AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Traffic Utilization on Internet Application: Trends and Impact in Student Wireless Network

[1]A.A. Noraniah, [2]Y.C. Yahaya, [3]M.M. Hanipah

[1]*Faculty of Computer, Media & Technology Management, TATI University College, 24000Terengganu, MALAYSIA.*
[2]*Information Technology Services Center, TATI University College, 24000Terengganu, MALAYSIA.*
[3]*Faculty of Computer System and Software Engineering,* University of Malaysia Pahang, *26300Kuantan, MALAYSIA.*

ARTICLE INFO

Article history:
Received 20 November 2013
Received in revised form 24 January 2014
Accepted 29 January 2014
Available online 5 April 2014

Keywords:
Traffic analysis; bandwidth utilization; Internet applications; network traffic monitoring measurement.

ABSTRACT

Understanding trends and impact of utilization on Internet application is critical for those who develop, deploy, and manage wired and wireless network. This study has taken place at TATI University College (TATIUC) in student wireless network.The effectiveness of student wireless network operations has been disrupted resulting in degradation of network performance. In order to sustain its network effectiveness, traffic analysis has been conducted to figure out bandwidth utilization on Internet application. The hardware-based network monitoring tool is used in this study which is focused only on network VLAN 300. Monitoring was conducted for seven consecutive days in the academic semester. The main data was captured from the monitoring tool included attribute on application flow based on number of active user, flow pattern based on application type and percentage of application type consumed on designated bandwidth.Overall, this study shows user behavior on the application in which more than 95% of the student population uses the network connection and contributes to 50% of consumption to the Web Browsing Application, 21% of the Intelligent Domain Identification application and 20% to the HTTP File Download application on average.

To Cite This Article: A.A. Noraniah, Y.C. Yahaya, M.M. Hanipah., Traffic Utilization on Internet Application: Trends and Impact in Student Wireless Network. ***Aust. J. Basic & Appl. Sci.,*** *8(4): 52-58, 2014*

INTRODUCTION

A fundamental step for any network design, network expansion or network management task is a deep understanding of the traffic that the network itself is expected to carry. Traffic is a combination of application mechanisms and user's behavior, including attitude towards technology and life habit (Garc´ıa-Dorado, *et al*., 2012).Traffic flow measurement assist network administrator to distinguish the behavior of existing networks, design for network development and growth and to assign optimum network usage to users and application (Oppenheimer, 2011). This study focused on the user trend for network application usage in wireless network environment at TATI University College (TATIUC), Kemaman, Terengganu. TATIUC is a higher institution which having about 1734 students and campus area covers nearly 200 acres. The investigation enables researcher to study the network traffic parameter that interrelated for network performance which is network application. The analysis of user trend on network application usage concentrates on VLAN 300. VLAN 300 is one of primary VLAN group dedicated for student wireless network,other than Academic VLAN, Administrative VLAN, Library VLAN and Laboratories VLAN. Campus network services are supported by the Metro-Ethernet technology which total bandwidth of 34Mbps, whilst network administrator allocates 24Mbps to VLAN 300.Campus network equipped with a firewall and network monitoring device at the entrance where it regulates the security and inspects traffic.

VLAN 300 is a wireless connectivity dedicated for student Internet usage on WLAN group named hostel and collegenet. Network administrator has designed a wireless network to three types of user which are staff, student and visitors. Staff users require authentication via server to log into the WLAN group admin and the WLAN group faculty. Students and visitors do not require authentication to log on to WLAN group hostel, collegenet and guest and WLAN group library need authentication for both student and staff. Table 1 describes the description, bandwidth allocation and policy applied for each types of user community.

Number of student is expanding every year that leads to the increasing size of users for VLAN 300. When the number of users increases, it becomes a challenging task for the network administrator to ensure efficient support for a variety of applications and services over the network. All students rely on various Internet

Corresponding Author: A.A. Noraniah, Faculty of Computer, Media & Technology Management, TATI University College, 24000 Terengganu, MALAYSIA.
E-mail: noraniah@tatiuc.edu.my

resources for getting assessment done. Due to the heavy reliance on Internet resources, demand for network bandwidth usability is increasing and causes critical applications to slow down and decline. To resolve the problem, it is important to monitor traffic flow and identify types of applications that may consumed the most of designated bandwidth.

Table 1: Campus WLAN.

User Community	Description	Bandwidth	Policy
Staff	For top management, administrative, academic staff and library.	8 Mbps	Require authentication.
Student	student	24 Mbps	No authentication
Outsider	Visitor	2 Mbps	No authentication

The aims of the network traffic monitoring analysis are (1) To classify type of application that affects the student wireless network performance (2) To analyze user behavior based in type of application in network VLAN 300.The rest of this paper is organized as follows. Section 2 describes the literature review on network traffic monitoring on Internet applications. Section 3 introduces a technique and monitoring tools used in the study. Section 4 describes methodology that applied. Section 5 discusses on analysis of result. Finally the conclusion of this work is described in Section 6.

2. Network Traffic Measurement on Internet Applications:

Network traffic measurement provides network administrator an understanding on traffic flow behavior in term of speed, throughput, latency, and packet transferred. By using specialized network measurement hardware or software, active or passive monitoring, online or offline measurement, network administrator can collect detailed information about packets transmission on the network, including packet's timing structure and contents (Claffy, *et al*., 1997; Kushida, 1999). It is possible to investigate significant information about the structure of a network application, or the behavior of user with detailed packet-level measurements, and some knowledge of the TCP/IP protocol stack (Williamson, 2001).

The importance of network traffic monitoring and analysis are parallel with increasing network usage demands from individual users as well as organization. Most of network traffic monitoring and analysis systems are based on flows which based on significant amount of packet data into flows, link utilization and the pattern of packet arrival. Traffic flow defines as a sequence of packets between given source and destination IP address and transport layer application port numbers (Myung-Sup Kim, *et al*., 2006).This paper studies the characteristics of network traffic in VLAN 300 from the perspective of flows and packet transferred whereas investigates the root cause for the high fluctuation in the number of flows.

Network traffic is affectedly increasing due to the simplification of Internet, thus make the need for Internet application classification becomes important for the effective use of network resources (Sung-Ho Yoon, *et al*., 2009). Based on research on Internet user behavior studied by group of researcher from Lund University, Sweden, they have categorized application into seven categories which are(Kihl, *et al*., 2010) web browsing, streaming multimedia, P2P, file transfer, online gaming, messaging and collaboration and secure session.Internet usage is evolving from the browsing web site, sending email into triple play usage where user may have all communication services which are telephony, data and TV through wired and wireless connection. Hence, size, complexity and dynamic nature of internet usage can make it difficult to identify bottlenecks or other issues if raised. Network administrator need to know precisely which applications or users are consuming the majority of network bandwidth or in other words he must critically understand Internet usage patterns in wireless network(Kotz, *et al*., 2005; Henderson, *et al*., 2004).

A study on mature 802.11 WLAN campus at Darmouth College, USA found that the applications used on the WLAN changed affectedly. Initial WLAN usage was led by Web Traffic; but the study shows significant increases in P2P, streaming multimedia, and voice over IP (VoIP) traffic (Henderson, *et al*., 2004). An increase in the percentage of P2P and multimedia traffic and inconsistent trend for Web traffic can be explained by the increasing complexity and overall size of Web pages that include more images, audio and video elements(Halepovic, *et al*., 2009).This is supported by a study, stated that unrestricted P2P traffic that involve the transfer of large audio and video files has the potential to monopolize bandwidth and severely degrade network (Novak, 2008).There was another study by Shanghai University researchers on Internet's bandwidth occupancy rate shows that HTTP services represent 22% while P2P services represent 20% of bandwidth's average (Xia Tianming, *et al*., 2009).

There are a number of issue on Internet application on network traffic which are application evolution and application masquerading. The fast evolution of applications recently has steered many networking researchers to propose new classification techniques which are inspecting packet payloads such as DPI or analyzing transport-layer characteristics. The second issue is on application masquerading. Application masquerading is when foreign application use well-known port numbers for Internet application classification such as KaZaA, a P2P file sharing provide their peers with the capability of communicating with other peers on port 80 which the port should be well known to HTTP applications only(Arlitt, *et al*., 2007).

3. Monitoring Tools and Technique:

A monitoring tool is device-based which are configured specifically for collection, processing and monitoring of network traffic on campus network backbone. Device-based measurement tools are more expensive than software-based measurement tools because its ability to capture packet on high-speed link (John, *et al*., 2010). The monitoring device is installed between the firewall and core switch at campus gateway. All Internet traffic passes through the monitoring tool network interface card which includes all incoming and outgoing Internet traffic andinformation required could be captured immediately. Packets captured with designated and sourced IP address 10.30.0.0; a subnet assigned for VLAN 300, only been analyzed, defined and described in order to understand the traffic patterns.

Passive monitoring measurement is a technique to monitor all transferred packets on the network, and copies these transferred packets into the system along with the captured time. These captured packets are accumulated and analyzed based on predefined parameters in the passive monitoring system as referred to Fig 1(J.Järvinen, 2009). In monitoring the traffic for campus area network, the location of measurement point can be at the host or at the network edge. In general, Internet traffic is monitored at the network exit to the Internet (Angrisani, *et al*., 2008). The benefit of this approach is that the incoming and outgoing network traffic information can be directly captured and analyzed (Kushida, 1999). Along with capturing packet during traffic monitoring, deep packet inspection (DPI) technologies been used. In DPI mechanism, it has to capture packets from the network interface cards, in order to create a data structure which represents the incoming and outgoing packets, and to forward or accumulate the received packets for further processing. DPI mechanism searches for well-known patterns, unique byte pattern, flow statistics and flow behavior within the packet payload (Antonello, *et al*., 2012).

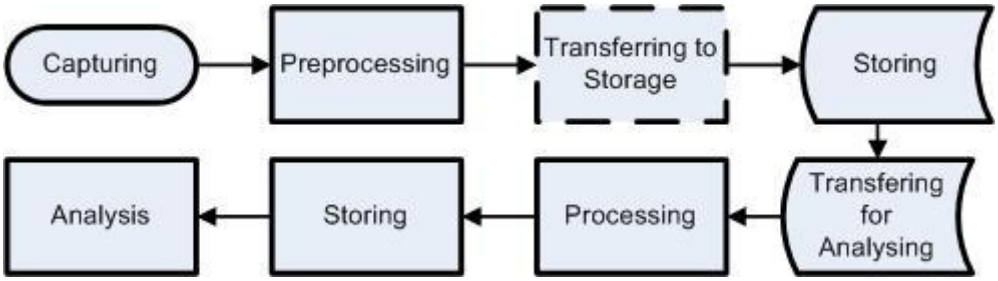

Fig 1: A flow chart of passive network monitoring.

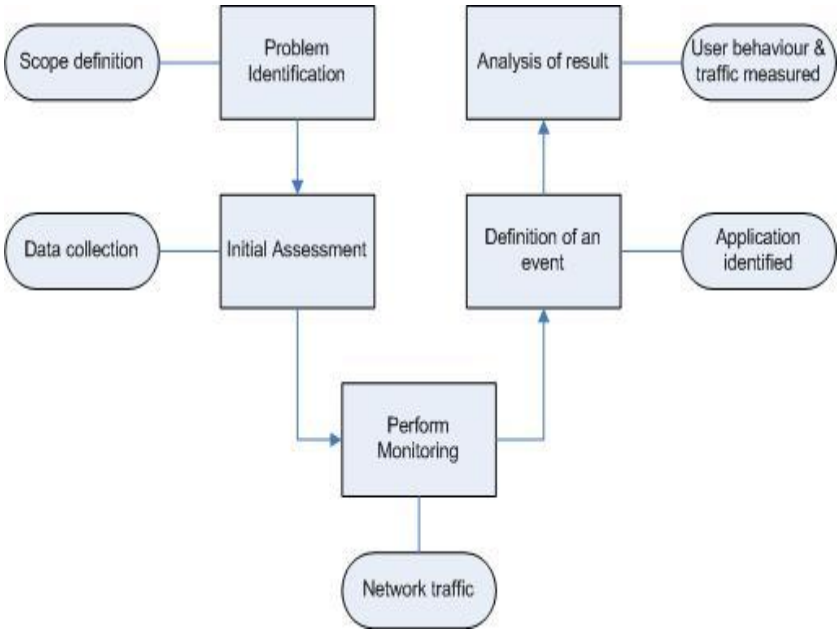

Fig. 2: Methodology process.

4. Methodology:

The research method used in this study is an adaptation from Donelan, Pattison and Palmer-Brown (Donelan, *et al*., 2005), which the study begins with the problem identification phase on student wireless

network performance. This is followed by data collection on network infrastructure and wireless network formation in the second phase. Third phase is regarding to find some fundamental issues regarding the major process of understanding information gatheredin the beginning of the study.

After that, the next phase is to perform monitoring using a suitable tool in order to obtain practical data. The fifth phase is to define and describe the data gathered from the previous phase and finally, the data analysis phase to draw conclusions as a result of the study. The research method is summarized in the flow chart as shown in Fig2.This paper mainly considers P2P applications, HTTP and HTTPS connections which cannot be specifically classified. P2P applications are well-known services that can consume more volume on network traffic. Furthermore, the higher the access bandwidth offered to the users, the larger the amount of traffic of P2P application able to send. Whilst according to a study about characterization on traffic trend shows that File Hosting services is carried over HTTP protocol (Garc´ıa-Dorado, *et al*., 2012) known as FTP traffic. FTP traffic is significant for traffic volume in such a way of downloading large file from server hosting.

Analysis of Result:

The discussion is focus on findings from monitoring of student network in network VLAN 300. Data collection from the monitoring that scheduled on seven consecutive daysfrom 00:00 AM until 23:00 PM. The process of analysis as referred to Fig 3will be conducted in 4 steps which are identification of total traffic used per day and amount of application bandwidth, categorization of application and reflection of user behavior on traffic generated. In other words, the final results of the analysis phase will be the behavior pattern of all users in the network VLAN 300. The characteristics of user behavior then will be translated in terms of the amount of bandwidth consumed and the types of applications used by the users. This is to identify the types of applications that users like to access and to distinguish types of applications that potentially impact on the network performance.

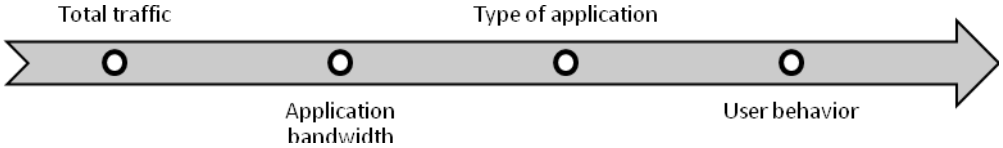

Fig. 3: Process of analysis.

The following results analysis has been figured into charts which represent a peak day analysis which is on the Day 4. This is evidenced from the traffic flow pattern on Fig 4 that clearly shows there is a peak traffic flow on Day 4 of 23 652 Kbps is equivalent to 23.1 Mbps for maximum flow. This covers 96% bandwidth utilization for student dedicated network where the total bandwidth is 24 Mbps. Similarly, the average flow pattern and total traffic flowin which there is a peak flow on Day 4 with 12.7 Mbps for average flow and 1, 702, 112 packets is transferred. The highest number of active users on application usage per hour can be seen on day 4 at 12 AM (Fig 5). While Fig 6 and 7shows that application type of Web Browsing is the highest application type in traffic flow and bandwidth utilization which utilizes more than 50% other than application type with maximum flow is 12815 Kbps which equivalent to 12.5 Mbps on Day 4. Application type of Intelligent Domain Identification utilizes more than 20% for bandwidth with the maximum flow of 5256 Kbpswhichis equivalent to 5.1 Mbps. Similarly, application type of HTTP File Download maximum flow is 4.3 Mbps with an average flow of 2.1 Mbps.

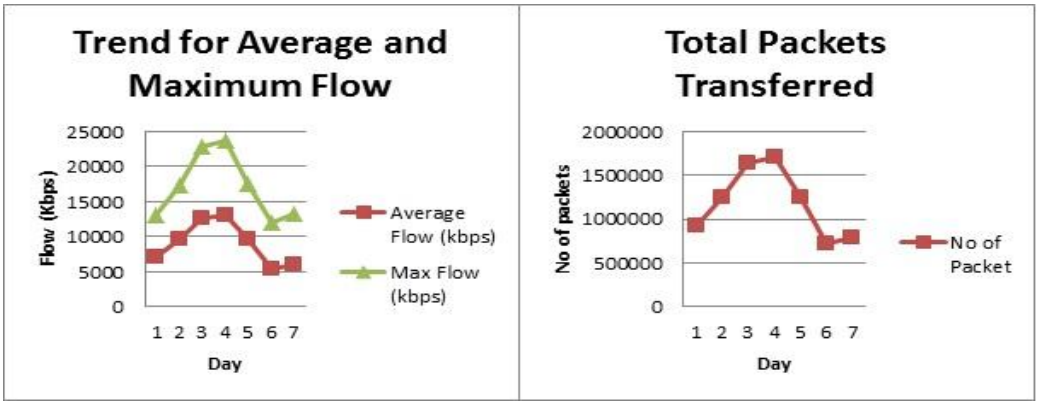

Fig. 4: Trend on average, maximum flow and total packets transferred for 7 days monitoring data.

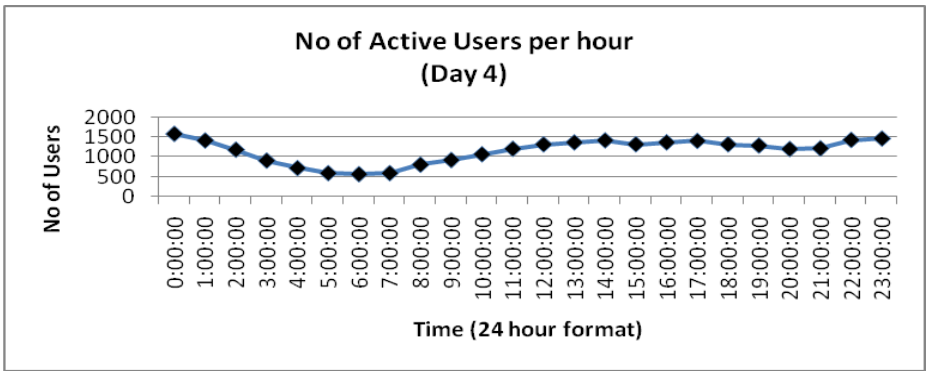

Fig. 5: Number of active users.

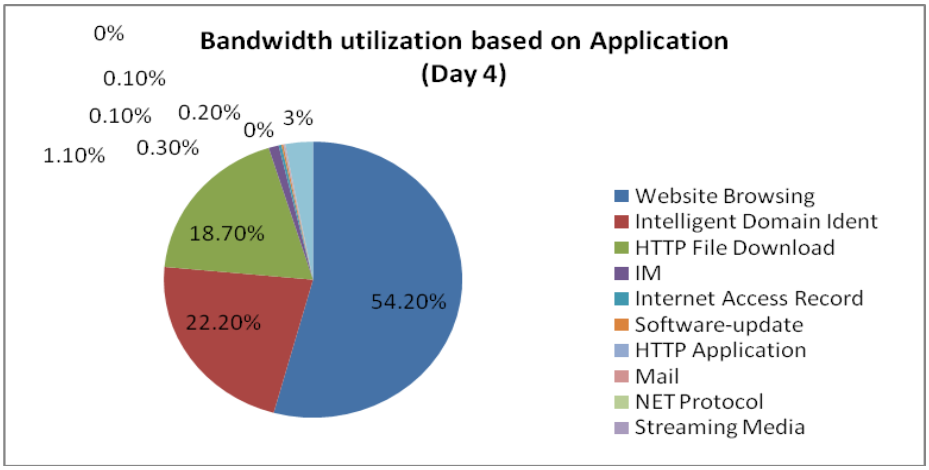

Fig 6: Bandwidth utilization on peak day.

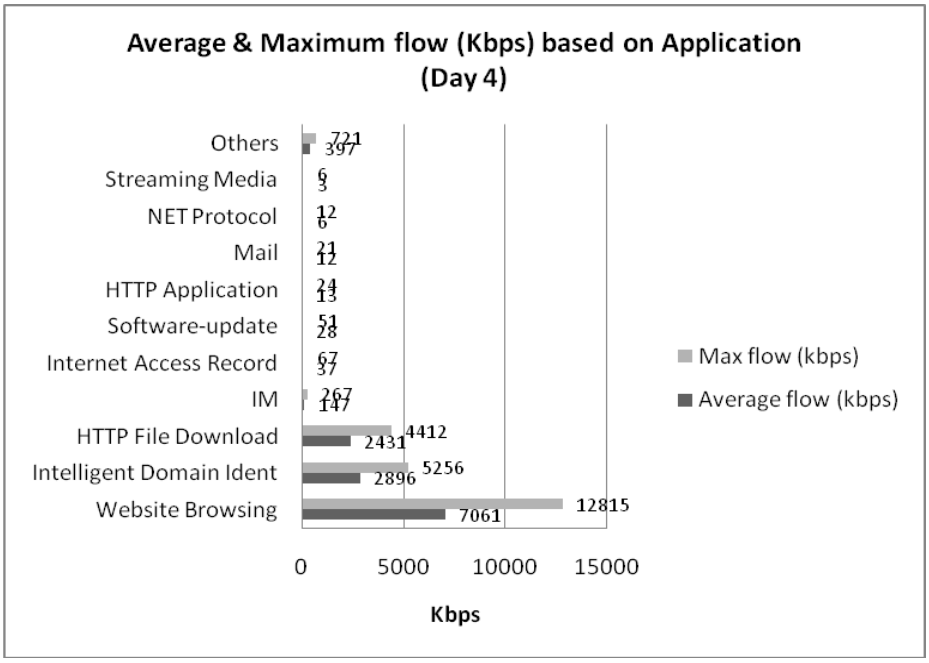

Fig 7: Average and maximum flow on peak day.

Web Browsing application mainly identifies all typical http application from http get method that retrieve at all information is identified by the Request-URI (Uniform Request Identifier) and also involves web application

contain user input (Fielding, *et al*., 1999). Intelligent Identification Domain application primarily identifies the plain text or cipher text form P2P applications, identifies the encrypted real-time voice video, SSL certificate, data from proxy and the VOIP(Sangfor, 2012). HTTP file download defines any http application with capability in downloading file known MIME type with binary format or recommend a filename for dynamic content.Capability of file downloading involve HTTP header field and also HTML *href* attribute (Nottingham, *et al*., 2005).

Conclusion:

This study focused on monitoring network analysis conducted in student wireless network. Overall, this study shows user behavior on the application in which more than 95% of the student population uses the network connection and contributes to 50% of consumption to the Web Browsing Application, 21% of the Intelligent Domain Identification application and 20% to the HTTP File Download application on average. The second highest application type, Intelligent Domain Identification contain application masquerading such as P2P application protocol that use traffic tunneling for encrypted P2P behaviors and well-known ports services (e.g., port 80 for HTTP traffic) for dynamic P2P services in order to escape packet filtering. Furthermore, evidence from number of studies (Garc´ıa-Dorado, *et al*., 2012; Henderson, *et al*., 2004; Halepovic, *et al*., 2009; Xia Tianming, *et al*., 2009) stated that web browsing application is among large majority of network traffic, but due the evolving of Internet application technology certain P2P services like Gnutella is an HTTPlikeprotocol whose signature checks for an optional field within the HTTP header. This proves the existence of abnormal activity in student wireless network which contribute to network performance degradation.

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