Abdulrahman Zuberu

Wireless Network Testing and Optimization

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ABSTRACT

Author	Abdulrahman Zuberu
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The project was meant to examine the areas covered by the wireless network of Vaasa University of Applied Sciences that needed optimization, including specific areas, such as classrooms, halls, conference rooms which are of priority when it comes to the optimization. The project was making use of HP switches and HP MSM422 wireless access points, so the knowledge of configuring HP switches in making this project a success was needed. The testing was done by Ekahau software specifically meant for site surveying. This helped in knowing which areas meet the needed requirement set for the signal strength. The result shows that there were few areas that needed optimization. The results after the optimization met the required standard for the network, which was setting the minimum signal strength at – 70 dBm. In my opinion this has been a successful project since the goals were achieved, that was making sure that internet access can be received at every part of the campus. Wireshark performance measurement was carried out to give much insight into the traffic flow and throughput of the wireless network compared to a wired network. The throughput at both minimum and maximum signal strength of the wireless network was considerably lower than that of the wired network. These results may not be the thorough reflection of the network throughput due to the minimum number of data collected and also the environmental factors that affects wireless signal.

CONTENTS

1 INTRODUCTION

The past years have seen a much technological advancement with wireless network playing major role in it. This is the more reason why industries and institutions are always finding ways and means of improving their wireless network for different reasons. VAMK is not exceptional from those institutions trying to improve their wireless network performance in order for it to serve the needs of the institution. In institutions such as VAMK where portable devices are all over the area, the need for very good wireless network becomes a priority. Moreover not all the class rooms and social gathering areas have computers and students will be making use of their laptop, with wireless network all over the area, it means you can do your homework and assignment at every corner of the campus with no problem of connecting to the internet.

Wireless network is a means that allows users to communicate at anytime and anywhere [Cisco systems - 2008]. The ability for a client (*wireless communication device*) to connect to an access point (*base station in LAN that allows connection to a wireless network*) without difficult is very important for every wireless network. There are several factors which can lead to poor wireless signal and it is important that all these factors are dealt with in other to achieve the desired signal strength. Distance has been a major factor when it comes to signal strength between client and access point. There are other factors such as obstructions (furniture, people, and wall) also have significant effect on the propagation of the signal [Atheros communication, 2003]. It is vital that throughput is measured at different locations since some remote locations can have good throughput than closer locations.

The stated factors above are presents on VAMK campus and they do affect the performance of the wireless network. It is for these reasons why VAMK wants to improve the throughput and coverage area of the network at any point on the campus to ensure effective wireless network. Benchmarking these factors helps in knowing areas that falls below standards and the need for improvement. Major industries such as Cisco and HP are providing alternative ways of achieving and managing very good wireless network. VAMK was once using Linksys Access point but decided to switch to HP wireless access point, which is MSM422 HP Access point. The introduction of various products comes with benefits and HP is actually giving VAMK a life time warranty on their products, this benefit triggered the idea of changes and improvements in the school network.

My task was basically to improve the network signal strength for it to be able to handle basic usage (web surfing), downloading emails etc. The project was divided into three parts, namely:

- deploying wireless access-points to optimal locations
- coverage area testing and optimisation
- Wire shark performance measurements

I did not deploy many access points at starting of the project; the testing was done using software called Ekahau, which is meant to be used for site survey. It also gives much information aside the signal strength, such as the number of access points, network health, signal to noise ratio. The data I collected provided me with the following detailed information:

- The areas on the network that need to be optimised.
- It indicates the WLAN wireless signal strength at different locations.

This activity was carried out in all areas of the institution to know which areas needed optimisation. The final results after optimization was analysed in other to make sure that they met the standard of performance; this was achieved during Wireshark performance measurements.

1.1 Outline of the Thesis

The following chapter outlines the theoretical framework underlying the practicality on which the work in this thesis is based.

Chapter 1covers the introduction to the project, it also describes the aims and problems of the project which will serve as a guide. It also gives the systematic approach to the project. This helped in preventing mistakes or oversight of some stages.

Chapter 2 is meant to give the theoretical background knowledge of the Thesis project; this will provide the theoretical foundation upon which this project was based on. It also helps in understanding basic terms that I will be using through the report.

Chapter 3 This chapter give details into how the measurements were made using the necessary tools.

Chapter 4 This chapter describe the pre-optimization measurement, optimization, and after-optimization measurements.

Chapter 5 The performance of the network was accessed during the Wireshark performance measurement and this has been explained in detail in this chapter**,** this was done to access the throughput and traffic flow using the throughput graph and Time sequence graph.

1.2 The aims and Problems

The initial problem with the school wireless LAN was most areas were not covered, and also areas that were not of priority were covered. In other to avoid making similar mistakes, the requirements were reviewed in order to meet the needs of the institution.

The main aim now is to make sure at least minimum throughput can be gained at the following areas:

a. Classrooms

b. Conference rooms

c. Social gathering rooms

d. Halls and

e. Offices

The project is also meant to improve the network to 802.11n standard; this provides the network with better:

- Reach
- Throughput and
- Reliability

The new standard which is been provided by the new network may not be in use now since most of our devices have been designed to handle the old standards. So in other to experience the benefits of the new standard the user needs device that can handle the new standard.

The above areas are the priority of the project. Corridors were not considered much because the assumption was that the probability of students staying on corridors is very minimal.

1.3 Research Material and Method

The environment where the test was to be carried out plays important role in achieving the desired results. Wireless environment falls into three categories, namely:

- Outdoor: This like inside large open buildings e.g.: conference rooms, halls etc. In this there is direct line of sight between access point and the client.
- Open office: This office area comes with cubicles and conference rooms; usually there is no direct line of sight between access point ad clients.
- Closed office: There are many obstructions in this and there is no line of sight between client and access point [Atheros communication]

The environment that I was working consists of all this three environments, outdoors normally provides the longest ranges whiles closed office provides the shortest.

The project's success depends on my ability to make use of the available tools. The tools used in carrying out the projects were:

a. Ekahau software

b. The knowledge of configuring HP switches and HP access points

c. Using Netperf software

d. Wire shark software

The tools above played important role in the success of the project, the Ekahau software is meant to be use for measuring the signal strength at each part of the area, this is done by walking around the area with the software activated into a survey mode. This helped me to know which areas needs optimisation, because the software was set to grade the signal based on their strength. In the case that a signal falls below the required minimum strength, then it needs to be optimised.

The configuring of HP switches helped in setting up the required VLANs needed on the access points. The access point will not have any configuration made on them. So it was important for me to know how they are configured. The project was using HP MSM422 access point which works on 2.4 GHZ and 5 GHz both belong to the license free spectrum.

In achieving the required results I used Netperf software to benchmark my required minimum signal strength by testing for end-to- end delivery and unidirectional throughput.

1.4 Methodology (solid project Management principles)

The project success depends on the following important processes. The process helped in measuring progress whiles I take corrective measures along the way. It also helped me in knowing how to approach the project stage by stage. The stages involved in the project are shown in table 1.

Stages	**Requirements**
Phase I	Surveying (pre - survey and actual – Survey)
Phase II	Analyzing Results of Survey
Phase III	Optimization if needed
Phase IV	Final Surveying
Phase V	Wire shark Performance Measurement
Phase VI	Analysis
Phase VII	Summary
Phase VIII	Conclusion

Table 1. Guidelines for the project

2 THEORETICAL BACKGROUND

The changing of technology is influenced much by wireless network, this is because most of our portable devices are making use of wireless communication and it is important that the performance of the network is taking much into consideration. This helps a lot in facilitating movement and communicating especially in our business and health sectors. The three networks, WLAN, WBAN, and WPAN are important part of our daily lives due to the different services and data they provide. The health sector makes use of Wireless Body Area Network (WBAN) in tracking the health issues of a person and exchanging data [Tai-hoon Kim – 1998, 77]. WBAN make use of physiological signal devices in executing their services. WPAN interconnects all the home appliances (e.g. PDA's, scanners, and printer) to the internet; this operates in a short range of 10m [Vijay Garg – 2007, 654].

Wireless networking is basically a way of connecting several wireless devices together using radio frequency as a means of communication. Wireless Local Area Network (WLAN) is a data communication system meant to augment wired Local Area Network within a building or campus. It transmits data over the air, as such eliminating the need for cables and promoting mobility within an area. It helps doctors and nurses to get patients data instantly. It serves as backup to wired networks and also rental and restaurants provide faster services with real time customer information input and retrieval [C.S.R Prabhu – 2004, 292 and 300]. Service Set Identifier (SSID) helps in device segmentation [Robert J Bartz – 2009, 343]; it acts as a password for any communication device trying to connect to the network and it also differentiates one WLAN from another. The SSID is configured in each access point installed and a wireless communication device needs to provide the SSID in other to have connection. It plays very useful part of our daily activities in schools, hospitals, airports, hotels etc. There are several wireless network types, these are:

- Wireless Local Area Networks (WLANs): This network is meant to serve a local area, such as University, Library etc. to help them gain access to the internet.

Figure 1 shows a LAN extended service set (ESS), the foundation of wireless LAN is the basic service set (BSS) which is a stationary or mobile stations with an access point WLAN offer that stations in different BSS can communicate among themselves as shown in figure 1 below. [Behrouz A. Forouzan – 2007, 422].

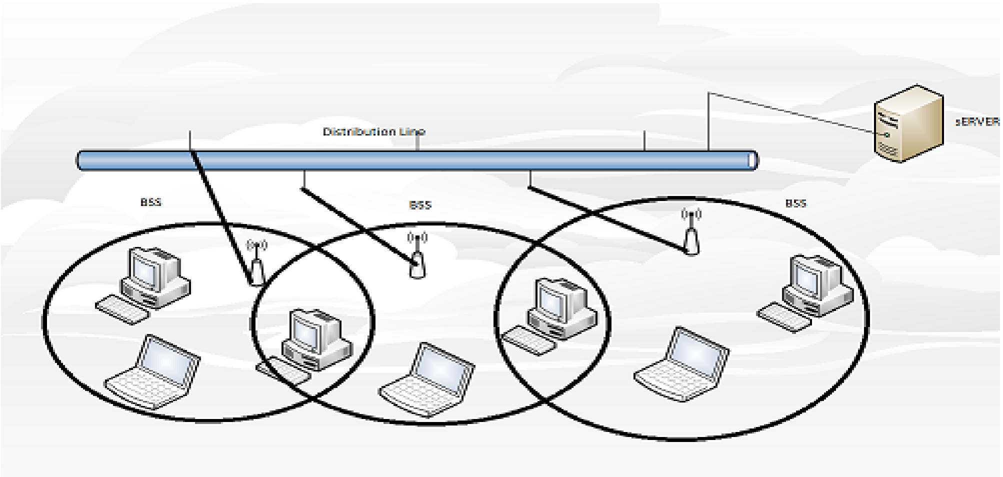

Figure 1. WLAN ESS diagram.

- Wireless Personal Area Network (WPAN): Devices within short range uses infrared and Bluetooth to communicate, this forms the personal area network as shown in figure 2. Devices such as printers, digital cameras, mouse etc [George Aggelou – 2005, 64].

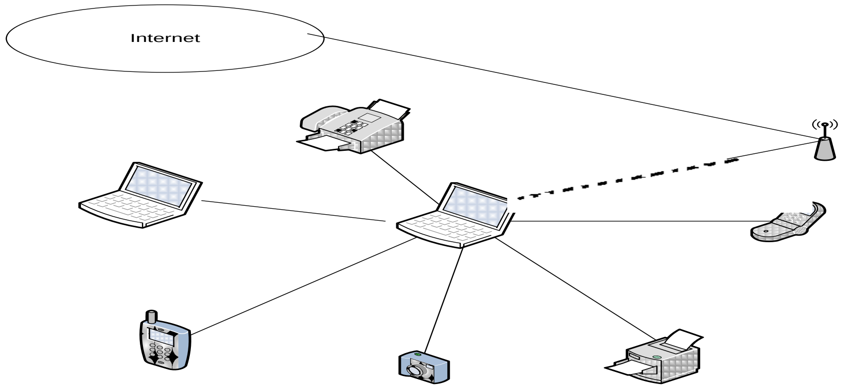

Figure 2. WPAN.

- Wireless Metropolitan Area Network (WMAN): This provides means of connecting several networks in metropolitan areas typically a City [David D. Coleman - 2009, 223].

- Wireless Wide Area Network (WWAN): It connects large areas to form wide area network that communicates using satellites or antennas [David D. Coleman - 2009, 223]

The above networks plays vital role in our daily lives, such as in schools, health sector, business sectors, Library etc. Access points serve has a transmitter and receiver of radio signals in WLAN, there are several types of access points with different specifications. Major companies such as Cisco and HP provide some of the finest access points to meet various needs. In other to maintain safe means of communication, the wireless spectrums have been placed under well managed system.

2.1 Wireless Network Spectrum

In order to control traffic that occurs on our wireless networks, there are rules and guidelines on for the use of equipments. In the effort to control interference and traffic, which are the two important factors that affect wireless signal strengths effectiveness, wireless spectrum have been sectioned, so that certain group of businesses can make use of one whiles the other section belongs to other activities. This brought about license free spectrum and licensed spectrum. The license free have rules already set for the hardware and the deployment, this is done to avoid interferences. So any device is allowed to transmit provided they meet the technical requirement for the band. The license free spectrum is heavily used by individuals for personal and commercial use, but it offers the needed results at a cheap cost. The most commonly license free spectrums are:

- 900 MHz: 902 – 928 MHz
- 2.4 GHz: 2403 – 2483MHz
- 5GHz: 5725 – 5850 MHz, 5150 – 5250 MHz, 5250 – 5350 MHz, 5725 – 5825 MHz

In the case that firms want to deploy wireless outside the three public bands, then a license is required before you do so. This is called licensed spectrum is meant for individuals or firms to broadcast on it without outside interference, this is expensive and not everybody can afford [P. Nicopolitidis – 2003, 250]. The table 2 gives the comparisons of the license free spectrum.

	900 MHz	**2.4 GHz**	**5 GHz**
Speed	Lowest Throughput	High Throughput	High Throughput
Frequency	Crowded	Crowded	Not crowded
Range	Weak	Average	Average

Table 2. License free spectrum Comparison.

The wireless network is made up of standards which are vital in building wireless local area network. There are currently four standards, namely: 802.11a, 892.11b, 802.11g, and 802.11n, which are the latest standard [Intel Corporation - 2008].

The latest standard; 802.11n has major advantages over 802.11 a/b/g, the standard is based on the previous standards; but there have been a lot of additions meant to overcome problems faced by the previous standards. The previous standards have problem with packet loss with no retransmission, security problem, and quality of service. The latest standard solves such problem with retransmission of every loss packet. Another addition to the new standard is the multiple in and multiple out technology (MIMO) [Intel Corporation - 2008]. MIMO is the use of multiple antennas both at the receiver and the transmitter ends in other to improve communication performance. The use of 802.11n standard gives your network the following benefits:

- The increase in throughput and
- Link range [Intel Corporation - 2008]

Table 3 gives the needed comparisons between the four standards.

	802.11a	**802.11b**	**802.11g**	**802.11n**
Popularity	New Technology	Widely adopted	Rapid growth	Latest Technology
Speed	Up to 54 Mbps	Up to 11 Mbps	54Mbps	Up to 600 Mbps
Frequency	5 GHz	2.4 GHz	2.4 GHz	5GHz
Range (Indoor)	150ft	300ft	300 ft	>300 ft

Table 3. Comparing WLAN standards. [Danny Briere and Pat Hurley, 171]

3 MEASUREMENTS AND TOOLS

Wireless network is playing major role in our daily lives and it is a prerequisite for any institution to provide effective means of communication at anytime. There were two basic goals of the project and it was important that they were achieved at the end of the project. The success of the project was based on achieving the goals set, these are:

a. The ability for clients to carry out basic internet usage.

b. To be able to get at least minimum signal strength in the rooms mostly used for studies or social gathering.

To achieve this it is important that the understanding and knowing how to approach the project be the priority for a successful project. The project methodology above states the exact processes that took place during the project. This section will be focusing on detail activities that took place at each phase of the project.

3.1 Surveying using Ekahau software

The campus map have been divided into three sections first, second and third floors, in other to make things easier I decided to consider each section separately using the Ekahau software, which is use in site surveying. The software is designed in a way that you can upload a map of the environment you have. It is pretty easy to use the software, using the software takes two stages, namely:

a. Pre-survey and

b. Actual survey

Pre-survey: The pre-survey stage involved walking around the environment to pick up the signals available and also the locations of the access points, not always precise when it comes to the location of the access points, as shown in Figure 3. The software picks the entire wireless signal available at that environment, there is a pull down menu on the top right corner which shows all the available access points that the software have picked. The required access point to choose from the pull down menu is “my access point”.

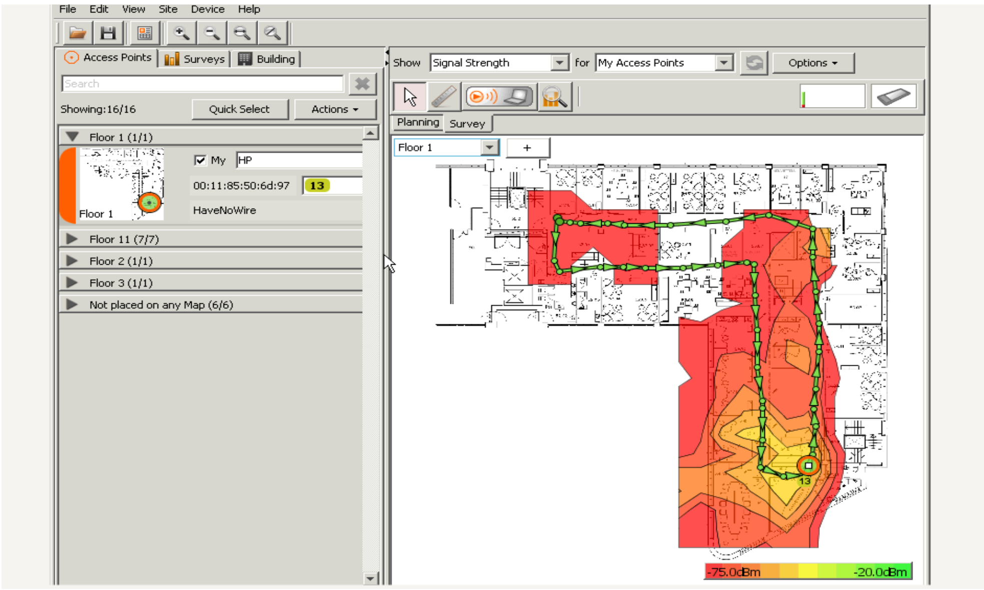

Figure 3. Pre-survey.

Actual survey*:* The software measurements are marked with colours that you can set it yourself. The green colours mostly mean strong signal whiles the red means weak or minimum signal strength. These measurements are not precise, they are assumptions made by the software, in actual survey, you take an area, preferably small area then you take the actual measurement of the place by walking in all corners of the place be it a classroom or corridor. This is shown in Figure 4.

Figure 4. Sample Actual-survey.

3.2 Netperf

The two tests that will be carried out under Netperf are inbound and outbound test.

Inbound measurement (TCP stream): Inbound metric provides a unidirectional measurement, end-to end delivery as shown in figure 5. The purpose of this test is to measure the network performance, by measuring the throughput between two hosts. This was done by sending stream of data from source Netperf to destination remote computer to sink over a TCP connection. This also helped in knowing the overall bandwidth between sources A and the remote server or destination B [Deborah Frincke – 2002, 57].

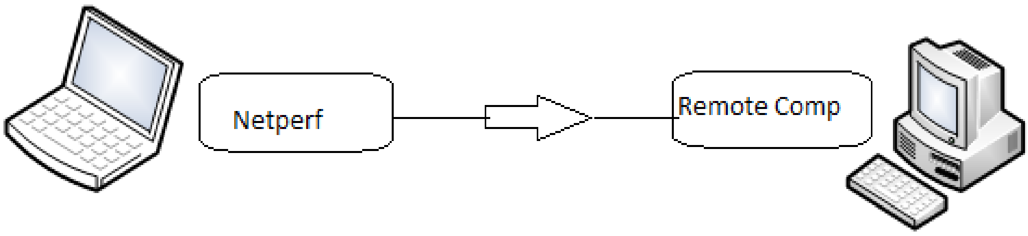

Figure 5. Inbound.

Outbound measurement (TCP maerts): Figure 6 shows the operation of an outbound metric. This is important when it comes to accessing web servers and downloading emails. The outbound test measures unidirectional transmission of TCP data from the netserver to the machine running the Netperf. This deals with measuring throughput from source remote computer to destination Netperf. This helps in knowing how fast response are received [Robert Broberg, Man-in-the-Middle TCP recovery].

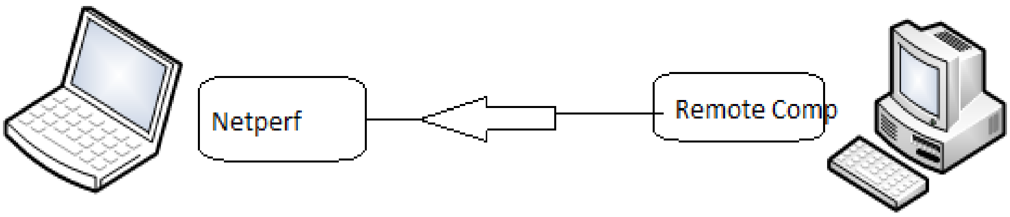

Figure 6. Outbound.

The purpose of the Netperf is to help me to benchmark and measure the throughput of the wireless network at minimum and maximum signal strength by saturating the network. Linux machine was used in performing this task. We have two commands in performing this task, one is for inbound, and the other is for outbound. This measurement is meant to help me find out the minimum signal strength which can be able to withstand transmission.

The Linux commands used are shown below:

Inbound*: Netperf –t tcp_stream –H monitor.cc.puv.fi –f*

Outbound*: Netperf –t tcp_maerts –H monitor.cc.puv.fi* –f

H: This is used when dealing with remote host

f: This is used to change the unit of measurements [Netperf Organization, 2007].

3.3 Measuring signal strength using Netperf

This section deals with the strength of the wireless signal, the signal strength of WLAN can be seen as the indicator at the right-bottom corner of the computer as shown in figure 7. It consists of five (5) bars and my focused at this section is the minimum signal strength I want to use for my measurement.

Figure 7. Signal strength indicator.

Netperf Measurement results and Analysis

The running of the Netperf commands resulted in the output shown below. It consists of ***inbound*** or TCP stream test and ***Outbound*** or TCP maerts measurements. The Netperf commands were run at two areas:

- The area where the minimum number of signal strength bars was achieved, which is the 2 bars and
- The area where the maximum signal strength was achieved, that was the 5 bars.

Minimum signal strength (2 bars)

Inbound Measurement (TCP stream test)

user@user-laptop:~$ netperf -H monitor.cc.puv.fi -t TCP_STREAM

TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to monitor.cc.puv.fi (193.166.140.44) port 0 AF_INET : demo

Recv	Send	Send		
Socket	Socket	Message	Elapsed	
Size	Size	Size	Time	Throughput
bytes	bytes	bytes	secs.	10^6bits/sec
87380	16384	16384	10.04	2.27

Minimum ***-60dBm - -55dBm***

Outbound Measurements (TCP maerts test)

user@user-laptop:~$ netperf -H monitor.cc.puv.fi -t TCP_MAERTS

TCP MAERTS TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to monitor.cc.puv.fi (193.166.140.44) port 0 AF_INET : demo

Recv	Send	Send		
Socket	Socket	Message	Elapsed	
Size	Size	Size	Time	Throughput
bytes	bytes	bytes	secs.	10^6bits/sec
87380	16384	16384	10.10	5.76

Strong signal strength (5 bars)

Inbound Measurement

user@user-laptop:~$ netperf -H monitor.cc.puv.fi -t TCP_STREAM

TCP STREAM TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to monitor.cc.puv.fi (193.166.140.44) port 0 AF_INET : demo

Recv	Send	Send		
Socket	Socket	Message	Elapsed	
Size	Size	Size	Time	Throughput
bytes	bytes	bytes	secs.	10^6bits/sec
87380	16384	16384	10.04	23.37

*Maximum = **-45dBm - -40dBm***

Outbound Measurements

user@user-laptop:~$ netperf -H monitor.cc.puv.fi -t TCP_MAERTS

TCP MAERTS TEST from 0.0.0.0 (0.0.0.0) port 0 AF_INET to monitor.cc.puv.fi (193.166.140.44) port 0 AF_INET : demo

Recv	Send	Send		
Socket	*Socket*	*Message*	*Elapsed*	
Size	*Size*	*Size*	*Time*	*Throughput*
bytes	*bytes*	*bytes*	*secs.*	*10^6bits/sec*
87380	*16384*	*16384*	*10.43*	*13.68*

The values had at the minimum signal strength shows that the throughput during the outbound measurement was higher than the value had during the inbound measurement. The whole idea was measuring the throughput for data flow from the remote computer to the Netperf. This meant the throughput for downloading or data flow from the remote computer to the Netperf was higher than that from the Netperf to the remote computer [Hewllet Packard - 2007]. This was not the same for the strong signal. These results can be due to several reasons; end-to-end connection in wireless network consists of one or more wired and wireless link. These links have different data rates, BERs and delays. These parameters affect the network and as such makes it difficult to insure the reliability of end-to-end network connection. TCP Packet loss in wireless network is assumed to cause by congestion. Moreover in wireless network poor link quality and intermittent connectivity can cause packet loss. Keeping in mind that the links we are measuring have poor link quality, so controlling congestion using congestion control mechanism for TCP can results in large and variable end-to-end delays and low network throughput [Jean Walrand and Pravin Vraiya 2000, 340]. This can be the main reason why the inbound had low throughput compares to the outbound.

I had already taken pre survey at the area in question, so by activating the Ekahau software and walking till the signal strength falls to the 2 bars the decibel value will be shown on the map by moving the cursor on the map at that area. The value I had was between -60dBm and -55dBm. This was the minimum signal strength capable of decoding information.

The 802.11 standard defines receiver sensitivity as the minimum signal strength that can be able to acceptably decode information. Every data rate is supposed to operate at a specific receiver sensitivity value but can be adjusted. A receiver performance at a 54Mbps and 11Mbps are supposed to have a receiver sensitivity of -65dBm and -76dBm respectively [Pejman Roshan and Jonathan Leary 2004, 193&194]. The network I worked on has a mixture of 54Mbps and 11Mbps data rates and due to that a decision was made to peg the general sensitivity at -70dBm.

The receive signal strength indicator metric gives much details about the receiver sensitivity threshold and its equivalent signal strength value in percentage. There was an adjustment in the values I used in my measurement. Table 4 shows that signal strength of -41dBm has signal strength of 90 %, I used values greater than or equal to – 40dBm for my measurement which can mean that the signal strength at that level will be almost above or equal to 91%. In the same sense we can say the 5 bars can be equated to this value.

The minimum signal I was using in terms of number of bars was the first 2 bars which also represent the value for the receiver sensitivity. This was set at -70 dBm and from table 4 a signal strength threshold of -75dBm has signal strength of 40%, the value I used for my signal strength threshold was -70dBm which will approximately have a signal strength value of around 46%.

Receiver Sensitivity Threshold	Signal Strength (%)	SNR	Signal Quality (%)
-30dBm	100	70dB	100
-41dBm	90	60dB	100
-52dBm	80	43dB	90
-52dBm	80	40dB	80

-63dBm	60	33dB	50
-75dBm	40	25dB	35
-89dBm	10	10dB	5
-110dBm	0	0dB	0

Table 4. Receiver sensitivity threshold table .

[David Coleman and David Westcott – 2009, 88]

Figure 8 shows the signal strength been represented with colours. Each colour represents the magnitude of the signal strength. The strongest signal is represented with 5 bars which is equal to the green colour. The red colour represents the weakest signal in the network, which are the 2 bars I used as the minimum signal strength.

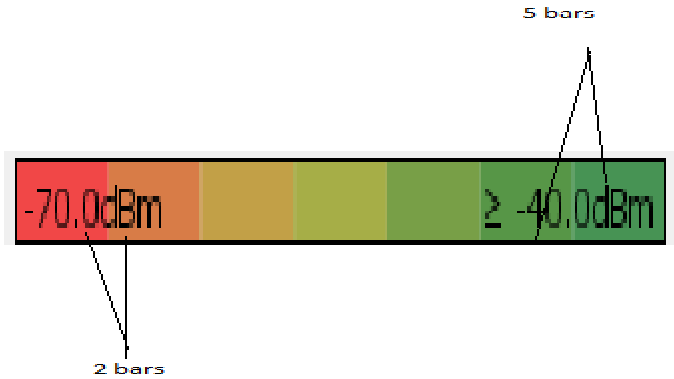

Figure 8. Signal strength indicator on a Ekahau.

To start the survey, the minimum and maximum signal strengths must be set on the software as shown in the figure 9. In my case the minimum signal strength was set to 46% of the signal strength, which was - 70dBm according to the measurement I took. So anywhere on campus where the signal strength falls below -70dBm needs optimisation. Figure 9 shows the minimum signal strength -70dBm in use. This figure is for the measurement at the 3rd floor.

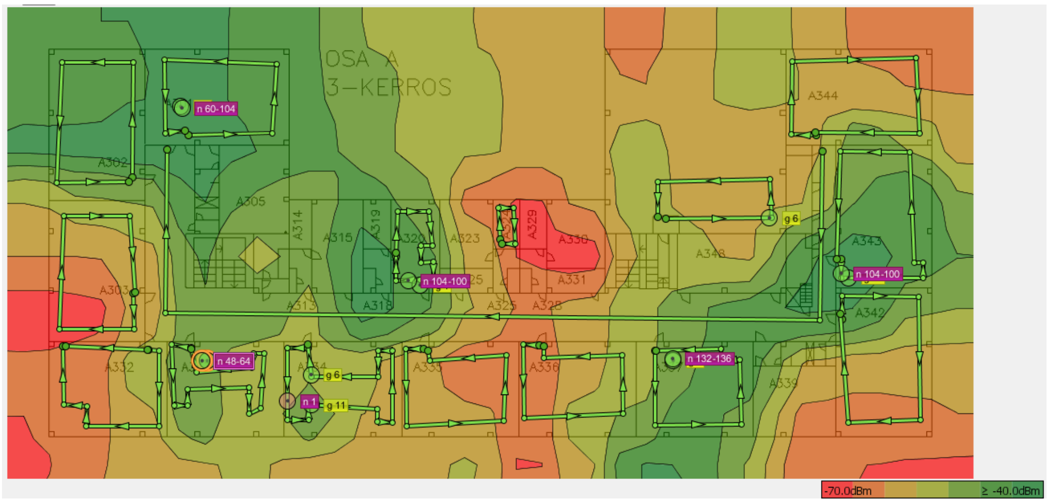

Figure 9. 3rd Floor showing the minimum signal strength used.

This means any signal that falls below the value set for the Red colour will not be picked by the software.

4 OPTIMIZATION AND RESULTS

There are some few things you should know in other to understand the analysis. The Ekahau software takes into consideration the signal strength from other floors or sections. In other to get the accurate signal strength provided by the access points at each floor, the signal strength from other sections needs to be deleted. This was done at each floor to make sure that the optimization is done accurately at the correct sections.

4.1 Areas been Optimized

First Floor

Figure 10. Signal strength measurement on first floor.

Analysis

Figure 10 show the magnitude of signal strength at each section of the first floor, as explained earlier, the red colours represents the minimum signal strength whiles the green represents the maximum signal strength. The white spaces in-between the colours are the areas with magnitude of signal strength below the required minimum value needed.

The survey consists of pre-survey and actual survey, areas that are the priority turn to get this actual – survey, sections that are not of much importance like the corridors do not get the actual-survey. The areas that needed optimisation were:

- The auditorium
- The physics Laboratory
- The VAMK office and
- Room WA 109

The number of access points present at the floor is shown in figure 11, this shows only the access points installed on the floor. In normal operation the floor gets signal from access points installed in the floors above or below it, this helps to boost the signal level at each floor. It is important that there is enough access points to ensure that there are overlapping in the signal, overlapping is needed for:

- Balancing load and
- Roaming of access points.

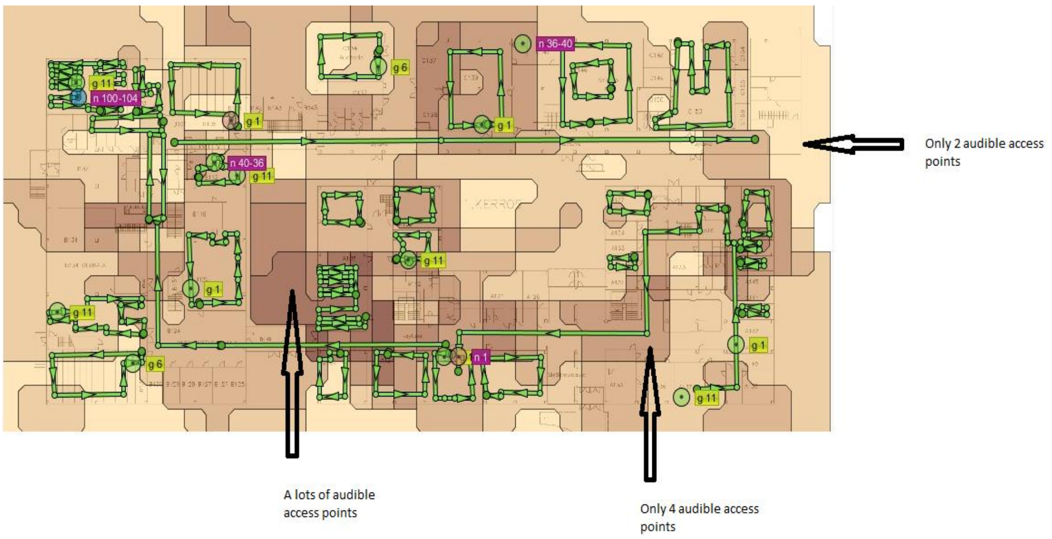

Figure 11. Number of access points on first floor.

Ground Floor

Figure 12. Signal Strength present on the ground floor.

Analysis

The ground floor has only 3 access points installed there; my concentration is in the white areas. In this section most of the white areas are store rooms and rooms not in used, so I did not consider those rooms. Figure 12 show that the following areas need optimisation:

- WC 001
- WC 007 and
- WC 008

The area is small enough to be covered by one access points. Figure 13 gives details of the number of access points available in that section.

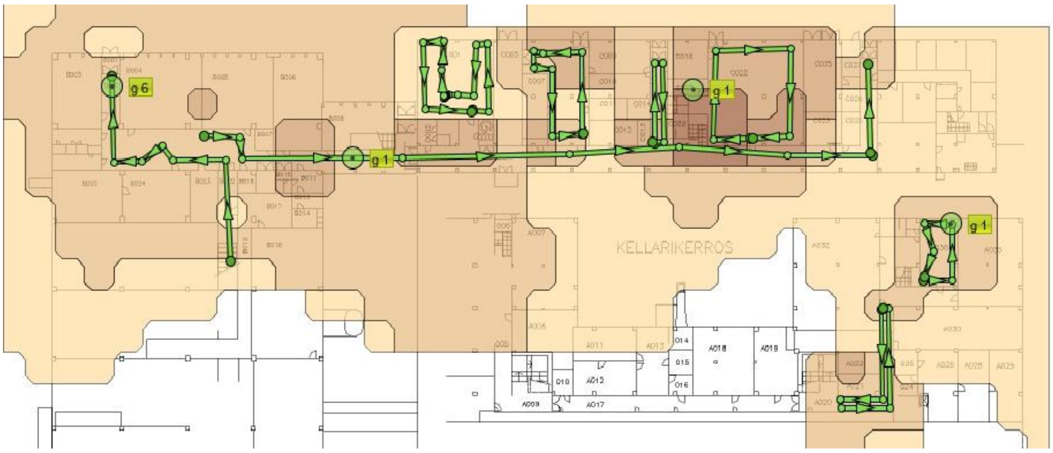

Figure 13. Number of access points installed on ground floor.

Second Floor

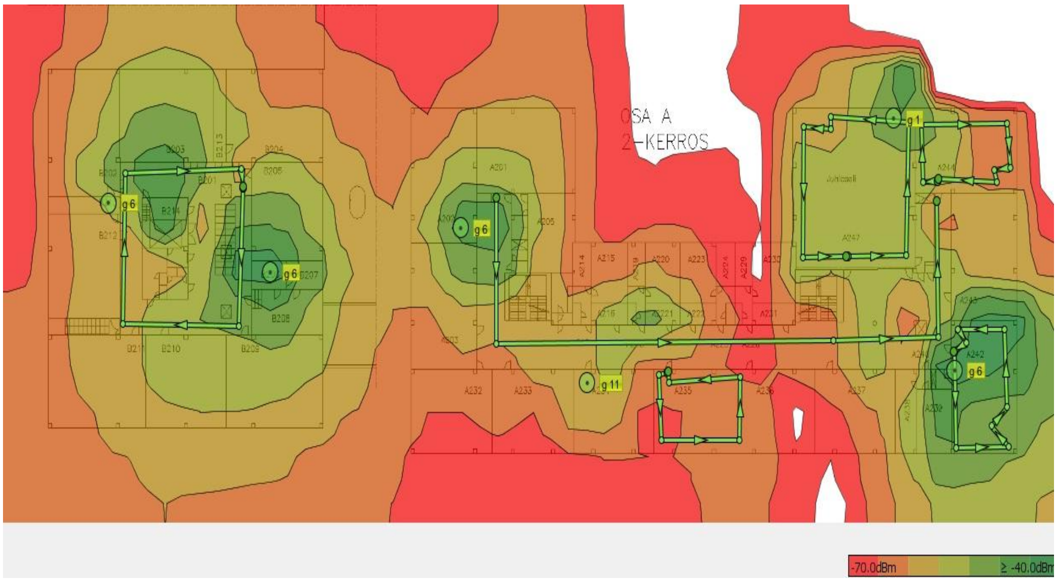

Figure 14. This shows the Signal strength present on second floor.

Analysis

This floor as shown in figure 14 is having 6 access points which was able to cover the floor pretty well. Optimization was not considered since all the sections were covered pretty well.

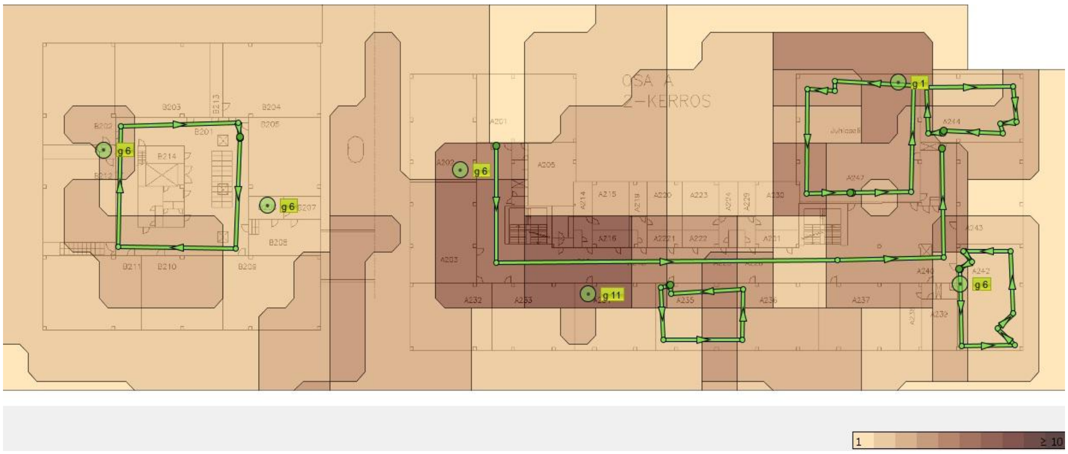

Figure 15. Number of access points on second floor.

The menu bar is represented at the bottom right corner of figure 15. It consists of different colours ranging from 1 to 10. The box tells the number of access points that can be received when you are at a region having a colour that corresponds to it.

Third Floor

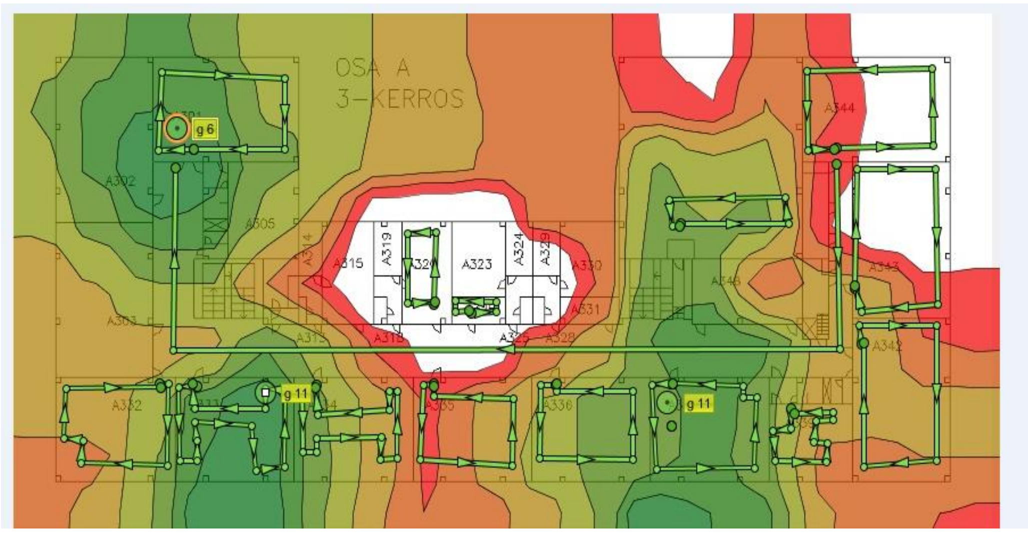

Figure 16. Signal Strength on third floor.

Analysis

The third floor is not exceptional when it comes to areas that needed optimization as this can be seen in figure 16, the areas that needed optimization were the teacher's offices and the two classrooms, WA 343 AND 344. Their locations called for the need of two access points, which will be able to cover those areas. This floor is also getting extra signal strength from the other floors.

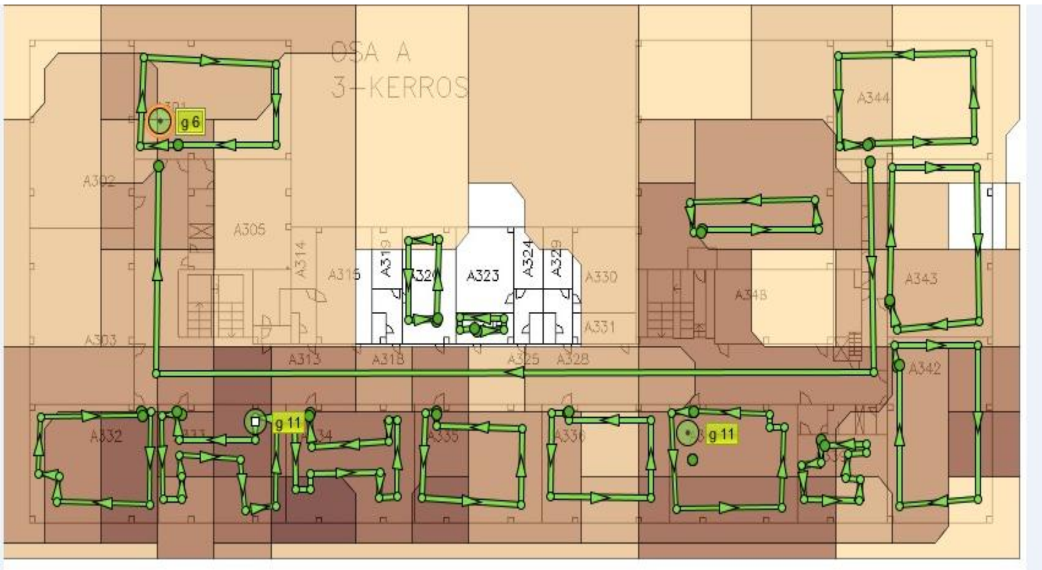

Figure 17. Number of access points on third floor.

The approach was very important because it helped me in knowing where I have gone wrong and I correct it before moving to the next stage

4.2 OPTIMIZATION

The optimization requires two stages before the access point can be installed. These are:

- Configuring the HP switch which is going to host the access point
- Editing the DHCP server configuration file

4.3 Configuring HP switches

This part is important since you are connecting the wireless access point to the network. The access point is supposed to have 5 VLANs, each for separate functions. These are:

- 329 untagged, this is the native "untagged" VLAN for the access point. Used for booting and administration of the access point.
- 306 tagged, filtered PCWN network (regular PCWN is in 305)
- 332 tagged Office network for VAMK Staff.
- 396 tagged, Classroom network for VAMK
- 397 tagged Classroom network for VAMK Mobile

The above VLANs were created on any switch that has access point connected to it. There was no configuration made on the access point. The VLANs were verify after been created to make sure that they exist. This was done as shown below:

 # show Mac-address VLAN 329

Status and Counters - Address Table - VLAN 329

MAC Address   Located on Port

------------- ---------------

000f61-0e2bd2 48

000f61-0e2fe0 48

000f61-0e3f62 48

000f61-0e3f7c 48

000f61-0e3f80 48

000f61-0e6da8 48

000f61-0e6dc4 48

000f61-0e6dc6 48

000f61-0e7d6e 48

The Mac addresses on the VLAN been verify will be shown, as shown above. This verification will be done to each VLAN created, anytime an access point is installed.

Finally, the ports to be used by the access points are also tagged and untagged to the required VLANs. The only untagging of the port is done on VLAN 329, which is purposely for administrative work. Configuring HP switch is different from other switches in the use of the commands. Table 5 shows the most important commands needed when it comes to the configuration.

Function	**Command**
Create VLAN	VLAN …(VLAN no.)
To remove VLAN	No VLAN (VLAN no.)
To save VLANs or any changes made	Write memory
To add a port to a VLN	Go to the VLAN: switch (config) (VLAN X) # Tagged (port no.)
To remove a port from VLAN	Go to the VLAN as above, then untagged (port no.)

Table 5. Commands for Hp switch Config.

4.4 Editing dhcp Configuration file

Dynamic Host Configuration Protocol (DHCP) is an automatic way of assigning IP addresses to devices that uses TCP/IP. It is also a way of providing other configuration information needed to host. To achieve this communication effectively, the Mac-address of the access points must be saved in the dhcp server configuration file. This was done as shown below:

- *You connect to ns2.puv.fi at ssh*
- *Change root: sudo -i*
- *Change directory: cd /etc/dhcp3/*
- *You then edit the configuration file: nano –w master.dhcpd.conf*
- *Scroll to the last line of the configuration file, you then copy and paste the last line, what you change after pasting is the Mac address, the host name and you then increase the IP address. Example is as shown below.*

Host wa109 {

00:0f:61:0e:3f:88;

192.168.29.26;

}

The access point is also assign a static IP address; in this case the DHCP will not be assigning IP address automatically, save file and exit. The command **'. /paivita.pl'** is run, this will restart the DHCP server and makes the real DHCP server configuration.

4.5 Installing MSM422

The installation of MSM422 is different from other aces points, the access points comes with one port power injector, power plug and the access point. The port power injectors have two ports, one for the access point Ethernet port connection (out) and the other for the switch port connection (Data in). There are two LED indicators which will light if all the connections made are correct. This shows that the access point is now in the network and will then automatically receive the rest of the configurations needed to make it operate successfully. The two connections are done at separate locations as shown in the figure 18. The port power injector must be plugged, in other for the access point to get power.

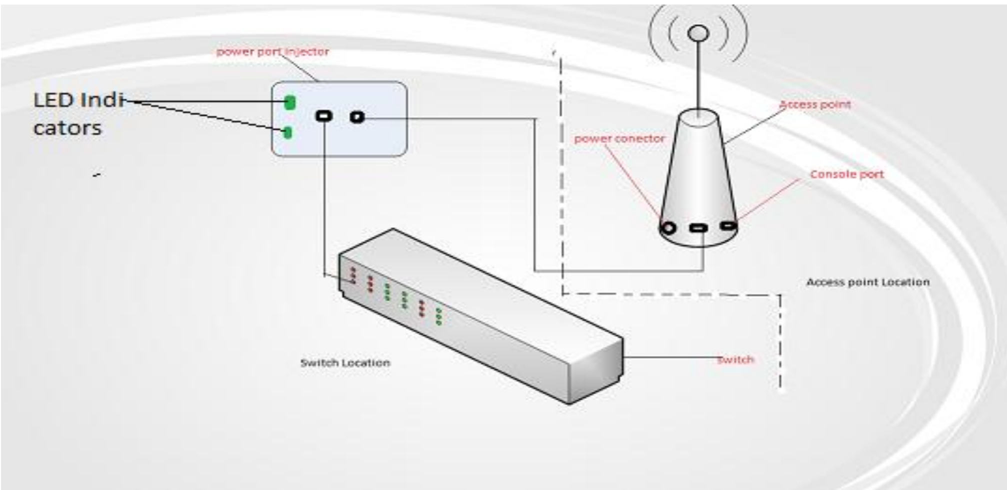

Figure 18. HP switch and access point connections.

The MSM422 access point has two radios; radio 1 operating on the latest standard 802.11n and Radio 2 operating on the old standards; 802.11 b/g. The two radios, Radio 1 and Radio 2 are operating on 5GHz and 2.4 GHz respectively. The access point has a management interface where certain configurations such as the channels to be used, frequency of operation for each radio, operating mode etc. can be entered [Hp MSM 422 Access Point Quick Start]. Figure 19 shows the management interface.

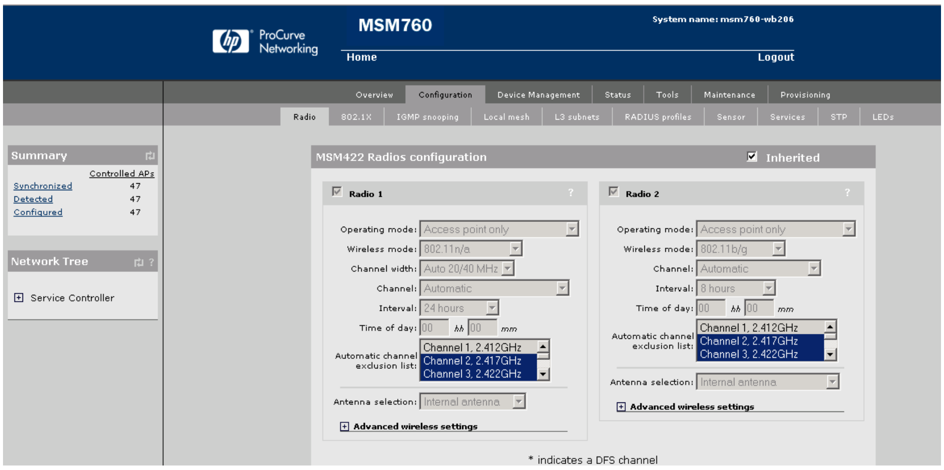

Figure 19. HP access points management interface.

In almost every project the possibility of having problems does exist. The connecting of access points to the required ports at their locations provided most of the challenges. The numbering of the ports on the racks was not corresponding to the numberings made on the Ethernet ports at locations, where the access point was to be installed. So tracing those ports to the required switch port was difficult, sometimes you will configure a switch port but after connecting the access points it will not be working. The cause of this was mostly faulty access points and also wrong Ethernet port.

The usual way I sometimes used for solving wrong Ethernet port problem was going through the configurations sometimes it gives you idea which switch port belongs to which room. In the absence of such details, the device is connected and at the command prompt the command “show mac-address” is run [Hewlett Packard 2010: Mac Address Management], this command will map the known devices connected mac-addresses to the switch port it is connected to. In such a case if the port was not configured for wireless network use, you then configure it for inclusion into the wireless network switch ports.

4.6 Final surveying and analysis

Ground floor

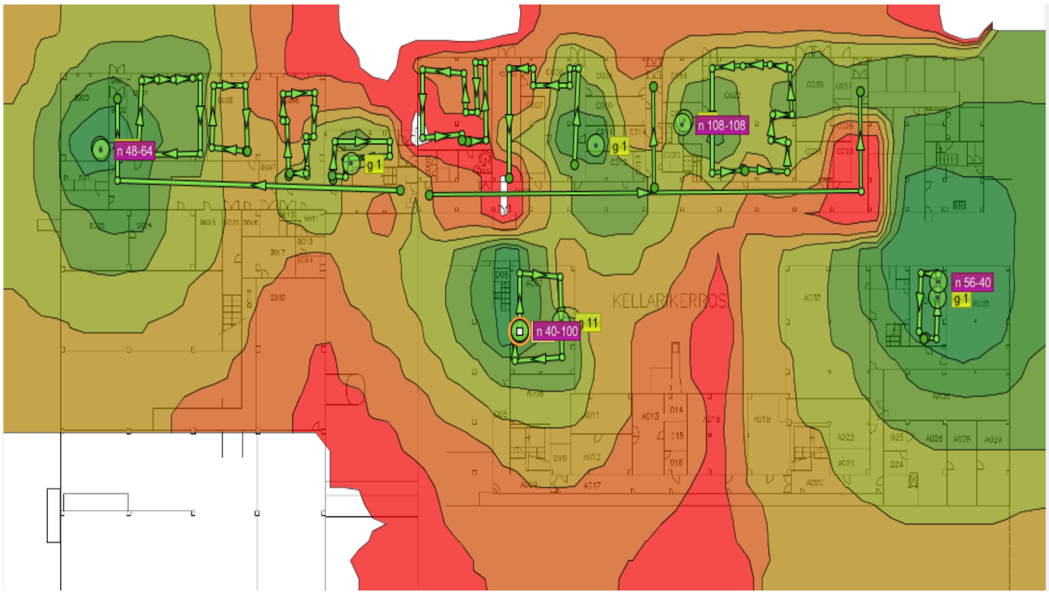

Figure 20. Ground floor signal strength after optimization.

Analysis

The analysis of the site survey of the ground floor as discussed earlier in figure 12 suggested that the following rooms needed optimization:

- WC 001
- WC 007 and
- WC 008

Figure 20 shows the results of the optimization; an access point was placed in room WA112 which was able to cover the needed areas. There were still some areas that were not covered, they are on the corridor and at an exit to the back of the building, but these areas are not of much priority so I was asked to leave it like that. There have been a great change in the signal strength, most areas have been covered, and anyone can connect to the internet at the remote areas of the campus.

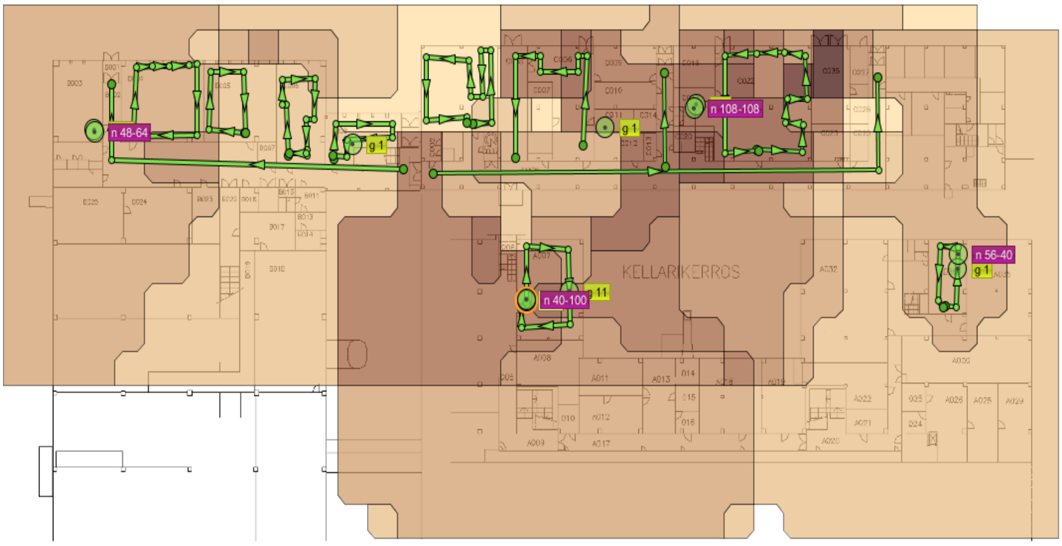

Figure 21. Ground floor number of access points after optimization.

Third floor

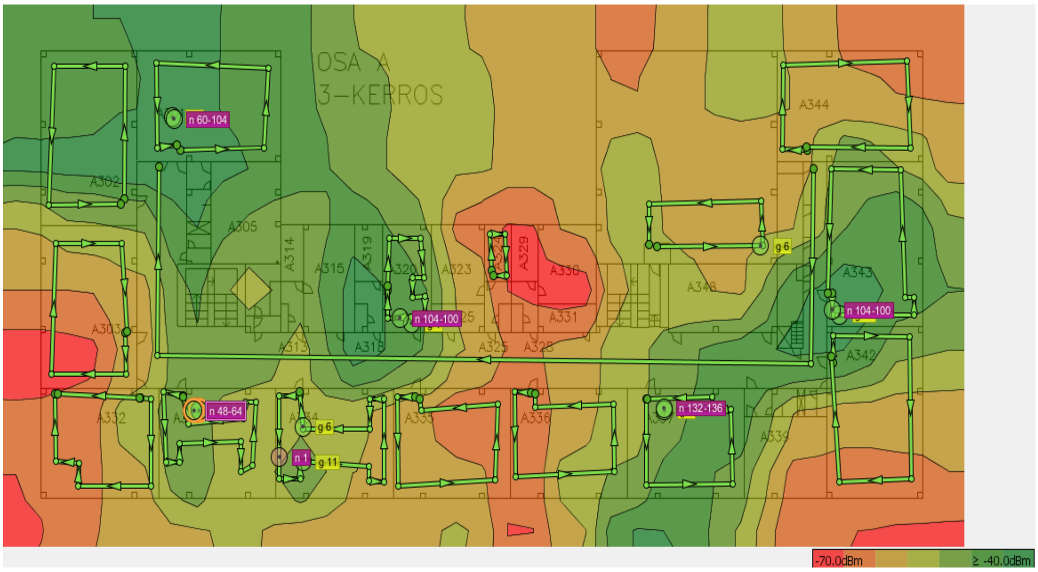

Figure 22. Third floor signal strength after optimization.

Analysis

Third floor also needed optimization after earlier site survey showed some areas that falls below the needed signal strength; the following areas had no signal strength:

- Teacher's offices
- WA 343 AND 344

Figure 22 shows massive improvement in the signal strength. Two additional access points were installed on this floor; one was installed at wa343 and the other at wa320.

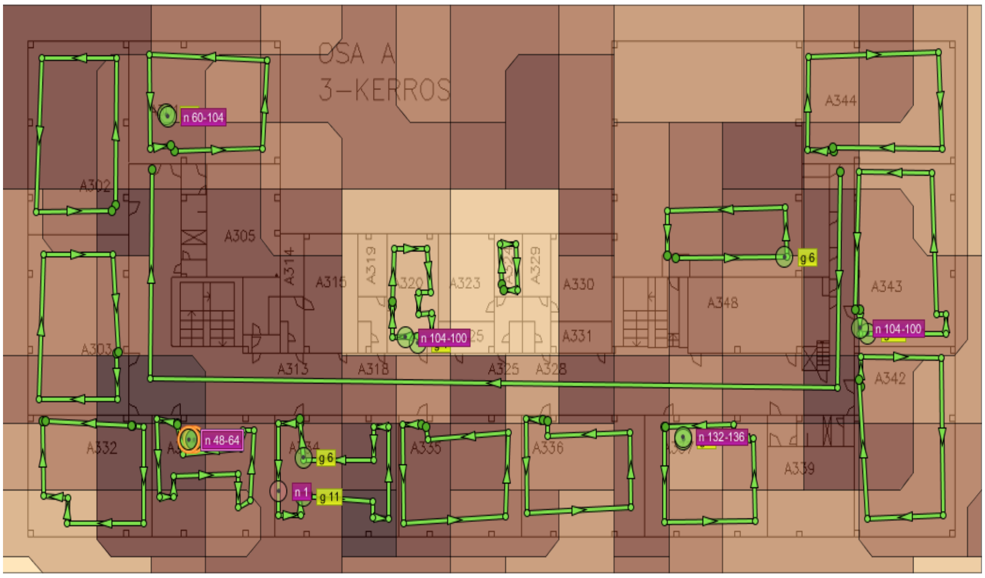

Figure 23. Number of access points, third floor after optimization.

Second Floor

There was no suggestion for optimization on second floor, so the floor was left as it was since it was covered enough with the needed signal strength.

First floor

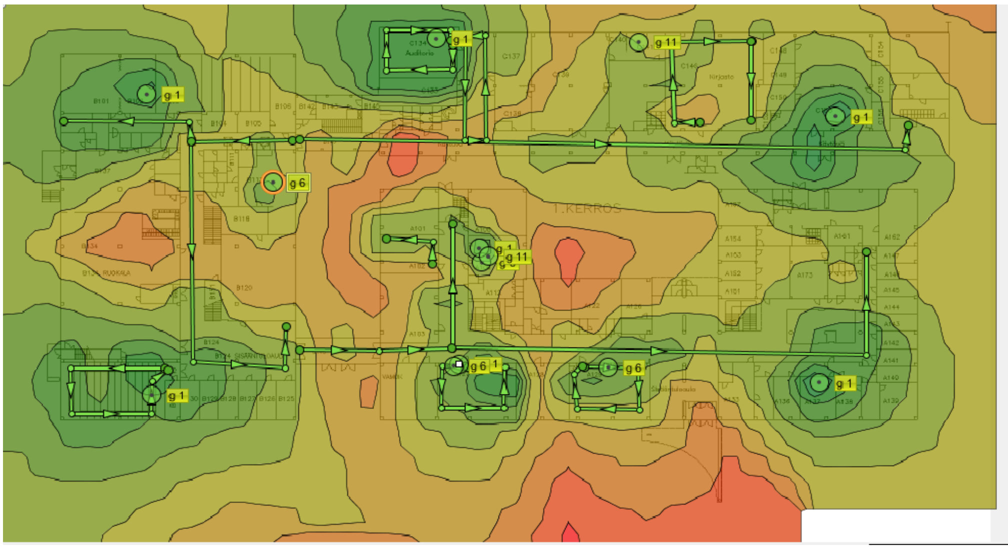

Figure 24. 1st floor optimization shot.

Analysis

The first floor needed optimization at the following areas:

- The auditorium WB106
- The physics Laboratory
- The VAMK office and
- Room WA 109

In total 4 access points were needed to make this optimization successful. One of the access points was installed at room WA102; this was meant to take care of the auditorium WB106 and the open I.T Laboratory. There was an access point already installed in room WA128, I decided to move it to Wa127 and installed a new access point at WA129. This will take care of the VAMK office and also improve the signal strength at the nearby rooms. The rooms are shown in figure 25.

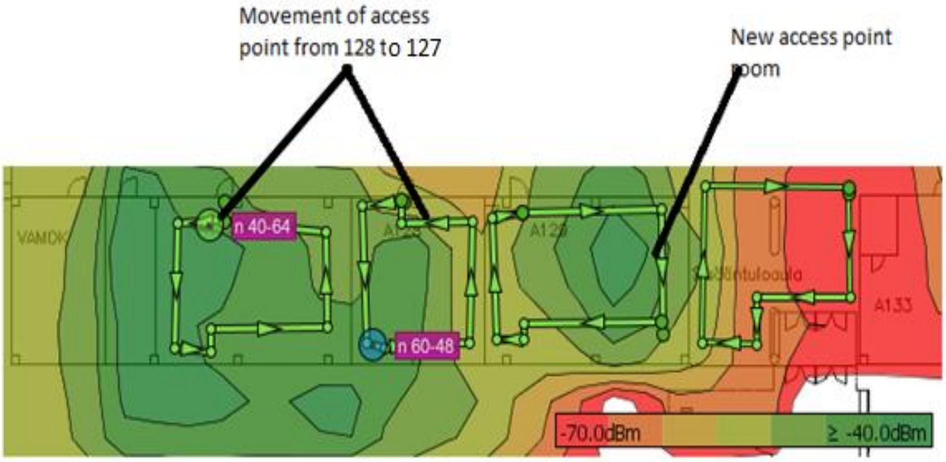

Figure 25. Access point movement.

Additional access point was installed in room WA109 to take care of Wa108 and the nearby rooms. The other access point was installed to take care of the physics Laboratory and the administrative rooms there. The signal strength improved dramatically as it can be seen in the optimization shot.

5 WIRESHARK PERFORMANCE MEASUREMENTS

Network performance have recently become the priority of every network manager, optimizing the network performance helps the clients, the system and certain applications to be run successfully. In other to ensure that the network performance can meets the demands of the clients, performance measurement must be carried out on the network. This was done using wire shark, which is a free open source application.

A typical network analysis consists of the following process:

- Capturing packet at the appropriate locations
- Focusing on traffic of interest by applying filters
- Analysing and identifying anomalies in traffic

5.1 How it works

In other to carry on this measurement it was important that I have knowledge on the following, which served as the foundation on my understanding:

- TCP/IP communication understanding
- Knowledge on usage of wire shark
- Packet structure and packet flow understanding

In other to capture the packet for analysis, it was important for me to choose suitable and appropriate locations for the capture. I decided to consider three scenarios in this measurement, these are:

- Wired network traffic capture
- Wireless network traffic capture when having full network strength
- Wireless network traffic capture when having minimum signal strength.

I needed these measurements in other to compare the difference in traffic flow between these networks. The school wired network is intensely used than the wireless network and due to that the measurements results may not be a through reflection of the networks. The results will be used to plot two forms of graph, throughput graph and time sequence graph (Stevens), which I will use to give much detail in the network issues between wired network and wireless network.

In other to get very effective traffic capture, I will be carrying out several forms of activities during the traffic capture. The wireshark measurements were done in the evenings and I did it on three different days to make sure I get the at least a reasonable value when I find the average of the values. Figure 26 shows much details of the traffic captured and how to get the needed graph from the capture.

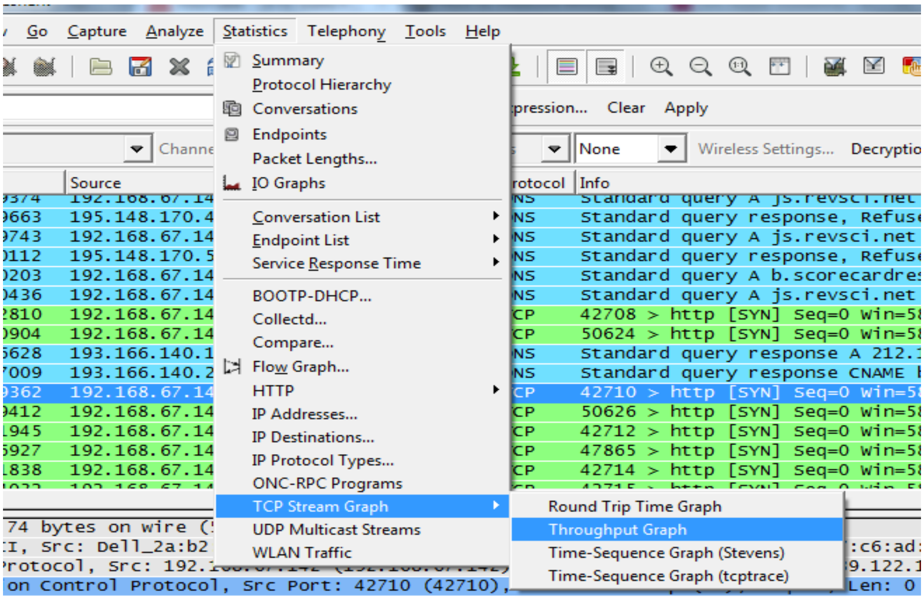

Figure 26. Getting the needed graph from traffic captured.

The above figure shows the process you have to follow in order to get the entire needed graph to analyze the traffic captured. The throughput graph gives much detail about the downloading speed at any instance and the time sequence graph (Stevens) will give the detail information or the activities and events that take place when connection is establish [Internetworking Research Group, Ohio University 2003]. Time sequence graph produces a graph of TCP sequence number (*Sequence number is a number assigned to every octet of data to help avoid duplication in case of retransmission*) [Douglas E. Comer – 2006, 220] vs.

Time (*Time for the TCP stream containing packet that was selected from the summary window*) [Angela Orebaugh – 2007. 197]. When connection is a establish during downloading a page or an application a lot of activities do take place and I will be taking a look at the difference in activities that take place when using wired network and wireless network.

The slope of the time sequence graph also represents the information about the throughput of the network [Internetworking Research Group, Ohio University 2003], this I will calculate using the available data. The ideal time sequence graph will be a straight rising line with its slope representing the throughput [Angela Orebaugh – 2007, 197] as shown in figure 27.

The Throughput graph measures the throughput of the network, every single dot represent instantaneous throughput. Excellent throughput is achieved when the number of dots keeps rising up along the y-axis as shown in figure 27. The y-axis represents the throughput, so the increase of instantaneous throughput vertically along the y-axis, means increase in throughput. In the event that there are spaces between throughputs, that space represents an instance when there was no throughput or transmission.

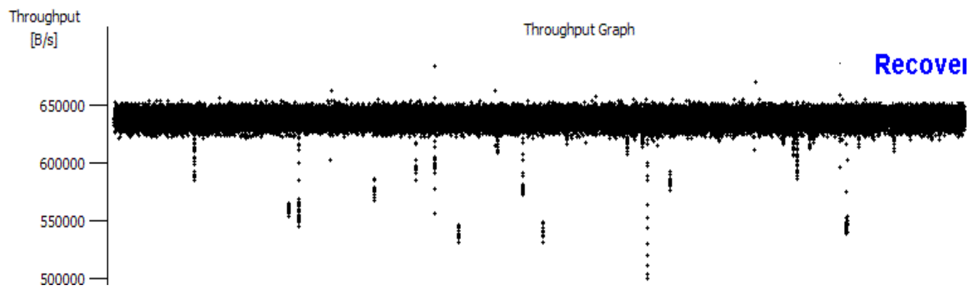

Figure 27. An approximately normal throughput graph with no problems.

Figure 28 shows an ideal Time Sequence graph, the slope of this graph should give the throughput of the network.

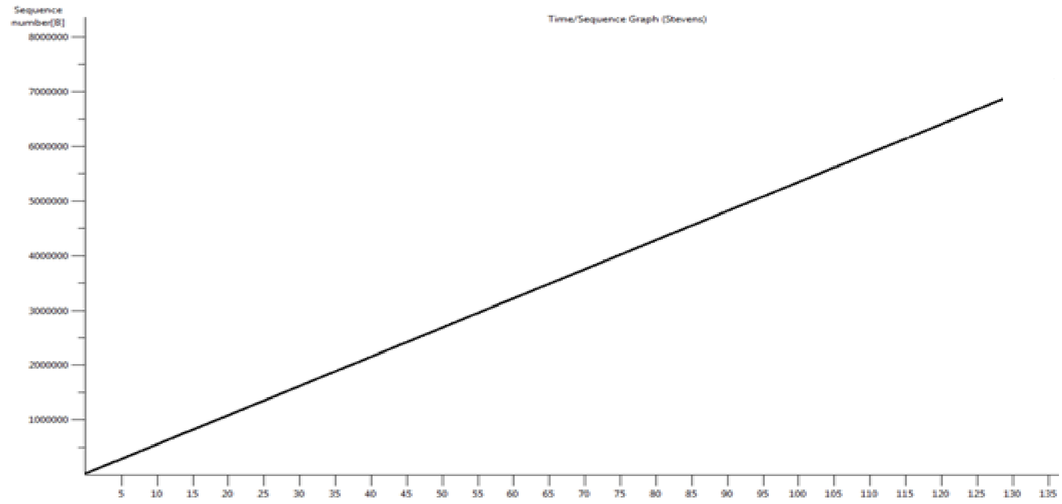

Figure 28. An ideal time sequence graph.

The figures below shows the graphs of the traffic captured for Wired Network, Wireless Network at minimum signal strength, and Wireless Network at strong signal strength. Each of the mentioned networks contains six different graphs, each day containing two graphs: Throughput graph and Time sequence graph.

5.2 Wired Network

Measurement on day 1

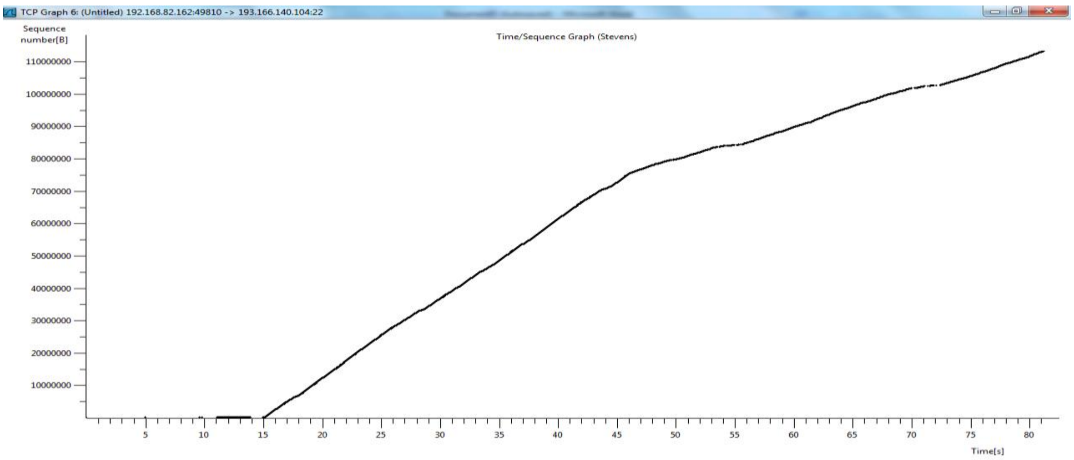

Figure 29. Time sequence graph (Stevens) of wired network at day 1.

The time sequence graph above shows a constant throughput which started at 15 seconds, there was no major disruption in this transmission. The throughput reduced at 45 seconds which shows the point where the graph was not even as it started.

Finding the slope of this graph:

$$Slope = \frac{y2 - y1}{x2 - x1}$$
$$Slope = \frac{70000000 - 50000000}{43.5 - 35.5}$$
$$Slope = \frac{20000000}{8}$$
$$Slope = 2500000$$
$$Slope = 2.5Mbps$$

[Lloyd Dingle and Mike Tooley – 2005, 147]

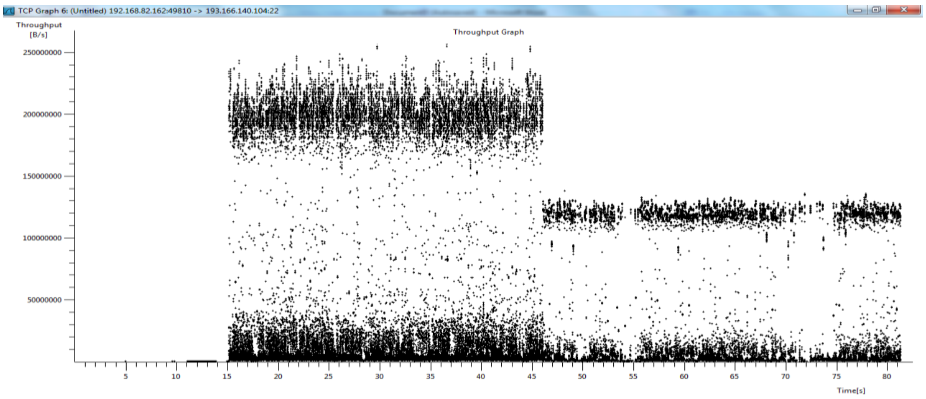

Figure 30. Throughput of wired network at day 1.

Figure 30 shows the throughput graph, it shows an even throughput from 15 seconds until the throughput reduces at 45 seconds, but maintained that throughput till the end of the transmission.

Measurement on day 2

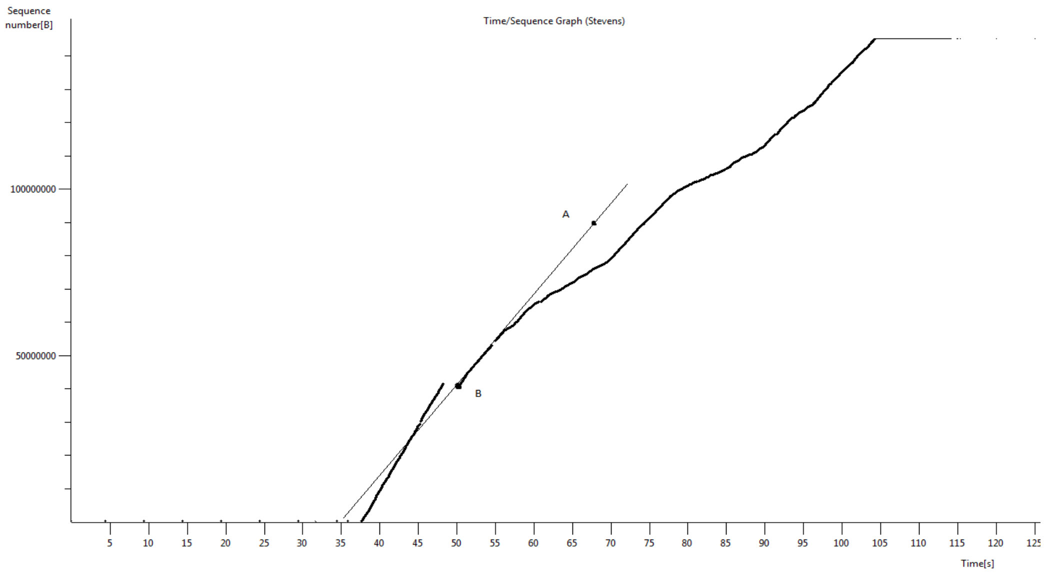

Figure 31. Time sequence graph (Stevens) of wired network at day 2.

The time sequence graph shows a constant throughput from 37 seconds until there was disruption 10 seconds later. The gap shows the retransmission of TCP, the throughput was un even after the retransmission until the end of the transmission as shown in figure 31.

Finding the slope of this graph:

$$Slope = \frac{y2 - y1}{x2 - x1}$$

$$Slope = \frac{90000000 - 50000000}{67.5 - 46}$$

$$Slope = \frac{40000000}{21.5}$$

$$Slope = 1860465$$

$$Slope = 1.86 Mbps$$

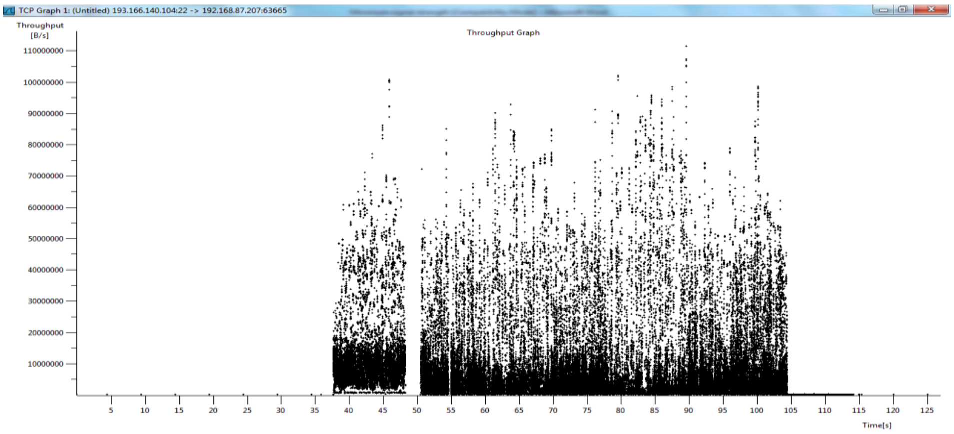

Figure 32. Throughput of wired network at day 2.

The throughput graph in figure 32 shows the details about how the throughput was increasing. The gap at 48 seconds shows the retransmission of TCP.

Measurement on day 3

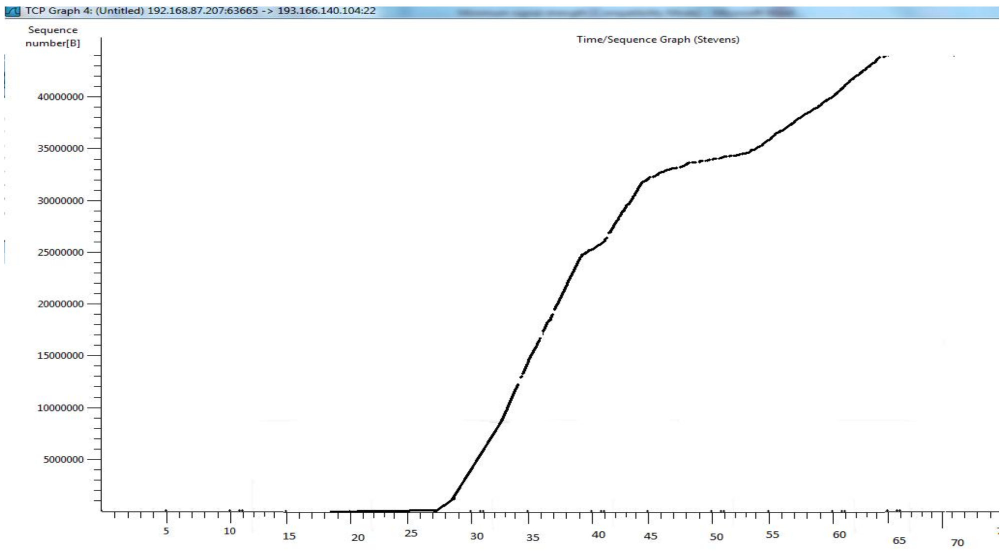

Figure 33. Time sequence graph (Stevens) of wired network at day 3.

The time sequence graph in figure 33 shows a constant flow of packet with no interruption for approximately 130 seconds,

Finding the slope of this graph:

$$Slope = \frac{35000000 - 20000000}{44.2 - 36.9}$$

$$Slope = \frac{15000000}{7.3}$$

$$Slope = 2.055 Mbps$$

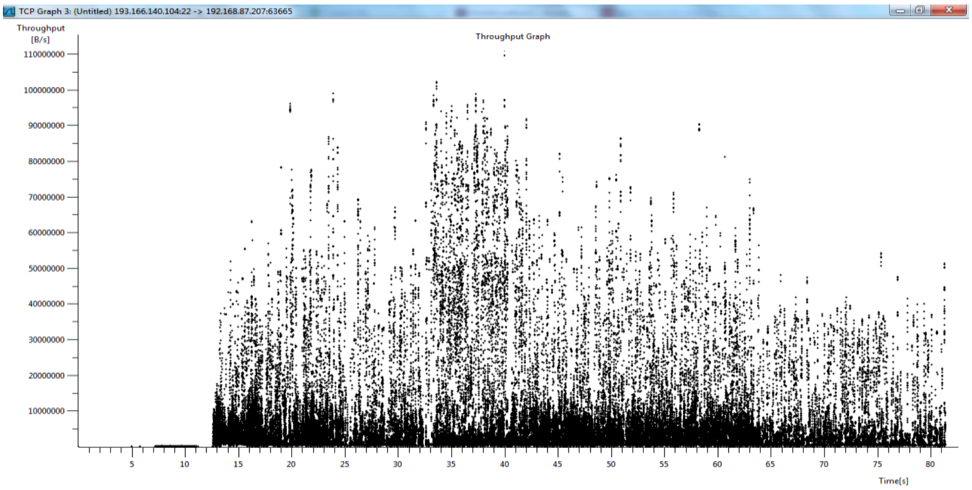

Figure 34. Throughput of wired network at day 3.

The throughput of the graph in figure 34 was even from the beginning, the reduction in throughput value started at 40 seconds into the transmission.

5.3 Wireless at strong signal strength

Measurement on day 1

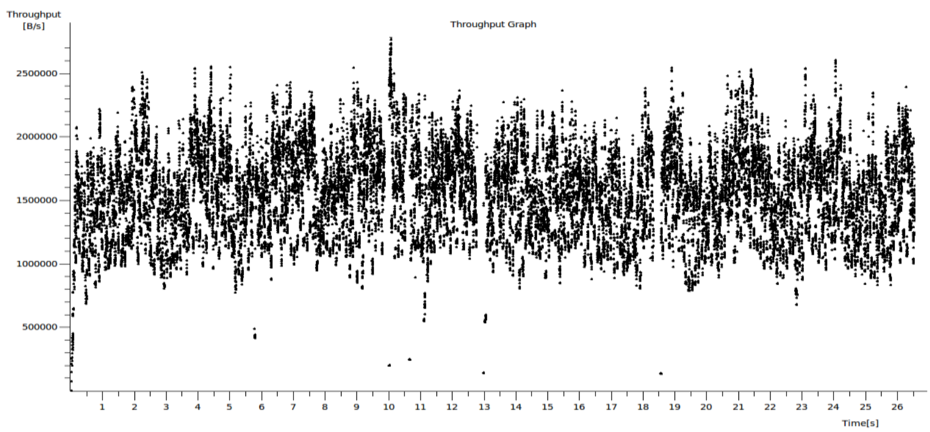

Figure 35. Throughput graph for strong wireless signal on day 1.

Figure 35 shows the throughput graph of wireless network at very strong signal strength. This graph represents the throughput during downloading files and applications; it shows how high the throughput was. This can be seen from the rising up of the dots (instantaneous throughputs). There were some few disruptions at 11 seconds and 19 seconds where the instantaneous throughput dropped for a short time. In general the throughput was high enough to withstand any downloading or uploading activities. It is higher than the throughput of the wired network as it can be seen clearly from the graph.

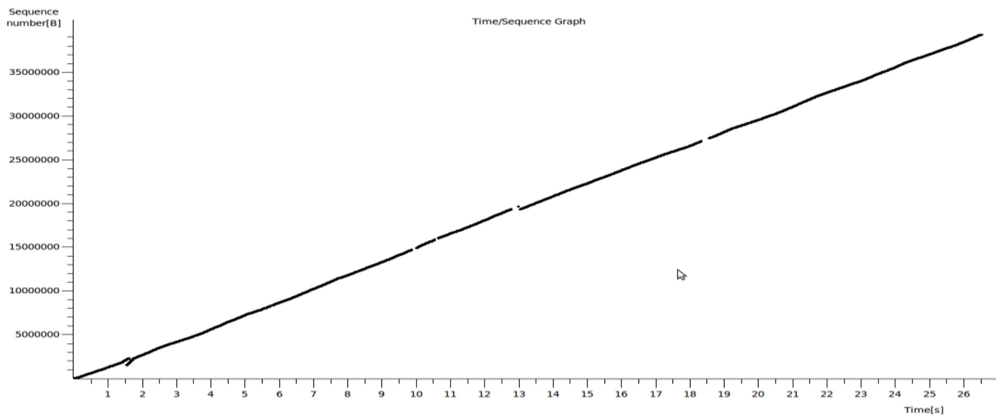

Figure 36. Time sequences graph (Stevens) of strong wireless signal on day 1.

The time sequence graph in figure 36 shows that there was constant flow of traffic with no interruption for the first 1.5 seconds before there was an interruption, which may be due to corrupt packet or dropped packet. The retransmission was done after that short interruption; it was constant with few interruptions. The major interruption was at the 10 and 13 seconds, in each case there was retransmission of the packets, it remained constant throughout the rest of the transmissions after the retransmission. A gap between transmissions mostly means there was no throughput for the packet to be transmitted.

The slope of this graph represents the throughput of the network and the calculation is shown below.

$$Slope = \frac{15000000 - 10000000}{9.9 - 6.6}$$

$$Slope = \frac{5000000}{3.3}$$

$$Slope = 1.514 MB / s$$

Measurement on day 2

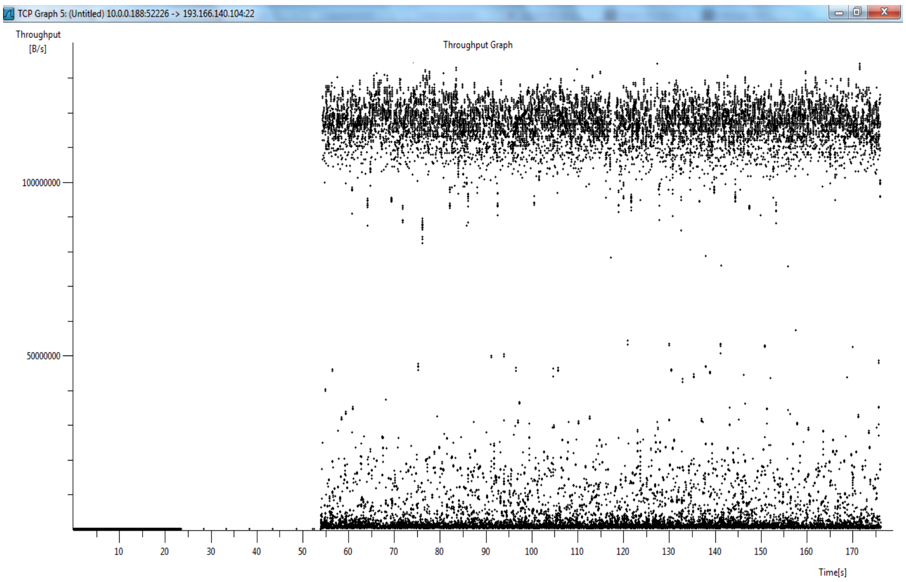

Figure 37. Throughput graph of strong wireless signal on day 2.

The graph in figure 37 shows the throughput graph on day 2, the throughput started increasing at 55 seconds and it was even till the end of the transmission.

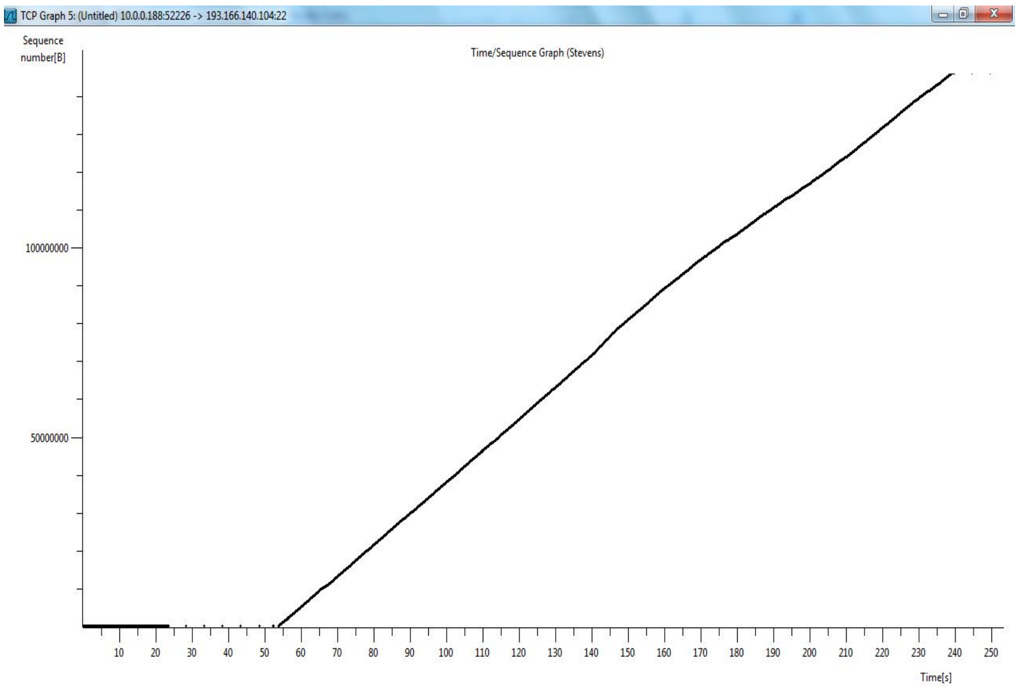

Figure 38. Time sequences graph (Stevens)of strong wireless signal on day 2.

This is the Time sequence graph and it shows how even the throughput was after 55 seconds, there was no interruption in this transmission.

$$Slope = \frac{y2 - y1}{x2 - x1}$$

$$Slope = \frac{700000000 - 50000000}{137.5 - 114}$$

$$Slope = \frac{20000000}{23}$$

$$Slope = 0.8511 Mbps$$

Measurement on day 3

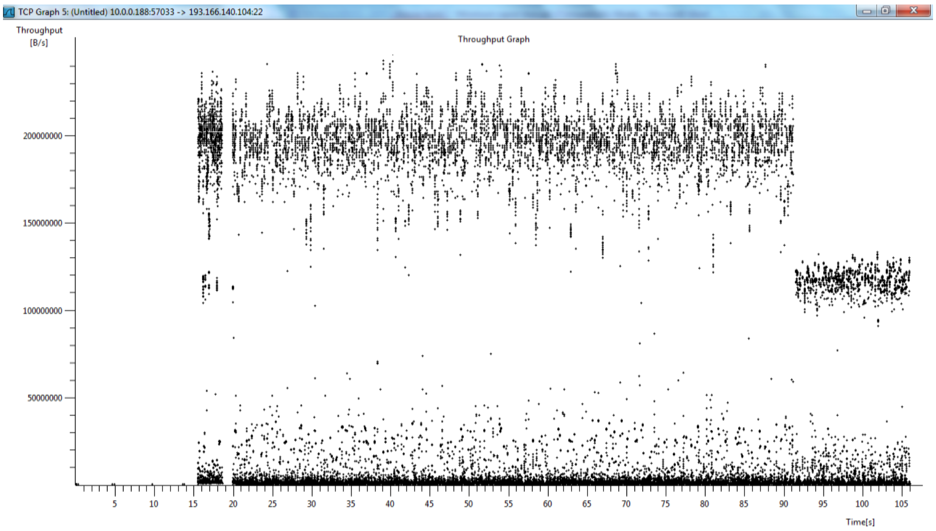

Figure 39. Throughput graph of strong wireless signal on day 3.

The throughput of this transmission started at 16 seconds but there was little interruption at 19 seconds before there was retransmission 1 second later. The throughput was maintained until it dropped slightly at 87 seconds.

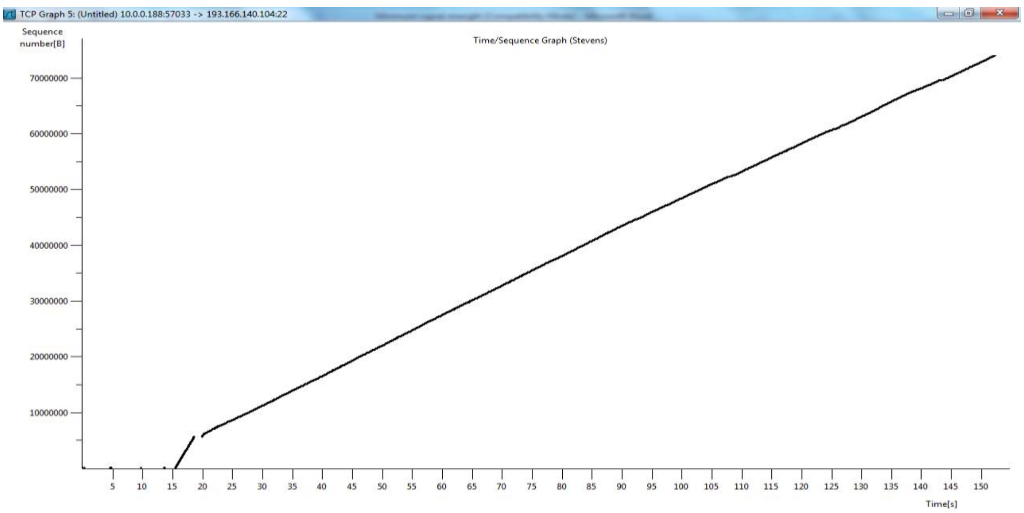

Figure 40. Time sequences graph (Stevens) of strong wireless signal on day 3.

The time sequence graph in figure 31 shows that there was constant flow of traffic with no interruption for the first few seconds before there was an interruption, which may be due to corrupt packet or dropped packet. The retransmission was done after that short interruption; it was constant with few interruptions. The slope of this graph represents the throughput of the network and the calculation is shown below.

$$Slope = \frac{y2 - y1}{x2 - x1}$$

$$Slope = \frac{50000000 - 15000000}{103 - 36}$$

$$Slope = \frac{35000000}{37}$$

$$Slope = 945945.945$$

$$Slope = 0.946 Mbps$$

5.4 Wireless at minimum signal strength

Measurement on day 1

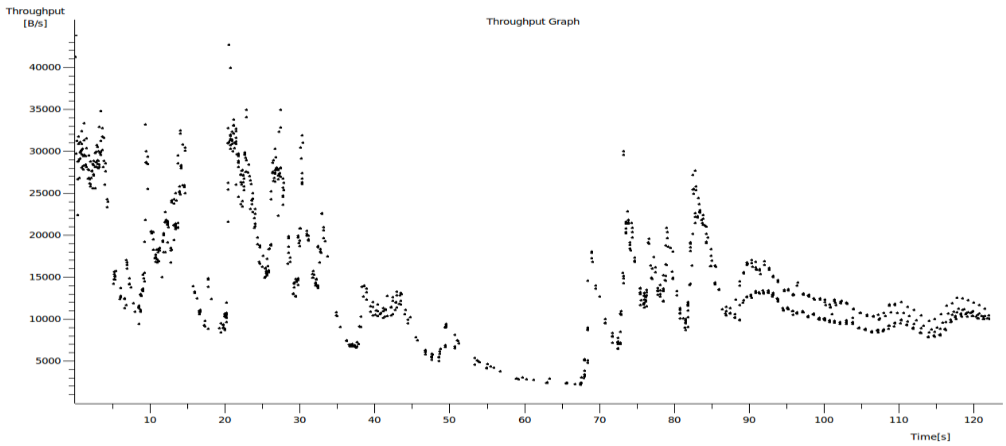

Figure 41. Throughput graph of minimum signal strength on day 1.

The throughput of this transmission it's not the best, it has few issues during the transmission. The first 5 seconds seems to be little bit alright but below the throughput of the wired network before it deteriorated, because it is operating at the minimum signal strength sometimes the network get slow and this can cause a lot of delay in the transmission. This is exactly what happened in this packet transmission. The transmissions throughput improved after 70 seconds, it maintained the throughput for a short while before it started to drop in quality for the rest of the transmissions. This is mostly the behaviour of transmission at the minimum signal strength.

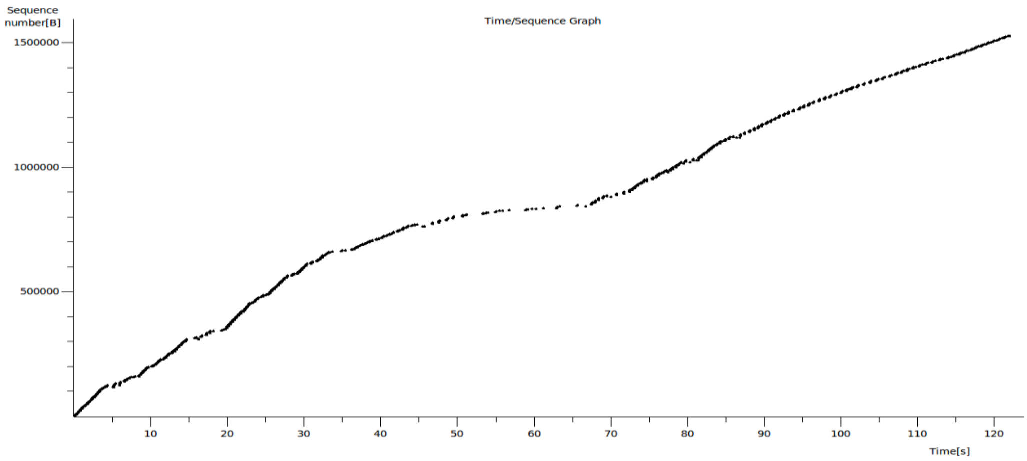

Figure 42. Time sequences graph (Stevens) of minimum signal strength on day 1.

The signal strength at this level was at its lowest but it was able to handle all other activity that was carried out. The problem was, since the signal was at its minimum there were issues with the transmissions, there can be retransmission of packet frequently due to packet loss or corrupting of the packet.

The 802.11 standards have been designed to ask for retransmission in the case of packet loss. The figure above shows that the transmission was constant for the first 5 seconds, and then there was interruption in the transmission. The packet was retransmitted at 7seconds before interruption occurred again. The transmission started again at 15 seconds and transmission was smooth for a period of time before interruption occurred again. This interruption mostly occurs due to the slow nature of the network since it was operating at minimum signal strength. The calculation below shows the slope value which represents the throughput.

$$Slope = \frac{y2 - y1}{x2 - x1}$$

$$Slope = \frac{1000000 - 500000}{77 - 15}$$

$$Slope = \frac{500000}{62}$$

$$Slope = 8.064 Kbps$$

Measurement on day 2

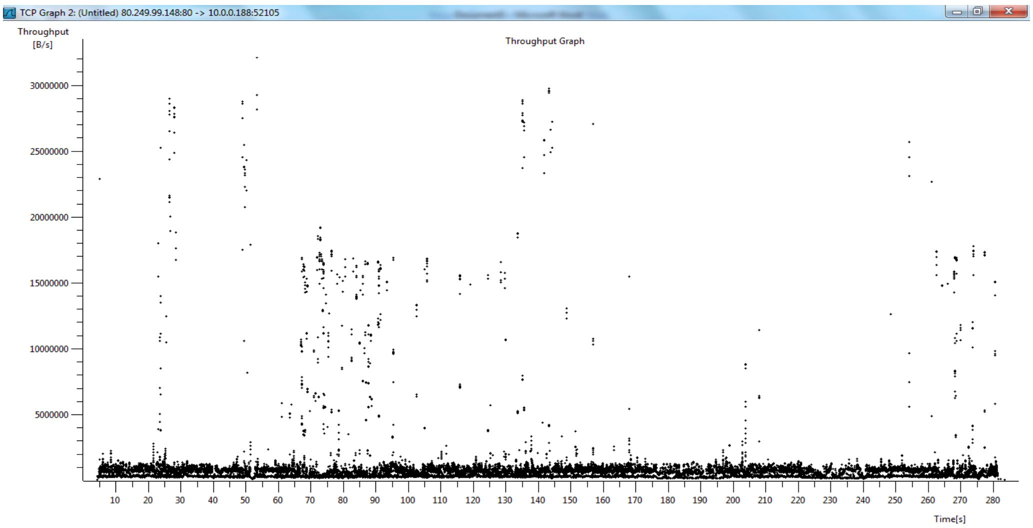

Figure 43. Throughput graph of minimum signal strength on day 2.

The throughput of this transmission it's not the best, it has few issues during the transmission. The first 5 seconds seems to be little bit alright but below the throughput of the wired network before it deteriorated, because it is operating at the minimum signal strength sometimes the network get slow and this can cause a lot of delay in the transmission. This is exactly what happened in this packet transmission. The transmissions throughput improved after 70 seconds, it maintained the throughput for a short while before it started to drop in quality for the rest of the transmissions. This is mostly the behaviour of transmission at the minimum signal strength.

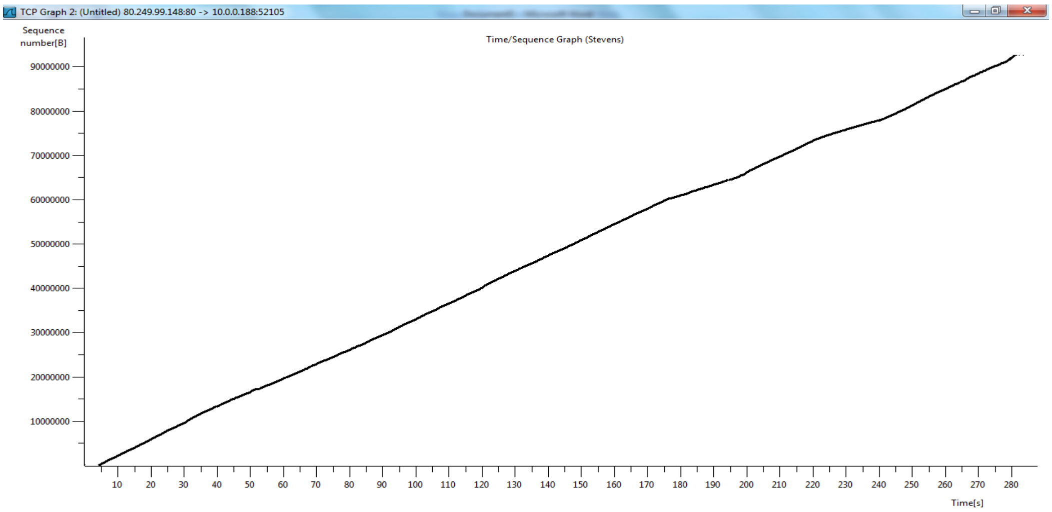

Figure 44. Time sequences graph of minimum signal strength on day 2.

The signal strength at this level was at its lowest but it was able to handle all other activity that was carried out. The problem was, since the signal was at its minimum there were issues with the transmissions, there can be retransmission of packet frequently due to packet loss or corrupting of the packet.

To find the throughput of the network, the calculation below shows the slope value which represents the throughput.

$$Slope = \frac{60000000 - 30000000}{175 - 92}$$

$$Slope = \frac{30000000}{83}$$

$$Slope = 361.445 Kbps$$

Measurement on day 3

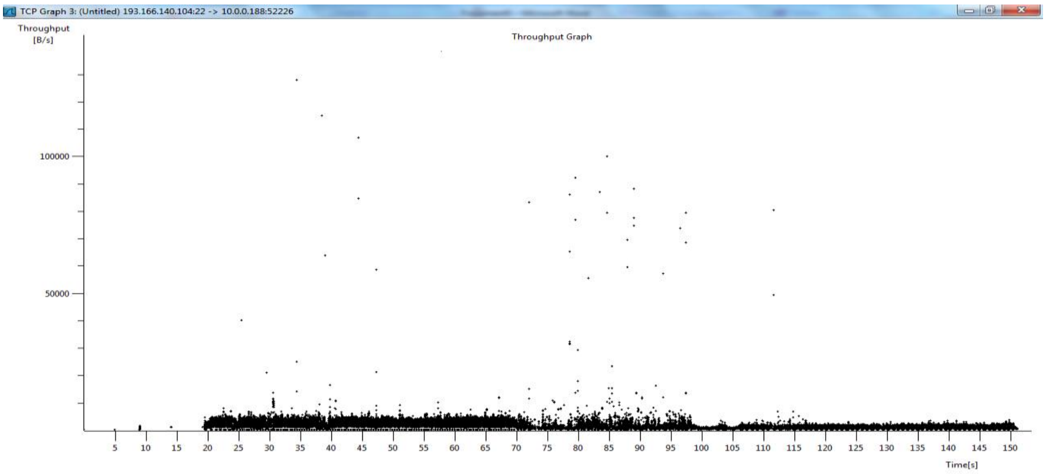

Figure 45. Throughput graph of minimum signal strength on day 3.

The throughput of this transmission it's not the best, it has few issues during the transmission. The first 20 seconds seems to have no throughput at all, throughput started to increase at 20 seconds and it was maintained at that level until it reduced at 70 seconds. There was little fluctuation after that until the end of the transmission. This is mostly the behaviour of transmission at the minimum signal strength.

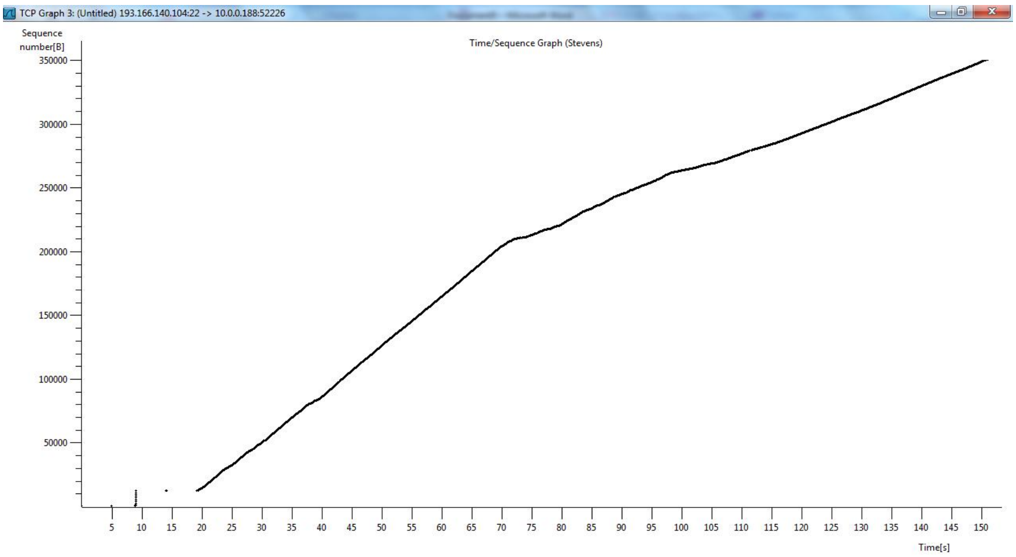

Figure 46. Time sequences graph of minimum signal strength on day 3.

The signal strength at this level was at its lowest but it was able to handle all other activity that was carried out. The problem was, since the signal was at its minimum there were issues with the transmissions, there can be retransmission of packet frequently due to packet loss or corrupting of the packet. The graph shows that the throughput started to increase at 9 seconds into the transmission before there was disruption. Retransmission was done 10 seconds later and the throughput was maintained even until it starts to drop at 70 seconds.

To find the throughput of the network, the calculation below shows the slope value which represents the throughput.

$$Slope = \frac{250000 - 150000}{85 - 52}$$

$$Slope = \frac{100000}{33}$$

$$Slope = 3.030 Kbps$$

	Wired Network	**Wireless Network at Maximum Signal**	**Wireless at Minimum Signal**
Day 1	2.5Mbps	1.515Mbps	8.064Kbps
Day 2	1.866Mbps	0.8511Mbps	361.445Kbps
Day 3	2.055Mbps	0.946Mbps	3.03Kbps
Total Throughput	6.416Mbps	3.3121Mbps	372.539Kbps
Average Throughput	2.1386Mbps	1.10401Mbps	124.17966Kbps

Table 6. The summary of throughput values.

5.5 Conclusion of Wireshark performance measurement

The throughput and time sequence graphs have given many details about the advantages and the disadvantages that exist between wireless network standard 802.11a/b/ g and the wired network. The wired network usually has packet loss due to temporary overload which is a situation that the standards 802.11 a/b and g encounter too. The Wireless access points installed is able to provide access to the latest standard 802.11n, which means if a client is using devices capable of handling the latest standard, then the client will not encounter most of the problems that the old standards have.

This comparison may not be the best since the data used in comparing the wired and wireless network is not enough to make a concrete conclusion. The wired network averagely had high throughput compared to the wireless network, there are various factors that can have impact on the throughput of a network. The average throughput value had for wireless network was 1.10401Mbps, which is very low compared to the estimated throughput which is supposed to be between 3 – 29Mbps [Joel Barrett – 2008, 143]. The increase in traffic load cans results high contention and collision which can results in reduction in throughput [Zoubir Mammeri – 2008, 182]. Data packets include overhead such as routing information, checksum, and data recovery data. The increment of the number of users in the network, packet loss, and collision are eminent, all these are major factors that have impact on the network throughput. Wireless network signal degrade as it passes through obstacles such as walls, doors, these are also few factors that can contribute to the reduction in throughput of a network [Mike Harwood – 2009, 268].

In wireless network where there is a shared access connection, consequently if two people share a connection each will get half of the throughput, if four people each will get one fourth of the throughput. The wireless network at minimum signal strength had pretty low throughput but it was able to handle most of the files I used in the measurements. In general there has been tremendous improvement in the throughput compared to the initial state of the network.

6 SUMMARY

Wireless network has proven to play an important role in our daily activities, aside the mobility that it provides for students and staff, It is now possible to connect to the internet and surf the internet successfully at any part of the campus with ease, that was one of the main goals of this project and it has been achieved, this was not possible at the start of the project.

There were minimum number of access points on campus and the signals were not able to reach far due to obstacles. So the increment of number of access points helped in covering most of these areas that were not covered. This was proved using the signal strength snap shots taken after the site survey with Ekahau software, showing before and after optimization was done, this showed the improvement in the signal strength coverage.

To achieve these goals knowing how to configure HP switches and Cisco switches was an advantage, various processes took place and each provided its own challenges. The installation went successfully with the network performing at the standard needed, in other to confirm the performance level, Wireshark performance measurement was done. This was done to find out how well the network can perform under heavy network usage when downloading or uploading files.

I considered the throughput and traffic flow measurement; they give the rate of flow and the activities that take place during transmissions respectively. The measurement was taken in the evenings in other to make sure that the usage of both networks is at a minimum during the three days. Wired network had the highest throughput after the average of the values were taken during the three days measurement, which can be attributed to the less usage of the network at that time and as such less activities were taking place which means transmission did not face much traffic. The Wireless network throughput was not as high as I expected even though the network was not that much in use. This can be due to environmental effects which normally degrade wireless signal. In general it has been a successful project.

7 CONCLUSION

Afterwards there have been endless discussions about providing good wireless network that can meet the needs of the clients. The standards 802.11 a/b/g have been designed to ask for retransmission in the case of packet loss. The new standard improves the previous standards since they have their own issues with packet loss, security, quality of service and it was important for the new standard to address this issue, so there should be no worries when it comes to packet loss. This standard helped in solving most the problems the previous standards exhibited, the benefits of the new standards can be access only when a client have device that is capable of handling the new standard.

The main goals as stated earlier was to make sure that some vital places be covered, the classrooms, conference rooms and social gathering areas, where there is the possibility for wireless network use. This goals have been met and it is possible to get connected anywhere on the school campus, this was done by providing a lot of access points on campus, this was not the case earlier. In other meet the main goals, it was important that some areas were not taking into much consideration, e.g. the corridors, the assumption was the corridors are not mostly use extensively like the classrooms, but you can still get connected when you are on the corridor.

The Wireshark performance test I made was purposely to find out the performance of the wireless network and also used it to compare the wired network. The comparison will not be the best since relatively small amount of data was gathered during the measurement. The wired network provided higher throughput than the wireless network after the average value was taken, the inability of the wireless network to achieve higher throughput maybe due to environmental effect and factors related to the overhead information attach to the data packets. To achieve the real values of throughput a lot of time must be dedicated to it, this will help in gathering much data for the analysis.

The effectiveness of the network when it comes to the signal strength may not be the same; the software used gives estimated signal strength of an area. In other to get the actual signal strength of areas of interest, that is when we do actual survey. The vast areas of the network are working on estimated values of signal strength and may not be strong as it has been portrayed on the results, this can lead to network not been able to handle some activities. This applies to some offices, so in the near future I hope they can get time to help improve those areas working on estimated values of signal strength. The school populations is increasing and with time the school will be making effective use of the wireless network for voice and other activities, so improving those areas will help in achieving that successfully.

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