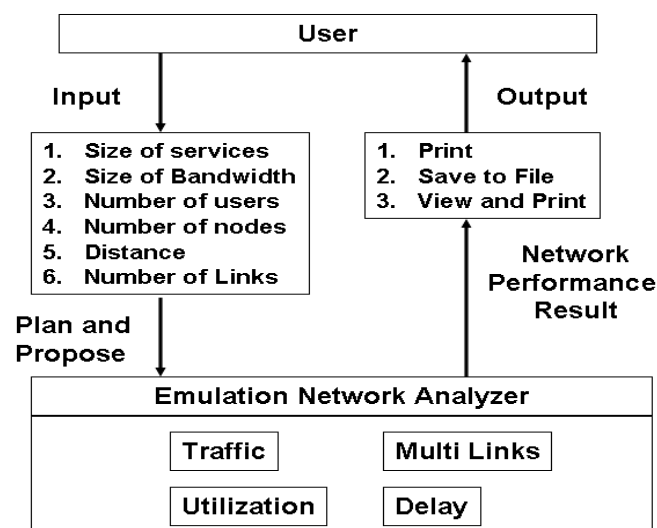


Figure 8. General Architecture for ENA Tool

### 3.3 Model Description

Figure 9 depicts the open queuing network based on M/M/1 and M/M/n will use to develop logical model of heterogeneous network environment. Parameters like bandwidth capacity, size of packet services and distances between two networks are used to 'characterize'

the application traffic. The logical model is the important area need to define which mathematical techniques should be used in development of heterogeneous environment.

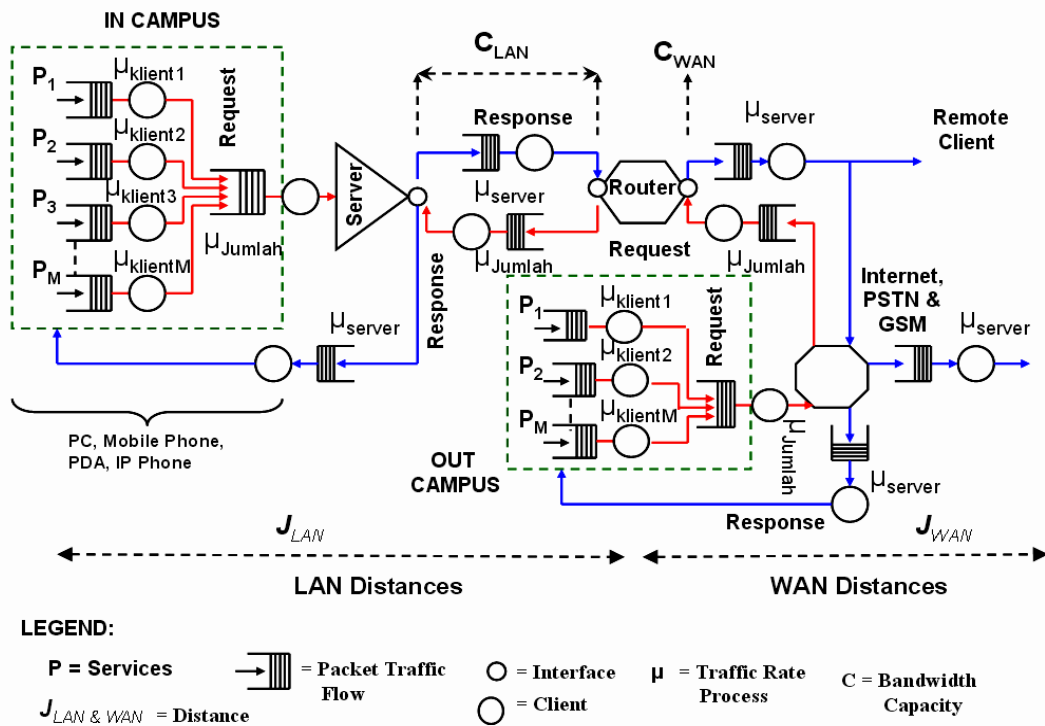


Figure 9. Logical model for Heterogeneous Network Environment

#### 4. Implementation

Figure 10 shows ENA tool implementation process. It also shows the mathematical model validation and verification process has conducted to ensure the accuracy of selected algorithms. After we satisfy and agree with real network, independent data, Opnet application experimental, code performance and accuracy of the model then we will develop and produce a complete ENA tool.

#### 5. Evaluation

Figure 11 shows the evaluation process on software network analyzer prototype. We use qualitative technique to measure our software network analyzer prototype to identify this software is able to plan, propose and analyze computer network performance. Evaluation of software network analyzer prototype is based on focus groups. Three evaluators will select who are experienced in industrial sector only, while, another three evaluators experienced in academic and industrial sector. All evaluators need to complete the following task such as: acceptance test, performance test, loading test, network responsive test and repetition test.

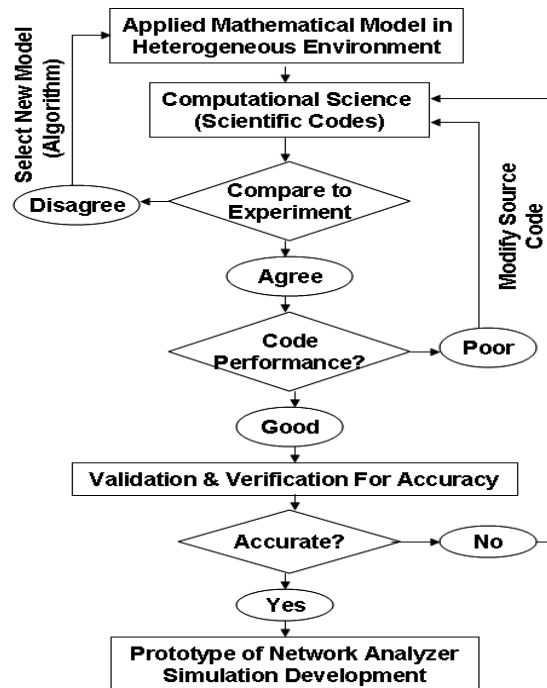


Figure 10. ENA Implementation Process

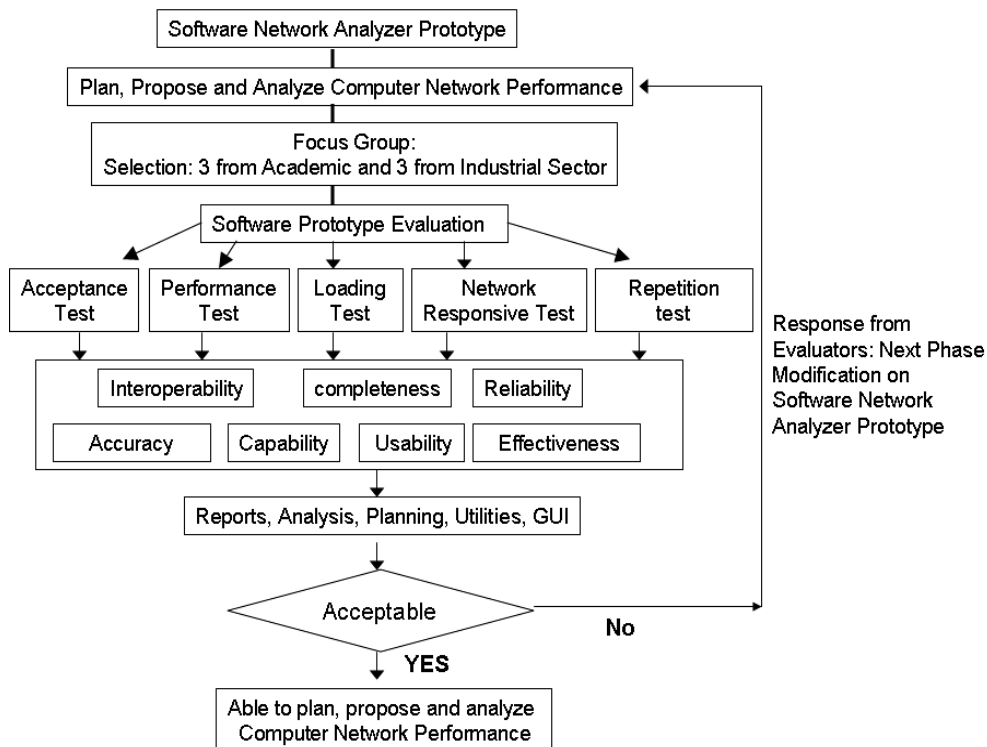


Figure 11. Software Network Analyzer Prototype Evaluation Approach

**Accuracy, Capability, Usability and Effectiveness:** Most of evaluators agreed this software has significant value on usability and capability during solving the network problem. Some of the evaluators mention this software prototyping has significant value on accuracy. Some of the

evaluators comments this software prototyping has higher significant value on effectiveness. Finally, we found, evaluators mostly agreed and satisfied with our software prototyping development (refer to Table 1).

Table 1. Software Network Analyzer Prototype Performance Overall

Software Prototype : Functionality and Interface	
Software Network Analyzer Prototype Performance Overall	Interoperability and Completeness
	Reliability and Accuracy
	Capability, Usability and Effectiveness
	Able to generate report, analyzing problem, improvement suggestion and user friendly

## 6. Case Study: How Accuracy of the Network Analyzer Model Development

This section will discuss on the reliability of network analyzer model development. It is important to verify and validate our model is accurate to measure the computer network performance. Figure 12 shows network analyzer model reliability test. The independent data output is generated based on number of users input, size of bandwidth input and size of services input. These inputs will use in OPNET, real network and network analyzer software.

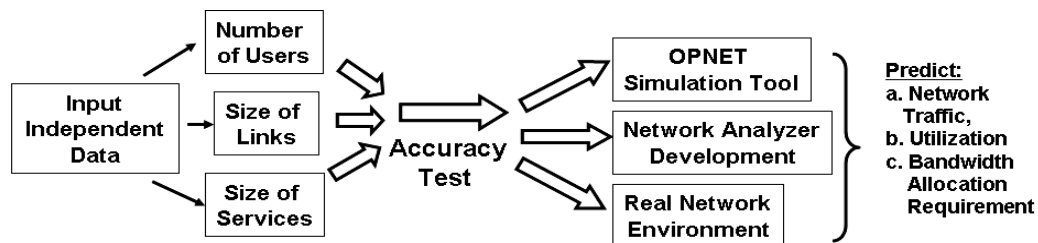


Figure 12. Input Parameters for Network Analyzer, OPNET and Real Network

Table 2 shows input for independent data for single user that will be used in network analyzer software, OPNET application and real network. Table 3 shows the inputs data and output results generate by PeopleSoft application (independent data) based on number of users and usage of network utilization percentage (refer to Figure 13).

Table 2. Inputs for Independent Data Use by Single User

Types of Services	Size of Services Estimation
Web (low usage)	2.8 – 3.0 Kbps

Table 3. PeopleSoft application: Input and Output for Web Service Usage

Size of Service(Kbps)	User	(%) 56	Link (%) 64	(Kbps) (%) 128	(%) 256	(%) 512
2.8-3.0	1	5-5.36	4.4-4.7	2.2-2.3	1.1-1.2	0.55-0.59
5.6-6.0	2	10-10.7	8.8-9.4	4.37-4.7	2.18-2.3	1.1-1.2
8.4-9.0	3	15-16.1	13.1-14	6.56-7.0	3.28-3.5	1.64-1.75
11.2-12.0	4	20-21.4	17.5-18.8	9-9.4	4.3-4.7	2.2-2.3



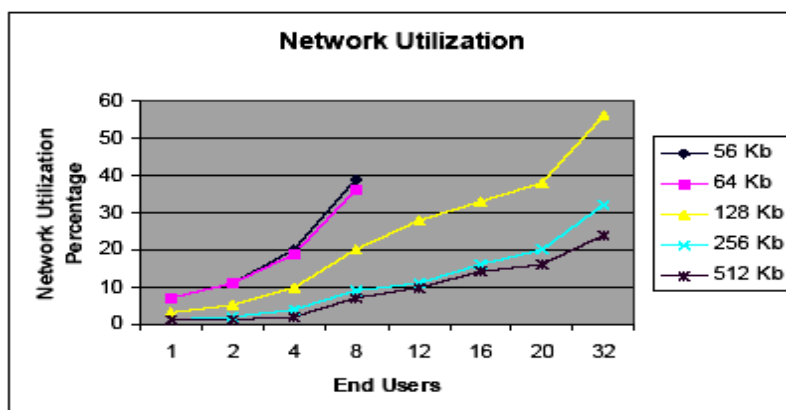


Figure 13. PeopleSoft application for Web Service Usage

Only four users will test on the reliability of network analyzer development with OPNET application and independent data. Size of web service will configure in OPNET application (refer to Figure 14) then it will simulate the scenario and measure the network performance. The results show that OPNET application generates higher network utilization percentage for lower bandwidth compared to higher bandwidth (refer to Figure 15 and Figure 16).

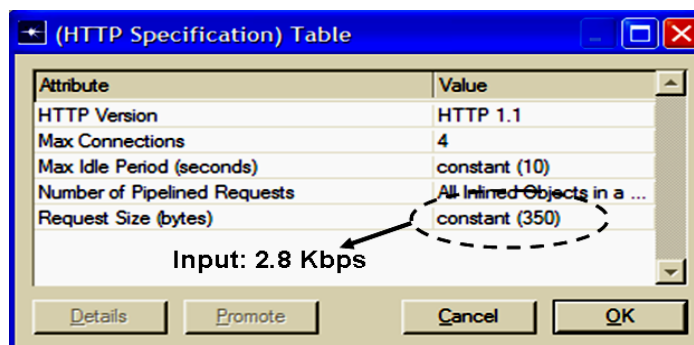


Figure 14. Configure Size of Web Service

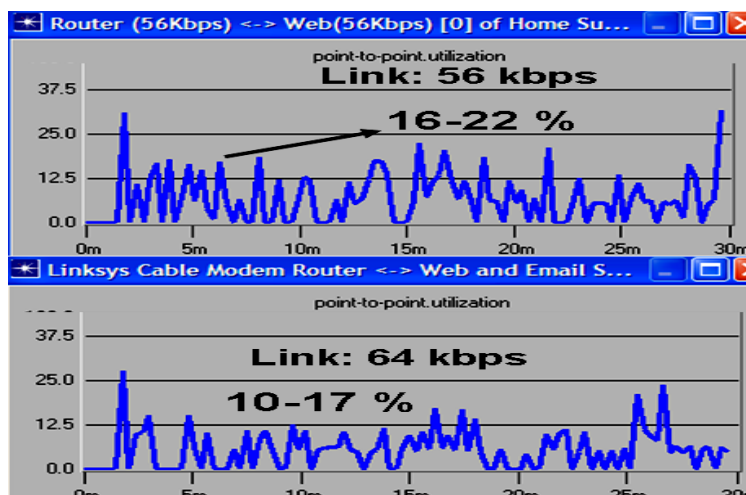


Figure 15. Network Bandwidth Utilization Over 56 and 64 Kbps

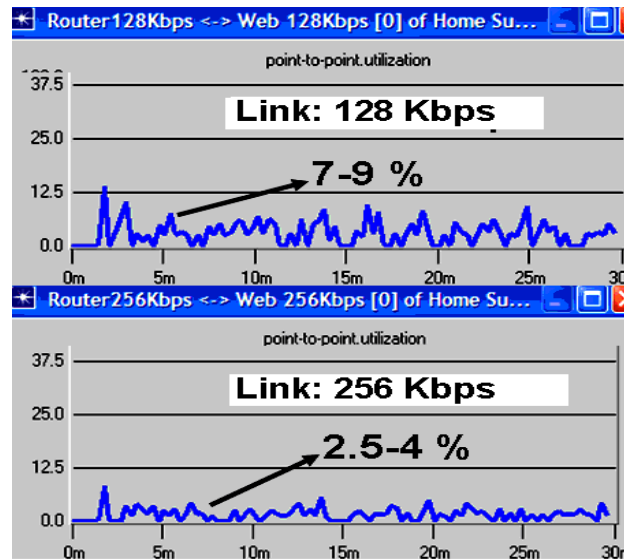


Figure 16. Network Bandwidth Utilization Over 128 and 256 Kbps

Then, network analyzer development will configure using the same input from independent data and OPNET application. The network analyzer development shows percentage results of the bandwidth capacity design (refer to Figure 17). Table 4 shows a reliability and accuracy of network analyzer development with OPNET application and independent data. We conclude that base on our findings, network analyzer development able to plan and estimate network traffic and utilization for web service usage.

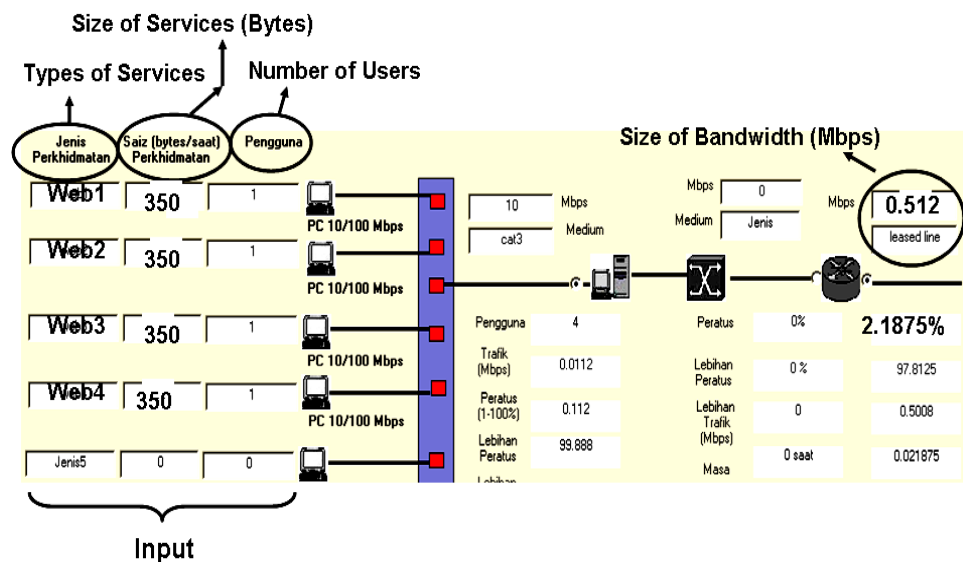


Figure 17. Network Analyzer Design: Bandwidth Capacity for 512 Kbps

Table 4. Network Analyzer Application Development, OPNET Application and Independent Data Comparison

Size of Service (Kbps)	User	56 (%)	Link 64 (%)	(Kbps) 128 (%)	256 (%)	512 (%)
Network Analyzer Development						
11.2-12.0	4	20	17.5	8.75	4.37	2.19
OPNET Application						
11.2-12.0	4	16 to 22	10 to 17	7 to 9	2.5 to 4	1.5 to 2.5
Independent Data (Input)						
11.2-12.0	4	20-21.4	17.5-18.8	9-9.4	4.3-4.7	2.2-2.3

## 7. Conclusion

Today's networking environment has become very complex. Networks have been growing in size rapidly and support complex applications. Even, our ENA tool cannot compete with OPNET simulation but it can determine and solve problems for planning network performance in LAN and WAN such as: i) network utilization; ii) network traffic; iii) allocate and define minimum bandwidth requirement; iv) upgrading network capacity; v) rescheduling network services and vi) multi-links connectivity to LAN and WAN. ENA tool still in preliminary phase and need further extend to other characteristics or functions. ENA can analyze and predict network behavior during preparation and planning phases. In general, evaluators perceive software network analyzer prototype in a positive manner. Based on focus group feedback, this software network analyzer can significantly enhance to analyze and propose solution on computer network performance.

## References

- [1] Mohd Nazri Ismail, Abdullah Mohd Zin. "Comparing the Accuracy of End-to-End Network Performance Measurement Testbed and Simulation Model for Data Transfers in Heterogeneous Environment". *IEEE, Second Asia International Conference on Modelling & Simulation (AMS)*. 2008: 124-131.
- [2] Mohd Nazri Ismail, Abdullah Mohd Zin, "Development of Simulation Model: An Ethernet Case Study in Heterogeneous Environment". *IEEE, the 3<sup>rd</sup> International Symposium on Information Technology 2008 (ITSim08)*. 2008; 3: 1438 – 1445.
- [3] Mohd Nazri Ismail and Abdullah Mohd Zin. "Development of Simulation Model in Heterogeneous Network Environment: Comparing the Accuracy of Simulation Model for Data Transfers Measurement over Wide Area Network". *Asian Network for Scientific Information. Information Technology Journal*, Pakistan. 2008: 2448, ISSN: 1812-5638 (Print).
- [4] Mohd Nazri Ismail and Abdullah Mohd Zin. "A Simulation Model Design and Evaluation for Aggregate Traffic Over Local Area Networks". *International Journal of Advanced Computer Engineering (IJACE)*.
- [5] Mohd Nazri Ismail and Abdullah Md Zin. "Measurement and Characterization of Network Traffic Utilization between Real Network and Simulation Modeling in Heterogeneous Environment". *IJCSNS International Journal of Computer Science and Network Security*. KOREA. 2008; 8(3): 326-337. ISSN: 1738-7906.
- [6] Barry Nance. 2002. "Handheld network analyzers". *Network World*, 07/01/02, <http://www.networkworld.com/reviews/2002/0701rev.html>
- [7] Fluke. "OptiView® Link Analyzer", <http://www.flukenetworks.com>.
- [8] Panko R, "OPNET Labs to Accompany Business Data Networks and Telecommunications (4th ed.) by R Panko", [http://www.opnet.com/university\\_program/teaching\\_with\\_opnet/textbooks\\_and\\_materials/itg\\_panko.html](http://www.opnet.com/university_program/teaching_with_opnet/textbooks_and_materials/itg_panko.html).
- [9] Brown K, Christianson L. OPNET Lab Manual to Accompany Data and Computer Communications 7th ed. And Computer Networking with Internet Protocols and Technology 4th ed. by William Stallings, Pearson Prentice Hall, Upper Saddle River, NJ. 2005.
- [10] Andrew Kim. "OPnet Tutorial", <http://zstux.ita.pwr.wroc.pl/bogdan/opnet/doki/Opnet%20Tutorial.pdf>
- [11] MIL3, OPNET, Available at: <http://www.mil3.com>.