

# WLAN TRAFFIC GRAPHING APPLICATION USING SIMPLE NETWORK MANAGEMENT PROTOCOL\*

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## ABSTRACT

As today's world is making transition from being wired to becoming wireless, Wireless Local Area Networks (WLANs) are gaining importance. Like the wired networks, WLANs also need to be managed. One of the key things in managing a WLAN is to monitor the bandwidth usage. This is possible by monitoring the network traffic at the wired and wireless interfaces of an access point, a device that acts as a bridge between the wireless and wired networks. In this work, we present a Web-based graphing application that can be used to monitor, collect, maintain, and visualize traffic data of the access points deployed in a network. The application uses the Simple Network Management Protocol (SNMP) to communicate with the access points in a network. This application can be used by a network administrator to determine idle or underutilized access points as well as congested or overloaded access points in a network. This information can be used by the administrator for relocating the idle access points or deploying additional access points at the overloaded segments of a network for better load sharing. The application can also be used for educational purposes in a computer networking course.

## 1. INTRODUCTION

In the recent years, the market for wireless networks is growing fast and wireless Local Area Networks (WLAN) are replacing or extending wired network services. Unlike the traditional LANs, the WLAN users can move about freely and access the network from anywhere [3]. WLANs offer the services of wired networks with no expensive wiring. They have practical uses in warehouses, hospitals, factories, and universities to

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name a few. A Wireless LAN comprises of two main components, the Wireless Network Interface Card (WNIC) and Access Point (AP). The wireless users connect to the network with WNICs via the access points. The access points act as a bridge between the wired and wireless networks. The wireless users connect their mobile stations via the Radio interface and the connection to the wired network is through some traditional interface (such as Ethernet) of an access point. IEEE has approved a family of standards for WLANs that include IEEE 802.11, IEEE 802.11a (also known as Wi-Fi-5), IEEE 802.11b (also known as Wi-Fi), and IEEE 802.11g. The lowest data rate of 1 Mbps is supported by IEEE 802.11 standard, whereas the highest data rate of 54 Mbps is supported by IEEE 802.11a or IEEE 802.11g standard [1]. There are APs available in the market that are tri-mode i.e., they support IEEE 802.11a/b/g standards. They have three interfaces, namely, the 'Ethernet Interface' which provides connectivity to a wired network, a 5 GHz interface (Radio-0) for IEEE 802.11a standard, and a 2.4 GHz interface (Radio-1) for the IEEE 802.11 b/g standards (IEEE 802.11g is backward compatible with 802.11b).

The number of wireless users is increasing by the day. It is important for the network manager to know the usage at every access point in order to determine the number of access points to be installed at various locations in a network so that a huge user base, such as in an educational institution, can be supported efficiently. By monitoring the network traffic at the access points, the network manager can decide if an additional access point is needed to share the load at a particular location or the existing access point can be relocated to some highly congested location on the network.

There are some similar tools available on the Internet. One such tool is the Multi Router Traffic Grapher (MRTG). This tool monitors traffic on a network and graphs it. It is an open source tool and is coded in C and Perl. However, it is not Web-based and is not flexible enough to provide the bandwidth usage information for all interfaces of a networking device for a given time period. For example, using MRTG, it is not easy to monitor and visualize traffic for the Ethernet and Radio interfaces of an access point. In this work, a Web-based application has been developed using Simple Network Management Protocol (SNMP). This application monitors network traffic at various access points on both wired and wireless interfaces and graphs it to provide visual representation to the user.

The rest of the paper is organized as follows. Section two describes the Simple Network Management Protocol (SNMP). Section three describes the system architecture based on the popular client-server computation model. Section four explains its various interfaces to visualize traffic data. Section five and six highlight some advantages and limitations of the application and suggests how the application can be used for instructional as well as network planning purposes.

## **2. SIMPLE NETWORK MANAGEMENT PROTOCOL (SNMP)**

SNMP is an application layer protocol in the TCP/IP protocol suite and facilitates the exchange of management information between network devices. SNMP helps network managers to monitor the network performance and solve network problems [2]. An SNMP managed network has three components, namely, Managed Device, Agent, and Network Management System (NMS) [2]. A managed device is a network node that has

an SNMP agent. A SNMP managed device maintains a Management Information Base (MIB), a collection of information which is organized hierarchically in a tree structure. An MIB is comprised of many managed objects, in which each object is identified by an object identifier. MIBs are accessed using SNMP. These devices reside on a managed network, collect, and store management information. This information is made available to the Network Management Systems (NMS) using SNMP [2]. An agent is a network management software component that resides on a managed device. An agent has access to the local management information and translates it into a form compatible with SNMP [2]. An NMS executes applications that monitor and control managed devices. NMSs carry out the processing and provide memory resources required for network management [2].

Three versions of SNMP have evolved over time, namely, SNMP Version 1 (SNMPv1), SNMP Version 2 (SNMPv2) and SNMP Version 3 (SNMPv3). SNMPv1 is basic and is not in much use anymore. SNMPv2 offers additional protocol operations over SNMPv1. SNMPv3 offers additional security. However all three versions have a number of common features [2]. SNMP provides basic commands for protocol operations and security, defines message formats and data types to monitor and control managed devices. SNMP uses a subset of Abstract Syntax Notation.1 (ASN.1) to accommodate communication between diverse systems. The standard ASN.1 data types are Integer, Octet, String and Object Identifier. SNMPv2 made enhancements to the existing SNMPv1 Structure of Management Information (SMI) data types. New SMI (Structure of Management Information) data types like Bit Strings, Network Addresses and Counters were added along with the standard data types. SNMPv3 has incorporated authentication, authorization, and access control [2].

The Network Traffic Grapher tool is built using SNMPv2 data types and operations. The application requests traffic information from the access points using `snmpget` command by specifying the object identifiers for incoming and outgoing traffic. The interface and traffic information of the access point are stored in its MIB.

### 3. SYSTEM ARCHITECTURE

The WLAN Traffic Grapher is a Web-based tool that allows a user to display graphs on the traffic data for each access point deployed on the network. For each access point, the traffic data are collected periodically from its MIB and saved in a database. Instead of obtaining data every time from the access point for a graph, a query is issued to the database to retrieve data for the access point from the database. Figure 1 shows the interactions among the various system components. The following are the main components of the wireless LAN Traffic Graphing application:

- Web Client
- Web Server
- Database Server
- Data Collection Server

**Web Client.** The Web client provides a Web-based interface to the user. It takes the user's selection of the access point and the time for which the graph is needed, retrieves corresponding traffic information from the database, plots the graph of traffic in kilobits

per second (kbps) versus time duration, and displays it to the user. Any Web browser such as MS Internet Explorer or Netscape Navigator can be used as a client to display the graphs.

**Data Collection Server.** The data collection server program collects the traffic information from each of the access points in a campus-wide network and stores it in the database. It uses SNMP to communicate with the access points. The server process is run as a cronjob. The cron executes the server script every ten minutes. PHP, a general purpose server-side scripting language is used to write the scripts to collect traffic data [6] from the access points. It has support for Simple Network Management Protocol (SNMP). In order to use SNMP functions on UNIX using PHP, the UCD SNMP or NET SNMP package is necessary [7][8]. PHP provides SNMP commands such as `snmpget` to fetch an object, `snmpwalk` to fetch all the SNMP objects from an agent and many more.

**Database Server.** Since the data collection from all the access points is done every ten minutes and a year's data is stored and often retrieved, a program that can store large amounts of data in an organized format was needed. For this application, MySQL is chosen as the database management system. MySQL is a very fast, robust relational database management system (RDBMS). It is the most popular Open Source SQL database developed and provided by MySQL AB [9]. The MySQL server controls access to the data to ensure that multiple users can work with it concurrently, provides fast access to data and also ensures that only authorized users can get access to the data. MySQL is a multi-user, multi-threaded server. In addition to supporting standard Query Language (SQL), it compiles on a number of platforms and has multi-threading capabilities on UNIX, which is good for great performance [6]. Linux also has support for MySQL. So a Linux based system was used for this application.

The server process is always running irrespective of whether the application is being used or not. When the application is in use, the client and the server run in parallel.

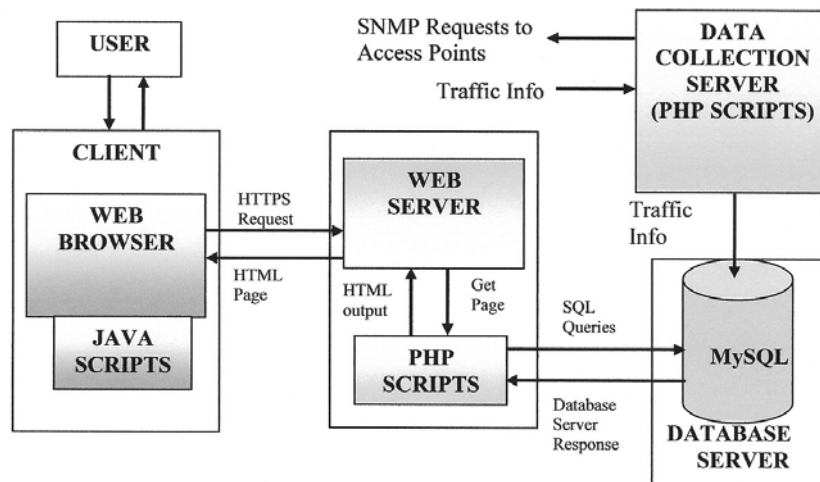


Figure 1. System Architecture

The database contains tables to store the information for user authentication (user id, and password), identification of each access point in a building (building name or location, IP address), identification of interfaces in each access point (Radio0 interface, Radio1 interface, Ethernet interface), and the traffic data collected for each access point at a specific interface. The database table on traffic data specifically contains data about incoming and outgoing traffic on all interfaces for each access point. The traffic data collected from the access points every ten minutes goes into this table. As a result, this table is expected to grow in size very quickly. The important fields of this table are listed below:

- access point id - IP address of the access point
- date – date on which the traffic information is collected
- time – time at which traffic information is collected
- interface – Ethernet, Radio – 0, or Radio -1 interface
- data type – Incoming or Outgoing
- bytes – Total number of bytes

The database table on traffic data is the primary table accessed by the application to generate graphs in most situations.

**Web Server.** In order to generate dynamic web pages, PHP scripts are used [6]. It is a general-purpose scripting language widely used for web development and is easily embedded into HTML. It can be used on most of the widely used operating systems such as Windows and Linux. PHP also works with most of the web servers such as Apache, Microsoft Internet Information Server, Personal Web Server and Netscape [Yank 2001]. PHP with MySQL is a great combination because it is cross – platform [9]. This means that we can develop on windows platform and serve on a UNIX platform [6]. Graphing is the main part of the application. JpGraph is used for graphing. PHP when compiled with option to include GD Library provides support for drawing graphs [5]. JpGraph is an Object Oriented graph library which makes it easy to both draw a "quick and dirty" graph with a minimum of code and quite complex graphs which require a very fine grain of control [4]. JpGraph supports PNG and JPG format. Most browsers support these formats. This becomes particularly useful for World Wide Web applications. JpGraph is available for non-commercial use and can be downloaded from [www.aditus.nu/jpgraph](http://www.aditus.nu/jpgraph) website. The SNMP, MySQL, and Graphing support in PHP made it ideal for developing the application.

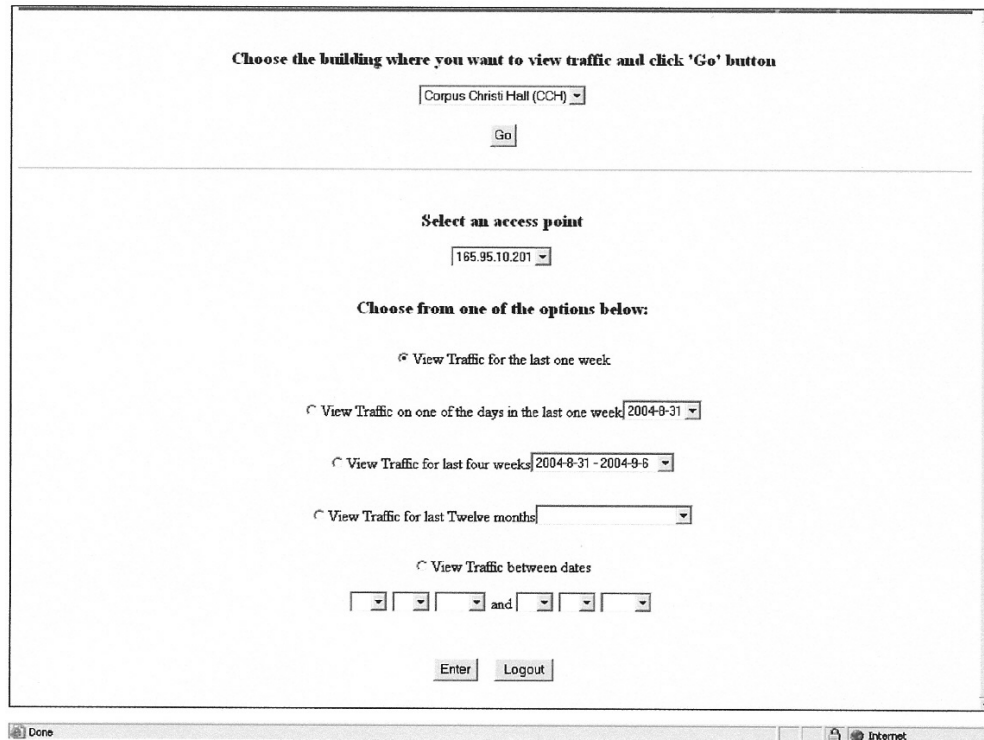
#### 4. USER INTERFACE

The application has a client component, a server component, and a database serving as a data repository. It is secured with login and session variables. Secure Hyper Text Transfer Protocol (HTTPS) is used to secure Login information. HTTPS, in turn, uses the Secure Socket Layer (SSL) protocol. Sessions are used to overcome the stateless nature of HTML. In order to allow data to be saved across pages in a secure manner, PHP uses session variables. Each session file is unique to the user request and can only be accessed by subsequent requests from the same user.

Through a Web browser, a user can communicate with the servers or the access points. Besides traffic graphing, a user can do tasks such as updating information in the

database on access points, including information about newly installed access points, and deleting information about any nonfunctional access points.

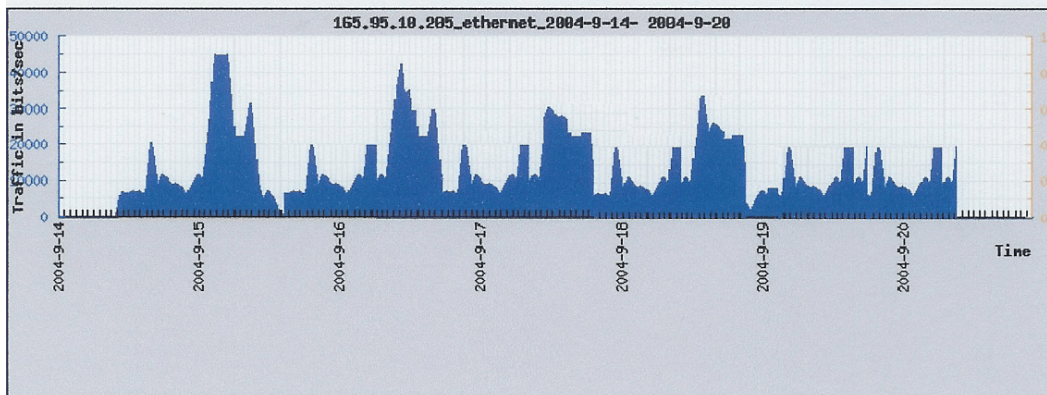
As stated earlier, traffic graphing is the main task of the application. A screen shot for user selections on graphing requirements are shown in Figure 2.



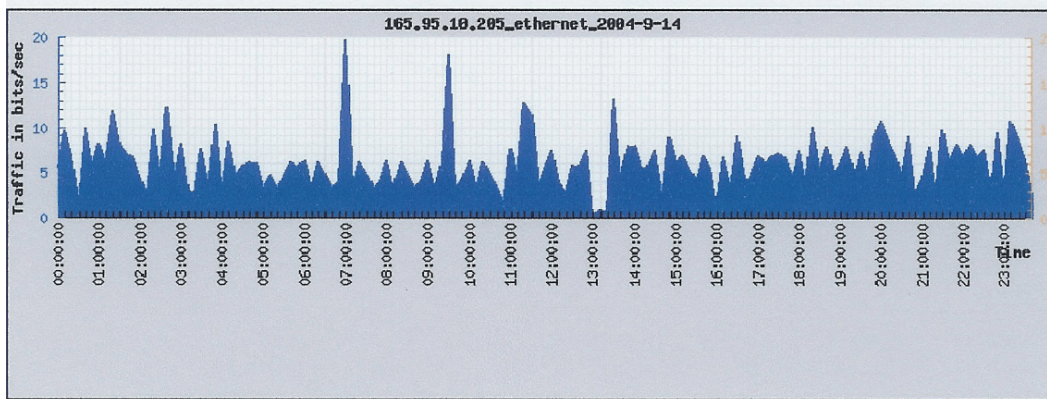
**Figure 2. User screen for inputting graphing options**

A graph on the traffic data available for an interface of an access point can be displayed for a specific day of the previous week, the previous week, the previous four weeks, the last 12 months, or any time period.

As mentioned earlier, JpGraph library has been used for graphing support. The application is real time one. Hence the time durations such as, the last twenty-four hours, last month, last year are all with respect to the date and time at which the user uses the application. Due to this reason and also because the choices made by the user can vary considerably, new graphs are generated every time. Old graphs are deleted before the new ones are plotted. The user, however, can save the graphs in PNG format for future reference. Both incoming and outgoing data are plotted on the same graph with two different scales on Y-axis. This is to handle the difference in the range of scale for incoming and outgoing traffic. The incoming traffic is marked with blue color and the outgoing traffic with orange. The name of the graph is always displayed at the top in the graph. For the sake of convenience and easy identification, the graphs are named in the format 'AP IP address.interface.time duration'. This is done so that, when the user saves the graph, the name itself suggests the access point, interface, and the time duration for which the graph is plotted. Figure 3 shows two example graphs on traffics data collected on an interface of an access point.



a) Graph based on weekly traffic data



b) A graph based on daily traffic data

**Figure 3. Traffic at an interface of an access point.**

## 5. DISCUSSIONS

The main contribution of this work is to develop a Web-based traffic graphing application that can be used from anywhere, anytime to graph traffic data obtained from various access points deployed in a wireless local area network. Network managers can use the application to find underutilized or heavily used access points in a WLAN. Accordingly, the network manager can plan to buy and deploy additional access points to handle heavy traffic or redistribute the existing access points in the network to handle traffic in some uniform manner. As stated earlier, the application is based on SNMP protocol. Hence, it can also be used to collect traffic data from any SNMP-compliant device including routers, switches, proxy servers, and firewalls. Traffic graphs can also be obtained for these devices as well. Since the system saves traffic data in the database, data can also be analyzed later for many other purposes.

The wireless LAN graphing application has undergone both software and usability testing. The application has been tested for its performance with respect to time to display a graph and the accuracy of information conveyed in a graph. The application is being currently used at Texas &M University-Corpus Christi. For short term traffic data, its

performance is very good. However, when traffic for long term is asked, the user might experience some delay in obtaining the graphs.

The application can be used for instructional purposes in computer networking courses. For an experimental purpose, an access point can be attached to a wired network and several wireless workstations can be connected to the network via the access point. For the application, all the system components have been developed or set up using freeware such as MySQL, PHP and JpGraph libraries, Apache Web Server, and Linux operating system. These system components must be installed in order to use the application.

## 6. CONCLUSION

A real time, robust, and efficient wireless LAN Traffic graphing application has been developed. Simple Network Management Protocol (SNMP) has been used to communicate with the access points. It helps the wireless LAN manager to monitor traffic at all the access points across the network. The application plots graphs of traffic in kilobits per second over time. As soon as the user logs in, traffic for the last 24 hours at all the access points can be viewed location-wise. The application also provides the user with a number of options to specify the time period for which a traffic graph is needed. These options include viewing traffic for last one week, for last four weeks, for last twelve months, and between two specific dates. The user can get old traffic data up to a year from that day. This application helps the wireless LAN manager to determine the necessity of access points at various locations. If there is heavy traffic at some locations, extra access points could be placed at those locations to share the load or if there is no traffic at all, the access point could be removed from that location. This application can be used for educational purposes as well.

## REFERENCES

- [1] Ciampa, M., *Guide to Wireless Communications*, Course Technology, 1st edition, 2002.
- [2] Cisco Systems, Simple Network Management Protocol, Retrieved January 14, 2005 from [http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito\\_doc/snmp.htm](http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/snmp.htm).
- [3] Lough, D. L., Blankenship, T. K., and Krizman, K. J., Short Tutorial on Wireless LANs and IEEE 802.11, Retrieved January 14, 2005 from <http://www.computer.org/students/looking/summer97/ieee802.htm>.
- [4] JpGraph Graphing Library, Retrieved January 14, 2005 from <http://www.aditus.nu/jpgraph/>.
- [5] Kent, A. Graphing with PHP and GD, Retrieved January 14, 2005 from <http://www.phpbuilder.com/columns/allan20000830.php3?page=1>.
- [6] Merral, G. PHP and MySQL Tutorial, Retrieved January 14, 2005 from [hotwired.lycos.com/webmonkey/programming/php/](http://hotwired.lycos.com/webmonkey/programming/php/).
- [7] Net-SNMP, Retrieved January 14, 2005 from <http://net-snmp.sourceforge.net/>.



- [8] UCD-SNMP Home Page, Retrieved January 14, 2005 from <http://www.ece.ucdavis.edu/ucd-snmp/>.
- [9] Ullman, L, *PHP and MySQL for Dynamic Web Sites*. Peachpit Press, 1st Edition, 2003.