# Task1: Bangkadi Wireless LAN Coverage Map

This task focuses on creating a wireless LAN coverage map for 5th and 6th floors of IT/MT Building of SIIT at Bangkadi campus. The locations that the experiments are conducted are shown in Figure 1.

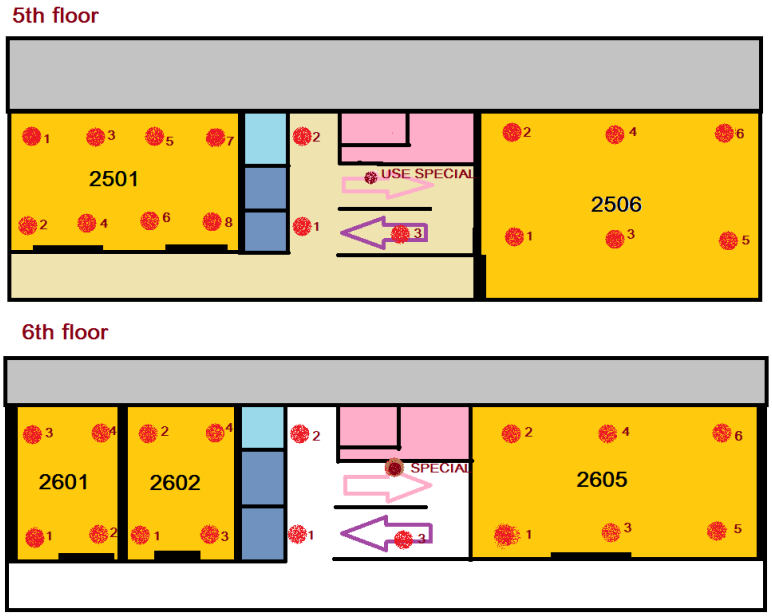



*Figure 1:* Locations of experiments

From the task, 18 wireless LAN signals with SSID of "wsiit" are found within 5th and 6th floors of IT/MT Building. The network type of "wsiit" is infrastructure with different channels range from 5 to 11. There is no encryption method used, hence the security level is none.

Signal strengths are categorized into 5 levels: excellent, good, fair, low, and troll. Signal strength levels are represented by different colors according to Table 1.

Let X be the signal strength measured from the experiment.

*Table 1:* Signal Strength Level Chart

| Average Signal Strength (dBm) | Signal Strength Quality | Color |
|---|---|---|
| X > -60 | Excellent | |
| -60 ≤ X < -70 | Good | |
| -70 ≤ X < -80 | Fair | |
| -80 ≤ X < -90 | Low | |
| X ≤ -90 | Troll | |

Since 2 trials are conducted for this task, the one with better signal strength quality is selected to be shown on the map. For instance, if position 1 has a fair quality signal for the 1st trial but has a good quality signal for the 2nd trial, the 2nd trial is chosen. The method of signal selection comes from the reason that the stronger signal is possible to have less interference from noises or have fewer clients during the experiment time.

Below are wireless LAN coverage maps of 5th and 6th floors of IT/MT Building, SIIT Bangkadi. There are 2 maps for each router, one for the 5th floor and another for the 6th floor.

# Bangkadi Wireless LAN Coverage Map

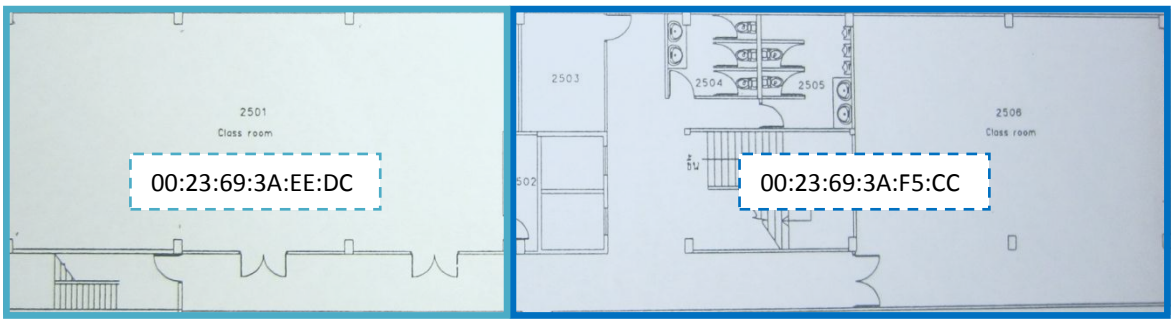
**Of**

# IT/MT Building: 5th and 6th floor

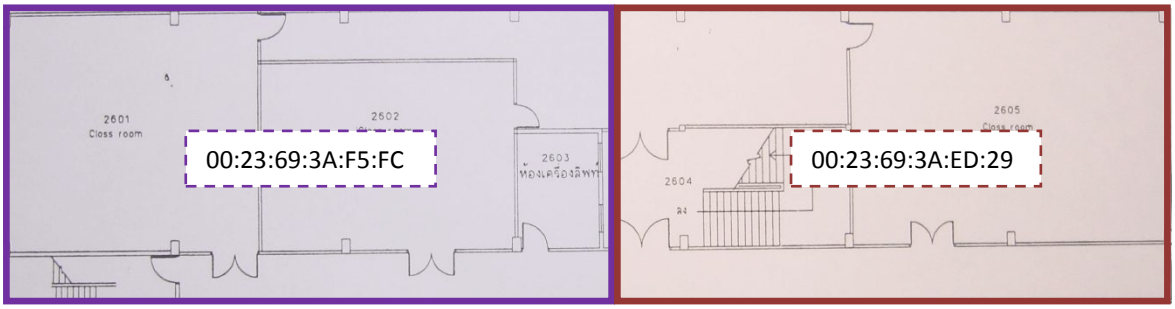
task1_spreadsheet.xlsx

**Map of the routers with the strongest signal strength within each location**

5th Floor

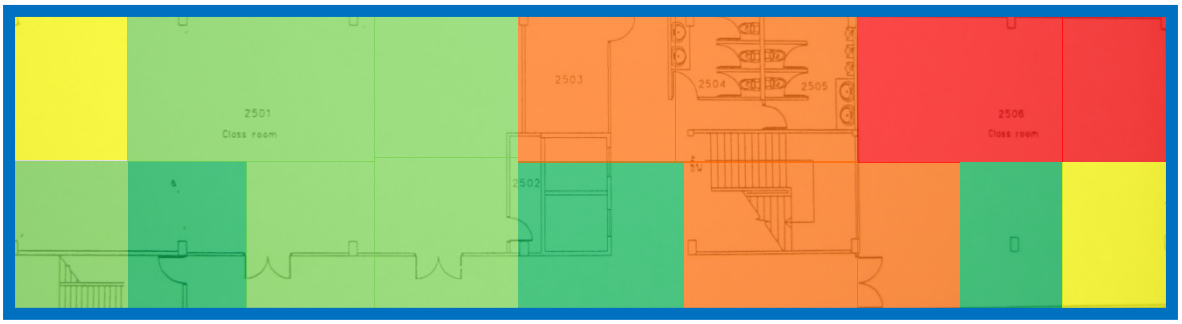



6th Floor

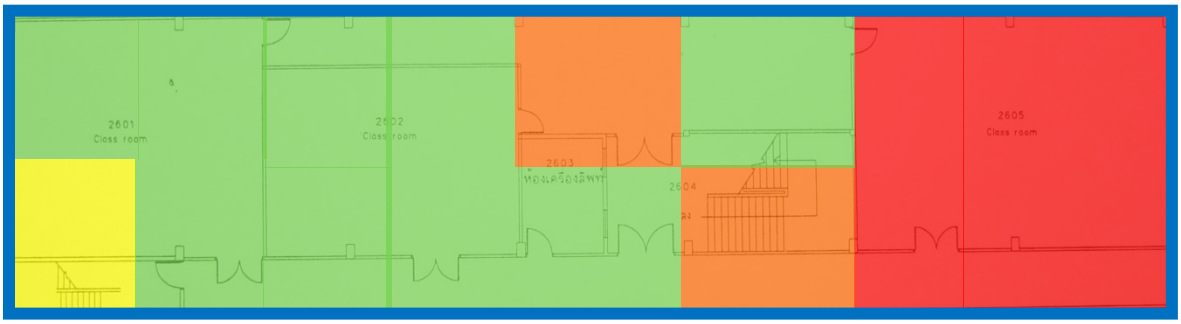


**Signal strength map of router with MAC address of <u>00:23:69:3A:F5:D2</u>**

*5th Floor*



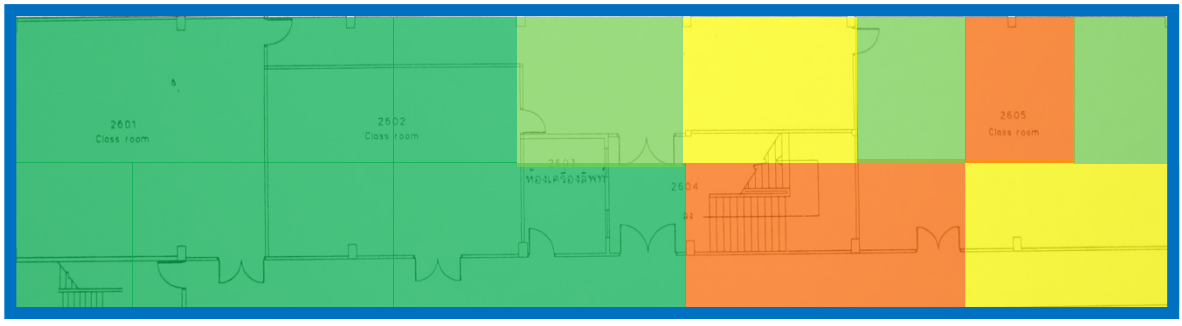

*6th Floor*




**Signal strength map of router with MAC address of <u>00:23:69:3A:F5:FC</u>**

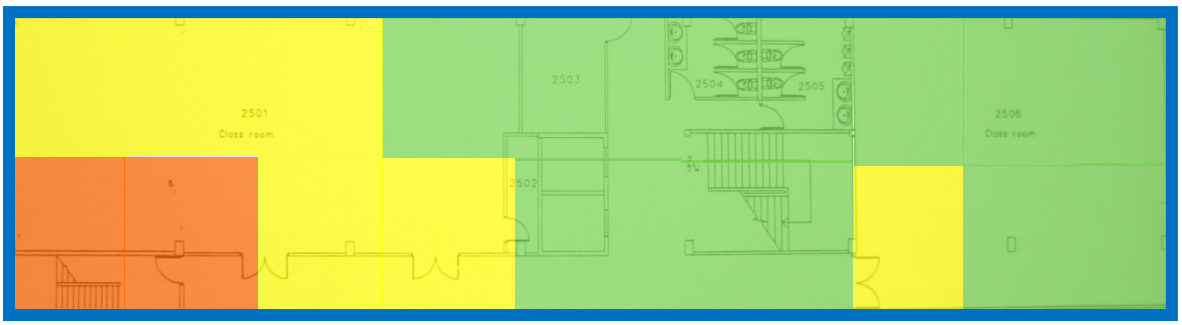
*5th Floor*


*6th Floor*

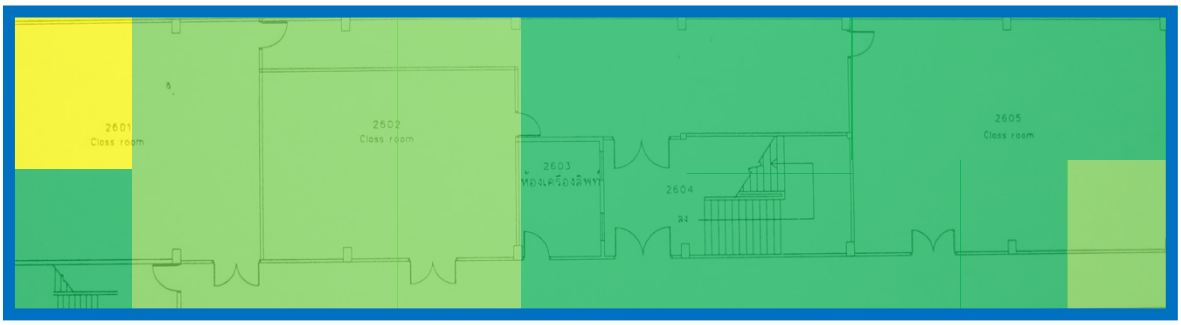


**Signal strength map of router with MAC address of <u>00:23:69:3A:ED:29</u>**

*5th Floor*

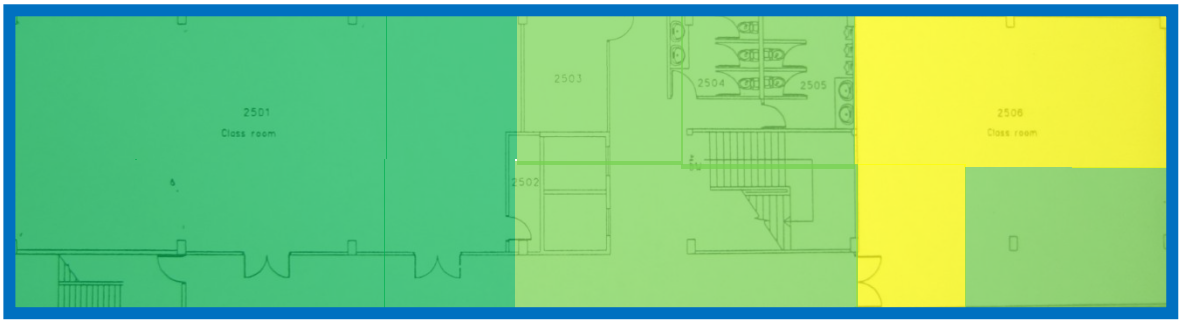



*6th Floor*

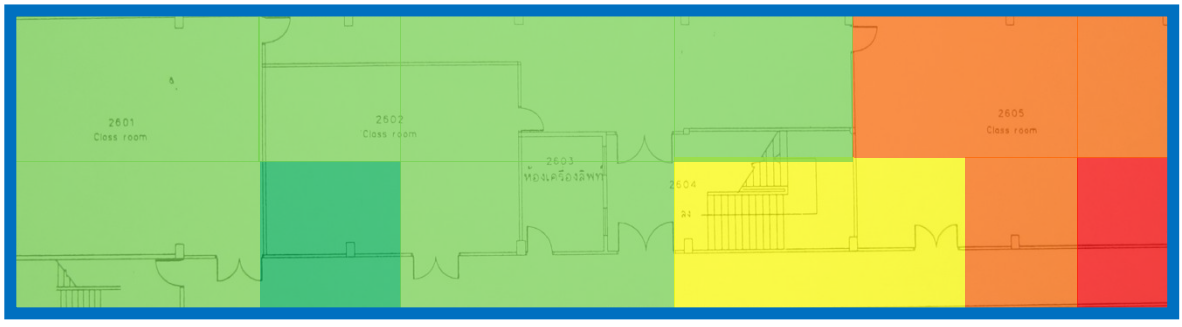



**Signal strength map of router with MAC address of <u>00:23:69:3A:EE:DC</u>**

*5th Floor*

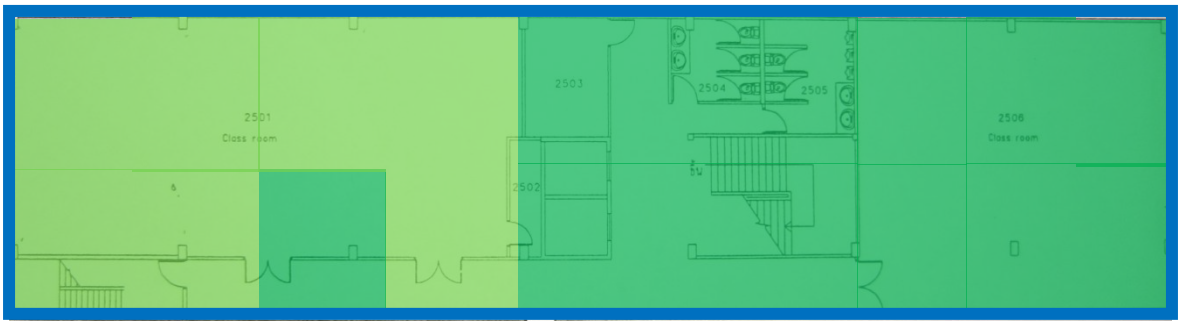



*6th Floor*

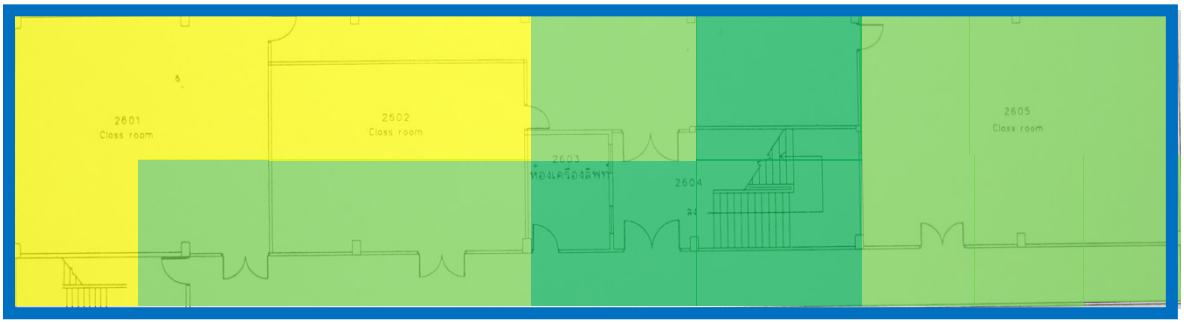


**Signal strength map of router with MAC address of <u>00:23:69:3A:F5:CC</u>**

*5th Floor*



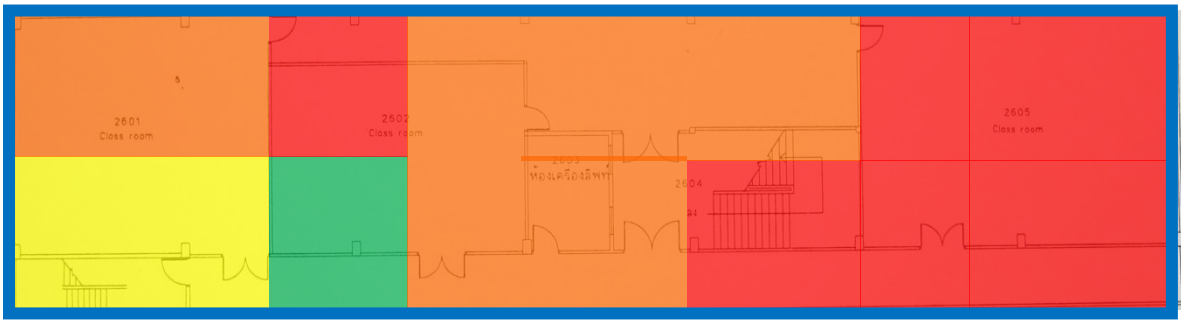

*6th Floor*




**Signal strength map of router with MAC address of <u>00:23:F8:6E:C0:CC</u>**

*5th Floor*

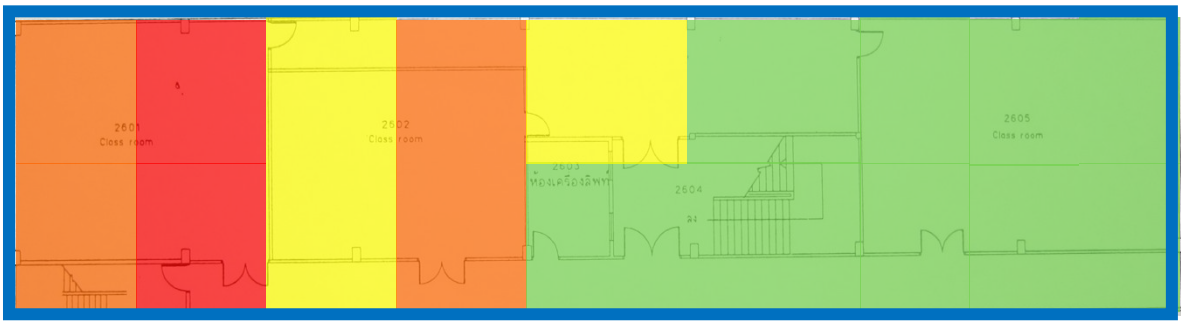

*6th Floor*



**Signal strength map of router with MAC address of <u>00:23:69:3A:F6:92</u>**

*5th Floor*

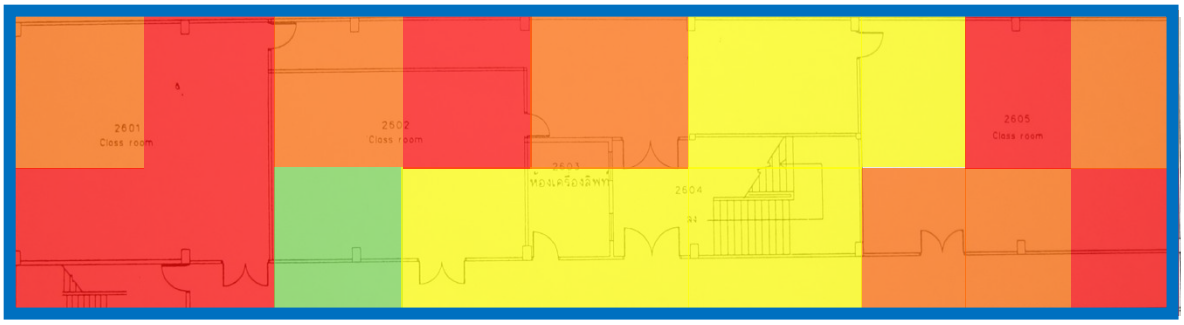

*6th Floor*




**Signal strength map of router with MAC address of <u>00:19:CB:4F:0A:0E</u>**

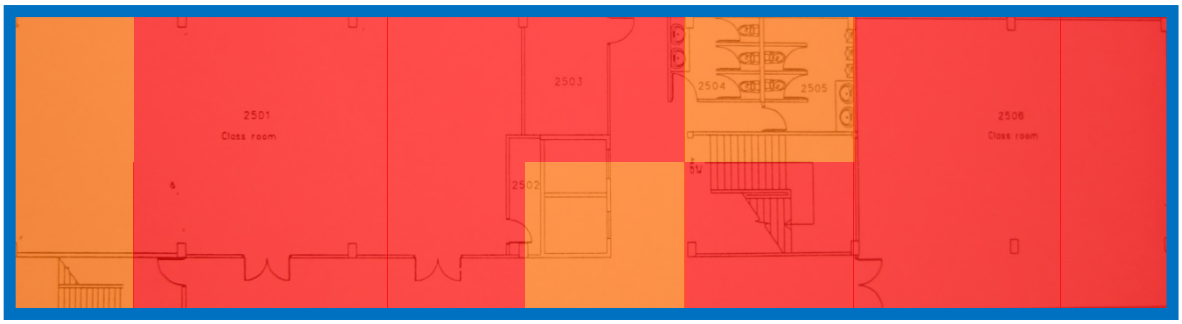
*5th Floor*


*6th Floor*



**Signal strength map of router with MAC address of <u>00:A0:C5:D4:77:D7</u>**

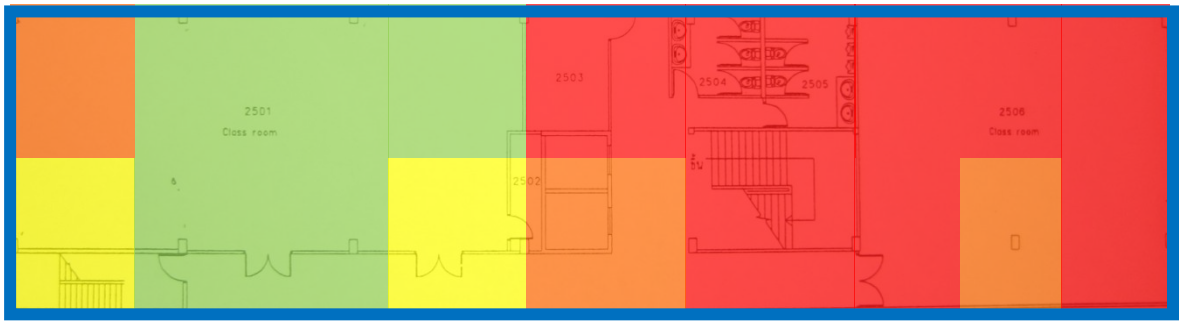
*5th Floor*




*6th Floor*


**Signal strength map of router with MAC address of <u>00:19:CB:4F:09:C3</u>**

*5th Floor*




*6th Floor*

**Signal strength map of router with MAC address of <u>00:A0:C5:D4:77:DB</u>**

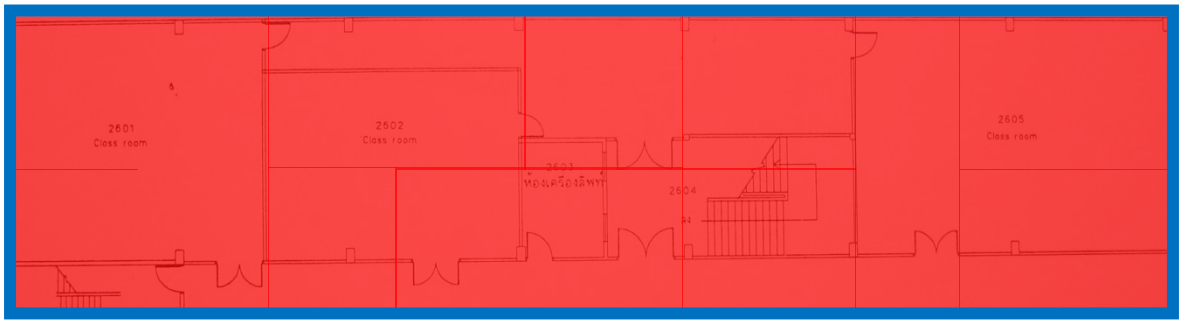
*5th Floor*


*6th Floor*


**Signal strength map of router with MAC address of <u>00:19:CB:4F:0A:14</u>**

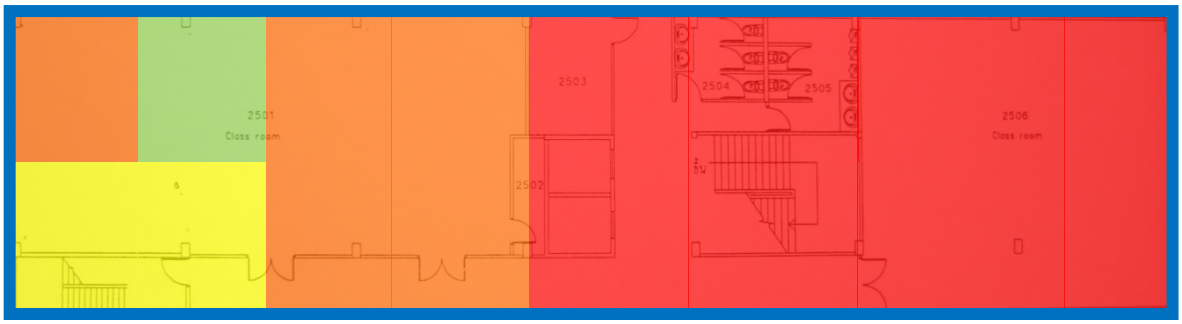
*5th Floor*


*6th Floor*



**Signal strength map of router with MAC address of <u>00:A0:C5:73:62:56</u>**

*5th Floor*




*6th Floor*

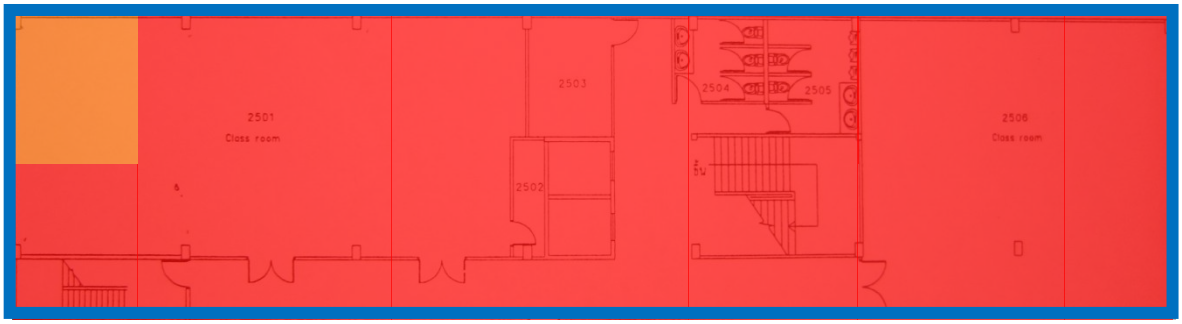

**Signal strength map of router with MAC address of <u>00:A0:C5:D4:77:D9</u>**

*5th Floor*

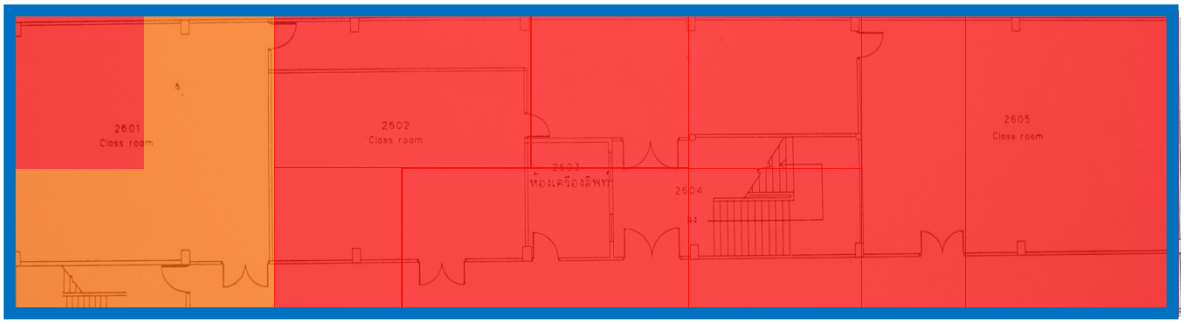

*6th Floor*

**Signal strength map of router with MAC address of <u>00:19:CB:7E:8F:FE</u>**

*5th Floor*




*6th Floor*




**Signal strength map of router with MAC address of <u>00:A0:C5:D4:77:D0</u>**

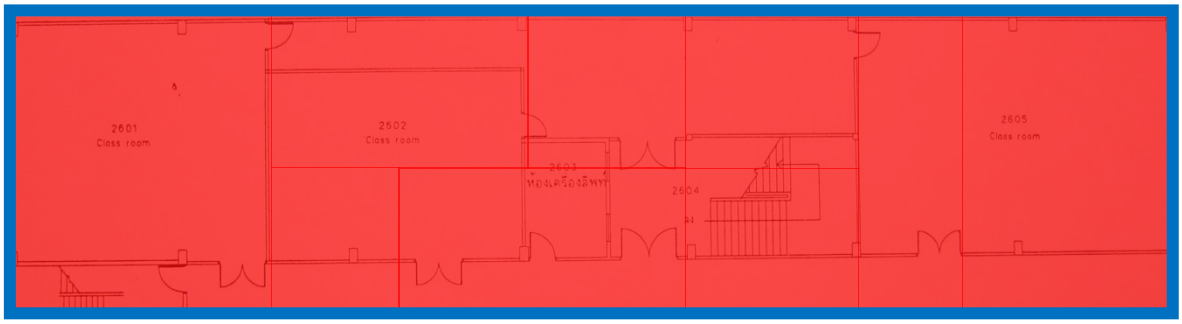
*5th Floor*


*6th Floor*

**Signal strength map of router with MAC address of <u>00:19:CB:4F:0A:02</u>**

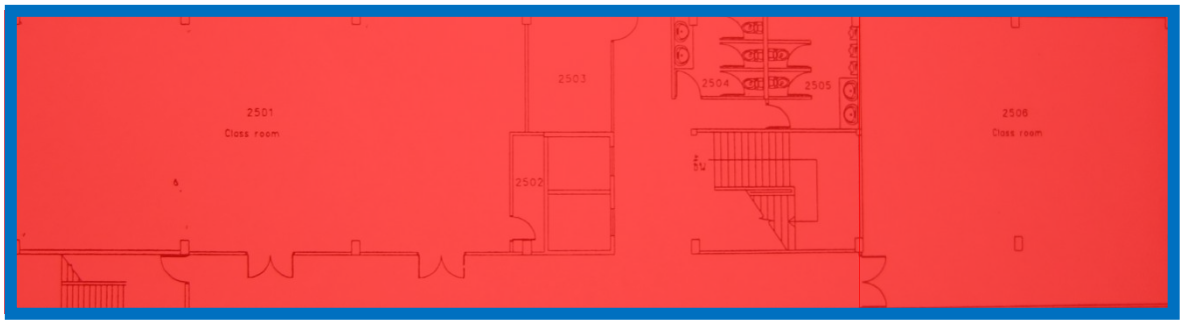
*5th Floor*


*6th Floor*

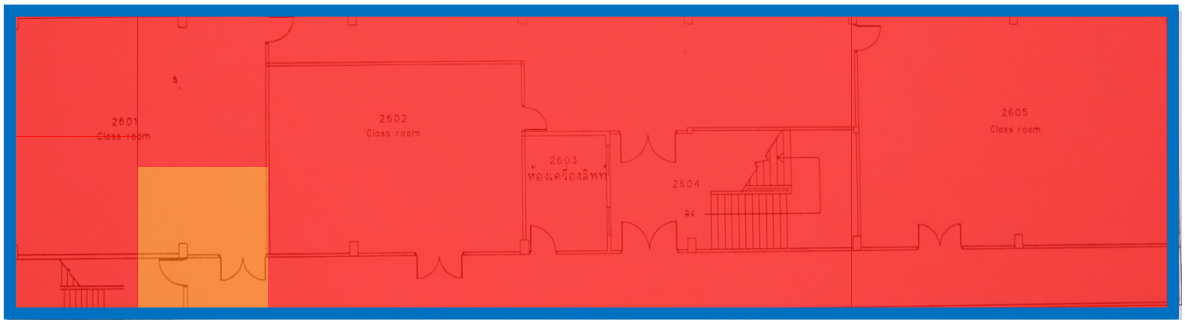



**Signal strength map of router with MAC address of <u>00:A0:C5:D4:77:DC</u>**

*5th Floor*




*6th Floor*



# Task2: Wireless LAN Throughput Performance

## Introduction

Wireless Local Area Networks (Wireless LANs) have become very popular and general for implementing internal networks of organizations and also internet service provider networks. Being the wireless technology, they provide mobility of users and devices. However, one of their drawbacks compared to wired technology is their performance, the throughput, which is much affected by many factors specific to wireless environment. Therefore, this experiment aims to learn about some of these factors.

## Objectives

1. To study the factors that impact on wireless LAN performance under various conditions.
2. To familiarize with techniques for testing network performance using iperf.

## Materials

1. The Linksys WRT54GL wireless router performing as an access point of a wireless network
2. One laptop[1] performing as a server of a wireless network
3. Two laptops[2,3] performing as clients of a wireless network

## Experimental Procedures

**Part 1: Wireless LAN Performance dealing with one client**

1. Set up a wireless network of one router, one server, and one client as shown in Figure 1.
2. Run iperf in a server mode using the UDP transport protocol at the server laptop.
3. Configure the router to operate using the IEEE 802.11b standard mode only.
4. Run iperf in a client mode using the UDP transport protocol at the client laptop with increasing packet sending rate in the Megabits/second unit.
5. Record measured throughput corresponding to each sending rate.
6. Configure the router to operate using the IEEE 802.11g standard mode only.
7. Repeat from Step 4 to Step 5.
8. Configure the router to operate using the mixture of the IEEE 802.11b and the IEEE 802.11g standard mode.
9. Repeat from Step 4 to Step 5.
10. Analyze the throughput results for the maximum throughput of the wireless LAN link.

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| | | | | |
|---|---|---|---|---|
| [1] | Windows 7; | Intel Core i7 Q720 1.60 GHz CPU; | 4 GB RAM; | Atheros AR9285 NIC |
| [2] | Windows 7; | Intel Core2Duo T5750 2.00 GHz CPU; | 3 GB RAM; | Intel WiFi Link 4965 NIC |
| [3] | Windows 7; | Intel Core2Duo T6600 2.20 GHz CPU; | 4 GB RAM; | Intel WiFi Link 5100 NIC |


*Figure 1:* Wireless network topology consisting of one client

**Part 2: Wireless LAN Performance dealing with two clients**

1. Setup a wireless network of one router, one server, and two clients as shown in Figure2.
2. Run one iperf in a server mode using the UDP transport protocol at the server laptop designating to one specific port number.
3. Run another iperf in a server mode using the UDP transport protocol at the server laptop designating to another specific port number.
4. Configure the router to operate using the IEEE 802.11b standard mode only.
5. Run iperf in a client mode using the UDP transport protocol at one client laptop designating to one predefined server port, and at the other laptop designating to the other predefined server port. Both of the clients run iperf at the same time with increasing packet sending rate in the Megabits/second unit.
6. Record measured throughput corresponding to each sending rate where the total measured throughput is the sum of each throughput of each client.
7. Configure the router to operate using the IEEE 802.11g standard mode only.
8. Repeat from Step 5 to Step 6.
9. Configure the router to operate using the mixture of the IEEE 802.11b and the IEEE 802.11g standard mode.
10. Repeat from Step 5 to Step 6.
11. Analyze the throughput results for the maximum throughput of the wireless LAN links.

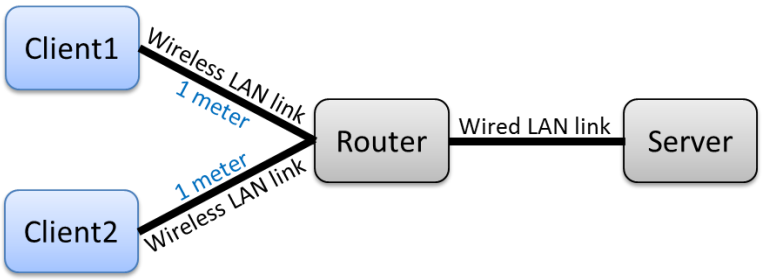


*Figure 2:* Wireless network topology consisting of two clients

In this experiment, all other parameters of iperf apart from the transport protocol, the server IPv4 address, the port numbers, and the packet sending rate were set to be iperf's default values and fixed throughout the experiment. The default value of the UDP buffer size was 8 kilobytes and the time each client send packets to the server for every test was 10 seconds. Also, the channel used by the router was selected to be the one not used by other nodes, whose channel information was obtained from inSSIDer.

# Experimental Results task2_spreadsheet.xlsx

**Part 1: Wireless LAN Performance dealing with one client**

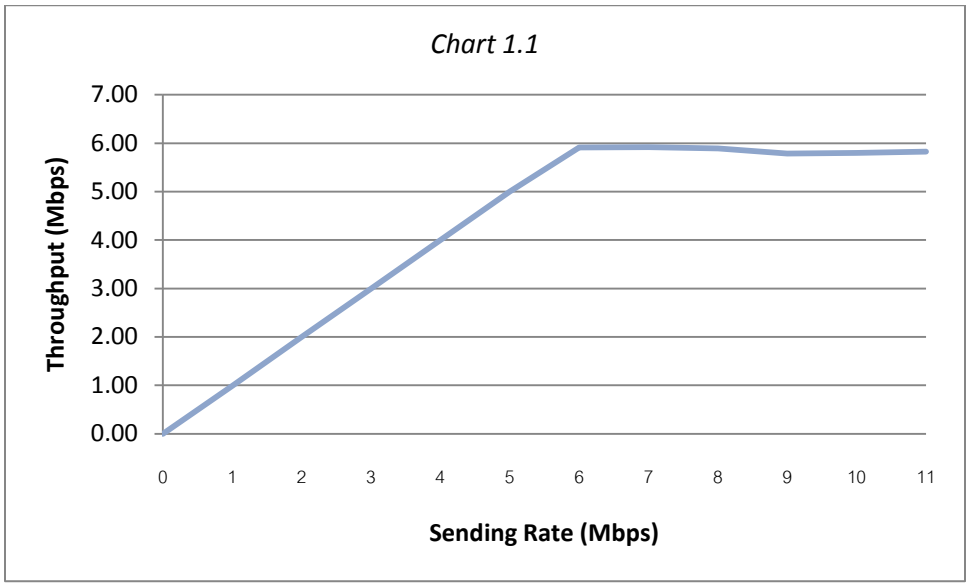


*Figure 3:* Relationship between the sending rate and the throughput
when the router operation was in the IEEE 802.11b standard mode only.
The maximum throughput was around 6 Mbps (54.55% of theoretical data rate of 11 Mbps).

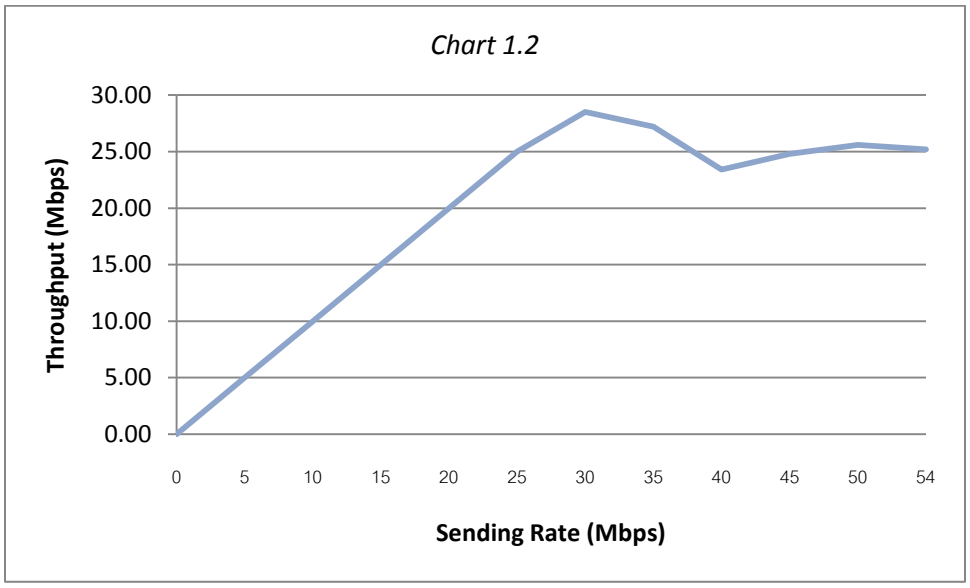


*Figure 4:* Relationship between the sending rate and the throughput
when the router operation was in the IEEE 802.11g standard mode only.
The maximum throughput was around 29 Mbps (53.70% of theoretical data rate of 54 Mbps).

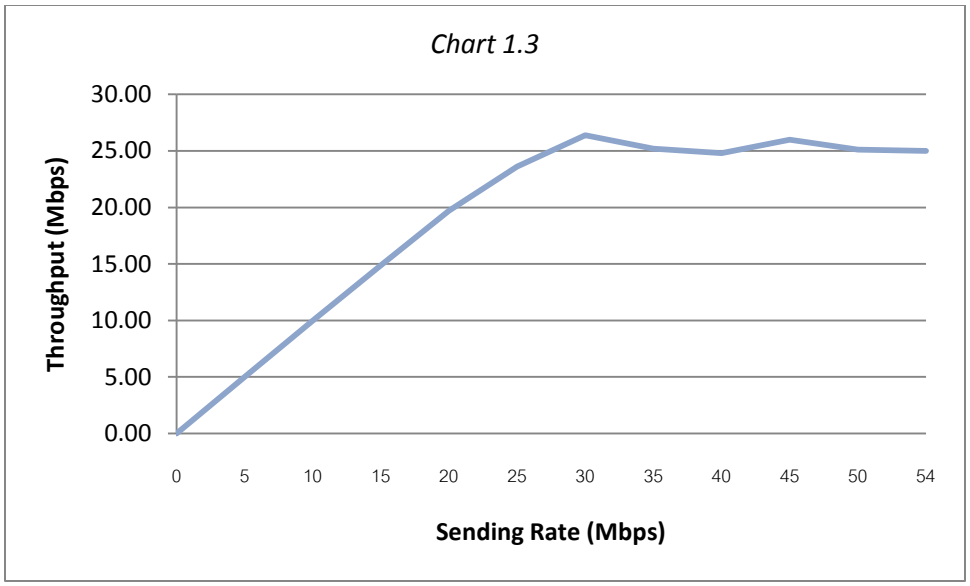


*Figure 5:* Relationship between the sending rate and the throughput
when the router operation was in the mixture of the IEEE 802.11b and the IEEE 802.11g standard mode.
The maximum throughput was around 28 Mbps (51.85% of theoretical data rate of 54 Mbps).

**Part 2: Wireless LAN Performance dealing with two clients**

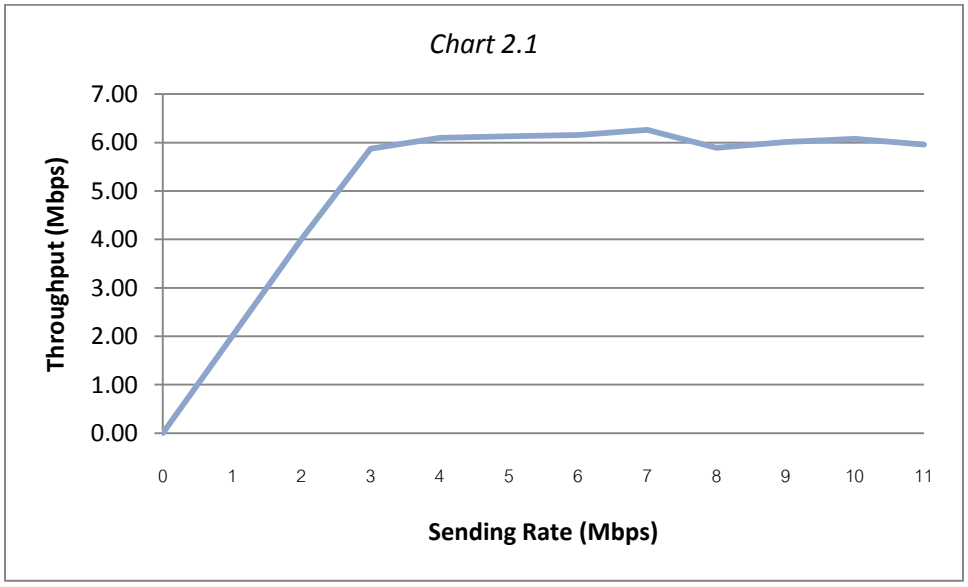


*Figure 6:* Relationship between the sending rate and the overall throughput
when the router operation was in the IEEE 802.11b standard mode only.
The maximum throughput was around 6 Mbps (27.27% of theoretical data rate of 22 Mbps).

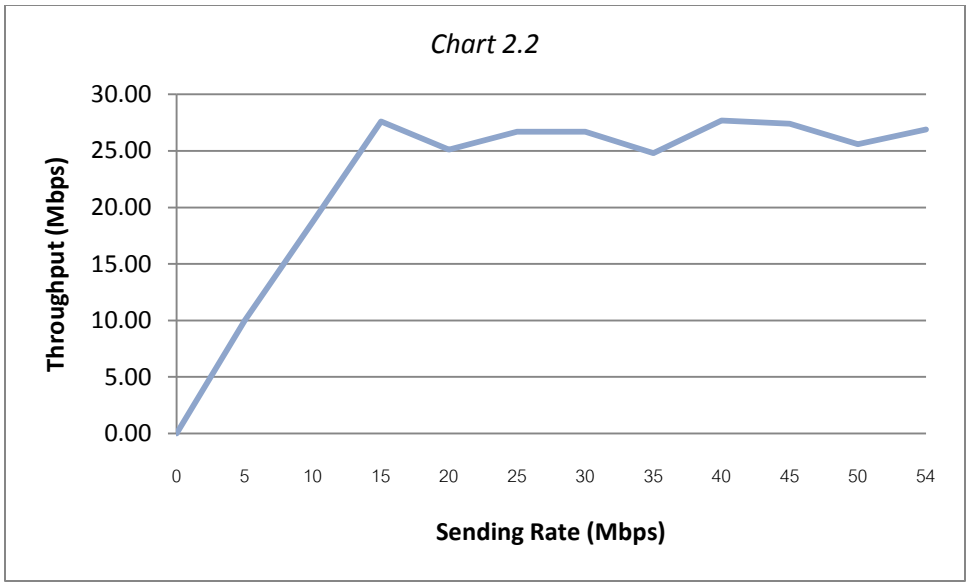


*Figure 7:* Relationship between the sending rate and the overall throughput when the router operation was in the IEEE 802.11g standard mode only. The maximum throughput was around 28 Mbps (25.93% of theoretical data rate of 108 Mbps).

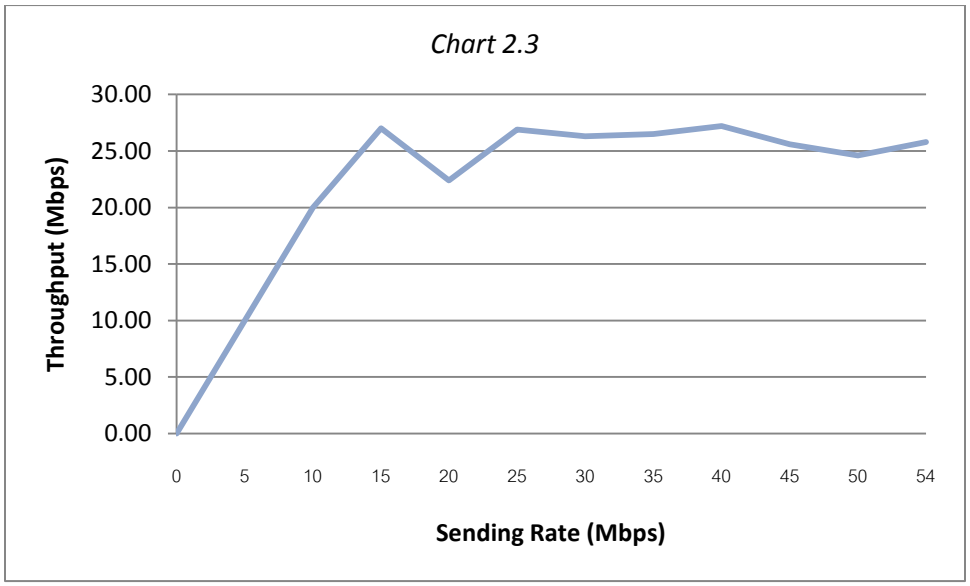


*Figure 8:* Relationship between the sending rate and the overall throughput when the router operation was in the mixture of the IEEE 802.11b and the IEEE 802.11g standard mode. The maximum throughput was around 28 Mbps (25.93% of theoretical data rate of 108 Mbps).

## Discussions

According to the experimental results of Part 1, it can be seen that all of the 3 cases of the IEEE 802.11 standards used by the access point gave the same trend of the achievable throughput. At the low packet sending rates, the throughput was as high as the sending rate until the increasing sending rate reaches around a halfway to the maximum theoretical data rate. At that point, which was around 6 Mbps for the IEEE 802.11b and 28 Mbps for the IEEE 802.11g and the mixture of both standards, indicated the maximum throughput that can be reached (around 50 percent of each specified IEEE 802.11 data rate). The higher sending rate after that rate had no distribution in increasing the throughput so the throughput stayed stable. The difference among those standards was their theoretical data rate which gave different values of the maximum throughput.

According to the experimental results of Part 2 which had the additional client introduced to the network, the throughput of the overall network appeared to have the same characteristic of the throughput of the network consisting of one client. The overall maximum throughput was a half of each specified IEEE 802.11 data rate. However, the sending rate that gave the maximum throughput was a half of the case of one client (around 3 Mbps for the IEEE 802.11b and 15 Mbps for the IEEE 802.11g and the mixture of both standards) because the throughput that each client earned was around a half of the overall throughput of the network.

In conclusion, the overall throughput was shared clients. When there was one client, the throughput it can gain was 50 percent of the theoretical data rate, which was the overall throughput. On the other hand, when there was two clients, the throughput each client can gain was 25 percent to result in the overall throughput of 50 percent. To predict, if there are 3 clients, the throughput each client can gain will be around 16.67 percent.

## Conclusions

The performance of wireless LAN links depends on many factors, and the examples of which are the implemented IEEE standards and the number of clients of the same basic service set. The IEEE 802.11g standard provides higher theoretical achievable data rate than the IEEE 802.11b does hence higher throughput can be reached by clients in the IEEE 802.11g wireless LANs. However, in reality, throughput of wireless networks cannot reach specified theoretical data rates since there are interferences from other wireless communications and obstacles along the way, and also frequency of wireless signal is shared among many clients. In general, the throughput is only around a half of the theoretical data rate. Moreover, when there are more than one clients rely on the same channel of communication at the same time, the throughput is decreased because the Medium Access Control protocol of the wireless LAN lets only one client to use the channel at a time in order to avoid interferences. In addition, the mixed mode of the IEEE 802.11b and the IEEE 802.11g standard of the access point gives similar throughput to the solely IEEE 802.11g standard. The mixed mode provides higher compatibility to the network, but implementation of it may cause the performance of wireless LAN link to be slower dependent on specific routers.

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