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Development of Internet Traffic Logger Access Point Based on Raspberry Pi 3B+

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***Abstract*—** *Thai computer law enacted in 2017 required Internet users to keep the Internet log file for 90 days as the minimum duration time threshold. However, the price of computer traffic loggers was high which was difficult for home users can reach. In this research, we developed the low-cost access point for home users based on the Raspberry Pi module to support the law. The developed access point had additional functions to keep the log file into both internal storage and the cloud server. The proposed access point can present its own environmental parameters, namely, the number of current users, CPU load, via social network services. Besides, our proposed access point detected the header of every passthrough IP packets and efficiently collected arrived time, source and destination MAC address, packet length, source and destination IP address, and protocol types. The efficiency of the proposed access point in the perspective of coverage and throughput were evaluated and presented compared to the current commercial access point. We showed the experimental result using graphs and analyze the Internet usage affecting the CPU Load, uplink and downlink traffic. From collected data, the uplink and downlink traffic and CPU load increased related to the number of users. Moreover, we forecasted that our proposed access point can support 223 users, at 80% of the CPU load.*

***Keywords*—** *Internet Traffic Logger, Access point, Raspberry Pi.*

I. INTRODUCTION

The wireless local area network (WLAN) is the IEEE 802.11 standard technology which conveniently provides a network connection to the Internet users. The access point is an important media device between network and users whose devices placed inside the signal coverage. Without the implementation of wire media between users' devices and network devices, the installation time duration of the WLAN network is short. The WLAN is flexible and can reduce the cost of network installation compared to the wired network. Cisco forecasted that in 2022, the Internet traffic will increase up to 350 exabytes per month and 56.8% of total traffic will be delivered via WLAN technology [1]. However, there are some limitations of WLAN technology, i.e., reliability, service coverage range, speed, and security.

In Thailand, cybersecurity was focused for two decades. The first Thai cybercrime law was announced in 2007 which initially enhance the security of computer networks and related services and prevent rights and freedom of computer users with the strong legal penalty [2]. However, the popularity of social network service raised up the number of Internet users. The Thailand Computer Emergency Response Team (ThaiCERT) report that there was a sharply increasing trend of total cybercrime from 2011 to 2016 which was 86.34% per year [3]. The second issue of Thai cybercrime law was announced in 2017 which added the legal penalty in terms of sharing fake news or posting fake information via social network services. There was an important section of the Thai cybercrime law which required companies, organizations including regular household users kept their own Internet traffic log file for 90 days to 2 years duration time since the Internet traffic was delivered via computer systems.

Most of ordinary household users in Thailand ignored the implementation of the Internet traffic logger devices in their own network [4]. The main reason was the additional cost. In 2019, there are 9.4 million household Internet consumers in Thailand including fiber to the home (FTTH) and very high-speed digital subscriber line (VDSL). The Internet service provider companies always provide home-used access point without Internet traffic logging function to their customers. If the government officer required checking Internet traffic log, home-used access point users who could not provide the required log to the officer would pay the high legal penalty charge.

This research aimed to develop a smart access point with Internet traffic logger function. Our proposed access point was developed based on Raspberry Pi which was a low cost, small sized computer. The WLAN module was built in the Raspberry Pi model 3B+ which can be programmed as a managed access point. There were extra major functions of our proposed access point as follows: 1) uploading Internet traffic log files to the cloud server. 2) self-environmental parameter presentation via social network services. We evaluated our proposed access point in the dimension of log files capability, CPU load, user traffic load, and signal service coverage.

The rest of the paper is organized as follows. We explain about related research works in Section 2. The detail about Raspberry Pi was explained in Section 3. Section 4 presents the design of the smart access point with Internet traffic logging function. We present the results of the evaluation in Section 5. Section 6 presents the conclusion and future works.

II. RELATED WORKS

There were many research works used Raspberry Pi for controlling home appliance and industrial machine. Anindya, S. C. and Haryatmi, E. (2019) designed 3 phase motor control system using PLC with Raspberry Pi based on IoT system [5]. Industrial operators controlled industrial machine remotely by PC. The Raspberry Pi received the control packets from the PC as input and generated output signal to activate relay.

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Rabea, C., et al (2018) presented smart control of the home appliance system based on Raspberry Pi [6]. The Internet of Things (IoT) was utilized to communicate between users and home appliances. The system can turn on or off appliances from the remote place. The user graphic interface (GUI) was created for users to access the system conveniently. Besides, Raspberry Pi was used in the home security system. Bhatkule, A.V., et al (2016) created the home-based security control system [7]. Various security sensors, namely, camera, PIR, vibration, air quality, and magnetic sensor were implemented as the input of the system. The system notified the user via SMS and send the snapshots picture via email. Not only home application, but also Raspberry Pi was used to the environment monitoring system. Saha, A. K., et al. (2018) monitor the air quality index and the noise intensity of a region by IoT-based method [8]. The Raspberry Pi received data from various sensors (sound, gas, humidity) and uploaded to cloud storage via GPRS/GSM system. The Raspberry Pi was used in industrial work.

Because of its built-in network modules, Raspberry Pi was programmed as the network device in some research works. Gupta, V., et al. (2018) developed software-defined networking (SDN) switch based on Raspberry Pi [9]. The load balancing and the firewall function of the switch were tested in the research. The Raspberry Pi can use as a low-cost SDN switch efficiently. With the programmability function and the small size of Raspberry Pi, Jamal, A., et al. (2019) presented portable the onion router (TOR) based on Raspberry Pi [10]. The proposed TOR can support users who care about their privacy and do not want their personal information to be shared with the low-cost device.

The revolution of Raspberry Pi was changed rapidly. The Raspberry Pi model 3B+ has a built-in WLAN module. With the programmability function and the built-in WLAN module, our research developed Raspberry Pi based access point which had the Internet logger function and self-environmental parameter notification function.

III. Details About Raspberry PI

A. Raspberry Pi – About Device

The Raspberry Pi 3 model B + is a board that has been developed from the Raspberry Pi model B. The Raspberry Pi is a powerful small computer which have the capability to work as a computer. Components are compacted in only 1 palm size circuit board which are suitable for all ages of users because the Raspberry Pi board is easy to learn for programming such as Python programming language. The Raspberry Pi is able to perform many tasks, such as working on documents, use to connect to the internet via web browser, play various multimedia files whether audio or video. The video can be played in HD or Full HD [11].

B. Specification

The Raspberry Pi 3+ is a motherboard measuring 85.60 x 56.5 mm and weighing only 45 grams with a 64-bit processor that runs at 1.4 GHz with a heat dissipation panel. It has a graphics processing unit (GPU) higher than 300 MHz or 400 MHz, support wireless and wire connection. There is an Ethernet LAN port used to connect the board to the computer network system, Local area network (LAN), allowing internet to be used. This means that software or update software can be installed as needed. The Raspberry Pi has an HDMI port, which is responsible for connecting various display devices, whether connecting to a computer screen or television. The Raspberry Pi can also support mounts, keyboards or various devices via USB port, which can be used like a small computer. There is a port GPIO which is a multi-purpose port that can control the program through software and can specify the port input / output. It also supports PoE (Power over Ethernet) which supports power via Ethernet which is used to receive power from a router or switch and has a SD card slot that is a memory card used to store operating systems and store various data [12].

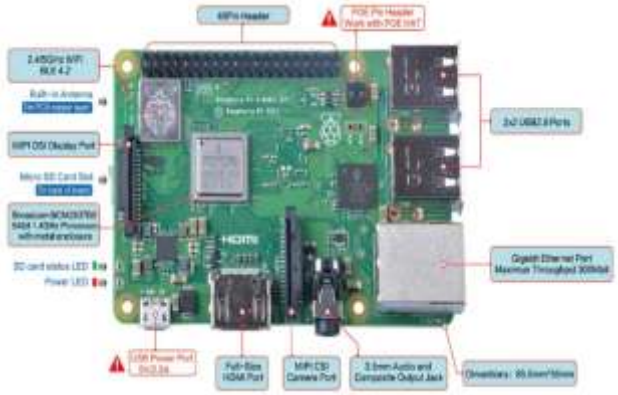

Fig. 1. Components of Raspberry Pi 3 B+ [4].

C. Model of Raspberry Pi 3 B+

In this research, we used the Raspberry Pi 3 B+, which consists of a Broadcom BCM2837B0 processor, Cortex-A53 64-bit with a speed of 1.4 GHz, Graphics processing unit (GPU) higher than 300 MHz or 400 MHz, and a memory that can store up to 1 GB of data. It supports dual-band wireless network at 2.4GHz and 5GHz frequencies, which provide IEEE802.11b/g/n/ac wireless LAN service. For Bluetooth connection, there is Bluetooth 4.2/BLE which is a Bluetooth technology that uses low energy and low latency. It has a Gigabit Ethernet port via USB 2.0 with a maximum throughput of 300 Mbps. There are four USB ports which make it more convenient for users if wanting to connect more devices. The model is able to support video in both High-Definition and Full High-Defemination (1080p30) since the Raspberry Pi 3 B+ board has a GPU graphics unit with a frequency higher than 300 MHz to 400 MHz. The Raspberry Pi 3 B+ consists of a 40 pin GPIO port, 1 port HDMI, 3.5 mm TRRS jack video output, 3.5 mm phone jack audio output, input power 5V via USB connector or via GPIO HEADER and support Power over Ethernet (PoE). On the Raspberry Pi device has a Micro SDHC slot and USB boot mode. It also supports the Linux Raspbian operating system, based on Debian and other third-party operating systems such as Ubuntu, IoT, Windows 10 [13]. Figure 1 shows the composition of Raspberry Pi 3 B+.

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D. Raspberry Pi 3 B+as Wireless Access Point:

According to studies, it has been found that the 90 days duration of computer traffic log file storage requires a lot of internal memory or cloud drive space. The normal home use routers provided from internet service providers cannot be able to store log data because they have limited storage and no function to upload data to the cloud server. If users need to collect Internet traffic log data, they might install a high-performance wireless router with special functions to support cloud server connection and store large storage for 90 days duration time of traffic log files. These mean that users have to pay for additional costs. Therefore, the Raspberry Pi 3 B+ was developed to a wireless access point with extra built-in function to be able to keep computer traffic log files at least 90 days according to the Thai Cyber Law and able to upload via cloud drive. This method can save user's capital cost because the Raspberry Pi is inexpensive. Besides, the model has capabilities similar to some wireless routers which are effective, suitable and easy for general users.

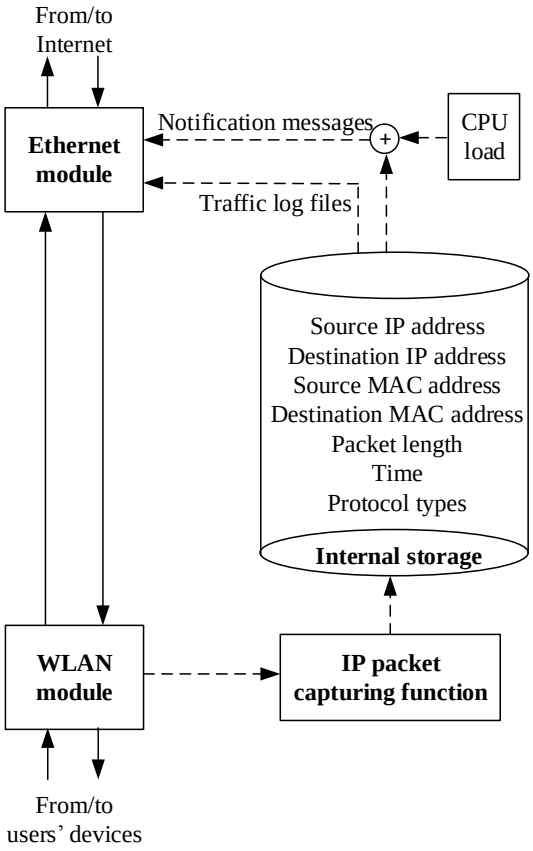

Fig. 2. Conceptual illustration of the proposed access point's function.

IV. Design of the Proposed Access Point

A. Function of the Proposed Access Point

The proposed access point had two major functions which were the Internet traffic logger and self-environmental parameter notification. The conceptual illustration of the proposed access point's function is shown in Figure 2. We added the IP packets capturing function into the Raspberry Pi based access point. The packet capturing function detected the header of every IP packet which passed through the built-in WLAN module. The data form the captured IP header, namely, source IP address, destination IP address, source MAC address, destination MAC address, packet length, time, and protocol types were saved as the traffic log files in the internal storage of the proposed access point. The duration time of capturing was one hour per log file. After completely saved each log file at the internal storage, the log file was upload to the cloud server via the built-in Ethernet module. The notification messages used information from the current saving log file and the self-environmental checking function. The current number of users' devices were detected by the number of MAC address which connected with the WLAN module. The CPU load checking function was added to the proposed access point. Both the current number of users and current CPU load information were sent as notification messages via the social media service application to the network administrators.

B. Implementation of the Proposed Access Point

Figure 3 presents the implementation of the proposed access point. The router was the connecter device between the Internet and our proposed access point. We used FTTx provided by True super speed fiber as a broadband connection between our test place and the Internet with 100/100 Mbps download/upload speed. The fast Ethernet connected between our proposed access point and the router. Besides serving the wireless connection to the user devices, the proposed access points capture the Internet traffic log and upload it to the cloud server via the router and the Internet. The notification messages were sent to the network administrator via the router and the Internet as well.

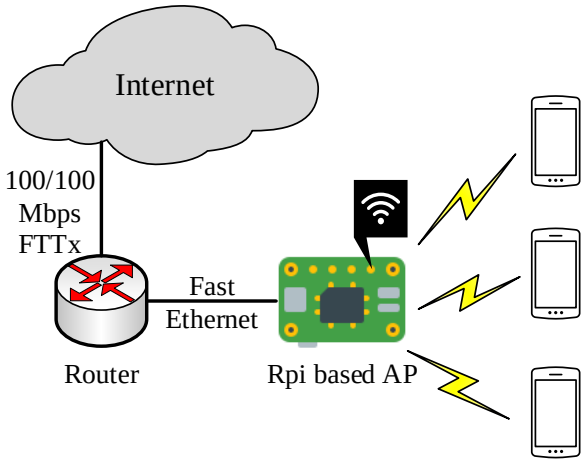

Fig. 3. Network configuration environment.

V. Experimental Results

A. Logger and Environment Notification Function

From the experimental setup in Figure 3, we conducted an experiment of logger function and the access point's environment notification function. For the logger function, the

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log files were saved at the internal storage and routinely upload to the cloud server. Dropbox was our selected cloud server which was popularly used and access the log files easily. The free version of the Dropbox can support 2 Gigabytes of online storage. With the advanced version, cloud storage can provide unlimited storage for log files [14]. We used five smartphones as user's devices in our experiment. Each user's device watched online video on YouTube for 30 minutes time duration. We increased the number of user's devices from one to five. The log file size of our proposed access point was increase related to the number of users as shown in Figure 4. the relation of the number of users and the log file size can be present in the exponential function $y = 8.3902e^{0.7466x}$. When considering five users the log file size was 351 Mbytes which should be compressed before upload to the cloud server to reduce the size and upload bandwidth utilization of the proposed access point.

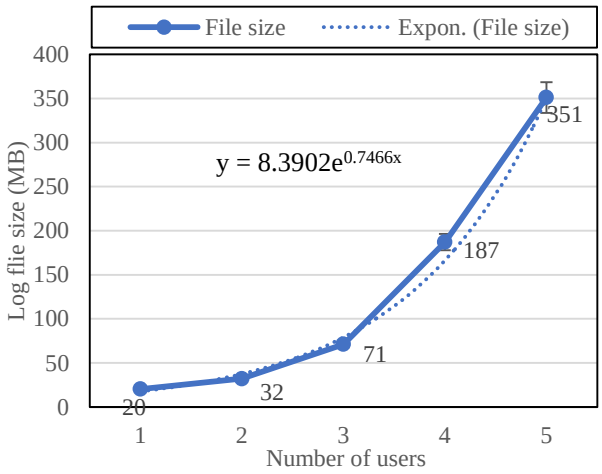

Fig. 4. Log file size versus number of users when playing 30 minutes duration of online video.

Fig. 5. Example of CPU load and number of user notification via LINE Notify application.

Beside file logger function and log file size evaluation, the environmental function was collected and evaluated. We set up the proposed access point notification function by presenting the number of users and CPU load via LINE application [14]. The number of users function was operated by counting the current MAC address of the user's device and report via LINE notification if there were any changing of current users' numbers. Figure 5 shows an example of CPU load and number of user notification via LINE Notify application. The CPU load notification sent to the network administrator routinely or when the CPU load was higher than the setup threshold (80%). We conducted a CPU load experiment versus the number of users. The results of the average CPU load were shown in Figure 6. We increased the number of user's devices from one to five and collected the CPU load data. The CPU load was slightly increased when the number of users increased. There was a linear relationship between the number of users and CPU load which can be explained as $y=0.278x+9.66$. Therefore, if the CPU load threshold was set at 80%, our proposed Raspberry Pi based access point can support up to 253 users.

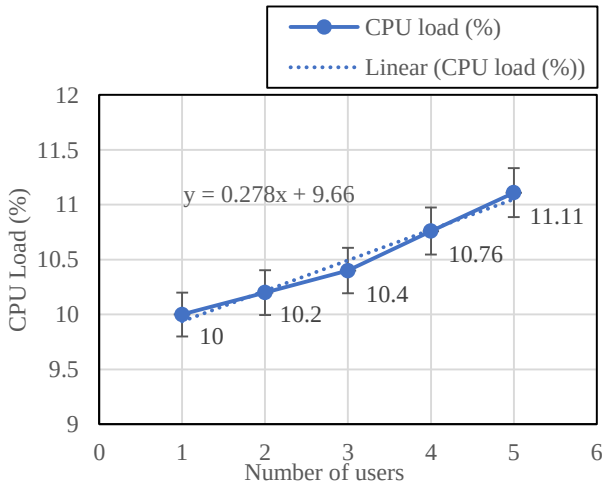

Fig. 6. Linear relationship of the number of users and CPU Load.

B. *Traffic Monitoring Function*

Traffic was an important factor to evaluate the utilization of network devices. This affects the network planning and optimization including troubleshooting when the problem occurred. The proposed Raspberry Pi based access point can present real-time download and upload traffic as shown in Figure 7. The traffic of the proposed router when supporting one, three and five users were shown in the Figure 7 (a), (b), and (c) respectively. The traffic load was related to the number of users. This advantage function can help the network administrator conveniently analyze the network which led to the improvement of the network efficiency.

C. *Signal Strength and Speed Test Evaluation*

The level of signal received by the receiving station determine the possibility of transmitting on wireless lan networks. [15]. We tested the signal strength and the speed of the WLAN link at the frequency of 2.4 GHz. The experiments were conducted in the resident area which had actual WLAN traffic usage. We compared results between our proposed access point and the home-used access point. The Edimax BR-6208AC wireless router which activated only wireless access point function was acted as the compared access point. Figure 8 shows the results of signal strength versus the distance

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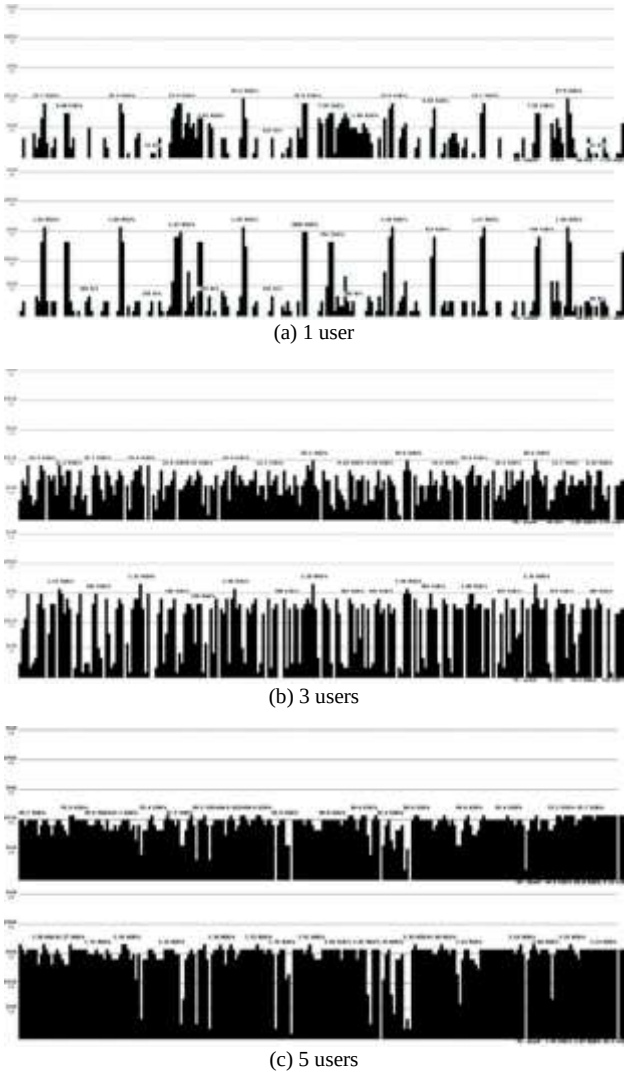
between the access point and user devices. The signal strength of our proposed access point was slightly lower than the compared access point. The longer the distance away from the access point decreased the received signal strength at the user device which mean that the signal strength varies with the distance.



(a) 1 user

(b) 3 users

(c) 5 users

Fig. 7. Realtime download/upload traffic shown at the proposed access point.

For the speed test evaluation, the download/upload test at fast Ethernet LAN was 94.07/94.85 Mbps which closed to the speed provided by the operator at 100/100 Mbps. The WLAN link speed test via 2.4 GHz is shown in Figure 9 (a), the download graph shows that at the proposed Raspberry Pi based access point had a 4 Mbps of download speed. On the other hand, the home-use router had 19 Mbps download speed. Therefore, the speed of the raspberry pi is lower than the home-used router. The Raspberry Pi based access point had the tiny built-in WLAN module with single antenna, the home-used router had three antennas, two of them support at 2.4 GHz and another one support 5 GHz in the signal distribution which had a higher performance of the transceiver including signal strength and speed. Besides, there were a lot of other WLAN networks around the experimental area that interfered our experiment. The home-used access point was actual operate in the residential area which served many users during the experiment.

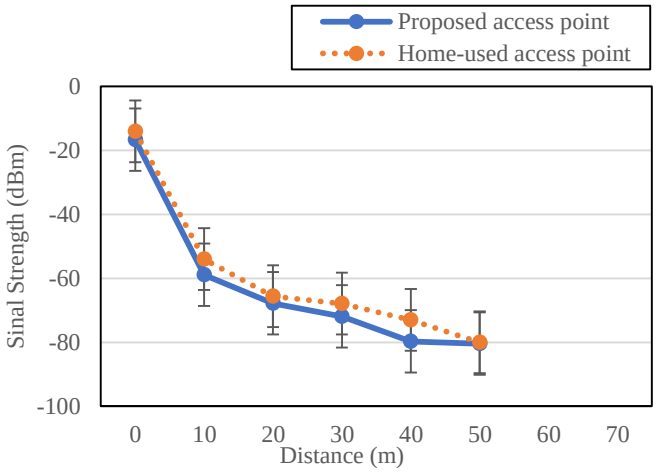
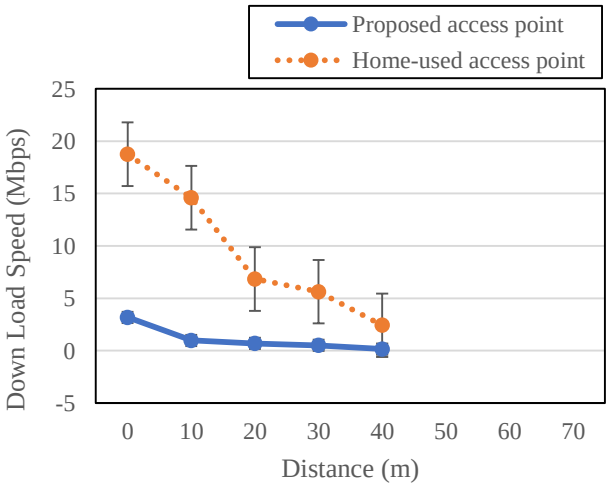
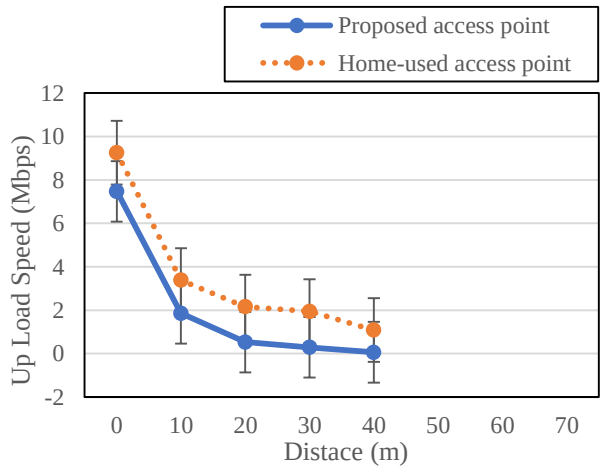


Figure 8: Signal Strength versus distance between access points and user device.



(a) Download speed



(b) Upload speed

Fig. 9. Download/upload speed test versus distance between access points and user device.

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The collision of data packet from many users was a reason of dropping speed compared to the fast ethernet connection. The upload speed results of our proposed access point and the home-used access point were shown in Figure 9 (b). The upload speed of the proposed access point was slightly lower than the home-used access point. Therefore, when looking at the overall picture, the signal strength and upload speed of the Raspberry Pi had the similar performance as the router home use, but the download speed was less than due to the limitation of transceiver module and interference signal.

VI. Conclusion and Future Works

This research developed the Raspberry Pi based access point which had two major functions which are the Internet traffic logger and self-environmental notification. The Raspberry Pi model 3B+ was used in this research because of its built-in WLAN module. The proposed access point captured the header of every packet which was sent via the WLAN module and saved as the log files. The log files routinely upload to the Dropbox as the cloud storage. The number of current users and the CPU load were routinely sent to the network administrator via LINE Notify. We conduct the experiment by varying the number of users and observed parameters, namely, log file size, CPU load, upload traffic, download traffic. These parameters increase relate to the number of users. The signal coverage and speed of the proposed access point were tested compared with the home-used access point. The proposed access point had a lower signal and efficiency than the home-uses access point.

Our future work will increase the efficiency of the proposed access point in case of signal coverage and upload/download speed. We will add a router function to the access point as a Raspberry Pi based wireless routers.

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