UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MODELLING AND FORECASTING THE BANDWIDTH CONSUMPTIONS IN TECHNOLOGY CAMPUS OF UTeM BY USING A STATISTICAL METHOD (ARIMA)

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (ELECTRONICS & COMPUTER ENGINEERING TECHNOLOGY) (Hons.)

by

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **MODELLING AND FORECASTING THE BANDWIDTH CONSUMPTIONS IN TECHNOLOGY CAMPUS OF UTeM BY USING A STATISTICAL METHOD (ARIMA)**

SESI PENGAJIAN: **2015/16 Semester 1**

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I hereby, declared this report entitled "Modelling and Forecasting the Bandwidth Consumptions in Technology Campus of UTeM by Using a Statistical Method (ARIMA)" is the results of my own research except as cited in references.

Signature : …….

Author's Name : NURAFIZA SURAYA BINTI MOHD YAACOB

Date : ……

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of the degree of Bachelor of Engineering Technology Electronic Telecommunication with Honours. The member of the supervisory is as follow:

……

(RAHAINI BINTI MOHD SAID)

ABSTRAK

Jaminan jalur lebar dari rangkaian tidak disediakan untuk applikasi pengguna di Internet hari ini. Oleh itu, pengukuran jalur lebar seperti saiznya dan kapasiti rangkaian harus dititikberatkan sama ada kadar kegunaan applikasi penghantaran itu adalah sesuai dengan anggaran ukuran lebar jalur. Objektif projek ini adalah untuk menghasilkan sekumpulan model data dan peramalan siri data yang merupakan penggunaan jalur lebar dengan menggunakan ARIMA yang merupakan kaedah statistik yang berkesan untuk peramalan. Analisis ini mungkin berguna untuk meningkatkan sistem rangkaian kami untuk menjadi sebuah universiti terkemuka dalam teknologi rangkaian.

ABSTRACT

The guarantees of bandwidth from the network is not available for end-user application in the Internet today. Therefore, the measurement of bandwidth such as size of bandwidth and capacity of link should be concerned whether the application transmission rate is suitable with the estimation of bandwidth measurement. This project is for producing group of models of data and forecasting the data series which is the bandwidth consumption by using ARIMA which is an efficient statistical method for forecasting. This analysis may be useful for improving our network system to be a leading university in network technology.

DEDICATION

All the effort is dedicated to my beloved parents, family lecturers and friends, whose love can never be forgotten for their support, guidance and encouragement upon completing this project and report.

Special dedication to my parents and lecturers

MOHD YAACOB BIN MOHD JAAFAR

CHE JAH BINTI MOHAMED

MADAM RAHAINI BINTI MOHD SAID

MADAM NOR HAMIZAH BINTI MISWAN

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INTRODUCTION

1.1 Background

Bandwidth is the transmission of data that can be transmitted in a fixed range of time between a range of band of frequencies or wavelengths. Data transfer speed is limited. Despite the media used to assemble a system, there are cutoff points on the system ability to convey data. The facility of the internet is a need in the era of technology. From the observations, we can see almost all the students have smartphones. By providing WiFi connection, and having the telecommunications technology such as smartphones, students are able to access the internet wherever they go. It is important to know the higher the bandwidth, the better the response of the website. Higher bandwidth the faster the speed of website loading. However, by having a large number of students to access the internet at the same time, the traffic may jam and it will lead to failure log in into the facility provided by the university. The purpose of this research is to investigate the usage of data rate consumption by students in UTeM Technology campus. The difference between traffic and bandwidth is the bandwidth is actually a capacity of how much (traffic) a site or server can handle, while the traffic can be both in the number of people visiting the site or the amount of data exchanged on the website.

In this research, the type of data we used is a time series data. Time series is a grouping of numerical data focuses in progressive order, normally happen in uniform intervals. The data collection will be carried out by daily for 8 months which is from January to August. Then, the data will be analysed by using a statistical analysis using ARIMA (AutoRegressive Integrated Moving-Average). In addition, the collected data will produce a model of bandwidth consumption for the next 3 months. An ARIMA model can predict a value in a response time series as a line combination of its own past values. These models are believed to have the ability to capture the bandwidth consumption whereby their accuracy will be measured by using Mean Absolute Percentage Error (MAPE) and Root Mean Squared Error (RMSE) with the help of Eview software. The aim of this research will be successfully achieve once the most reliable model with minimum MAPE and RMSE values in forecasts bandwidth consumption in Technology Campus is produced.

1.2 Objectives

These are the objectives of this research:

i. To explore and study the network system in UTeM.

ii. To develop the time series models of bandwidth consumption by using ARIMA model.

iii. To forecast the bandwidth consumption in Technology campus of UTeM

1.3 Problem Statement

Nowadays, majority of students are well exposed in internet usage and it has become one of the needs in their live as a student. The lack of adequate access will slow down the efficiency of the learning process. Therefore, this study is to investigate whether the provided network bandwidth for students is sufficient enough to accommodate their needs. In case, there is too many user use the bandwidth at the same time, it may cause the traffic jam and hence slow down the work done. To live in such an evolving technology era, everything we do is a race. When it comes to race, it means we need to do the work as fast as we can or else we will be left out and not comparable with any university model.

1.4 Scope

This research will not cross over any limitations as below:

i. Study the network system at Technology Campus of UTeM.

ii. Bandwidth of wireless data collection used in Technology Campus for 3 months.

iii. Analysis and forecasting the data by using ARIMA method.

1.5 Expected Results

At the end of this research, I should be able to:

i. Understand the network system in UTeM.

ii. Produce a model of bandwidth consumption in Tech campus.

iii. Analyse and forecast the data of bandwidth by using ARIMA.

CHAPTER 2
LITERATURE REVIEW

2.1 Technology

Nowadays, smartphone is one of the important communication technology. Moreover, recently it has a great processing capabilities and they are occupied with excellent graphical user interface (GUI), and multiple radio interfaces due to the momentous development in micro- electronics technology, (Palit, Naik, & Singh, 2012). In addition, they are increasing the functionality of the phones and they have built the ability to support resource intensive application. Next, the applications that have been added in the function of the phone are multimedia playing, global social networking, online gaming, global system (GPS) based navigation, and weather/stock updates. Plus, these applications are the application that related to the network will lead the smartphone to consume a high amount of wireless access traffict along with producing many uplink traffic. There are two ways of smartphone routing for wireless access traffic, first is infiltrate cellular and second is 802.11 based WiFi data networks, (Zhuang, Syed, Georgy, & El-Sheimy, 2015). Normally WiFi based networks consume less energy with higher data rates compared to the Universal Mobile Telecommunications System (UMTS) based 3G cellular data networks. Hence, because of its approachibility, comparison in bigger bandwidth and cheaper cost make it more preferable for smartphones to use WiFi data link by default.

As can be seen, some the most important aspect in telecommunication that needs to be concerned are size of the capacity and complex real-time delivery services.(Koutitas & Demestichas, 2010). Networks of telecommunication and

broadband access showed to use a huge amount of energy for delivering data. Furthermore, learning science principles and amend education are going along with the specification of new technologies consistently.(Kozma, 2003). Henceforth, by providing platforms and materials to student it can help them to enhance learning process, new information and technologies of communication (ICT).. Additionally, students and teachers can build local and global communities through network technology and enable them to connect with interested peoples and expand opportunities for learning.

2.2 Wireless

Wireless local area networks technology which also known as WiFi is compling with IEEE 802.11 standards and owned by WiFi Alliance (Systems, 2009). The objective WiFi Alliance promotes standards is to improve the interoperability of wireless local area network products based on the IEEE 802.11 standards. Figure 2.1 describes the overview architecture of a WiFi LAN.

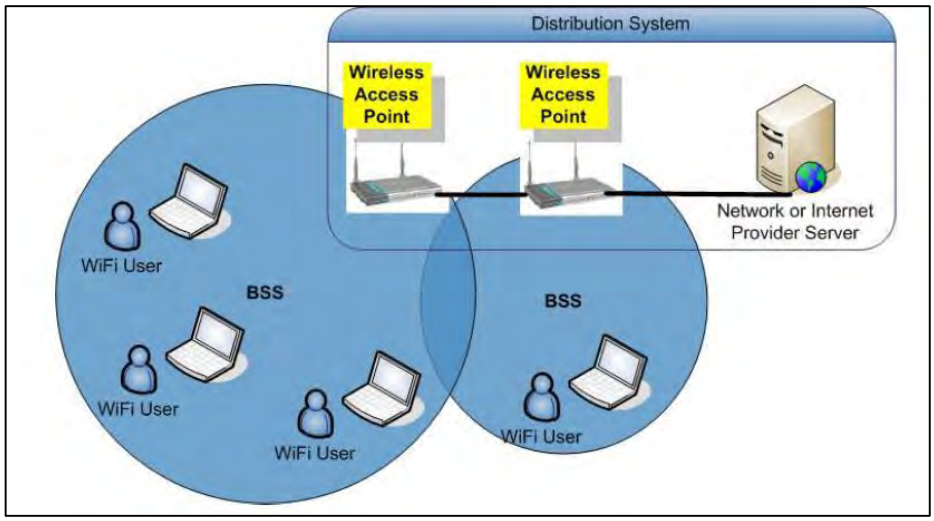

Figure 2.1 Overview of a WiFi LAN

2.2.1 Wireless Network Component

There are 4 basics wireless components. The first is Access Point (AP). This component is to connect a wired LAN to a wireless network. Plus, it can increase the limits of a wireless network to work well and extra network maintenance. Second is PC Card, it will provide the ability for laptop users do the connection to the LAN wirelessly. This component normally have effective limits for connection of ad hoc up to 3 computers maximum is 1000 feet in open space. The third one is PCI adapter which allow the PC users to access to the LAN through a wireless adapter. It has same function as a wireless access PC card. The fourth is a router. This component act as a bridge to share a network across multiple gadgets.

These are the other components that form WiFi LAN:

- BS/AP – Base Station or Access Point – a device equipped with antenna that will do the transmission and receiving radio packets between the end-user devices over wireless environment;
- BSS – Basic Service Set – is the coverage of cell that is formed by radio antenna in Access Point;
- DS – Distribution System – is the items that provide the Internet to the APs. It is possible to have in the office or home an Intranet without having a distribution system. There is where the internet to the APs is provided. In the office or home an intranet can be well functioning even without a distribution system. All devices can communicate and interconnect through a router even with only one AP.
- ESS – Extended Service Set – contains all the BSSs, Aps, and Dss from a WiFi LAN and it is seen as a single IEEE 802.11 layer to all the upper layer from OSI Network Model, (Jo, Chang, Kweon, Oh, & Cheun, 2015).

2.2.2 WiFi Protocols and Data Rates

Table 2-1 802.11 Wi-Fi protocol summary

Protocol	Frequency	Signal	Maximum data rate
Legacy 802.11	2.4 GHz	FHSS OR DSSS	2 Mbps
802.11a	5 GHz	OFDM	54 Mbps
802.11b	2.4 GHz	HR-DSSS	11 Mbps
802.11g	2.4 GHz	OFDM	54 Mbps
802.11n	2.4 or 5 GHz	OFDN	600 Mbps (theoretical)
802.11ac	5 GHz	256-QAM	1.3 Gbps

2.2.3 Wireless LAN Networking

As can be seen, wireless innovation has simplify networking by empowering various PC clients to at the same time share resources in a home or business without extra or meddling wiring, (Frank, 2009). These resources may include a broadband Internet connection, network printers, information documents, and even streaming audio and video. This sort of resource sharing has turned out to be more pervasive as PC clients have changed their habits from using single, stand-alone PCs to work on networks with numerous PCs, each with conceivably diverse operating systems and varying peripheral hardware, (Hong, Nam, & Kim, 2015).

2.2.4 Different WLAN Technologies

In WLAN technology, there are 4 types of common transmission technology used. First one is Narrowband, it uses a specific radio frequency of range between 50cps to 64kbps. Next is Spread Spectrum where at first it is only available for military use only. This technology will continually altering the frequency of the transmitted signal and it allows greater bandwidth. Then, Frequency Hopping Spread Spectrum (FHSS), it will synchronize the changing of frequency of both receiver and transmitter when a narrowband carrier is used. However, FHSS consumes additional bandwidth and the 'hopping' frequency can happen as often as several times a second; before changing frequency again, it will transmit data at a certain period. Last but not least, Direct Sequence Spread Spectrum (DSSS) can break down the transmitted data into small pieces through a frequency channel, (Ding, Jiang, & Liang, 2012). A chipping code is generated for each bit transmitted. DSSS is more reliable and interference resistance as it can recover the data by using chipping code generated.

2.2.5 Ad Hoc (Peer-to-Peer) Mode vs. Infrastructure Mode

Two modes of operational model: ad hoc (peer-to-peer) mode and infrastructure mode.

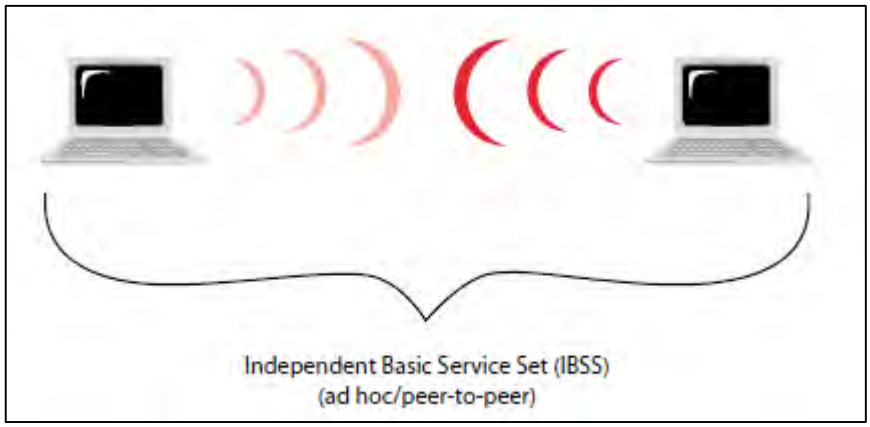

Figure 2.2 Basic Service Set and Extended Service Set

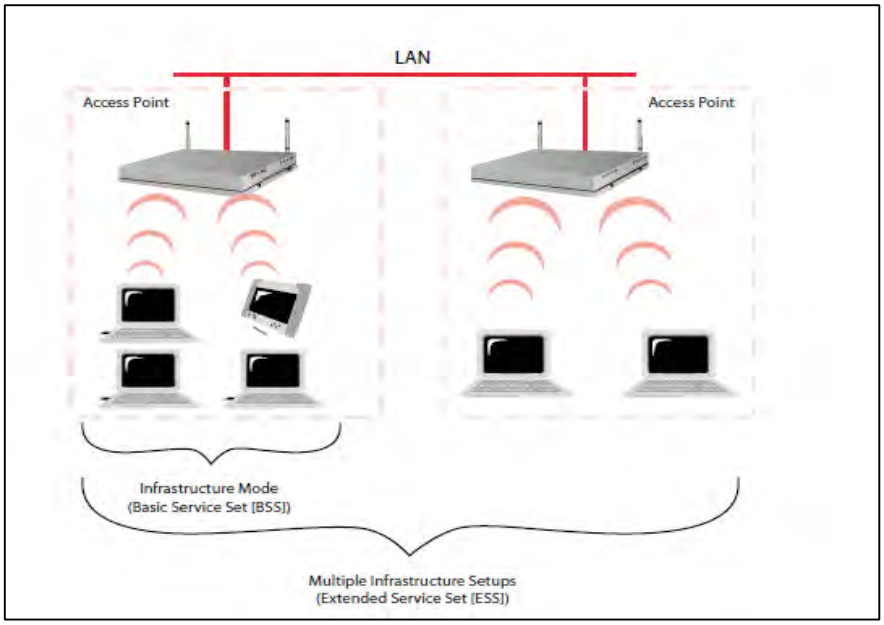

Figure 2.3 Ad hoc Mode

2.2.6 Wi-Fi Security

- WEP

WEP (Wired Equivalent Privacy) was the default encryption presented in the first IEEE 802.11 standard in 1999 (Lehembre, 2005). It depends on the RC4 encryption algorithm, with a mystery key of 40 bits or 104 bits being joined with a 24-bit Initialisation Vector (IV) to encrypt the plaintext message M and its checksum – the ICV (Integrity Check Value). Hence, the encrypted message was determined using the following formula:

$$C = [M||ICV\ (M)] + RC4(K||IV)]$$

Where, || = concatenation operator and

+ = XOR operator

The key to WEP security is the initialisation vector, hence to maintain a decent level of security and minimise disclosure the IV should be incremented for each packet,(Mekhaznia & Zidani, 2015). However, for WEP security, the IV conducted in plain text and the 802.11standard does not mandate IV incrementation, leaving this security measure at the possibility of particular wireless terminal (access point or wireless card) implementations.

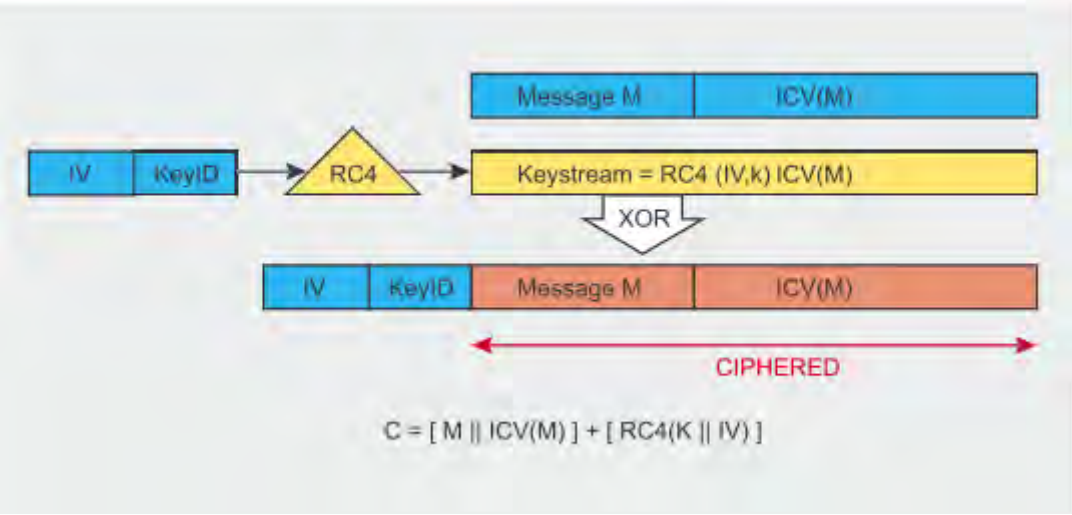

Figure 2.4 WEP encryption protocol

Table 2-2 Timeline of WEP

DATE	DESCRIPTION
September 1995	Wagner: Potential RC4 weakness.
October 2000	Walker: In the first place distribution on WEP weaknesses: Unsafe at any key size; An examination of the WEP encapsulation.
May 2001	Arbaugh: An inductive picked plaintext assault against WEP/WEP2.
July 2001	Borisov, Goldberg, Wagner: The Insecurity of 802.11 (CRC bit flipping assault – Intercepting Mobile Communications) .
August 2001	Fluhrer, Mantin, Shamir: FMS assaults – Flaws in the Key Scheduling Algo-rithm of RC4.
August 2001	Introduction of AirSnort.
February 2002	H1kari: Improved FMS assaults.
August 2004	KoreK assaults (one of a kind IVs) – Introduction of chopchop and chopper.
July/August 2004	Appearance of Aircrack (Devine) and WepLab (Sanchez) actualizing KoreK assaults.

2.3 Wireless Infrastructure in UTeM

Overview

The wireless infrastructure mentioned here is the Cisco Wireless Service Module (WiSM) which is installed on both the Data Center Switches. The Catalyst 6500 Series Wireless Services Module (WiSM) is an integrated Catalyst 6500 supports up to 300 lightweight access points. The switch has eight internal Gigabit Ethernet ports that connect the switch and the controller. The switch and the internal controller run separate software versions, which must be upgraded separately.

A single Cisco WiSM actually has two Wireless LAN Controller (WLC) 4404 built-in to the module and is managed as a separate entity. Each module has the ability to support 150 lightweight Access Points. With two WiSM modules in place, therefore a total of 4 x WLC 4404 controllers will be fully functional and operational for scaling UTeM's Wireless network in the future.

The WiSM controllers here in the Data Center are to cater for all the access points within the Industrial campus. UTeM has an existing LAN Controller which will be installed in the City Campus for the AP's that are there.

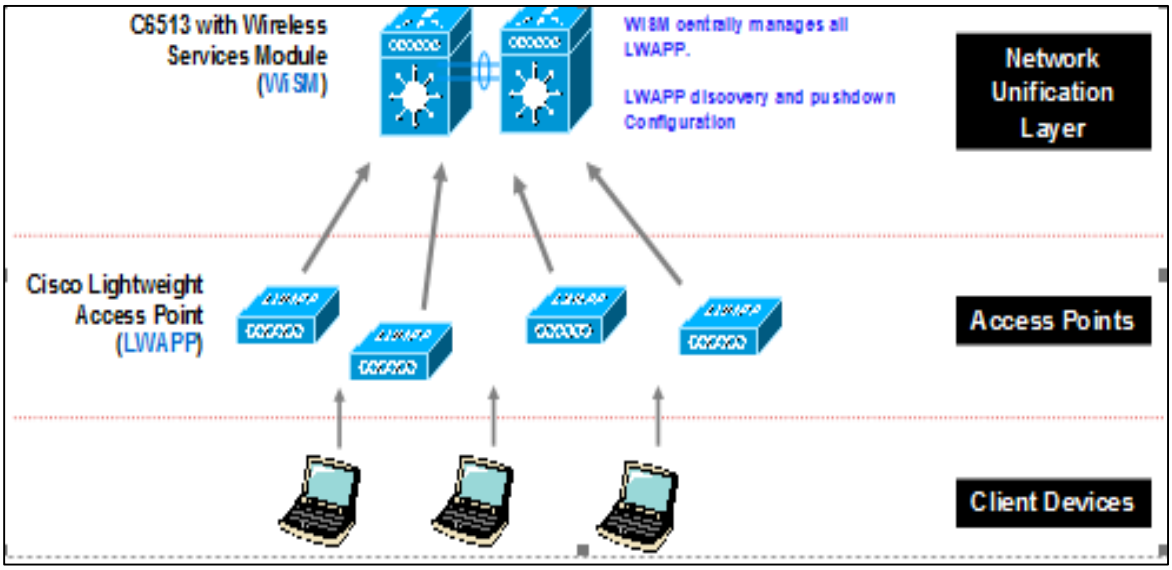

Figure 2.5 Wireless Infrastructure