Monitoring Bandwidth Usage and Server Performance

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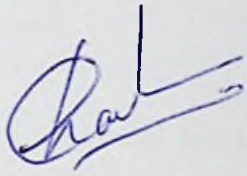
Declaration

We declare that this thesis is our own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.



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C.L. Wimalarathne

Abstract

The University of Ruhuna, one of the leading Universities in Sri Lanka is committed to quality education, research excellence, and strategic partnership with industry and community development. The University needs to take an initiative in developing an intellectual, academic and research base that can attract energetic young academics and professionals to engage in creating the knowledge base that is essential for the development of the Southern region. Since the University of Ruhuna now consists of 7 faculties - Agriculture, Engineering, Fisheries and Marine Sciences & Technology, Humanities & Social Sciences, Management & Finance, Medicine and Science - that cover vitally important aspects in the development paradigm, what remains to be done is to energies the faculties in their research and training activities.

Use of Internet grew fast rate after the introduction of the World Wide Web. Most of the people trying to do their day-to-day work by using Internet. Also the "e" concept is more popular and grew very fast in the world.

For the Internet, bandwidth usage is the very important and valuable issue. Users have to pay for Internet usage, due to that monitoring is one of the very essential events. This project is addressing the Monitoring Bandwidth usage, on application level which runs on a computer system with squid web cache software on Linux operating system. Currently University of Ruhuna does not have any efficient bandwidth monitoring system. Proposed system will address this problem.

Table of Content

Table of Figures

List of Tables

List of Acronyms

Ruhuna-MBS	: Name of the Outcome system of the Project
Ruhuna-LAN	: Local Area Network at University of Ruhuna (wellamadama complex)
DCS	: Department of Computer Science/ Computer Unit
LEARN	: Lanka Education And Research Network
UoR	: University of Ruhuna
PHP	: Hypertext Preprocessor
MRTG	: Multi Router Traffic Graper
OS	: Operating System
HTML	: Hyper Text Markup Language
XML	: Extensible Markup Language
DBMS	: Database Management System
MS SQL	: Microsoft Standard Quarry Language
SQL	: Structured Query Language
MS	: Microsoft
UML	: Unified Modeling Language
WWW	: World Wide Web
MBS Server	: Bandwidth monitoring server

Chapter 01

1 Introduction

1.1 The Organization

The University of Ruhuna, one of the leading Universities in Sri Lanka is committed to quality education, research excellence, and strategic partnership with industry and community development. The University needs to take an initiative in developing an intellectual, academic and research base that can attract energetic young academics and professionals to engage in creating the knowledge base that is essential for the development of the Southern region. Since the University of Ruhuna now consists of 7 faculties - Agriculture, Engineering, Fisheries and Marine Sciences & Technology, Humanities & Social Sciences, Management & Finance, Medicine and Science - that cover vitally important aspects in the development paradigm, what remains to be done is to energies the faculties in their research and training activities.

1.2 Overview of the Project Environment

Out of the above mentioned seven faculties, four faculties plus main administration complex and main Library also located at the wellemadama site which is consider for this project.

More than three thousand students and Hundreds of academic and nonacademic staff members were at the wellamadama complex in University of Ruhuna. At present all the departments in each faculty, main library and all the administration branches have networked computers with Internet facility. There are about nearly two thousand computers connected to Internet through the Ruhuna-LAN and number of computers connected to Internet is growing day by day.

The Department of Computer Science (DCS)at faculty of Science is the main responsible body for maintain and administration of Ruhuna-LAN and all the network and Internet services. The head of the computer science department is the person who representative of Ruhuna-LAN. The DCS mainly provides Internet, E-

mail, DNS, VoIP, LMS and other varies web base services to Ruhuna University community.

As the other Sri Lankan universities the University of Ruhuna also get the Internet connection from the Lanaka Education And Research Network (LEARN) which is the non profitable company buildup by all Sri Lankan government Universities and Institutions. Behalf of all the universities LEARN get the bulk of Internet bandwidth from the Sri Lankan reputed Internet service providers and distributed among the universities.

This project is concerned with setup and developing the systematic methodology to monitor bandwidth usage and server performance at Ruhuna-LAN. The final result of this project will help the DCS to provide efficient and reliable service to community of University of Ruhuna.

1.3 Motivation

The maintenance, monitoring and administration of such big network like Ruhuna-LAN is not a simple task. The DCS takes the best effort to provide reliable and better network services to Ruhuna-LAN community.

Most of the department/units handle few (less than 20) networked computer labs which are used by staff and special degree students. And there are five computer labs heavily used by students at DCS, faculty of Humanities & Social Sciences, faculty of Management & Finance, faculty of fisheries marine science and technology and Main Library. Most of the network traffic transfer especially from these five locations. When Administrator had a better traffic monitoring technique he can manage and analyze network traffic and identify the people who are using this internet service.

The students try to download bulk of data from the internet because of that overall internet speed going very slow. The DCS not going to control the bandwidth at any level due to that some people and some faculties may have to face very unfair situation when using internet services. Currently DCS do not have the monitoring tool for check the user behavior and bandwidth consumption at each department.

Bandwidth monitoring and management software and hardware are available at market and users have to pay lot of money for buy these equipment or software. Most of the times it will not 100% match for user requirements.

There for the Author sees that the requirement of the suitable bandwidth monitoring and analysis software for University Network is a very important issue.

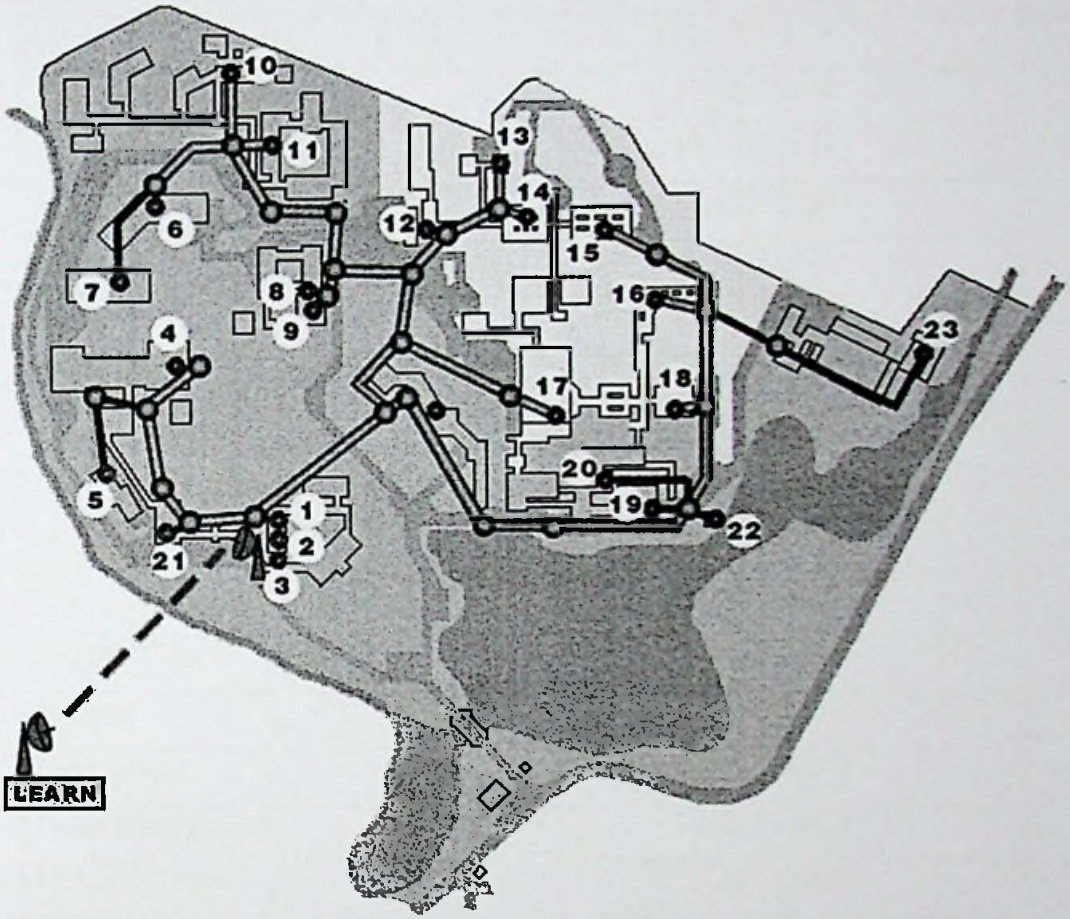
The main goal of this project is giving web base bandwidth monitoring and analyzing system for all Ruhuna-LAN users and the Administrators to overcome the problems discuss bellow.

1.4 Services Handled by the DCS

Since 1995 the Computer Unit University of Ruhuna **was got** the Internet connection from LEARN through Dial-up connection only for few PC's. After one year CU upgrade its Internet connection to 64Kbps link and gave Internet service and email to other departments by dial-up connection through intercom telephone lines. In 1997 the CU change to DCS.

On year 2000 the Swedish funded agency provide funding to develop the network Infrastructure at University of Ruhuna, Colombo, Peradeniya and LEARN. UoR (here after UoR means University of Ruhuna Wellamadama site) interconnected all the departments, units, administration branches, medical center and main library by fiber back bone. After the fiber back bone was build up all the departments and branches develop their internal networks and speed up the requirements of internet services. The DCS increases the Internet bandwidth to 2Mbps to fulfill the requirements of the UoR after getting approval from the Vice Chancellor. The head DCS is the representative for LEARN management committee and ***ruh.ac.lk*** domain handle by the DCS.

Like that DCS increase the local bandwidth (within LEARN) to 100Mb and International bandwidth to the 60Mb.



1/2 - Department of Computer Science.
3 - Department of Mathematics.
4/5 - Department of Physics.
6/7 - Department of Chemistry.
8 - Office of the Dean/Science.
9 - Department of Fisheries Biology.
10 - Department of Zoology.
11 - Department of Botany.
12 - Department of Sinhala
13 - Department of History.
14 - Department of Pali and Buddhism.
15 - Business Administration.
16 - Department of Geoggraphy.
17 - Dean/Humanities & Social Science.
18 - Department of Economics.
19 - Administration branch.
20 - Finance branch.
21- Department of Computer Science
22 - Engineers office
23 - Department of Physical Education

Figure 1-1: Ruhuna University (Wellamadama Site) Fiber Backbone Plan

IP Address allocation at Ruhuna-LAN

No	Departments	IP Address
1	All the Servers and some of the staff members	192.248.48.0/24
2	Computer Science	10.48.2.0/24
3	Computer Pool	10.48.3.0/24
4	Mathematics	10.48.4.0/24
5	Physics	10.48.5.0/24
6	Chemistry	10.48.6.0/24
7	Zoology	10.48.7.0/24
8	Botany	10.48.8.0/24
9	Fisheries	10.48.9.0/24
10	Dean Science	10.48.10.0/24
11	Main Library	10.48.11.0/24
12	History	10.48.12.0/24
13	Pali & Buddhism	10.48.13.0/24
14	English Unit	10.48.14.0/24
15	Sinhala	10.48.15.0/24
16	Dean HSS	10.48.16.0/24
17	Dean Management	10.48.17.0/24
18	Cultural Center	10.48.18.0/24
19	Computer Unit - HSS	10.48.19.0/24
20	Sociology	10.48.20.0/24
21	Faculty of Management - 2	10.48.21.0/24
22	Geography	10.48.22.0/24
23	Economics	10.48.23.0/24
24	Administration Complex	10.48.24.0/24
25	Finance branch	10.48.25.0/24
26	Maintenance Engineer	10.48.26.0/24
27	Supply Branch	10.48.27.0/24
28	Accounts branch	10.48.28.0/24
29	Local Services	10.48.30.0/24

Table 1-1: IP allocation, UoR

Department of Computer Science provide following Services

- World Wide Web service to wellamadama site
- E-mail service to all the faculties in University of Ruhuna
- Domain Name Service to all the faculties in University of Ruhuna
- Maintaining Ruhuna University Home page (www.ruh.ac.lk)
- Administration and Maintaining the Ruhuna-LAN
- Consulting and helping all the faculties to develop and improve their network and performance.
- Technical evaluation of the entire network related equipment and services.
- Providing LMS services to Staff members/Students at UoR.
- Defining policy decisions for Internet access.
- Coordinate with LEARN and Administration officers at UoR for the Internet payments, Increase bandwidth and other technical matters.
- Providing Video Conferencing facility

1.5 Problem to Solve

The Department of Computer Science is the main responsibility for giving above mentioned services to users in Ruhuna-LAN. E-mail is one of the critical service which we have to be very careful. Most of the staff members using Internet to find out places for their higher education, publish their papers, conference with their overseas supervisor, preparing lecture materials and improve their knowledge with latest updates. Students also use internet to find out more details about their subjects, communicate with other people all over the world ect...

Because of above reasons and limited bandwidth availability we have to maintain the reliability and speed of the internet service. LEARN use the MRTG graphs to monitor the bandwidth usage of each University. To maintain a reliable service followings are the problems we are facing:

1.6 Main Difficulties faced by the DCS are,

- There is no way to identify the bandwidth usage at each department or each faculty. If the payment going to be calculated by each faculty or each department this will be a big problem.
- Some students use peer to peer downloading tools to download software. This kind of application should be identified because it may slowdown the whole network traffic.
- The mentioned bandwidth usage for given link may be consumed by one or few persons in one location. But DCS do not have any method to check that.
- DCS do not have any permanent tracking system to find out the user activities.
- If unnecessary traffic generate from any location of network DCS have to have some methodology to find out where it is generated.
- LEARN manage MRTG monitoring graphs. It only shows total outgoing and incoming traffic of Ruhuna-LAN.
- There is no systematic methodology to monitor the availability of all the links at one instance and servers.

1.7 Aim and Objectives

Outcome of this project is to develop a web based Bandwidth and server Monitoring System to implement in the wellamadama site, University of Ruhuna. The implementation of this project will make

- Overcome of the complexity of administration work of UoR network
- Easy to identify and troubleshoot the network problems.
- Users get the advantage of the well manage networks by getting good performance from the bandwidth they are paying.
- Can be inquire current/past accessing information base on department level ,IP or URL

- Can get the idea of the web usage in each department, each user and can do the comparison with other department or all.
- Daily, monthly bandwidth usage reports.
- Daily, monthly server downtime reports.
- Real time modification of Internet access control to the administrator base on the situations arising from the monitoring.
- Online server monitoring system and if any failure inform to the administrator and graphically indicate.
- Users can see the graphical representation of University network topology with link status and current bandwidth usage.
- Administrator can get more technical traffic details in each link.
- Real time network fiber backbone status in graphical user interface.

1.8 Structure of the Report

Report is divided in to chapters each discuss particular aspect of the project. The remainder of the project organized as follows: More detailed background and literature review relevant to the project work will be given in the chapter 2. The chapter 3 discussed the technological requirements of new system. The chapter 4 will discuss the requirements analysis for the new system. Chapter 5 contains design issues of the Ruhuna-MBS system implemented in this project. Chapter 6 relates to implementation of design issues that are discussed in chapter four. Testing and evaluation of the system is described under the chapter 7. Final chapter presents the conclusion of the project work and further work which could be carried out in next remaining time period.

Chapter 02

2 Background

2.1 What is Bandwidth Monitoring System?

Bandwidth in computer networking refers to the number of bits (data) transfer any given network connection or interface in a one second. One most commonly way to expresses bandwidth in terms of bits per second (bps). The term comes from the field of electrical engineering, where bandwidth represents the total distance or range between the highest and lowest signals on the communication channel (band).

Bandwidth measure the capacity of the communication media. The greater the capacity, the more likely that greater performance will follow, though overall performance also depends on other factors, such as latency.

Indiscriminate Internet surfing and bandwidth-guzzling downloads by internal users often leave enterprises with insufficient bandwidth for business-critical applications. Bandwidth monitoring allows optimum utilization of bandwidth and offers bandwidth control over congestion, preventing bandwidth abuse and resultant choking. Enterprises receive committed, burstable bandwidth, preventing non-critical applications from degrading network performance in addition to gaining control over investment in bandwidth.

2.2 Data collecting Objects

Normally the projects like monitoring any activity should have to get data from one or more devices. For the monitoring bandwidth usage we consider three types of data source devices.

1. Switches
2. Router
3. Squid web cache proxy

2.2.1 Switches

University of Ruhuna has two layer 3 switches and nearly hundred layer 2 switches. Most probably each department has one or more L2 switch. As data-collecting sources for calculation of Internet usage the switches have lot of disadvantages. But for consider the status of the link is can be taken from the Layer3 switches.

- We can't identify the outgoing traffic is for Internal or External.
- Not only user traffic, the traffic belongs to manage the network, broadcasting traffic is also passing through this switch network.
- Switches are spread all over the network at different places due to that data collecting is a big bandwidth consuming work.

Therefore as a data-collecting source for bandwidth usage, the switches are ignored.
But Ruhuna-LAN distributes all the fiber links at the one single point and that is where L3 switches connected to the network. All port status of L3 switch is indicated the link status of the fiber backbone.
Therefore to check the link status of the most of the location, core switch (L3 switch) is the very suitable place.

2.2.2 Router

Lot of traffic monitoring and bandwidth monitoring software is producing base on Internet Router. In our case everyone in the University of Ruhuna, access external web resources through web cache proxy server. Therefore router gets the outgoing web traffic only from one IP address that is belong to cache server. Cache proxy server sends the web request to web server's behalf of internal users.

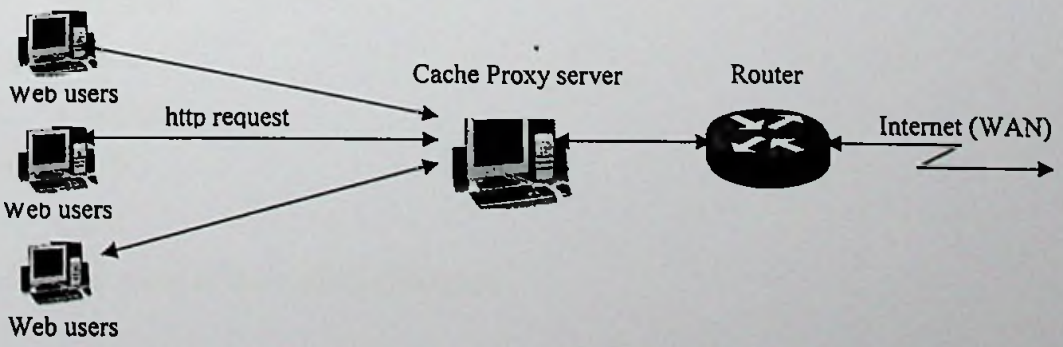


Figure 2-1: Architecture of web request

Because of above setup Router received web request only from one IP address. From that we cannot identify, from where the request comes from. Therefore Internet Router does not fulfill our requirements.

2.2.3 Squid web cache proxy

From the total bandwidth usage more than 96% is for incoming web traffic. The Proxy server only keeps the entry for web access. That means we do not mention other than web traffic for this project. But it does not affect very much.

For each web request there is an entry on access.log in proxy server. We can get every detail, which we required, to monitoring bandwidth usage in each department or faculty from analyzing the log file in the proxy server.

2.2.4 Review of relevant projects

Brief description of relevant projects of Bandwidth monitoring and Server Performance.

i). Bmon
ii). Bwbar
iii). Bwm
iv). bwm-ng
v). iftop
vi). Iperf
vii). Ipfm
viii). Speedometer
ix). Cbm
x). Ibmonitor
xi). Pktstat
xii). Mactrack
xiii). MRTG
xiv). Cacti

We will see some of the tools individually.

bmon

bmon is a portable bandwidth monitor and rate estimator running on various operating systems. It supports various input methods for different architectures.
Various output modes exist including an interactive curses interface, lightweight HTML output but also formatable ASCII output. [19]

Bmon give the output as *Figure 2.2 :*

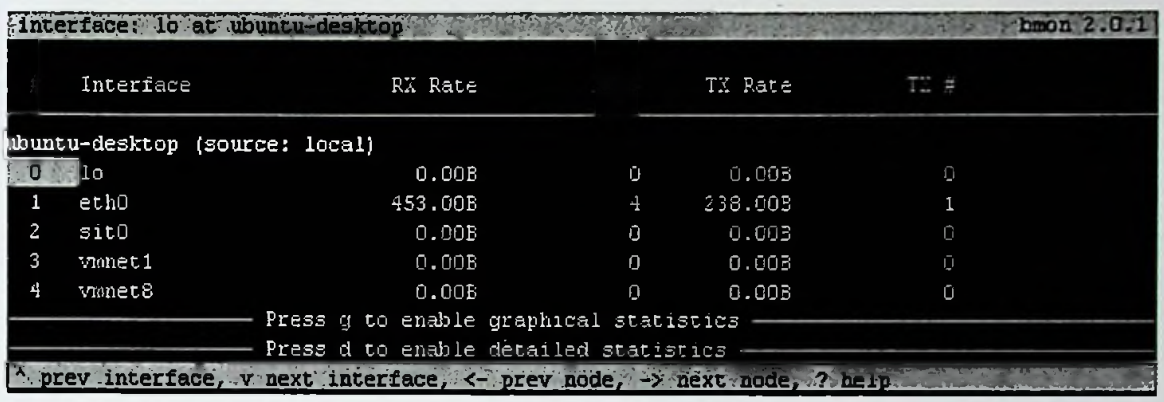


Figure 2-2: output of the bmon

bwbar

This program will output a PNG and a text file that can be used in scripts or be included in web pages to show the current bandwidth usage. The amount of total bandwidth can be customized. The PNG output appears as a bar graph showing maximum possible usage with the current inbound or outbound usage shown as a differently colored bar.[20]

Bwbar indicate the bandwidth bar as *Figure 2.3 :*

Figure 2-3: output of the bwbar

iftop

iftop does for network usage what top does for CPU usage. It listens to network traffic on a named interface and displays a table of current bandwidth usage by pairs of hosts. [20]

Output looks like *Figure 2.4 :*

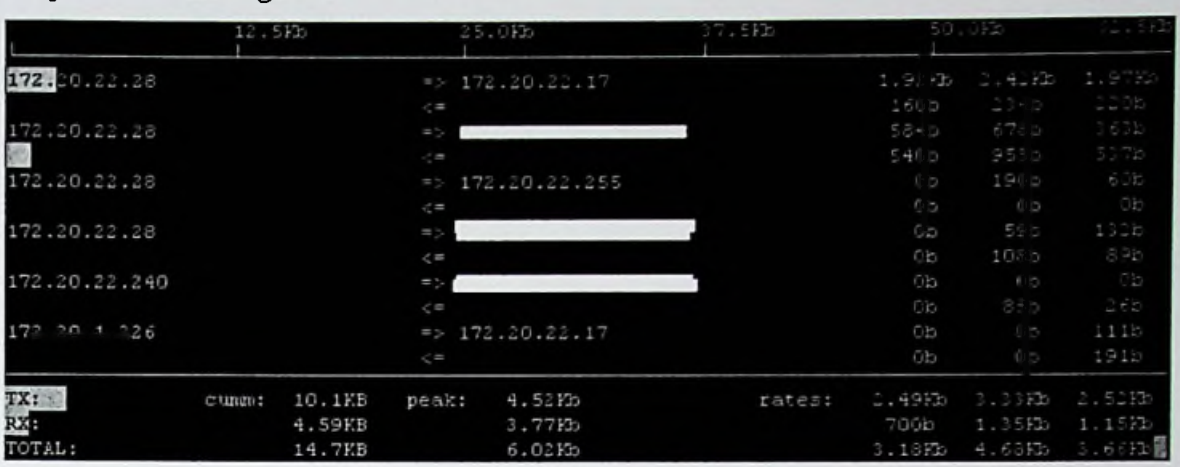


Figure 2-4: output of theiftop

cbm

cbm — the Color Bandwidth Meter — displays the current traffic on all network devices. [20]

Output looks like *Figure 2.5 :*

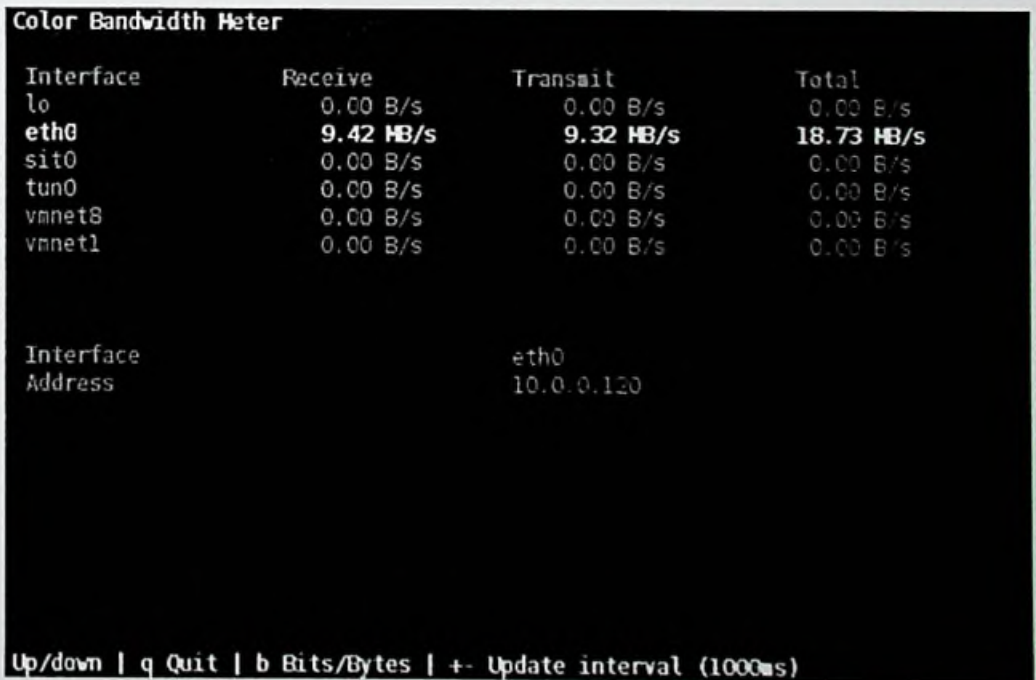


Figure 2-5: output of the cbm

pktstat

pktstat listens to the network and shows the bandwidth being consumed by packets of various kinds in realtime. It identified some protocols (including FTP,HTTP, and X11) and include a descriptive name next to the entry (e.g., 'RETR cd8.iso', 'GET http://slashdot.org/' or 'xclock -fg blue'). [20]

Output looks like *Figure 2.6 :*

```
interface: eth0
load averages: 11.6k 3.4k 1.2k bps

  bps   %  desc
167.8   0% llc 802.1d -> 802.1d
 83.9   0% loopback
125.9   0% snap oui 00.0c.00 ethertype 0x0300
 83.9   0% snap oui 00.0c.20 ethertype 0x0401
275.5   0% tcp 172.20.22.17:4402 <-> ns1:ftp
167.8   0% tcp 172.20.22.17:4506 <-> ik-in-f99:www
           tcp 172.20.22.17:4539 <->          :8080
           - 200 POST /officescan/cgi/cgiOnUpdate.exe
           udp 172.20.22.255:ipp <-> 172.20.22.28:ipp
           udp 172.20.22.255:netbios-dgm <-> 172.20.22.25:netbios-dgm
 1.9k   1% udp 172.20.22.28:4208 <->          :domain
```

Figure 2-6: output of the pktstat

ibmonitor

ibmonitor is an interactive linux console application which shows bandwidth consumed and total data transferred on all interfaces. [20]

Output looks like the *Figure 2.7 :*

```
Interface     Received        Sent        Total
                  Kbps        Kbps         Kbps

eth0              0.80        3.04         3.84

lo                0.00        0.00         0.00

sit0              0.00        0.00         0.00

vmnet1            0.00        0.00         0.00

vmnet8            0.00        0.00         0.00

All               0.80        3.04         3.84

Press ctrl+c to quit...                Elapsed time: 0 hrs, 0 mins, 10 s
```

Figure 2-7: output of the ibmonitor

Iperf

Iperf is a Lightweight tool to measure network performance. Iperf was developed as a modern alternative for measuring TCP and UDP bandwidth performance. It's work with IPv4 and IPv6 to measure datagram loss, delay jitter and report various parameters of bandwidth. Also it support cross platform and client and server can handle multiple simultaneous connections. [20]

tcptrack

tcptrack is a sniffer which displays information about TCP connections it sees on a network interface. It passively watches for connections on the network interface, keeps track of their state and displays a list of connections in a manner similar to the unix 'top' command. It displays source and destination addresses and ports, connection state, idle time, and bandwidth usage. [20]

Output looks like the *Figure 2.8*

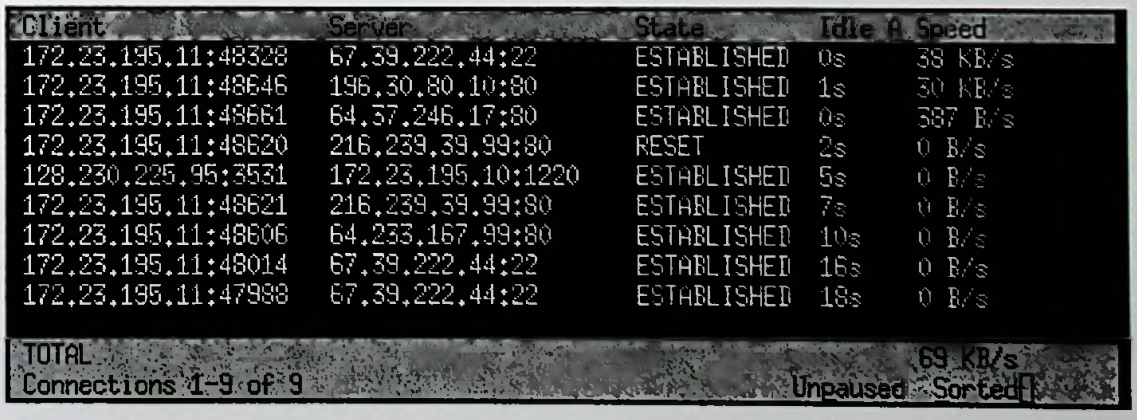


Figure 2-8: output of the tcptrack

MRTG

The Multi Router Traffic Grapher or just simply MRTG is free software use for monitor the traffic load on network interfaces. It allows the user to see incoming and outgoing traffic load on a network over time in graphical form. [21]

MRTG is a network management application that can monitor any remote network host, which has the SNMP protocol support enabled. MRTG, as a SNMP based application, runs SNMP requests against the target hosts on a regularly basis.

Originally MRTG was designed to acquire bandwidth information related to the network interfaces on a network host. Currently MRTG can interrogate a host about any supported SNMP OID and construct the variation graph. More than that, the new versions of MRTG are able to extend beyond of SNMP capabilities and collect numerical information from any host that collects and stores this kind of information (for more info on the new capabilities visit the MRTG and RRDTOOL websites).

MRTG acquires the SNMP information performing the following tasks:

- Interrogates the remote host and gets the value of the specific SNMP OID.
- Updates the variation graph with the new values and deletes the old graph. The graphs are images in PNG format. The new variation graph is stored in a location, which can be local or remote on a dedicated MRTG storage server.
- Stores the new value in the log file. The log file can be located on the local host or remotely on a MRTG storage server.

The classic version of MRTG builds the graphs immediately after a new SNMP value is acquired and does not store any historical data for future reference. [21]

Output looks like the following screen

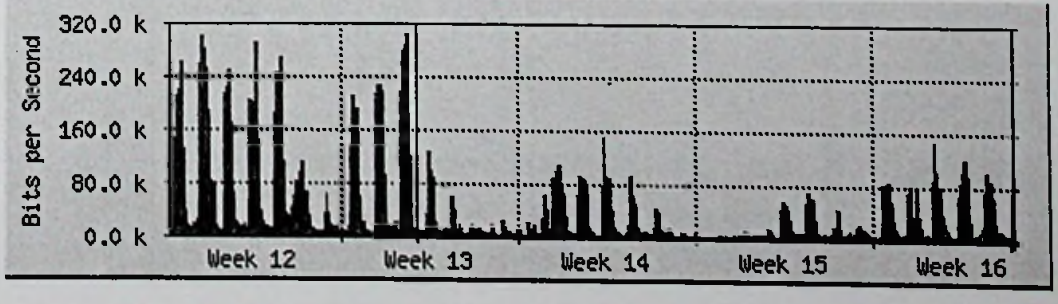


Figure 2-9: output of the MRTG

Cacti

Cacti [22] is another GUI network graphing solution which is powered of RRDTool's data storage and graphical functionality. It's only gathered data from the network devices and provides easy to use, ease of user management and very attractive graphical representation. It can be sense hundreds of devices.

Nagios

Nagios [26] also powerful network monitoring tool and it is use to monitor critical systems, application and services. This tool provide such as alerting, event handling and reporting any issue regarding the applications, services, operating system, network protocols, system metrics and network infrastructure components.

2.2.5 Summary

Most of the above applications support to analyze server performance or the network device monitoring and analyzing. There is no any application to monitoring/analyzing bandwidth, network devices and servers in one application. And also these applications are not well fitted to our requirements.

2.3 Why web based Monitoring System?

The proposed Bandwidth and server Monitoring System for the University of Ruhuna is designed as a web based system. And that will help to eliminate lot of problems discussed below.

Web based applications have evolved significantly over recent years and with improvements in security and technology there are plenty of scenarios where traditional software based applications and systems could be improved by migrating them to a web based application.

Below are some of the core benefits of web based applications.

2.3.1 Cross platform compatibility

Most web based applications are far more compatible across platforms than traditional installed software. Typically the minimum requirement would be a web browser of which

there are many. (Internet Explorer, Firefox, Google Chrome to name but a few). These web browsers are available for a multitude of operating systems and so whether you use Windows, Linux or Mac OS you can still run the web application.

2.3.2 More manageable

Web based systems need only be installed on the server placing minimal requirements on the end user workstation. This makes maintaining and updating the system much simpler as usually it can all be done on the server. Any client updates can be deployed via the web server with relative ease.

2.3.3 Highly deployable

Due to the manageability and cross platform support deploying web applications to the end user is far easier. They are also ideal where bandwidth is limited and the system and data is remote to the user. At their most deployable you simply need to send the user a website address to log in to and provide them with internet access.

This has huge implications allowing you to widen access to your systems, streamline processes and improves relationships by providing more to your customers, suppliers and third parties with access to your systems.

2.3.4 Secure live data

Typically in larger more complex systems data is stored and moved around separate systems and data sources. In web based systems processes can often be consolidated reducing the need to move data around.

Web based applications also provide an added layer of security by removing the need for the user to have access to the data and back end servers.

2.3.5 Reduced costs

Web based applications can dramatically lower costs due to reduced support and maintenance, lower requirements on the end user system and simplified architecture.

By further streamlining our business operations as a result of our web based application additional savings can often be found.

3 Technology Requirements

3.1 Software for the Development

The web based Monitoring system is developed and operated on typical client server mode. All information (data) relevant to the system is kept in a central location, and users can access the information through an application running in the clients personal computers. According to the new trend towards Open source software, this Monitoring system is developed using open source softwares. Depending on open source; xampp is a good bundle of software for web based developments and other open source applications are squid, MRTG and Cacti[21] [22].

3.2 Reasons for Open-source software

Open-source software is a computer software whose source code is available under a license (or arrangement such as the public domain) that permits users to study, change, and improve the software, and to redistribute it in modified or unmodified form. It is often developed in a public, collaborative manner.

3.2.1 XAMPP

XAMPP is a free, cross-platform standalone server, consisting mainly of the Apache HTTP Server, MySQL database, and interpreters for scripts written in the PHP and Perl programming languages. XAMPP's name is an acronym for X (any of four different operating systems), Apache, MySQL, PHP and Perl. [10]

The program is released under the GNU General Public License and acts as a free, easy-to-use web server capable of serving dynamic pages. Currently, XAMPP is available for Microsoft Windows, Linux, Sun Solaris and Mac OS.

3.2.2 Apache

One of the world's most popular Web server program, Apache was built by a group of open-source programmers and is often used because of its outstanding performance, strong security features and the fact that it is free.

3.2.3 PHP

PHP (Hypertext Preprocessor) is a reflective programming language originally designed for producing dynamic web pages. PHP is used mainly in server-side scripting, but can be used from a command line interface or in standalone graphical applications. [24]
The main implementation is produced by "The PHP Group" and released under the PHP License. It is considered to be free software by the Free Software Foundation.

3.2.4 MySQL

MySQL, the most popular Open Source SQL database management system, is developed, distributed, and supported by MySQL AB[25]. MySQL AB is a commercial company, founded by the MySQL developers. It is a second generation Open Source company that unites Open Source values and methodology with a successful business model.

3.3 Open source Applications

Expand the covering area of the project the author thought the MRTG and Cacti software can integrated with developed system to get better picture of the network

3.3.1 Multi Router Traffic Grapher

The Multi Router Traffic Grapher or just simply MRTG is free software use for monitor the traffic load on network interfaces. It allows the user to see incoming and outgoing traffic load on a network over time in graphical form. [21]
MRTG is a network management application that can monitor any remote network host, which has the SNMP protocol support enabled. MRTG, as a SNMP based application, runs SNMP requests against the target hosts on a regularly basis.

3.4 Simple Network Management Protocol (SNMP)

Most routers and firewalls keep their operational statistics in Management Information Blocks (MIBs). Each statistic has an Object Identifier (OID) and can be remotely retrieved from the MIB via the Simple Network Management Protocol (SNMP). However, as a security measure, user needs to know the SNMP "community string" as a password to do so. There are a number of community string types and the most commonly used ones are the "Read Only" community string that only provides access for viewing statistics and system parameters. In many cases the "Read Only" community string or password is set to "public". There is also a "Read Write" community string for not only viewing statistics and system parameters but also for updating the parameters too. [26]

3.4.1 SNMP-Walk

SNMPWALK is one of the main tools used by a network engineer to troubleshoot behavior or verify configuration of devices. The output however is pretty hard to understand. Snmpwalk is a command line utility available on almost all routers platforms and switches.

The SNMPWALK command is used to retrieve a MIB subtree and print the results to the console. In reality, there is no "WALK" operation defined in the SNMP protocol. The SNMPWALK actually tool uses a series of GETNEXT requests in a loop. The first iteration of GETNEXT uses the OID supplied on the command line, all subsequent GETNEXTs use the OID contained in the previous response. The loop stops if the returned OID in the response is outside the subtree of the original OID or the end of MIB is reached. [27]

3.5 The Architecture

3.5.1 Three – Tier Architecture

A 3-tier architecture defines the division of a web based application into three layers. When we say 3-tier architecture, we are actually meaning the number of nodes (or computers) that are involved within the communication

In two-tier architecture the server contains all the contents that would be requested from the client, the contents can include web pages, the server-side technology implemented and the data-store. If we separate the contents of the server-side technology from the web pages and place them on a separate machine then this architecture would become three-tier architecture. Similarly if we keep on increasing the number of machines in between our client/server communication then we would be implementing the n-tier architecture for our communication.

3.5.2 Why do we need the three-tier architecture?

The three-tier architecture was introduced for better management of code and contents and to improve the performance of the web based applications. Within the three-tier architecture we divide our application into three layers.

- Presentation
- Business Logic
- Database

The first layer Presentation contains the interface code, which is going to be displayed to the user. This code could contain any technology that can be used on the client side like HTML, PHP Script, JavaScript or VBScript etc.

The second layer Business Logic contains all the code of the server-side technology. This layer mainly contains the code that is used for accessing the database and to query, manipulate, pass data to user interface and handle any input from the user Interface as well.

The third and last layer Data represents the data store like MS Access, My SQL Server, an XML file, an Excel file or even a text file containing data.

Following figure shows the layers we have just described.

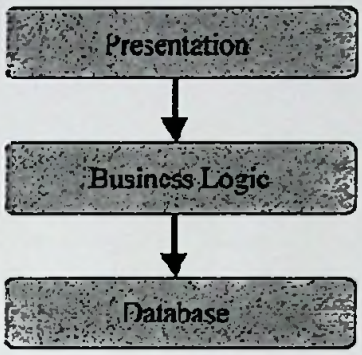


Figure 3-1: Typical Layers of three-tier architecture

One main benefit in the three-tier architecture is easy management of the contents of web application. Consider a scenario in which you require to change the presentation of the web pages because you have recently designed a new look for your website. In the case of two-tier architecture you would require to change the web pages that would be containing both the contents for the presentation as well as the business logic, this would mean an headache for you to keep the code for business logic as it is and change the code for the presentation layer. In case of three-tier architecture the code of the business logic would be residing on the middle layer, there for you would require only making a change on the presentation layer containing the code for your web page designs. Similarly if you require changing the database system for example, from Access to SQL Server, then you would require only changing the database on the data server without having to make any changes within the code of your business logics.

The three-tier application design also enables for better performing web applications, since the whole load of users is not placed upon a single server. As we can see in the figure displaying the design of a three-tier architecture web application, it can be seen that placing the business logic and the database on different machines reduces the load upon a single server. Similarly we can implement any number of servers we like on the backend of the application and such architecture would be known as n-tier architecture.

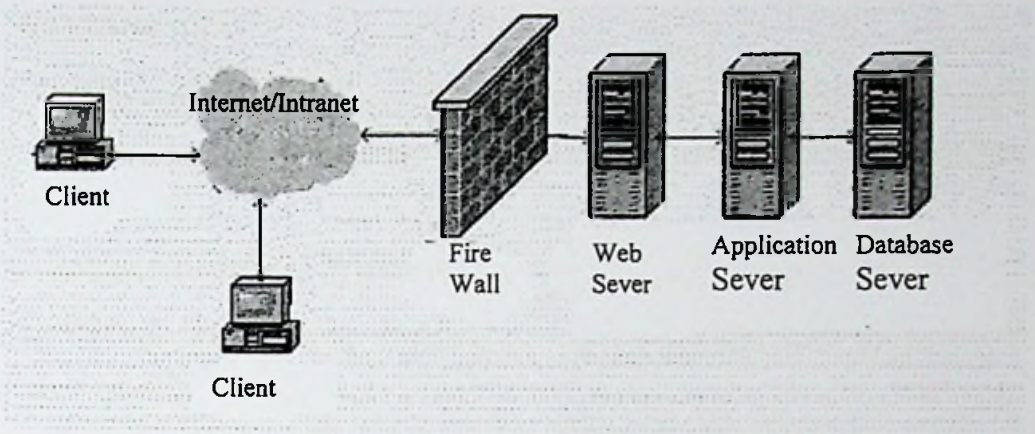


Figure 3-2 : Web Enable Application via Internet/Intranet

Chapter 04

4 Requirement Analysis for Ruhuna-MBS

4.1 Chapter Overview

This chapter intends to grasp the problem domain more firmly, identify which issues need to be addressed specifically, and lay down the features that are to be implemented in the prototype.

4.2 User characteristics and objectives

For the Ruhuna-MBS system, there are two user categories were interesting for this measuring values.

I. Network Administrators
II. Network users

4.2.1 Administrative staff

The Ruhuna-MBS system's major beneficially party is the network administrators. Network users and the University administrators always contact network administrator to verify or to trouble shoot for network problems. The requirements of the network administrator is as follows:

- Actual Usage of the bandwidth from each department
- Actual bandwidth usage of each user in departments
- Comparison of bandwidth usage within two departments
- Compare bandwidth usage within one department and total usage of Ruhuna-LAN
- Compare of in and out total traffic in one department Vs web traffic of same department
- Application level monitoring
- Search all accessing details from specific IP on given time period
- URL base searching for specific time or date
- Search for past details specially base on date, time, IP address and URL
- Check for unusual traffic transferring
- Availability of the link
- If the link was unavailable administrator wants to know at what time it was unavailable.

4.2.2 Network Users

All the members who use the Ruhuna-LAN can be categorize as network users. The users mainly consider the availability of the network connection. The requirements of the Network users are follows:

- They need to know the usability of the bandwidth from their department or faculty
- Need to check the availability of the link
- Need to check the reliability of the link
- Bandwidth usage of all the departments

4.3 Functional Requirements of the Product

The software product will perform the following Requirements:

- User Module
- Administration Module
- Search for specific record
- Comparison the bandwidth usage
- Comparison the total traffic with web traffic
- Network Topology status

4.3.1 User Module

This is the restricted mode of the bandwidth and server monitoring system. Users can only see the status and comparison status. They do not allow any searching functions in this system.

Features:

- Can check the Bandwidth usage of all departments
- Can check the availability of the link
- Can see the Server performance

4.3.2 Administration Module

This module included all the features of the proposed system. Administrator can search the specific records, comparison and analysis the bandwidth usage and server performance.

Features :

- Actual Usage of the bandwidth in each department
- Actual bandwidth usage of each user in departments
- Comparison of bandwidth usage within two departments
- Compare bandwidth usage within one department and total usage of Ruhuna-LAN
- Compare of in and out total traffic in one department Vs web traffic of same department
- Search all the accessing details from specific IP on given time period
- URL base searching for specific time or date
- Search for past details specially base on date, time, IP address and URL
- Check for unusual traffic transferring
- Availability of the link
- If the link was unavailable administrator wants to know at what time it was unavailable

4.4 Non Functional Requirements

Robustness

The system will continue to function accurately despite incorrect user input.

Ease of use

The users should be able to perform the main tasks with ease, without any expert knowledge.

4.5 Requirement capturing methods

Some technically sound users of Ruhunan-LAN were interviewed in order to get user requirements and administration requirements were provided by DCS network

administrators and some requirements were collected through working experience of the author.

4.6 Mechanism of Requirement Verification

Sole mechanism of verifying requirements was through Ruhunan-LAN users and the Ruhunan-LAN administrators.

Chapter 05

5 Design of Ruhuna-MBS

5.1 Design Methodology

The nature of facilitating multiple dimensions was the major reason to select UML as the main system design methodology. As described in the system analysis level, Use Case diagrams were drawn and gathered the requirements. In the preliminary stage of design phase, system has viewed in three-layered structure, which is also named as vertical visualization. Then the system was further divided in to separate logical and functional areas called subsystems, which gives the horizontal visualization of the system.

The main benefit made available with this technique is that it is extensible. Enhancement to the system could be added where necessary because each subsystem is independent. Lines of communication between subsystems (known as interface) must be formally defined to ensure the integrity of data and the execution of operations. Each subsystem can be tested independently, assisting the parallel implementation and testing of different subsystems.

5.2 High Level Design

A high level view of the system could be shown as three-tired structure. The presentation layer, business logic layer and storage layer would be the three components, which will provide the conceptual view of the system in highly summarized manner. Use case diagram, which included under the analysis stage, gave the high level view of the proposed system. But at this stage, system should be looked in an implementation viewpoint; hence it is possible to view this in a more descriptive manner. As it will be described in the below figure 5.1, clear separations between the layers could be identified. Thereby it provides an overall understanding of the system. The presentation layer consists of user interfaces for administrators and for other clients. The detail description of those subsystems would be presented at the latter part of this chapter. At this moment contents of each layer has been considered.

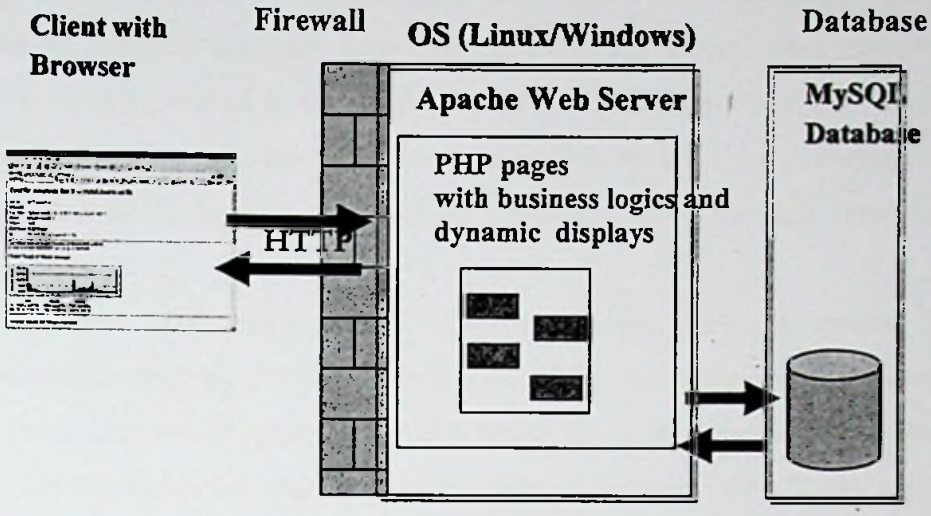


Figure 5-1 : Typical Three-tire Structure for the Ruhuna-MBS

5.3 User Interface Design

As this is a web enable application user interface design plays a major role and reliable user interface would be the ultimate deliverable of all subsystems. Hence at the design point of view user interface techniques and technologies employed by each subsystem should be measured from vertical visualization viewpoint.

5.4 The Big Picture for Development

5.4.1 Use Case Diagram

In the process of analyzing the system it is important to maintain clear communication between system users and the system analyst. Since actual user requirement is going to be identified under this period of time, it is necessary to use good communication mechanism with the users. Visualization techniques such as pictures or the diagrams would be the better communication link. For this process selection of good analysis technique would be required.

Use case diagrams provide a good way of getting an overall picture of what is planned to happen in the new system. And it is the effective means of communication with the users and other stakeholders about the system and what is intended to do. Producing use case

diagrams and the associated documents is an analysis technique rather than a design technique. It provides the high level view of what the system does and who use it. Therefore it could be used as basis for determining the human-computer interface to the system. Use case diagrams use a simple diagrammatic notation that is comprehensible to end-users and can be used to communicate with them about the high level view of the system.

Figure 5-2 represented the use case diagram for the proposed system. It clearly highlighted the roles interact with the system as well as main operations perform by those roles. There are two different actors/roles which could be identified from the problem domain. The administrator and the general users in Ruhuna-LAN. Those actors initiate several use cases such logon, administrate user accounts, Produce reports and graphs, Searching records, comparison. Once the use case diagram is drawn with describing system behavior, it used to gather user requirements from the system.

Use Case Diagram of the Proposed Ruhuna-MBS

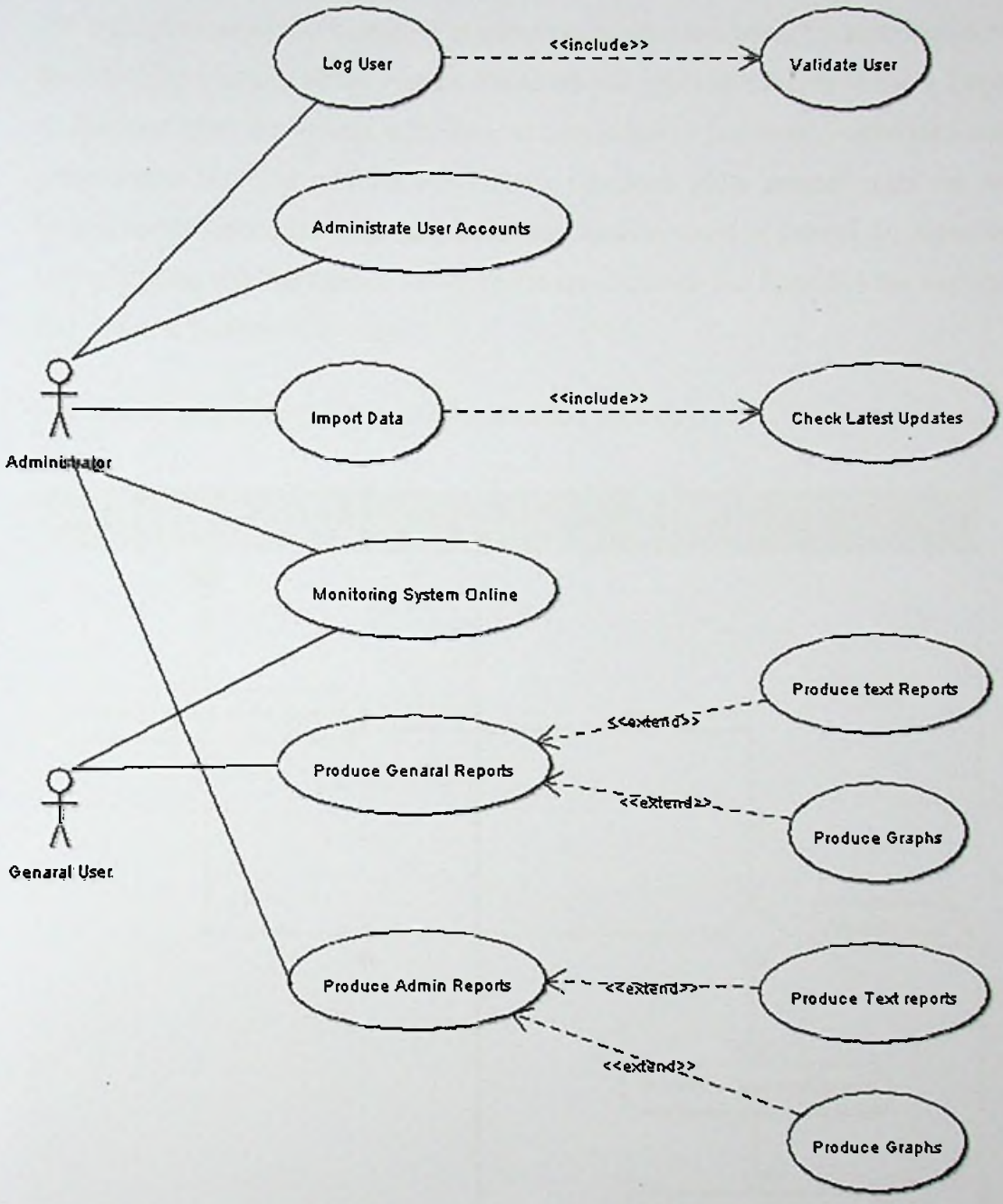


Figure 5-2: Use case diagram for Ruhuna-MBS

5.4.2 User Authentication Process Design

The main purpose of this module is to authenticate the users when the user wishes to enter the searching category of the system. There are two types of authorized users. Depending on the user type, the system will allow to access menu functions. Authorized users i.e. administrator user can perform every menu functions while general users can do only limited menu functions. When the user name and password is entered for Administrator Users is being verified against the values in the database and identifies the user function that could be performed by them.

Activity Diagram for the User Authentication Process

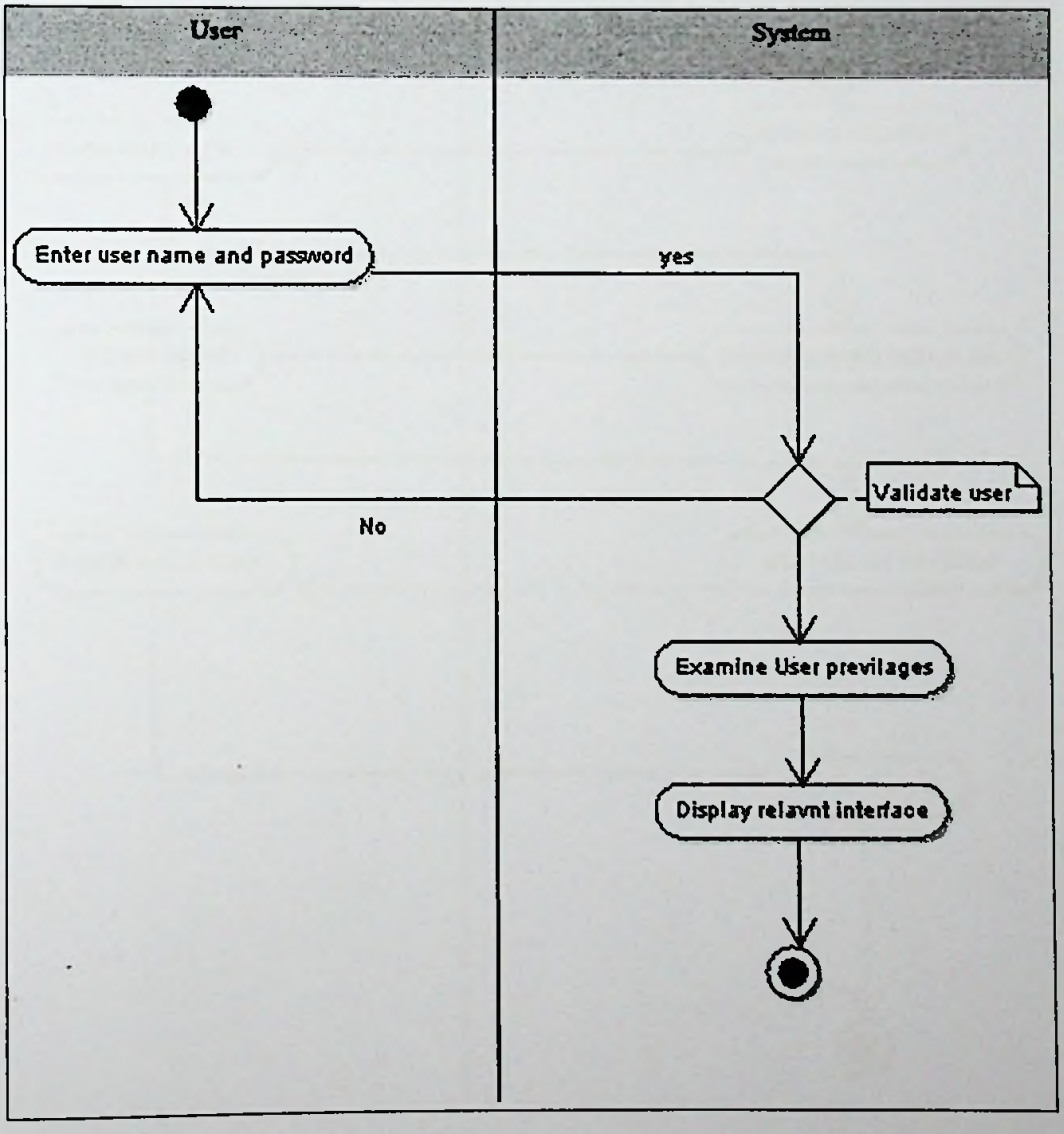


Figure 5-3 : Activity diagram for user authentication

5.4.3 Report Module Design

This module could not be accessed by the employee. The process was initiated with the selection of reports which are available in the system and then system displays a kind of wizard that should be followed by the user. (This wizard will depend on the report type). Finally the report is generated by the system according to the user selections.

Activity Diagram for the Report Module

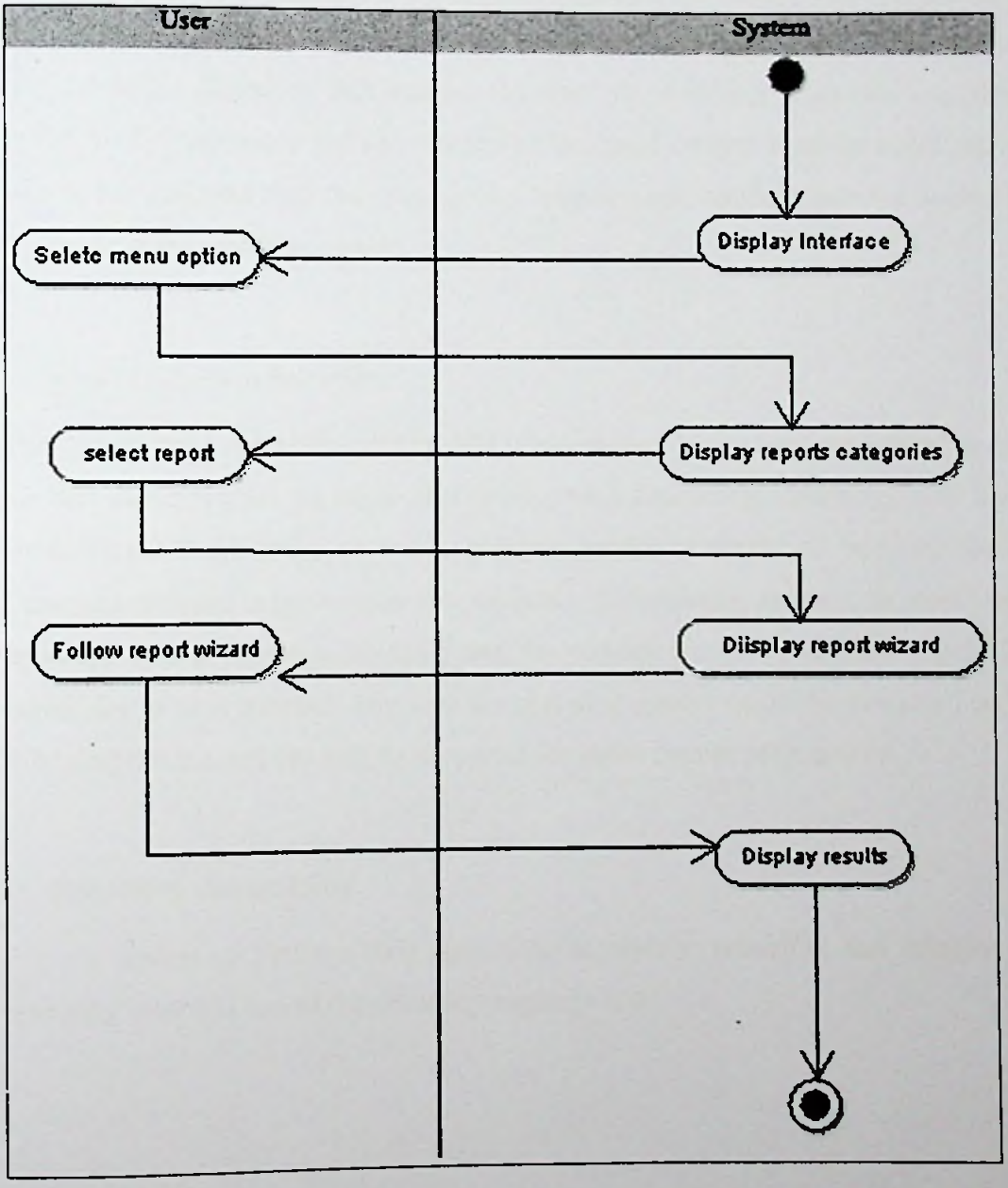


Figure 5-4 : Activity diagram for report module

6 Implementation of Design

6.1 Tool Selection

In order for the proposed system to be technically sound, choosing the proper implementation tools are extremely important. This is the first step in the process of implementing in any designed solution. When selecting the development platform it includes the selection of hardware and software, which needed to build the system. Many aspects need to be considered when selecting tools, to make sure that the requirements are met perfectly. Therefore this section explains the necessary concerns regarding the selection of development tools in order to build a good system. First the operating system will be selected, and then the development language and database selected depending on the pre-selected operating system.

6.2 Operating System Selection

Two mainly used operating systems; MS Windows and Linux were considered to identify the best-suited product for the project development. Operating system has to be handle is not much extreme because the system going to develop is totally will be a web based one. Other ads on build in application also support both Operating systems. In users view, the operating system is not much issue and the consideration of user view should be the familiarity of web browser. Any how the operating system would be evaluated under the following criteria and that will be supported for better system performance.

6.2.1 Reliability and Stability

For any system to perform their operations accurately, reliability and stability of the operating system is one of the necessary requirements.

6.2.2 Security

Security is one of the key features in any Operating System. Since information is going to be used for strategic decision-making, secrecy of data and knowledge is an essential requirement.

6.2.3 Familiarity and Popularity

When selecting the operating system familiarity and popularity of the operating system not only be an advantage to the developers, but also helps end-users when using them. But in this project the end-user environment will totally depend on the web browser and familiarity of the operating system has to be considered in developer view.

6.2.4 Performance and Resource Management

The selected operating system has to be capable of handling available resources with maximum usage to generate good output performance. Therefore performance support and accurate resource management is a main consideration.

The final choice

By considering above-mentioned criteria Linux was selected as the best suited operating system to host web server, database server and the application server.

6.3 Implementation Language Selection for Business Logic Components

Proper development language is the essence of developing a successful product. Selection of implementation language is evaluated under several features.

6.3.1 Execution Speed and Efficiency

Components are the essence of the proposed system. All business logic is included in the components. It should efficiently fetch data from the database and analyses them and present it to the user in appropriate manner. PHP, Java Script and Java Servelets could be used to develop business logic components.

6.3.2 Development Tools

Since product needs to be delivered in a very limited time period, rapid development is essential. Hence some special editors and tools that capable of developing web applications have to be considered.

6.3.3 Ease of Database Connectivity

Proposed system involves high degree of database manipulations. Those database activities should be carried out effectively and speedily. Therefore selected development language should support easy database connectivity and manipulation.

6.3.4 Familiarity

Another factor affects the selection of development language was its familiarity and easy of use. Also author considered the new trend of the web development field.

The final choice

PHP server side scripting language was selected as the main development platform for business components. Java Script and HTML were used for miner developments when necessary.

The main reasons behind this selection were its familiarity in ease of use and the new trend of the world in web development.

6.4 Database Selection

Data storing is another major issue which should be solved at the system developing time. Three different database technologies MS SQL Server, Oracle, MySQL were evaluated under the following criteria,

6.4.1 Ease of Use

Oracle and MS SQL Server have more advanced features and their technical materials can be used to handle them in a reliable way. MySQL is portable, open source DBMS that has

many free interfaces and materials which can be used in any computer without extra problems.

6.4.2 Familiarity

Most of web applications run in the world with MySQL back-end because of easy of use, open source and excellent support for web application development languages.

The Final Choice

Considering the familiarity, ease of use and the new trend MySQL was selected as the database provider for the product.

6.5 CASE Tool

CASE tool is an important item that is capable of designing a system. Today various case tools are available for the developer such as Rational Rose, Easy Case, Argo UML etc.

6.5.1 Ease of Use and Availability

Most of above mentioned CASE tools are easy of use. But most of them are commercial. Argo UML is a pure java open source UML CASE that provides cognitive support for object-oriented design. Argo UML provides some of the same editing and code generation features of a commercial CASE tool. [28]

The final choice

Considering the availability of free Argo UML tool was selected to design the product

6.6 Implementation of Ruhuna-MBS

6.6.1 Proxy Server

Introduction

A web proxy server is a useful service to have on your network, or between your network and the Internet, as it provides an extra security layer that insulates your users from the Internet. A proxy server can also act as a cache, allowing users to share downloads transparently and speeding up Internet access, especially for frequently-used files. Squid is a high-performance and relatively secure web proxy server that includes good caching facilities. It is one of the most commonly used proxy servers on the Internet. More information about Squid can be obtained http://www.squid-cache.org/.

All the users in Ruhuna-LAN network should have to go through the proxy server for access outside network. There for the machine use as the proxy server should have best performance. [29]

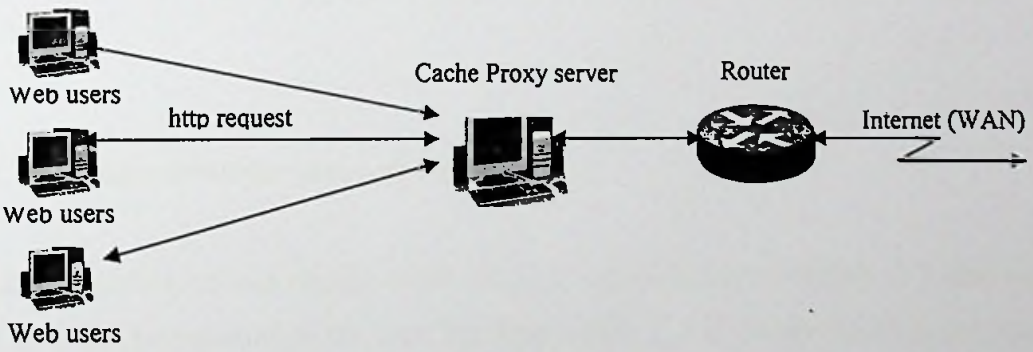


Figure 6-1 : Architecture of web request

All the successful http request made by user is logged in access.log file in proxy server. Within entire day may be proxy server logged nearly 2,000,000 log entries. One of the main tasks of Ruhuna-MBS is analysis this access.log file. Then execution of the project in the same proxy server machine is not a good idea from technical side. Therefore author thought this Ruhuna-MBS system should execute on separate machine to avoid the interruption to proxy process by this project.

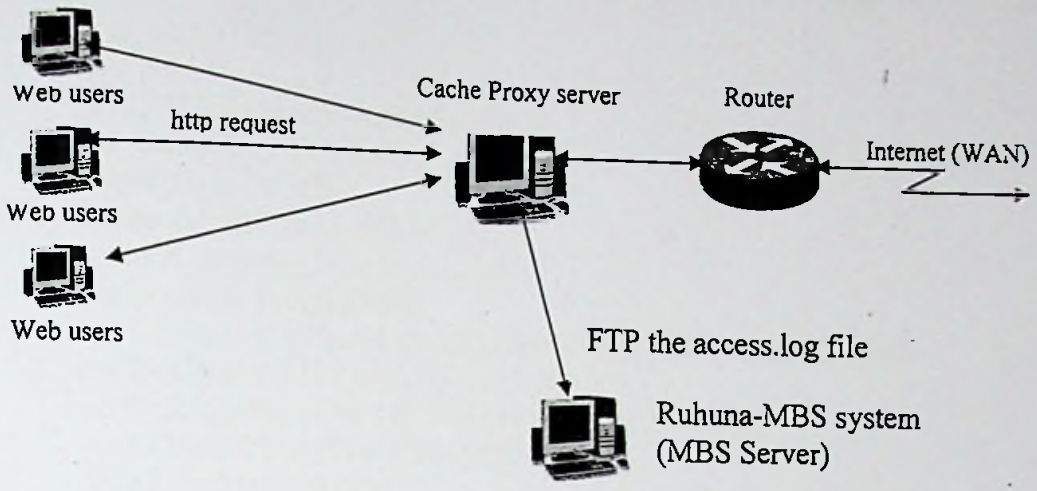


Figure 6-2 : Architecture of Propose system

Analyzing access.log file with nearly 2,000,000 records is getting little time. Only the root user can see the log files. Therefore before ftp the log file it is take the copy to another place which can access by the normal users. This process automated through daily cron job.

6.6.2 Configuration the proxy server

Linux distribution will usually come bundled with a packaged version of Squid; however, it may not be installed at the time the distribution was installed. Squid is governed by a configuration file, normally residing in squid.conf there is little other documentation shipped with squid in the form of manual or Texinfo (used by the info command) pages. However, in addition to the well-commented configuration file, FAQ's and documentation are also resided in the /usr/share/doc/squid directory. [29]

Listing 6.1 is the sample configuration topics for the squid.conf file in proxy server.

```
http_port 3128
icp_port 0
acl QUERY urlpath_regex cgi-bin \?
no_cache deny QUERY
cache_mem 16 MB
cache_dir ufs /cache 200 16 256
redirect_rewrites_host_header off
replacement_policy GDSF
acl localnet src 192.248.48.0/255.255.255.0 10.48.0.0/255.255.0.0
acl localhost src 127.0.0.1/255.255.255.255
acl Safe_ports port 80 443 210 119 70 21 1025-65535
acl CONNECT method CONNECT
acl all src 0.0.0.0/0.0.0.0
http_access allow localnet
http_access allow localhost
http_access deny !Safe_ports
http_access deny CONNECT
http_access deny all
cache_mgr admin@openna.com
cache_effective_user squid
cache_effective_group squid
log_icp_queries off
cachemgr_passwd my-secret-pass all
buffered_logs on
```

Listing 6.1 : sample configuration topics for the squid.conf file

All the internet users' have to access web service through the proxy server and it will keep the record of each web request in access.log file and sample entry of the log entry is as *Listing 6.2:*

```
04/Mar/2016:15:46:25 +0530 0 10.48.23.42 TCP_HIT/200 9163 GET
http://www.lankachannel.co/icon/Melody-of-Love.jpg - NONE/- image/jpeg
```

Listing 6.2 : sample row of the access.log file

Within one day there are about more than 2,000,000 entries logged on the access.log file. Daily backup will be generated by using daily crontab.

6.6.3 Automated Processes in Ruhuna-MBS

All the automated processes executed as cron jobs.

Proxy server

Each day at 6.25 a.m. proxy server rotate its log files and backup as zipped files. Before it rotate the current access.log file it copied to separate place as text file which can access by remote user. The part of the sample code as *Listing 6.3*:.

```
#! /bin/sh
#
# squid         Daily cron script for squid.
#
#  before zip the access.log file copy it to location /home/dial1/log/ as accesslog.txt

cp /var/log/squid/access.log /home/dial1/log/accesslog.txt

[ -x /usr/sbin/squid ] || exit 0

LOG_HISTORY=1

LOGDIR=/var/log/squid
cd $LOGDIR || exit 1
#
#       Gzip rotated logfiles, extensions 1 .. $LOG_HISTORY
#
zipit () {
        i=$LOG_HISTORY
        while [ $i -ge 1 ]
        do
                if [ -f $1.$i ]
                then
                        gzip -9f $1.$i
                fi
                i=$(($i - 1))
        done
```

Listing 6.3 : Daily cron script for squid

MBS Server

After 10 minutes the proxy server backup its log files, the MBS Server get the text file by ftp. The sample source code for ftp the log file to MBS server from squid cache server as follows:

```
#!/bin/sh
# Connect to remote machine
ftp squid.ruh.ac.lk <<mayday
binary
# User name and password of remote machine
quote USER test1
quote PASS test1pwd
# change the local file path
cd log
# change the remote file path
lcd squidlog
get accesslog.txt
#delete accesslog.txt
bye
mayday
```

Listing 6.4 : shell script for ftp connection to proxy server

The log file name format should have to change to current system date and remove the existing accesslog.txt file

```
#!/bin/sh
Today="`date +20%y%m%d`"
# rename the accesslog.txt file to Currentday.txt
cp /home/squidlog/accesslog.txt /home/squidlog/$Today.txt
# remove the accesslog.txt
rm /home/squidlog/accesslog.txt
```

Listing 6.5 : shell script for rename the filename

We have to apply filters to the log file to select actual out going bandwidth and other relevant information.

Some of filters

- Remove the entries which access the internal web servers by URL and IP address. (IP addresses 10.48.*.* , 192.248.48.* and URL ruh.ac.lk)

The proxy server also caches the sites accessed locally. If the local accessed bandwidth also calculated to total bandwidth the accuracy of the output result will be wrong. Therefore the system has to remove the entries belong to local sites.

- Remove the entries which access from the cache not from the real server. (Consider only TCP_MISS and TCP_REFRESH_MISS)

When the client send the web request to the proxy server the server first check its cache for the valid webpage. If server found the valid webpage from the cache it sends the page from the server not from the real server. This kind of bandwidth also rejected from the total bandwidth calculation.

After filter the log file information we get the time, IP addresses, no of bits, access URL and used application parameters. Ruhuna-MBS system not considers other unnecessary fields in the log entry. Finally one record in each department as follows.

time	Ip	bytes	url	applicatiom
2016:03:12:14:27:31	10.48.16.8	1548	proinfo.pandasoftware.com	Titanium06.htm

Table 6.1 : Sample record for each Department table

Each department can identify by the accessed IP address. There is a separate table for each department as describe by the *table 6.1*.

6.6.4 User Interface (Presentation Layer)

The success of a web application often lies in the effectiveness and user friendliness of the user interface. No matter how good the logic of the system or how sophisticate its knowledge, if the user cannot effectively interact with the system, then the web application will not achieve its primary goal of replicating human experts.

As the system is a web enable, navigational path is very important. Every page should have a link to other pages, especially to the home page so that the user should not confuse. To refrain user from confusion, a common menu system was handled throughout the entire system that can be accessed various parts of the menu by various users according to the authorities they have. The interfaces of the system were implemented with more decent color scheme and relevant icons were used to describe some operations as relevant.

No needs to authenticate general users for monitoring and comparison but only administrator users are given searching facility. Need to be authenticate when the user trying to enter the searching option.

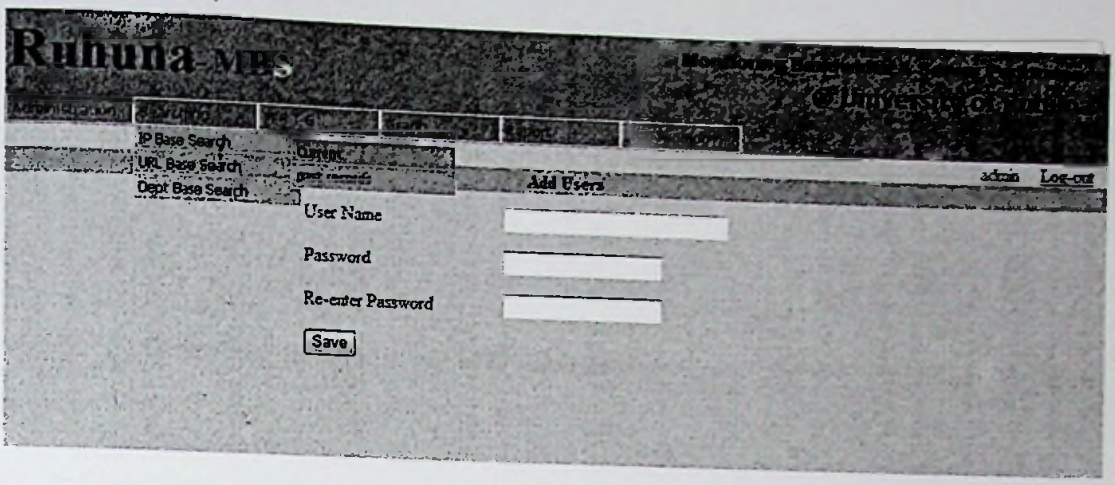


Figure 6-3 : User friendly interface of Ruhuna-MBS

6.6.5 Business Logic Layer of Ruhuna-MBS

Though business logic components could be included in the PHP pages, it is decided to implement the business logic separately. This will ease any modification on user interface and does not affect the business logic components. Reusable component library is handled separately for common access of other activities.

6.6.6 Error Handling

Error handling is one of the important aspects of any system. In order to avoid confusion, most of the time the inputs are given by the system. Only user has to select the relevant inputs from the combo box. In order to reduce the errors which that can be happened.

6.6.7 Storage Layer

As described under the system design chapter, MySQL tables act as backend of the Ruhuna-MBS system. In the case of accessing the database through the system, the request from the client to the database was handled using connection string of the PHP program. With that connection, the application sees three objectives; a connection object to establish a connection to the database, then a command object to execute commands against the database and finally, a record set object to hold the records retrieved from or the updated on the database.

All the database access is done within a single PHP script (see Listing 6.6). This simplifies the coding and eases the modification of the system. Suppose that database access

methodology has to be changed, and then we only need to focus on the script that handles database.

Considering the security of database, it would be achieved periodically by executing a stored procedure.

```
<? php
{
    $db_name="squid";

    $connection=mysql_connect("localhost","root","") or die("I Couldn't connect");

    $db=mysql_select_db( $db_name ) or die ( "Couldn't open $db: ".mysql_error() );

    }
? >
```

Listing 6.8 – Re-usable php connection string to connect with MySQL database

In *Listing 6.6*, php program establishes the connection with the MySQL database with parameters of host name of the database server, database name, username to connect to the database and the password of that user. This simple php code can be used in any program that is going to establish a connection with MySQL database.

Chapter 07

7 Testing and Evaluation of Ruhuna-MBS

7.1 Testing

Testing the system is extremely important since it is the only means by which the system developers can guarantee that the system is fully functional without any errors. Therefore testing of the system was done throughout the cause of implementation. The database was tested once the front-end interfaces were created. Data was populated and entered to reflect all or most possible situations. This form of testing was created out in order to avoid constraint violations, data type's inconsistencies and field width problems.

The design has addressed the system functionalities effectively by decomposing system in to subsystems. These subsystems have program segments to be tested. Hence testing was handled as individual component of each subsystem. Then the sub system integrated and tested for integration. By following these strategies, the author has tested whether each component is functioning properly and integrated correctly.

Following describes the test of functionality of the system, the objectives and how these objectives are achieved.

Test case 1 : Authentication.

Testing : Two types of users exist in the system and only the administration user need to be Authenticated by giving username and password. System was checked by giving different user names and passwords, whether it gives permission to login users with invalid user name as well as password. It was found that the system does not accept these users.

Test case 2 : Authorization

Testing : The general user can monitor and compare the bandwidth usage and only the administrator can search for the individual entry in log file. Try to access the searching functionality without giving admin password. The system did not allow permission to use searching functionalities to general users. Login as

administrator and check the availability of the searching functionalities then the system was allowed to do the searching.

Test case 3 : Check the squid proxy configuration

Testing : Use the proxy server to connect to the Internet by clients and check the functionalities of caching and proxy. It was allowed users to access Internet through the proxy server and cached the every object in right place.

Test case 4 : Check the accuracy of the automated processes

Testing : Mainly five automated processes in the system

- Backup the access.log file to different location
- Take the accesslog.txt file by File Transfer Protocol (ftp)
- Rename the file to current date.
- Analyses the log file and remove the unwanted entries of the file and store each entry to relevant departmental table in the database.
- End of the day backup the database.

No errors can be happened by the users for the automated system but author was checked all the automated programs individually and also after integrated all the programs by giving sample data.

Table	Action	Records	Type	Collation	Size
accounting_and_finance		136,501	MyISAM	latin1_general_ci	9.5 MiB
accounts_branch		0	MyISAM	latin1_general_ci	1.0 KiB
administration		205,732	MyISAM	latin1_general_ci	14.1 MiB
botany		27,511	MyISAM	latin1_general_ci	2.1 MiB
chemistry		79,393	MyISAM	latin1_general_ci	5.3 MiB
computer_pool		0	MyISAM	latin1_general_ci	1.0 KiB
computer_science		155,231	MyISAM	latin1_general_ci	11.2 MiB
computer_science_labs		106,117	MyISAM	latin1_general_ci	7.9 MiB
computer_unit_hss		22,830	MyISAM	latin1_general_ci	1.6 MiB
cultural_center		8,568	MyISAM	latin1_general_ci	633.8 KiB
current_temp		0	MyISAM	latin1_general_ci	1.0 KiB
daily_usage		30	MyISAM	latin1_general_ci	4.3 KiB
dean_hss		78,822	MyISAM	latin1_general_ci	5.4 MiB
dean_management		233,697	MyISAM	latin1_general_ci	16.8 MiB
dean_science		39,590	MyISAM	latin1_general_ci	3.0 MiB
department		30	MyISAM	latin1_general_ci	2.7 KiB
economics		28,858	MyISAM	latin1_general_ci	1.9 MiB
english_unit		0	MyISAM	latin1_general_ci	1.0 KiB
finance_branch		47,612	MyISAM	latin1_general_ci	3.2 MiB
fisheries_and_marine_science		151,591	MyISAM	latin1_general_ci	10.7 MiB
geography		124,495	MyISAM	latin1_general_ci	8.8 MiB
history		27,566	MyISAM	latin1_general_ci	2.0 MiB
maintenance_unit		201,482	MyISAM	latin1_general_ci	15.6 MiB

Figure 7-1 : Updated results by the automated processes

Objective 5 : Check searching module

Test case : Three type of searching

- IP base searching
- URL base searching
- Department base searching

IP base searching was tried to achieved through giving different IP's which not belongs to University of Ruhuna. Different numbering format rather than IP address format also not allow for the system.

User can write any text in the URL box in the URL searching module and system check the given URL in the database.

User has to select the department from the drop down menu for the department base searching.

7.2 Evaluation of New System

The success of any system depends on its acceptance by users. Therefore carrying out an user evaluation is one of the crucial in order to decide whether the "Ruhuna-MBS System" was a success or not. The foregoing chapters discussed various steps followed from analysis to the implementation. Such as what are the requirements of the users, how was the design carried out, and finally how the system was implemented.

The Importance of an Evaluation

Unless the end product meets the predefined requirements, a development process cannot be treated as completed. Evaluation can be considered as systemic acquisition and assessment of information used to provide feedback with regards to the development process. Therefore result of the system evaluation could be considered as key indicators in assessing the degree of success associated with the development process.

7.3 The Ruhuna-MBS Developed

Design and implementation chapters described some of user interface techniques adopted by the system. Once the project moves towards the completion, it is time to evaluate success or failure of the product development process. The product was evaluated under the criteria of user interface, ease of use, accuracy of the results and the performance of the system.

- **The User Interface**

  The first characteristic what a user wants to know is whether the requirements of the domain were met by the system. Through out the foregoing chapters, author highlighted how the system met its requirements. Therefore this would be a good opportunity to justify actual requirement achievement.

- **Ease of Use**

  This is to identify how it is easy to use the system. It is difficult to quantify and this depends on the user's previous computer experience. Ease of use generally covers how it is easy to use the system along with the user-friendly interface that the system

provides. This will also evaluate how well the developer adopted new interface techniques for project development.

- **Accuracy of the Results**

  This is the most important evaluation of any system before completion. To check the accuracy of results the user run the system facilities and the system will process the results and then the result will be checked with the predicted result.

- **Performance**

  The performance would be one of the critical factors to be evaluated in any system. This is to see how fast a given task could be accomplished within a short time period. Users should be able to operate and expect results within minimal response time. This response time effect can be achieved by using computers with faster processors, large memory and the bandwidth of the network. But at this point it is necessary to measure system performance with available hardware specified at the initial stage of the project.

7.4 Evaluation Result

A user evaluation was carried out using a questionnaire, which was prepared by using above-defined criteria with hands on experience of the new Ruhuna-MBS system.
As described in early chapters the Ruhuna-MBS system has two types of users. One is administrative users and other one is normal Internet access users of the Ruhuna-LAN. For the evaluation process we took 3 administrative users and 20 no of normal users.
The results summarized in following table 7.1.

	Admin Users			Normal Users		
	Poor	Good	V good	Poor	Good	V good
The User Interface	-	2	1	-	12	8
Ease of use	-	1	2	-	4	16
Accuracy of the Results	-	1	2	-	7	13
Performance	-	-	3	-	2	18
Meet requirements	-	1	2	-	6	14

Table 7.1 : Evaluation Summary

Chapter 08

8 Conclusion and Future Developments

8.1 Conclusion

The main objective of this system was to provide a web based Bandwidth Monitoring System to all Ruhuna-LAN users and network administrators of the University of Ruhuna. The implementation of Ruhuna-MBS project will make work carried by the network administrators much easier, quicker and can be well managed. The other Ruhuna-LAN users can test themselves the status of network without bothering network administrators ever time.

After the total system has been developed as a web based application and web applications can be implemented using various kinds of architectures. Three-tier architecture is used to implement the Ruhuna-MSB system. The system is developed as platform independent product and can be run on MS Windows or Linux environment and apache web server host the web site. PHP components are used to implement business logic of the system and MySQL is used to store information.

8.2 Achievements of the Project

- Ruhuna-MBS system is mainly developed using PHP (generating dynamic content and Business Logic Components). The author gained experience on using this programming language in real project.
- The project was really brought up the theoretical knowledge in to practical work.
- One of the key achievements gained throughout the development of the project was time management and deadline achievement.

8.3 Future Developments

Within the tough time frame, it was not easy to full fill all the requirements that were identified at the analysis stage and those identified requirements which was not implemented could be considered as further developments. Mainly some critical design

issues that are used to carry the data over on common network had to be simplified with these limitations.

- Monitoring Server performance module has to do as future work.
- If the Ruhuna-MBS system can be integrated with the squid cache the performance will be high and source code will be light weight.
- If the system can be integrated with the bandwidth controlling method the system will be highly valuable.
- At present the report module totally runs on web based platform and that would be not much printer friendly. The printer friendly reporting version will much useful when any one generate the hard copy of the reports.
- Present system does not have the internet payment calculation process. If the Internet payment can be calculated based on web access it will be improve the product value.

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