Analyzing the Improvement of the Receiver Signal Level and Receiver Signal Quality in Terengganu

Roszana Binti Hashim
Faculty of Electrical Engineering
Universiti Teknologi MARA Malaysia
40450 Shah Alam, Selangor, Malaysia
Email: roszana_hashim@yahoo.com

Abstract - **The aims of this project are to study receiver signal level and receiver signal quality in the different situation such comparison result about receiver signal level and receiver signal quality before and after the repeater was placed at the sample area. The project started with the application of using the coverage area data from the company. The data was converted from TEMS software to database using Oracle Database 10g Express Edition software. The Oracle database 10g Express Edition was chosen because this is a one of the multifunction database such as the Oracle Database 10g Express Edition software which can manage the collected data and store the data at the same time. Finally, the data at the database will be simulated using the MATLAB software to plot the graph pattern of the receiver signal level and receiver quality level before and after the repeater is placed at the sample area. In addition, the programming command was designed based on the range of the signal value to display the condition of the receiver signal level and receiver signal quality at the sample area.**

I. INTRODUCTION

As we know, Technology is about progression and mobile technology is of no exception.While people travel further and faster than ever before, it is still the case that they spend much of their time at a few important places. Identifying these key locations is thus central to understanding human mobility and social patterns. Such understanding can, in turn, inform solutions to large-scale societal problems in fields as varied as telecommunications, ecology, epidemiology, and urban planning. As an example, knowing how large populations of people that move about would help determine their carbon footprint and in turn help guide policies intended to reduce that footprint.Wireless cellular networks hold great potential for providing the necessary information to identify important places in people's lives. The growing ubiquity of cellular phones means that a large percentage of people keep a phone with them most of the time. In addition, the networks need to know roughly where each phone is in order to provide the phones with voice and data services.

The value of collecting data can be determined. So, its data can be used to solve the problem about coverage area at the sample area.

The receiver signal level or energy per bit-to-noise is used to compare two or more digital modulation systems that use different transmission rates (bit rates), modulation schemes (FSK, PSK, QAM), or encoding techniques (M-ary).The energy per bit-to-noise power density ratio is simply the ratio of the energy of a single bit to the noise power present in 1 Hz of bandwidth. Thus, E_b / N_o normalizes all multiphase modulation schemes to a common noise bandwidth, allowing for a simpler and more accurate comparison of their error performance. [1]

Mathematically, Energy per bit-to-noise power density ratio, E_b/N_o is

$$\frac{E_b}{N_o} = \frac{C/f_b}{N/B} = \frac{CB}{Nf_b} \qquad (1)$$

Where;

E_b / N_o = Energy per bit-to-noise power density ratio

C / N = Carrier-to-noise power ratio

B / f_b = Noise bandwidth-to-bit rate ratio

Stated in dB

$$\frac{E_b}{N_o}(dB) = 10 \log \frac{C}{N} + 10 \log \frac{B}{f_b} \qquad (2)$$

From Equation (1), it can be seen that the E_b /N_o ratio is simply the product of the carried-to-noise ratio and the noise bandwidth-to-bit rate ratio. [1]

Stated in dBm

$$\frac{E_b}{N_o}(dBm) = 10 \log \frac{E_b/N_o (W)}{0.001} \quad (3)$$

The receiver signal quality same mean as the quality of service and grade of service. Quality (QoS are mechanisms for controlling the performance, reliability and usability of a telecommunications service. Mobile cellular service providers may offer mobile QoS to customers just as the fixed line PSTN services providers and Internet Service Provider (ISP) may offer QoS. [2]QoS is of particular concern for the continuous transmission of high-bandwidth video and multimedia information. Transmitting this kind of content dependably is difficult in public networks using ordinary "best effort" protocols. QoS mechanisms are always provided for circuit switched services, and are essential for non-elastic services, for example streaming multimedia. It is also essential in networks dominated by such services, which is the case in today's mobile communication networks, but not necessarily tomorrow.

Many factors affect the quality of service of a mobile network. It is correct to look at QoS mainly from the customer's point of view, that is, QoS as judged by the user. There are standard metrics of QoS to the user that can be measured to rate the QoS. These metrics are: the coverage, accessibility (includes GOS), and the audio quality. In coverage the strength of the signal is measured using test equipment and this can be used to estimate the size of the cell. Accessibility is about determining the ability of the network to handle successful calls from mobile-to-fixed networks and from mobile-to-mobile networks. The audio quality considers monitoring a successful call for a period of time for the clarity of the communication channel. All these indicators are used by the telecommunications industry to rate the quality of service of a network. The purpose of Investigation on the Improvement of the Receiver Signal Level and Receiver Signal Quality in Terengganu is to compare the graph pattern of receiver signal level and receiver signal quality before and after the repeater is placed at the sample area through the collected data using TEMS software and graph simulation using Matlab software.

The main problem is how to collect the data of receiver signal level and receiver signal quality to make a comparison before and after the repeater is placed at the sample area? This problem can solve by using the TEMS software and Oracle Database 10g Express Edition software. The software can help to show the value of collecting data to identify the way to improve the coverage at the area. Finally, the value of the collecting data is displayed using graph pattern. Matlab software is used for this purpose because it is multifunction software is easy to use.

A brief overview of the methodology is presented in Section II. Section III describes about the application software which is used to achieve the project. Section IV is focused about the result and discussion to support this project. Section V discuss about the Conclusions of this project. Future recommendation is presented in Section VI and Section VII is acknowledgment.

II. METHODOLOGY

Figure 1 shows the flowchart of the project. Literature review was done to obtain information of coverage are and quality of service for mobile network. TEMS software was used to collect the data. A lot of collected data is consists different values and of many ranges. So, the collected data is stored and managed using Oracle Database 10g Express Edition software. Finally, MATLAB software was used to find out the graph pattern before and after repeater was placed in the sample area. In addition, the programming command was designed to display the range condition of the signal based on the range of the signal value obtained from TEMS software.

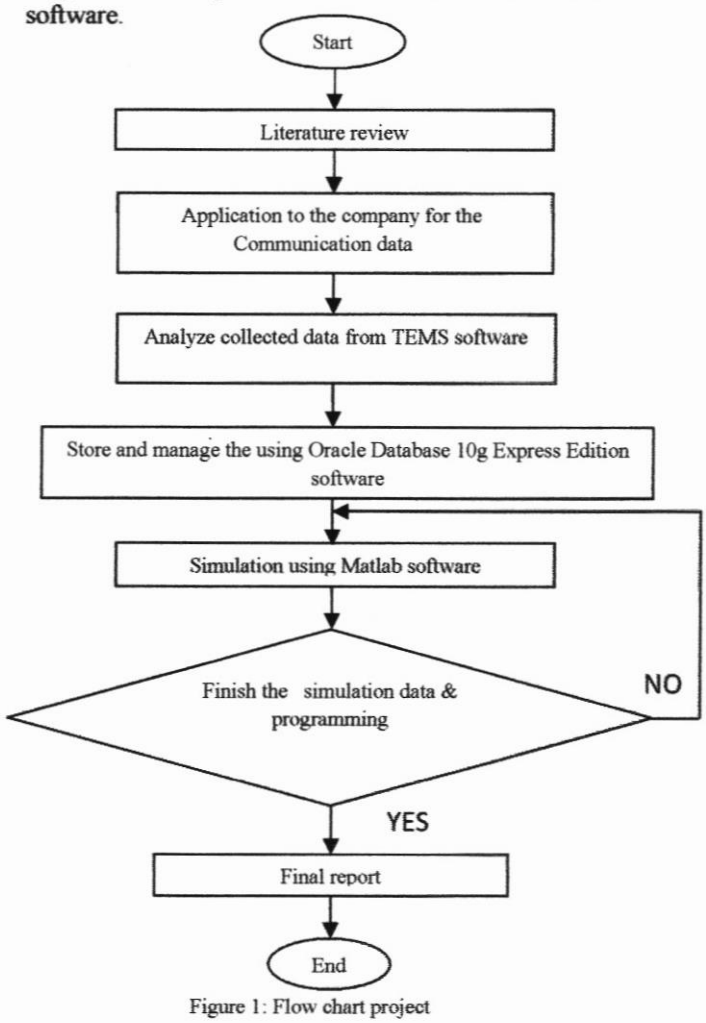

Figure 1: Flow chart project

III. APPLICATION SOFTWARE

Three software are used to investigate the improvement of the receiver signal level and receiver signal quality in Terengganu using TEMS software.

One of the software is TEMS software. TEMS software was used to do the drive test at the sample area. The Terrestrial Ecosystem Monitoring Sites (TEMS) is an international directory of sites (named T.Sites) and networks that carry out long-term terrestrial monitoring and research activities. The database provides information on the "who, what and where" in long-term monitoring.

This software was chose because the purpose of TEMS is to develop modeling, assess and research programs, assess gaps in geographic coverage of key variables, link ground and satellite observations, evaluate the quality of data and measurement methods, and identifying T.Sites that need upgrading. [3]

Besides that, TEMS software can also display the map of the drive test. So, from the whole data, the analysis can be continued to get the graph pattern

After all the data about receiver signal level and receiver signal quality was obtained, Oracle Database 10g Express Edition Software is used to manage and store the data.

Oracle Application Express is a hosted declarative development environment for developing and deploying database-centric Web applications. Thanks to built-in features such as design themes, navigational controls, form handlers, and flexible reports, Oracle Application Express accelerates the application development process.

The Application Express engine renders applications in real time from data stored in database tables. When you create or extend an application, Oracle Application Express creates or modifies metadata stored in database tables. When the application is run, the Application Express engine then reads the metadata and displays the application.

To provide stateful behavior within an application, Oracle Application Express transparently manages session state in the database. Application developers can get and set session state using simple substitutions as well as standard SQL bind variable syntax. [4]

So, this software is suitable to use to manage the project data since the collected data for this project are many different and contain value range.

The last software used is Matlab software. MATLAB (matrix laboratory) is a numerical computing environment and fourth-generation programming language.

Matlab software was chosen because developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems. [5]

So, this is suitable software to use compare with other software.

IV. RESULT AND DISCUSSION

As you know, in global life now have a lot of software can used to describe the graph pattern and measure the communication data. For this project, three of software was used to produce the best result and to make sure the project targets were achieved.

First of all, the whole data about receiver signal level and receiver signal quality was found out by using TEMS software. The TEMS software was showed the collected data automatically in dBm unit. So, the result is more exact value.

Table I & II shows the display about the range value of the receiver signal level and receiver signal quality in dBm unit.

Table I: Value range of receiver signal level

Range(dBm)	Colour	Condition
-70 to -10		Very good
-80 to -71		Good
-90 to -81		Moderate
-100 to -91		Weak
-120 to -101		Very Weak

Table II: Value range of receiver signal quality

Range(dBm)	Condition
0	Very good
1	Good
2	Moderate
>=3	Poor

The Figure 2 & 3 was show the map of drive test before and after the repeater was placed at the sample area by using TEMS software.

Based on the Table 1, the light green colour is a very good condition of the receiver signal level. Then, faded green colour is displayed for the good condition only.

Followed by yellow colour is a moderate condition level, dark orange colour for the weak

condition and the last is presented by red colour for the very weak condition of the receiver signal level at the sample area.

Besides that, Figure 2 & 3 also shows the draft of the data about receiver signal level and receiver signal quality in the map shape before convert to the raw data by using TEMS software also.

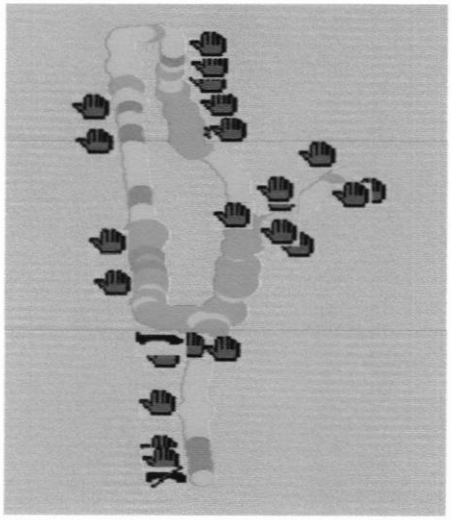

Figure 2: Map drive test before the repeater is placed.

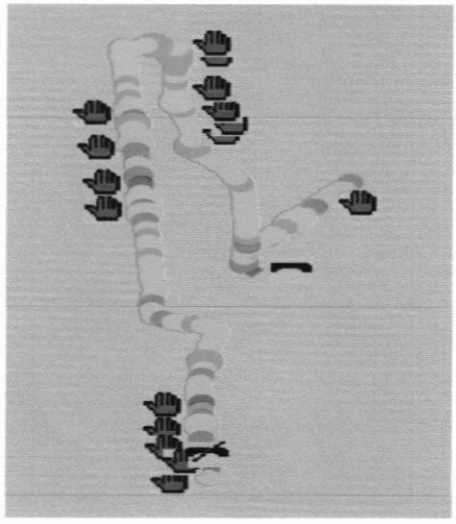

Figure 3: Map drive test after the repeater is replaced.

Secondly, the raw data about receiver signal level and receiver signal quality was stored and managed using Oracle Database 10g Express Edition software.

The collected data was stored and managed based on the types and condition before and after the repeater was placed in the sample area.

So, the programming command was according to the different data and condition is used to store and manage the different types and conditions of data by using Oracle Database 10g Express Edition software.

Table III: Data of the receiver signal level before the repeater was placed.

Value of ranges	Number of samples
BFRE_RXLEV	COUNT(*)
-103	5
-102	39
-101	90
-100	158
-99	257
-98	204
-97	303
-96	412
-95	295
-94	627
-93	750
-92	541
-91	877
-90	1064
-89	721
-88	1564
-87	1692
-86	998
-85	1250
-84	961
-83	455
-82	342
-81	140

-80	134
-79	64
-78	59
-77	52
-76	5
-75	11
-74	22
-73	22
-72	6
-71	21
-70	11
-69	10
-68	5
-67	5

Table IV: Data of the receiver signal level after the repeater was placed

Value of ranges	Number of samples
AFTER_RXLEV	COUNT(*)
-105	11
-102	17
-101	4
-100	11
-99	16
-98	13
-97	36
-96	94
-95	65
-94	201
-93	238
-92	268
-91	669
-90	1098
-89	1025
-88	2132
-87	2298
-86	1561
-85	2049
-84	1839
-83	874
-82	712
-81	404
-80	430
-79	230
-78	102
-77	136
-76	67
-75	56
-74	68
-73	30
-72	27
-71	56
-70	64
-69	39
-68	17
-67	32
-66	10
-65	10
-63	24
-62	35
-61	37
-60	11
-59	6
-56	6
-54	6
-51	5

The Table III & IV shows the data of receiver signal level before and after the repeater was placed based on the range in dBm unit.

(Refer to Table IV) the value of sample at the ranges from -70 to -10 is higher after the repeater was placed compare the condition before.

Based on the Table I, that's mean, the condition of the receiver signal level at the sample area is become well after the repeater was placed.

Table V: Data of the receiver signal quality before the repeater was placed

BFRE_QUAL	COUNT(*)
0	6137
1	1807
2	1689
3	1627
4	1515
5	945
6	321
7	57

Table VI: Data of the receiver signal quality after the repeater was placed

AFTER_QUAL	COUNT(*)
0	13601
1	1492
2	994
3	537
4	287
5	122

The Table V & VI shows the data of receiver signal quality before and after the repeater was placed based on the range in dBm unit.

(Refer to Table VI) The value of sample at the range 0 dBm is higher after the repeater was placed compare the condition before.

Based on the Table II, the best condition of the receiver signal quality is at the range 0 dBm. So from that, the condition of the receiver signal quality at the sample area is become well after the repeater was placed.

After that, the graph pattern was simulated from the collected data was managed by Oracle Database 10g Express Edition software using Matlab software.

The programming command was according to the different data and condition is used to display the each of graph patterns.

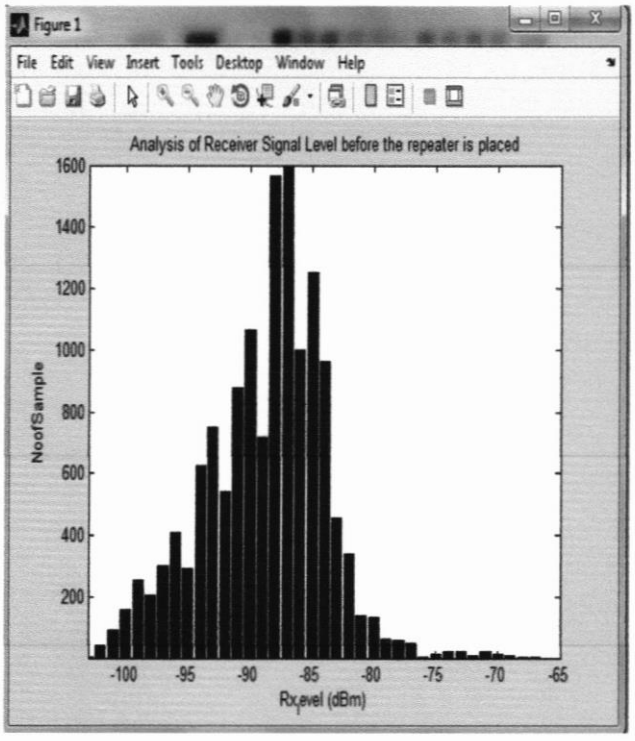

Figure 4: The graph pattern of receiver signal level before the repeater was placed

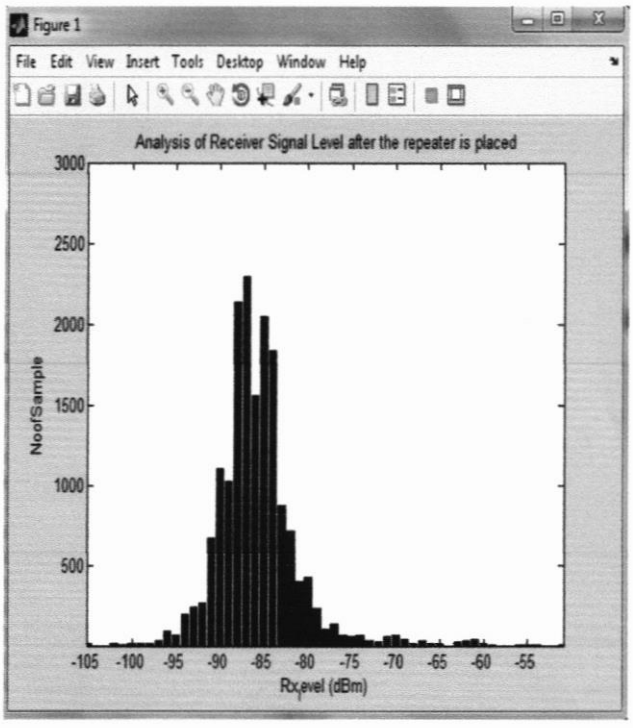

Figure 5: The graph pattern of receiver signal level after the repeater was placed

The Figure 4 & 5 shows the graph pattern of receiver signal level before and after the repeater was placed in the sample area by using Matlab software.

Based on the Table I, the very good condition of the receiver signal level is presented by range from -70dBm to -10dBm. Then, the good condition is the range from -80dBm to -71dBm.

Moderate condition is noted at the range from -90dBm to -81dBm. The weak condition is range from -100dBm to -91dBm. The last is the range from -120dBm to -101 is presented for the very weak condition of the receiver signal level.

The graph pattern shows the receiver signal level is better after the repeater was placed because the value of the samples was noted to be range from -70dBm to -10dBm as shown in Figure 5.

So, this situation was supported the theory that the coverage area about the receiver signal level becomes better after the repeater was placed at the sample area.

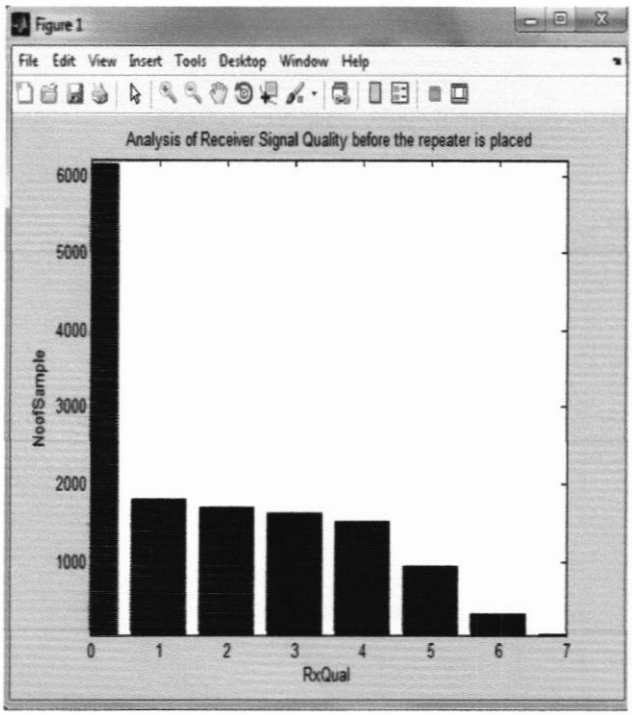

Figure 6: The graph pattern of receiver signal quality before the repeater was placed

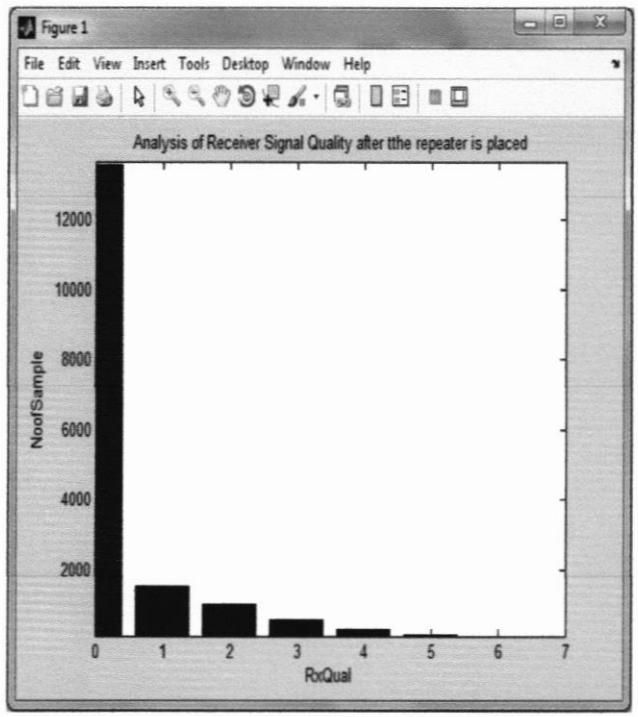

Figure 7: The graph pattern of receiver signal quality after the repeater was placed

The Figure 6 & 7 shows the graph pattern of receiver signal quality before and after the repeater was placed in the sample area by using Matlab software.

(Refer to Table II) The very good condition of the receiver signal quality is at the range 0 dBm. The range 1 dBm is presented for the good condition. The moderate condition is noted by the range 2 dBm. The range below than 2 dBm is displayed for the poor quality.

The conclusion about the range of the receiver signal quality is the condition become very poor if the value of the range is higher.

Figure 7 shows the sample value of the receiver signal quality is double value (more than 13000 samples) compare before the repeater was placed at the sample area(below than 7000 samples).

This shows that the number of samples is increase and at the same time that's mean the condition of the receiver signal quality at the sample area is better after the repeater was placed.

In addition, Figure 7 clearly shows that the number of sample at the ranges 6 dBm and 7 dBm (very poor quality) compare before the repeater was placed as shown in Figure 6.

This situation clearly describe that the condition of the receiver signal quality also is better after the repeater was placed at the sample area like the receiver signal level.

The programming command of data about receiver signal level and receiver signal quality can

be produced from the surveyed data in Terengganu using TEMS software. So from that, the condition about the range of the receiver signal level and receiver signal quality can be defined. The programming was displayed by using Matlab software.

The both of the programming were produced to make an easy system for user to use.

V. CONCLUSION

In this work, the impact of different graph patterns for receiver signal level and receiver signal quality in the sample area at condition before and after the repeater is placed has been studied through simulation. Both of the data for a good condition is seen to improve after the repeater is placed at the sample area as compare to the condition before.

VI. FUTURE RECOMMENDATIONS

This project can be further investigated if the collected data can display more data. The example is the name of each base station. So, the collected data with base station name according to the range of signal value can be displayed in the programming command. In addition, it will be most useful if TEMS software can display the name of all cells.

VII. ACKNOWLEDGMENT

A lot of Thanks to all staff of Optic Global Sdn. Bhd especially to its manager, Mr. Vincent Hsu for his permission to use communication data from his company for this project.

REFERENCES

[1] Wayne Tomasi, Electronic Communications Systems, Prentice hall Publication, 2004.

[2] P. Mohana Shankar, Introduction to Wireless Systems, Publication Services, January 2001.

[3] Wikipedia,"http://en.wikipedia.org/wiki/quality of service ", (Accessed on 14 Aprill 2011)

[4] Blogspot,"http://evolving-technology.blogspot.com/2009/04/global-system-for-mobile-communication.html", (Accessed on 24 April 2011)

[5] GSMfavorites," http://www.gsmfavorites.com/ documents/introd uction/", (Accessed on 2 May 2011)

[6] Hadi Saadat, Power Sytems Analysis (Introduction of MATLAB), McGraw-Hill Education, 2004

[7] Michael V. Mannino, Database, Design, Application Development and Administration, McGraw-Hill/Irwin, 2004.

[8] Wikipedia, "http://en.wikipedia.org/wiki/quality of service", (Accessed on 11 March 2011)

[9] Searchsoa, "http://searchsoa.techtarget.com/definition/software", (Accessed on 1 May 2011)

[10] Gosic, "http://gosic.org/gtos/TEMS-prog-overview.htm", (Accessed on 1 May 2011)