AN ANALYSIS OF NETWORK PERFORMANCE AT KEMENTERIAN PERUMAHAN DAN KERAJAAN TEMPATAN USING OPNET MODELER

ANAS IMRAN BIN GHAZALI

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FACULTY OF INFORMATION AND COMMUNICATION TCHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ABSTRACT

The world of information technologies experienced an explosive period of growth toward the end of the 20th century with the widespread availability of the Internet and the development of the World Wide Web. On top of that, we can see that the network sake is very important nowadays because without that people could not communicate each other in free medium. So this thesis intends to analyze the network performance at Kementerian Perumahan dan Kerajaan Tempatan (KPKT). It will explain about the network performance, network traffic, bandwidth utilization and packet management analysis that will be done using simulation software. In this project, it will show what the major problems that happening at KPKT and how to overcome the problems as to improve the network performance. Different simulation software also had been differentiated, as to choose the best simulation software for map and produce the analysis result. A detail network design also had been generated based on the network of KPKT. All the analysis result will be the useful for KPKT as for their future implementation.

ABSTRAK

Dunia teknologi maklumat kini telah berkembang dengan pesatnya pada abad ke-20 dengan perkembangan keupayaan Internet dan pembangunan dunia web meluas. Sehubungan dengan itu, kita dapati bidang rangkaian adalah amat penting pada masa kini kerana tanpa rangkaian Internet manusia tidak dapat berhubung antara satu sama lain dengan bebas walaupun berada dikawasan atau benua yang berbeza. Projek ini dicadangkan adalah untuk menganalisa keupayaan rangkaian di Kementerian Perumahan dan Kerajaan Tempatan (KPKT). Projek ini juga menerangkan bagaimana keupayaan rangkaian, trafik rangkaian, penggunaan jalur lebar dan analisa penggunaan paket dimana ia dilakukan dengan menggunakan perisian penyerupaan. Di dalam projek ini juga, ia menerangkan apakah masalh utama yang berlaku di KPKT dan cara untuk mengatasi masalah rangkaian itu. Perbezaan perisian penyerupaan akan dibezakan kerana untuk memilih perisian yang terbaik untuk menghasilkan keputusan analisis. Maklumat penuh mengenai pelan rangkaian juga akan dihasilkan. Segala keputusan analisa akan dicadangkan kepada KPKT adalah untuk meningkatkan keupayaan rangkaian. Segala keputusan analisa akan memberikan faedah kepada KPKT untuk dilaksanakan pada masa akan datang.

CHAPTER I

INTRODUCTION

1.1 PROJECT BACKGROUND

Computer network comes in different scale such as LAN, MAN, and WAN. They also come in various protocols, topologies and architectures. There is no computer network that is perfect. Network analysis is the process of capturing network traffic and inspecting it closely to determine what is happening on the network. A network analyzer decodes, or dissects the data packets of common protocols and displays the network traffic in human-readable format. A network analyzer can be a standalone hardware device with specialized software, or it can simply be software that you install on your desktop or laptop computer. Network analyzers are available both free and commercially. Differences between network analyzers tend to depend on features such as the number of supported protocol decodes the user interface, and graphing and statistical capabilities.

Computer simulation on the other hand is the discipline of designing a model of an actual or theoretical physical system, executing the model on a digital computer, and analyzing the execution output. By analyzing or simulating a computer network, we can identify its weakness, or identify the opportunity for improvement. Slow internet connection, unable to access email, unable to share drive and computer not functioning properly are the most common problem. If we want to know what devices burden the network excessively, who uses the bandwidth and how, what devices are located within

your network and how it affects the network, then analyzing or simulation is the best way to get the answer.

This thesis is mainly about analyzing a network, identify its problem or its weakness and come up with a solution to improve it. The network choosen is from Kementerian Perumahan dan Kerajaan Tempatan (KPKT), a government ministry located in Pusat Bandar Damansara, Kuala Lumpur. Opnet Modeler Simulation will be the software used for this project. This project will take in account the information collected from the officer incharge of the network and the user of the network in the ministry. The exact network design will be mapped in the simulator, and as the result, the simulator will generate information that will be vital in designing a new network. Designing a totaly new network may not be nessasary, as maybe only a little adjustment in the current design is required. When analyzing the network, it will focus majorly on the network performance, network behavior and network bandwith. The result of this thesis can and will be used as a proposal to improve the current network

1.2 PROBLEM STATEMENT

At KPKT, they are having few problems related to their computer network. They do not have a complete logical or physical design of their computer network.Without the design, it is difficult to manage, and plan for future expansion or improvement.

Next problem is slow internet access. This problem is considered normal by the staff of the ministry because they never really felt the internet response time is low except in the morning of after office hours. This problem is proberly caused by the bandwidth, or many pc crampt into one cable to access the internet. This causes packet drop. This causes problem as the mimistry staff does use the internet for working purposes, and slow internet will always slow down their progress.

Database accesss is also a problem in this ministry. It is very slow, for example the database query response time is high . Database is really important in this ministry because registration, enforcement, and other activity happens everyday. It is belived the heavy usage of database contributes the most to the network congestion.

Besides internet, the staff also complaints about the email service or sharing large file through the local network are slow and sometimes fails. The cause of this problem is maybe similar to the one above.

1.3 OBJECTIVE

There are three main objective in this project. These objective determains weather this project is successful or not. These objective are all directly related in the process of inproving the computer network at KPKT. The objectives are:

1.3.1 Generate Logical and Physical Network Diagram Based on the Original Network

This process is to identify every device or hardware connected to the network and maps it on to a logical device. In the same time, identify where every item is located and map in on to a physical design.

1.3.2 Analyze the existing network

This process is done by mapping the existing design into the OPNET simulator. The analysis will focus on the database response performance and the point to point link utilization. Information on the behavior of the network will be

find out or asked from staff and the officer in charge .This information is important to get the most accurate result from this analyzing process.

1.3.3 Improving the network performance

After identifying the weakness or problems on the computer network of KPKT, the process of designing a new network or altering the existing network for improvement begins. The new design must also run pass the simulation program to compare performance with the existing network

1.4 SCOPE

This network analysis will be done at KPKT. This project will include activity such as identifying hardware used to produce the logical and physical network design of KPKT. Although there are few problems in KPKT's computer network, this project will focus on the database service, such as its query response time. We will also be looking at the bandwidth utilization in this network.

This project needs plenty of information to be accurate. Observation will be done on the behavior of user of the computer network. Relevant data is required to assure the result of the simulation is accurate. All this data and the network design itself will be mapped in the simulator. The results will be analyze and an improved network design will be created.

This new design or this prototype will go through the same process as the original network, it will be tested in the simulator. If the design is successful in improving the KPKT's current network, it will be suggested or be used as a proposal to improve the ministry computer network.

1.5 PROJECT SIGNIFICANT

Network analysis will definitely help the administrator of the network in case of any problems. It is easier to locate or identify problem with the aid to the analysis result. For example the admin can identify which device is more utilize than the other, this will help because a device more frequently used have higher probability to fail or damage.

This network analysis was very important in that it help to understand the complexity and differences of each network and systems they support in the ministry. Analysis also provides data upon which various decisions are made, and these data can be documented as part of an audit trail for architecture and design process.

This analysis will help determined the exact amount of performance required to maintain a trouble free network. So, incase the hardware requirement is not enough, the admin can choose to upgrade it, but not spending on unnecessary requirement or technology.

By having an improved and successful design tested by the simulator, it will help the ministry if the ministry decides to upgrade the network. They can defiantly plan their budget accurately with the help of this analysis.

1.6 EXPECTED OUTPUT

The first outputs of this project will be the logical and physical design of the ministry's current network. The network diagram is very important in this project.

Next, after the simulation process, we will see graphs, data's, diagrams, charts and tables on the performance of the computer network of KPKT. All this information will be analyze and a new network will be design. The new design will also produce an output like the current network. Both this result will be compared and used to prove the differences in the two designs

1.7 CONCLUSION

As stated above, this project aims to analyze the computer network of KPKT. The logical and physical design will be prepared and mapped into simulation software, Opnet Modeler Simulation and it will be generate graph, diagram and tables.

Result of this analysis will be used to design a new and improved network. It can and will be used to demonstrate or used as an explanation in order to convince the higher management for a computer network upgrade.

This project will defiantly show the difference between simulated network and real network. It can be a useful guideline for students or other researches studying in networking R&D.

Next chapter will be focusing on the methodology of this project and also literature review on this issue.

CHAPTER II

LITERATURE REVIEW & PROJECT METHODOLOGY

2.1 INTRODUCTION

Computer networking is the discipline concerned with communication between computer systems. Such communicating computer systems consist a computer network and these networks generally involve at least two devices capable of being networked with at least one usually being a computer. The devices can be separated by a few meters such as Bluetooth or nearly unlimited distances such at the internet. Computer networking is sometimes considered a sub-discipline of telecommunications and information technology.

A computer network is any set of computers or devices connected to each other. Examples of networks are the Internet, a wide area network that is the largest to ever exist, or a small home local area network (LAN) with two computers connected with standard networking cables connecting to a network interface card in each computer.

For this project the analysis that intend to be discuss here is were analyze a network performance of network, in terms of the traffic, the network bandwidth, the network utilization and all the devices in the network, functioning as a unit and not as autonomous units.

A method to understand networks analysis and their participants is to evaluate the location of all the devices and connectors in the network. Measuring the network location is finding the centrality of a node. These measures help determine the importance, or prominence, of a node in the network.

This chapter will explain the methodology that will be used for this project. It will be focusing on the methodology for the project, the requirement of this project and also will be discussing some topic related to this project.

2.2 FACT AND FINDING

2.2.1 Defining Network Simulation

In computer network research, network simulation is a technique where a program simulates the behavior of a network. The program performs this simulation either by calculating the interaction between the different network entities such as host, routers, data links and packets using mathematical formulas, or actually capturing and playing back network parameters from a production network. Using this input, the behavior of the network and the various applications and services it supports can be observed in a test lab. Various attributes of the environment can also be modified in a controlled manner to asses these behaviors under different conditions. When a simulation program is used in conjunction with live applications and services in order to observe end-to-end performance to the user desktop, this technique is also referred to as network emulation.

R. Currier in his article Test-drive your network designs explains that network simulators have grown in maturity since they first appeared as performance, management and prediction tools. Simulators are normally used as network management tools, for which packet level analysis is not commonly employed. However, more studies are

needed to establish guidelines for researchers so that they may select and customize a simulator to suite fine-grained packet level analysis.

Network simulators are used to predict the behavior of networks and applications under different situations. Researchers use network simulators to see how their protocols would behave if deployed. It is typical to use a network simulator to test routing protocols, MAC (Medium Access Control) protocols, transport protocols, and applications. Companies use simulators to design their networks and applications to get a feel for how they will perform under current or projected real-world conditions.

This section below will discuss a few well known computer network simulator.

2.2.1.1 OMNet++

OMNeT++ is a public-source, component-based, modular and open-architecture simulation environment with strong GUI support .Its primary application area is the simulation of communication networks and because of its flexible architecture, it has been successfully used in other areas like the simulation of IT systems, queuing networks, and hardware architectures. OMNeT++ is rapidly becoming a popular simulation platform in the scientific community as well as in industrial settings. Several open source simulation models have been published, in the field of internet simulations such as IP, IPv6, and MPLS, mobility and ad-hoc simulations and other areas.

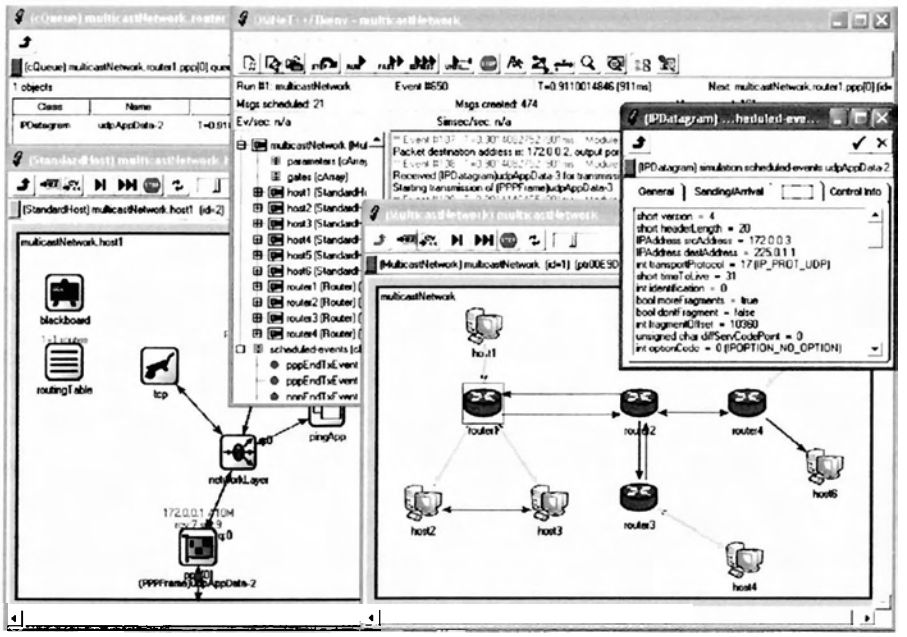

Figure 2.1: Screenshot of OMNet++

2.2.1.2 Ns-2

Ns is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks. According to Lucio et al. (2003) this simulator was developed by the Virtual InterNetwork Testbed (VINT) project and it is and event-driven network simulator, which is popular with the networking research community.

According to Fall (1999) this simulator also includes numerous models of common Internet protocols including several newer protocols, such as reliable multicast and TCP selective acknowledgement.

2.2.1.3 Net Sim

NetSim is a one of its kind Network Simulator and has proved to be an indispensable tool for network lab experimentation, research and development. The software provides for network simulation across various protocols like Ethernet, Wireless LAN. TCP / IP, ATM etc and devices like routers, ATM switches etc. NetSim also includes programming exercises using C, C++, or Java.

Some of its features are greatly extended protocol functionalities including Reno, New Reno and Sack flavors for TCP and ATM Layering. It also includes in-depth tools to analyze simulation results with export to text and spread sheets. Besides that extended database functionalities with Multi-tier control is also available. Lastly a new sleek and intuitive User Interface makes this simulator a good choice for users.

2.2.1.4 OPNET Modeler

OPNET Modeler is the industry's leading environment for network modeling and simulation, allowing you to design and study communication networks, devices, protocols, and applications with unmatched flexibility and scalability. Modeler is used by the world's largest network equipment manufacturers to accelerate the R&D of network devices and technologies such as VoIP, TCP, OSPFv3, MPLS, IPv6, and more.
The Opnet modelers also provide GUI (Graphical User Interface) along with the considerable amount of documentation and study cases.

Below are some key features of this software:

I. Most scalable and efficient simulation engine
II. Hundreds of protocol and vendor device models
III. Open model source code

IV. Object-oriented modeling
V. Comprehensive graphical user interface
VI. Discrete Event, Hybrid, and Analytical simulation
VII. 64-bit fully parallel simulation kernel
VIII. System-in-the-Loop for external interfacing
IX. Integrated debugging and analysis

Opnet Modeler will be used for this project because, based on Lucio, Paredes-Farrera, Jammeh and Fleury when "fine-tuning" of parameters was performed, Opnet Modeler was a more accurate simulator for this particular case

2.2.1.5 Conclusion on Network Simulator

A research to compare OPNET Modeler and Ns-2 was done. It focuses on comparing the accuracy of network simulator for Packet-Level Analysis using a network Test bed. The research done by Gilberto Flores Lucio, Marcos Paredes-Farrera, Emmanuel Jammeh, Martin Fleury, and Martin J. Reed from the University of Essex concludes that Ns-2 behaved differently to the testbed, and instead Modeler gave more accurate results. In terms of simulation speed, their research shows both Ns-2 and the Modeler have similar speed. They also stated that the learning curve for each of the simulators was different, and sometimes steeper than expected. To create an Ns-2 model involves writing a script in an extension of tcl, which will be unfamiliar to most of those using the simulator for the same time. On the other hand, as benefits a commercial product, OPNET has a well-engineered user-interface using mainstream software and operating system.

According to W. G. Bragg in his article "which network design tool is right for you?" ,states that OPNET Modeler has a "heavy suite" (large software overhead) but provides diverse statistics modules at different levels while Ns-2 needs several modifications and extra care has to be taken to manage memory allocation and CPU time

for large-scale network. With the reason that OPNET Modeler is more accurate, fast and user friendly, it is chosen to be used to as the simulation software of this project

2.2.2 Types of Network

Casad and Newland (1999) nicely sum up the comparison. A server-based network consists of a group of user-oriented PC's, called clients that request and receive network services from specialized computers called servers. Servers are generally higher-performance systems that are optimized to provide network services to other PC's. Examples of common server types include file servers, mail servers, print servers, fax servers, and application servers. A file server is a server that stores files on the network for users. A user at a client machine can save a file to a hard drive located on the file server. If the user wants to access the file later, he can access the file from the client machine through a network connection to the file server. A print server manages access to network printing resources and enables several client machines to use the same printer. File and print services are the basic components of many network operating systems. Examples of network operating systems are Novell NetWare, Banyan VINES, and Microsoft Windows NT Server. A single machine usually serves as both a print and a file server. An application server is a server that executes an application or part of an application for a client. Whereas a file server simply holds files that are retrieved and processed by the client, an application server performs all or part of the processing on the server end. The client may still perform part of the processing in client/server architecture. A server-based network model is more efficient for all but a network of five computers because hardware resources can be concentrated on a few well-utilized network servers. Client computers can be designed with minimal hardware configurations.

A peer-to-peer network is a group of user oriented PC's where each PC operates as an equal. Resources are distributed throughout the network on computer systems that can act as both service requesters and service providers. The peers share resources such as files and printers are but no specialized servers exist. Each peer is responsible for its'

own security and administration. In a sense, each peer is a client because it requests services from other peers. Each peer is also a server because it offers services to the other peers. A peer-to-peer network is sometimes called a workgroup. O'Brien (1996) describes work group computing as a group of members that use a local area network (LAN) to share hardware, software, and databases to accomplish group assignments.

A peer-to-peer network does not centralize security and they are usually much smaller and simpler than server-based networks. File and device security is tighter and able to be controlled in detail in a client/server network. A client/server network makes centralized backups and version control easier because files are stored on each local computer in a peer-to-peer network. Files are centrally stored on a server in the client/server network. Sharing programs is more efficient in the client/server network; peer-to-peer requires the program to be installed on each computer in the network. They provide a decentralized alternative for situations in which a server network would be too large or complex a task. Peer-to-peer networks are most suited for networks of 5 computers or less (Business Tech Inc 1998). Performance is less than optimum with more than five computers. A client/server network has a higher startup price due to the cost of the server. Therefore, it is often not an option when only five or so computers need to be connected. The software required to operate a peer-to-peer networks are usually simpler also. Now days all desktop operating systems come with built-in peer-to-peer networking capabilities.

2.2.3 Defining Network Performance

Referred to wikipedia.com Network performance refers to the level of quality of service of a telecommunications product as seen by the customer. It should not be seen merely as an attempt to get "more through" the network.

For example in an Asynchronous Transfer Mode (ATM) network, performance can be measured by line rate, QoS, data throughput, connect time, stability, technology, modulation technique and modem enhancements.

There are many different ways to measure the performance of a network, as each network is different in nature and design. Performance can also be modeled instead of measured; one example of this is using state transition diagrams to model queuing performance in a circuit-switched network. These diagrams allow the network planner to analyze how the network will perform in each state, ensuring that the network will be optimally designed.

When discussing about network performance we will be focusing on bandwidth utilization, and network traffic.

2.2.3.1 Defining Bandwidth Utilization

Bandwidth is a key concept in many applications. In radio communications, for example, bandwidth is the range of frequencies occupied by a modulated carrier wave, whereas in optics it is the width of an individual spectral line or the entire spectral range. There is no single universal precise definition of bandwidth, as it is vaguely understood to be a measure of how wide a function is in the frequency domain. For different applications there are different precise definitions. For example, one definition of bandwidth could be the range of frequencies beyond which the frequency function is zero.

This project will be about computer network and focusing on a large local area network using mostly wired connection. In this case bandwidth is understood as the amount of data that can be transferred over a period of time. The measurement or unit usually used is Mbps or megabits that can be transferred in 1 second. The relevance to focus on this issue is to study does the bandwidth allocated to every device and computer in KPKT is suitable with the type of use and number of computers using a specific link.

2.2.3.2 Defining Network Traffic

Traffic refers to overall network usage at a given moment. From the webopedia.com, network traffic was about the load on a communications device or system. Monitoring network traffic is one of the most important tasks of a network admin. In case network becomes heavy, appropriate action must be taken by network admin.

It is important to keep tabs on the traffic that's flowing across the network. The network traffic must be monitoring us to make sure and know how the bandwidth is being used. Refer to Posey (2005) on his article said that "I'm not saying that you need to be intimately familiar with every single packet that's sent or received, but you need to know what types of protocols are flowing across your network. So by doing the network monitoring traffic, it allows you to find out if users are running file sharing programs, or if some kind of evil Trojan is silently transmitting information in the background". So in this project it is intensely important to monitor the traffic moving around the network so we can identify how the bandwidth is being utilized. This will be an important input to the simulator to get an accurate data as the result of the KPKT network simulation.

2.2.3.4 Defining Database Performance

According to Craig Mullins (2006) database performance is using the familiar concepts of supply and demand. Users demand information from the database. The DBMS supplies information to those requesting it. The rate at which the DBMS supplies the demand for information can be termed "database performance."

In his article he stated five factors influence database performance: workload, throughput, resources, optimization, and contention.

The workload that is requested of the DBMS defines the demand. It is a combination of online transactions, batch jobs, ad hoc queries, data warehousing analysis, and system commands directed through the system at any given time. Workload can fluctuate drastically from day to day, hour to hour, and even minute to minute. Sometimes workload can be predicted (such as heavy month-end processing of payroll, or very light access after 5:30 p.m., when most users have left for the day), but at other times it is unpredictable. The overall workload has a major impact on database performance.

Throughput defines the overall capability of the computer to process data. It is a composite of I/O speed, CPU speed, parallel capabilities of the machine, and the efficiency of the operating system and system software. The hardware and software tools at the disposal of the system are known as the resources of the system. Examples: database kernel, disk space, memory, cache controllers, and microcode.

The fourth defining element of database performance is optimization. All types of systems can be optimized, but relational databases are unique in that query optimization is primarily accomplished internal to the DBMS. However, there are many other factors that need to be optimized (SQL formulation, database parameters, etc.) to enable the database optimizer to create the most efficient access paths.

When the demand (workload) for a particular resource is high, contention can result. Contention is the condition in which two or more components of the workload are attempting to use a single resource in a conflicting way (for example, dual updates to the same piece of data). As contention increases, throughput decreases.

Therefore, database performance can be defined as the optimization of resource use to increase throughput and minimize contention, enabling the largest possible workload to be processed.

2.2.5 Defining Network Analysis

Referring to McCabe (2004) network analysis is about studying the network component from network device such as switches and routers, to requirement and performance levels and their inputs and outputs to understand network behavior under various situations. There are few components that make up a network analysis process. The four main components before the process of network analysis is first, knowing the state of existing network, identifying problem with existing network, determine network goals and understanding the requirement of user, devices, and anything connected to the network. After the analysis process, the result should include the description of requirement and traffic flow as well as mapping of user, application and device within the network environment

2.2.6 Technique

Besides simulation there are other technique are available in improving the performance of a computer network. One logical technique is by monitoring the traffic in the network and immediately confronts the problem by changing or relocating the devices or links.

Another way is to immediately upgrade the network by adding latest and more powerful switches and servers. All we need to do is identify the hardware which is under-performing and change it with better ones.

There is specific and relevant reason why this technique was not chosen. First of all, without simulation, we will not know how our alteration or hardware upgrade will affect the network. If it fails, it will cost the organization time and money. Other reason is that upgrade is not the only solution, in some cases, resetting, relocating or a little

adjustment on the devices could solve problems. We must make sure all resources are fully utilized.

2.2.7 Organization Background

The Ministry of Housing and Local Government was established on 24 May 1964 as the Ministry of Local Government and Housing. Following a Cabinet reshuffle on 18 July 1978, the Ministry was renamed the Ministry of Housing and Local Government. This was the result of a merger between the Ministry of Housing and Rural Development and the Department of Local Government which was previously part of the Ministry of Local Government and the Federal Territory. It is now located in Pusat Bandar Damansara Kuala Lumpur. Below are the main functions of this ministry:

- Planning and implementation of KPKT policies to achieve primary national development goals.
- Provision of adequate housing for all citizens, particularly for the low-income group.
- Setting up of Local Authorities which are strong and able to contribute to the establishment of a progressive society and a clean and healthy environment.
- Provision of efficient Fire and Rescue Services for the safety of life and property.
- Strengthening and implementation of physical, social, economic, and town and country environment planning in accordance with the Town and Country Planning Act. 1976.

2.3 PROJECT METHODOLOGY

To complete this project, there are plenty of method that can be followed. In this project, there will be five main phase.

First step is to collect the required data. The data must be analyzed so only the appropriate data willl be used. Data about the network design and its users are most important. Next is to map the original network into the simulator based on all the information gathered. When it is complete, run the simulator. The third step is to analyze the result. Identify the problem or the chance to improve. Then redesign or make alteration to improve the network performance. The fourth step is to map it into the simulator and run it..

Lastly, compare the result with the result from the first simulation. If the result are positive, then this project is complete. It not, repeat step 3 onwards.

2.4 PROJECT REQUIREMENT

To fulfill the goals of this project all the requirement must be delivering. The project requirements are the detailed view of the objective, so that the entire characteristic was archived.

2.4.1 Software Requirement

1) Opnet Modeler Simulation Software

Table 2.2: Opnet Modeler System Requirement

Category	Explanation
Supported Platforms	Windows XP with Pentium 500 MHz or better
Required System Patches	Service Pack 1 and 2 are not supported but not required
System Configuration	Recommended 256mb of RAM and 550MB of Hard Disk space
Supporting Software	Microsoft Visual C/C++ 6.x or Visual Studio .NET (Windows NT, 2000, and XP) Note: OPNET highly recommends the Professional Edition of the Visual C/C++ compiler. Using the Standard Edition of the compiler, which does not allow for code optimizations, will result in slower Discrete-Event simulations. TCP/IP networking software is required.
Display	Colors: At least 256-color display. Resolution: 800x600 minimum, 1024x768 or higher strongly recommended.