NETWORK DESIGN BY USING OPNET™ IT GURU ACADEMIC EDITION SOFTWARE

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Abstract

This article outlines essentials of designing a network by using OPNET™ network simulation software. Various scenarios have been designed and the impacts of these design decisions on different users have been analyzed for educational purposes.

INTRODUCTION

Designing a network for optimal performance and meeting the requirements for all the users in an organization is very important decision. Before purchasing and deploying the equipment, it is beneficial if the network can be simulated quickly with ease and without much expense. The OPNET Technologies, Inc. offers simulation software for the enterprise and the universities [1]. The OPNET™ IT Guru Academic edition software, which is available for downloading under the University Program initiative without any cost to the students, is very useful for creating a simulated network and learning the fundamentals of networking technologies.

The software has a toolbox, which allows a user to simulate any network with a variety of equipment, including workstations, routers, switches, servers, and links between the devices. It also enables users to make modifications to the network for latency, bandwidth, and utilization, and, then, study the impact.

1 OBJECTIVE

The objective of this lab project is to design the network configuration and select the equipment to be deployed to ensure maximum network performance after considering the requirements of different users. Using the network simulation software, various parameters were modified to determine the best design option.

2 EQUIPMENT

The network setting consists of four subnets with 16-port Ethernet switches, local area network (LAN) with 10 workstations connected via the 10baseT link, and one subnet with 3 servers connected to 16-port Ethernet switch via the 10baseT link. All four subnets are connected to a subnet centrally placed with a server using a 100baseT link. Three servers are: a web server (that supports Web-browsing, e-mail, and Telnet services), a FTP server (that supports FTP and file print services), and a database server that supports database access. Four subnets (each with 10 workstations) are dedicated to Research, Engineering, E-Commerce, and Sales applications.

3 SETUP

Various setups deployed to design the network are: Simple network, Busy network, Fast network, and One-server network.

3.1 Simple Network

Simple network setup is the initial network design. It contains the previously described four subnets connected to a server subnet. The settings for statistical analysis include Page Response time (Web-browsing), Download Response time (e-mail), Download Response time (FTP server), Response time for Database Query, and Response time for Remote Login.

3.2 Busy network

Busy network setup is a duplicate of the Simple network with background utilization changed to 99% to simulate the Busy network. The CPU utilization percentage is analyzed for all three servers in the Busy-network setting.

3.3 One-server network

One-server network setup is a duplicate of the Busy network but the three servers are replaced by one server that provides all the services. The CPU utilization percentage is analyzed and compared to the Busy-network setup.

3.4 Faster network

Faster network setup is similar to the Busy-network setup but the link between the server subnet and individual subnets (Engineering, E-commerce, Research, and Sales) are upgraded to 10Gbps Ethernet links to increase the bandwidth. In addition, the background utilization is changed to 99% in this increased bandwidth subnet. The HTTP page response time is analyzed.

4. ANALYSIS

4. 1 Response Time of Simple Network vs. Busy network

The statistics was collected when the background utilization of the network was increased to 99% of the page response time of HTTP request (Fig. 1), response time of Database query (Fig. 2), download time of e-mail (Fig. 3), download time of FTP get (Fig. 4), and time taken for logging in to remote server (Fig. 5) increased.
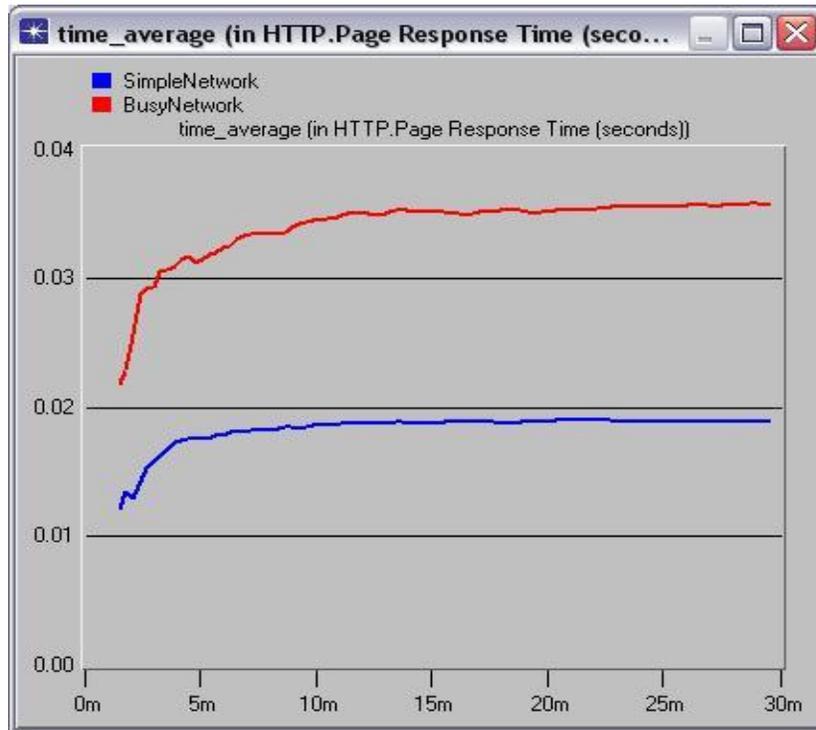
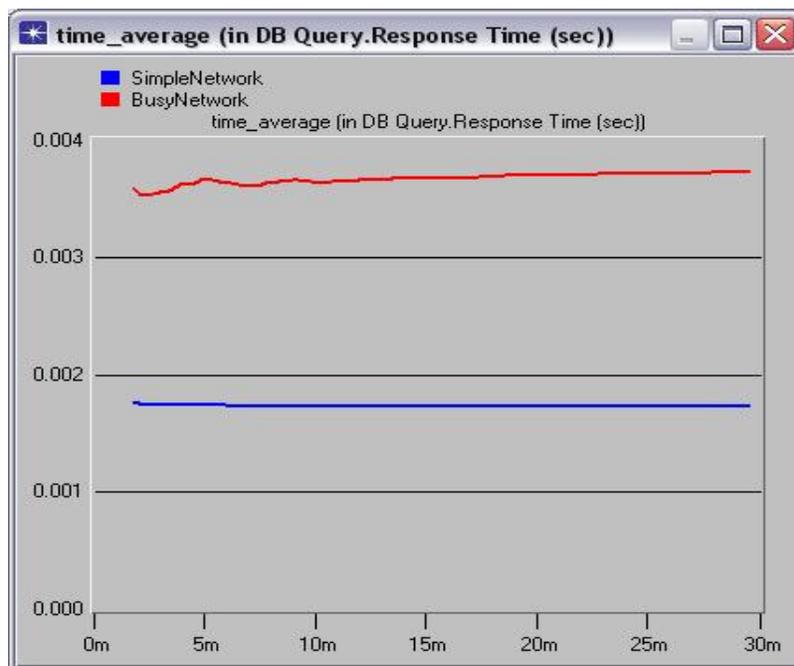**Figure 1: Average time used to download a Web page**

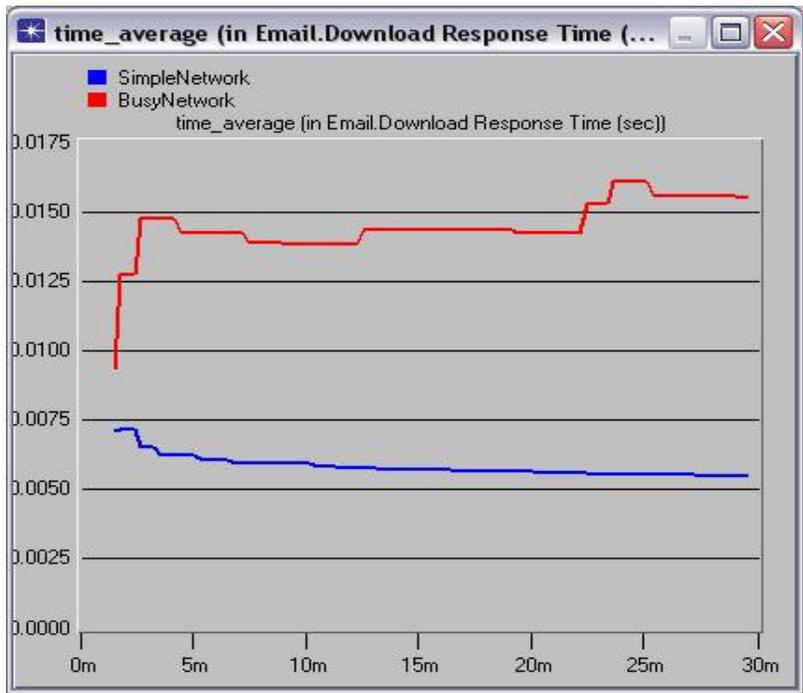**Figure 2: Average time used by database to respond to query**

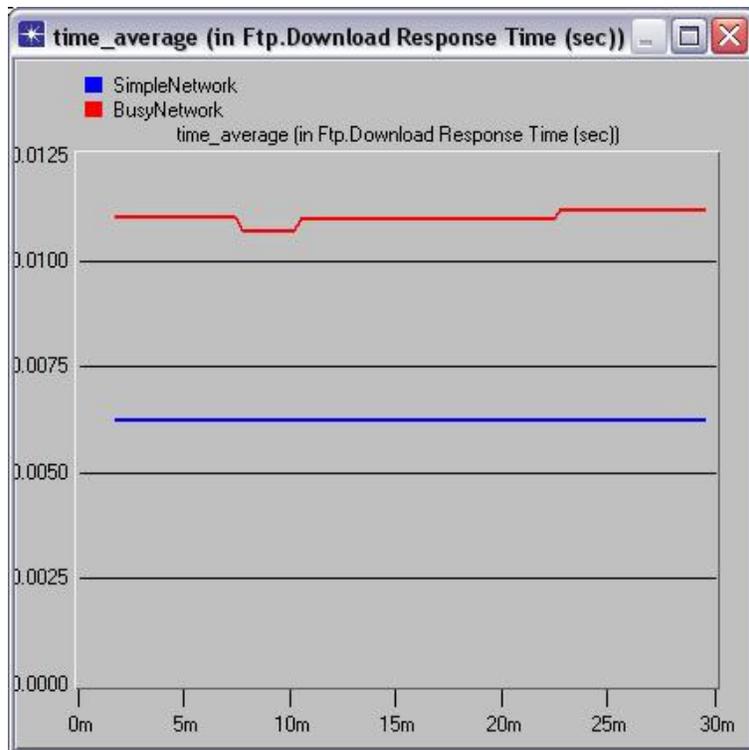**Figure 3: Average time used to download email**

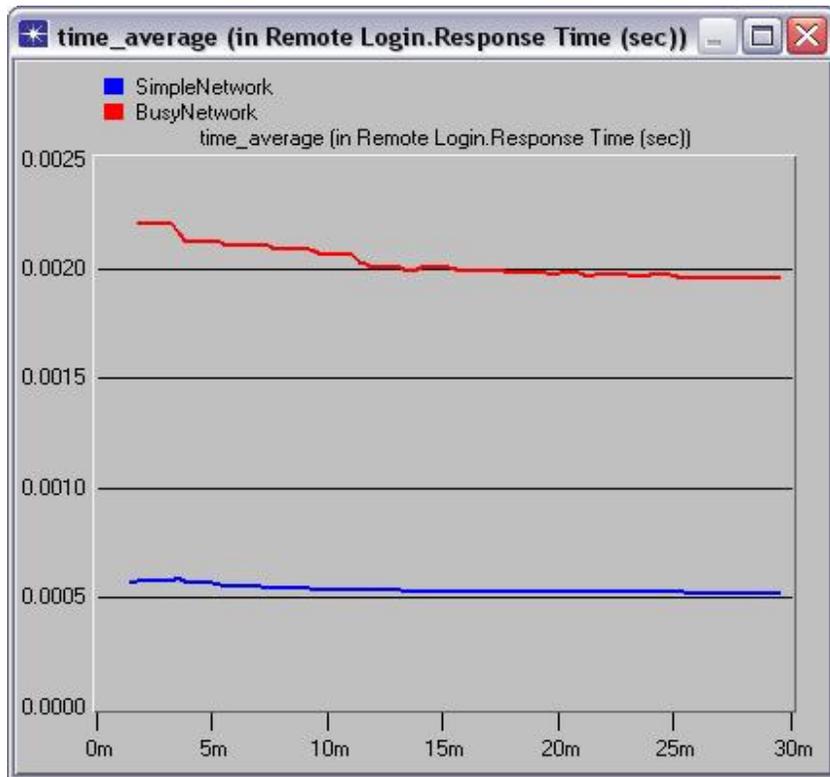

Figure 4: Average time used to download file from FTP server

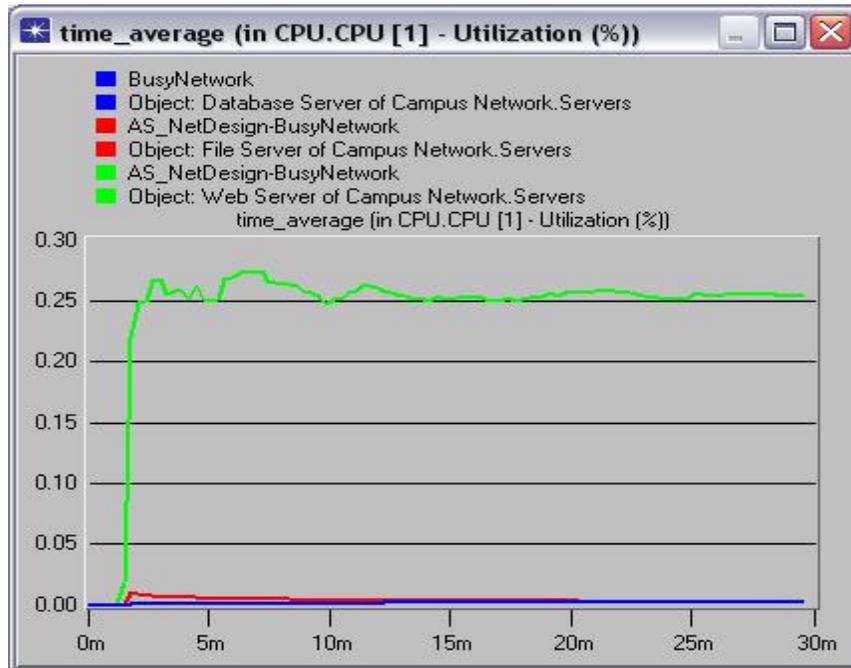**Figure 5: Average time used to respond to login request**

Figure 6: Average CPU utilization (%) of three servers

4.2 CPU utilization of various servers in the Busy network

The CPU utilization of the Web server is the highest because the Web server processes requests from other services, such as Web browsing, e-mail, and Telnet sessions; whereas the other servers handle fewer services, such as file transfer and file print, which are supported by the FTP server and database server. They process database access requests only (see Fig. 6).

Also, the CPU utilization is higher for the Web server because it supports more common services used by all subnets, such as Web browsing and e-mail services.

4.3 CPU utilization when all services are supported by one server vs. services distributed between three servers (Busy network vs. One-server network)

The CPU utilization is almost the same for one server and for multiple servers because the services contributing to higher utilization are Web browsing and e-mail; whereas for FTP, file print and database access requests have minimal effect on the CPU utilization (see Fig. 7).
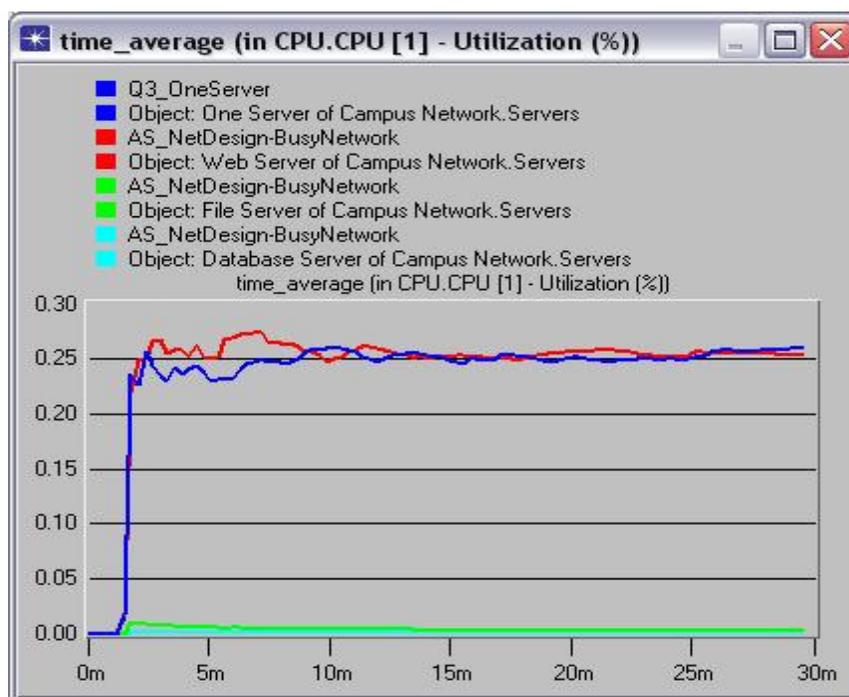

Figure 7: Average CPU utilization (%) one server vs. three servers

4.4 Faster network (10 GbpsT link) vs. Busy network (10baseT link) between individual subnets and server subnet

The Faster network has a higher bandwidth compared to the Busy network because it uses cable, which provides a higher transmission rate. In both networks, the background utilization of the network is 99%, but, because of higher bandwidth, the page response time of HTTP pages is lower in the Faster network. For example, the HTTP requests are handled quickly and pages are downloaded or shown in the Web browser using less time (Fig. 8) [2].
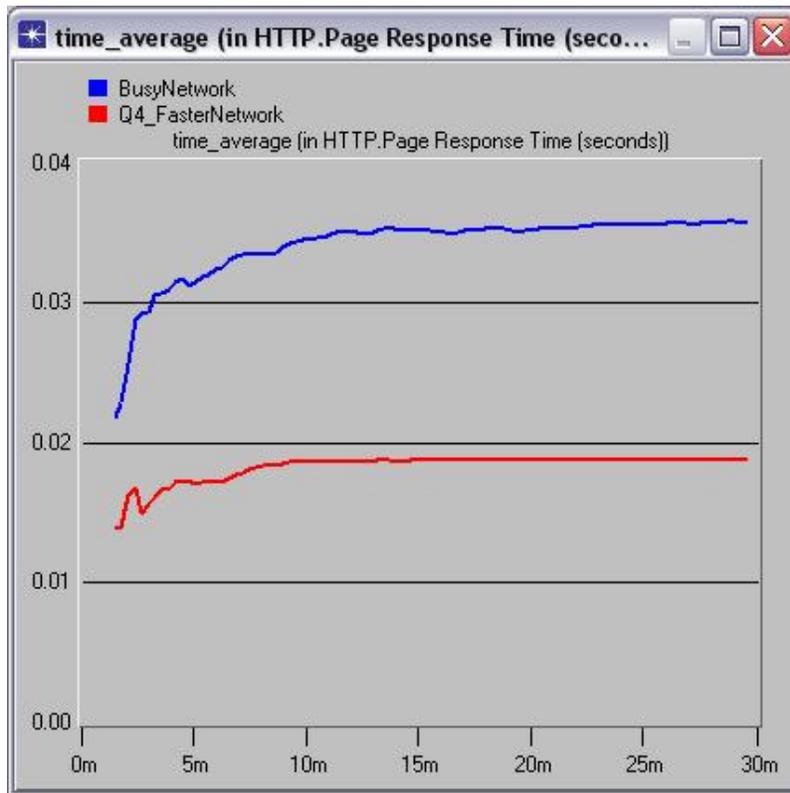
Figure 8: Average Web-page download time in a Faster vs. Busy network

5 CONCLUSION

To get better performance when designing a network, the faster Ethernet cabling is useful. The distribution of the services between multiple servers versus services handled by one server impacts the CPU utilization depending on the kind of services supported. If there is a balance between frequently used services and less frequently used services, it does not make sense to deploy more than one server to support different services.

REFERENCES

[1] IT Guru Academic Edition, OPNET Technologies, 2007. Retrieved on April 5, 2007 from
    http://www.opnet.com/services/university/itguru_academic_edition.html
[2] William Stallings, *Local And Metropolitan Area Networks*, 6th edition. Prentice Hall, 2000.

GLOSSARY

10baseT: A 10 Mbps Ethernet standard that uses twisted wire pairs for transmission medium.
100baseT: Also known as Fast Ethernet, an Ethernet specification using speed of 100 Mbps over twisted cable pair.
10GbpsT: A newly released standard that provides 10-Gbps connections over conventional unshielded or shielded twisted pair cables.

CSMA/CD: Carrier Sense Multiple Access/Collision Detection.

DB: Database such as Oracle and MySQL.

Ethernet: Network specification developed by Xerox, Intel, and Digital Equipment that uses IEEE 802.3 CSMA/CD standard.

Ethernet Switch: A LAN interconnection device which operates at the data link layer (layer 2) of the OSI reference model using Ethernet.

FTP: File Transfer protocol, an application-layer protocol using TCP/IP (Transmission Control Protocol/Internet Protocol) to transfer a file from one computer to another.

Gbps: A data rate measured in Giga bits per second.

HTTP: Hypertext Transfer Protocol, an application layer transaction oriented "stateless" protocol used by Web server and Web browser.

IEEE: Institute of Electrical and Electronics Engineers.

LAN: Local Area Network.

Mbps: A data rate measured in Mega bits per second.

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* **ARTI SOOD** received her Bachelor's degree in Science and Education from Punjab University, India. After obtaining P.G. Diploma in Computer Science, she worked as database application developer. She moved to the U.S. in 1996 and worked with Emerging Markets, Inc., and Gambit Communications, Inc. on web development and network simulation tools till 2005. Arti works currently as Senior Quality Assurance Engineer at Juniper Networks, Inc. developing security products and pursuing M.S. in Computer Science at Rivier College.