

CONFERENCE PROCEEDING

Channel Characterization for Wireless Communication at 2.4 GHz Frequency

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Abstract

Wireless communication technology is one of the most accessed technology now and everywhere. The term wireless defines to communication or transmission of data without requiring cables, wires or any electrical conductors. The deep study of wireless communication was held to find ways to increase the speed of data transmission so less time to transmit data or avoid data loss. The loss in transmitted data usually occurs due to multi-path fading especially in an indoor environment. This research is carried out by conducting a measurement campaign at 2.4 GHz in an indoor environment at administration building hallway of Kolej GENIUS Insan to evaluate the path loss. 2.4GHz radio signal is used to evaluate the path loss. The signal is generated by the Wi-Fi router in Kolej GENIUS Insan. The Received Signal Strength (RSS) is measured, hence the loss or data delay in data transmitted is calculated and analysed. This study found that the element of building furniture and edge result to better signal reception.

Keywords: *Wireless signal, 2.4GHz, indoor environment, path loss*

INTRODUCTION

The demand for wireless communication has grown up rapidly. Wireless communication has a higher possibility for flexible and efficient products. The term wireless refers to communication or transmission of data and information without requiring cables, wires or any electrical conductors. This information or data transmitted using wireless communication technology using electromagnetic waves like radio frequencies, infrared, satellite, etc (A.Kong, 1975). It's a fast and rapid technology used for communication world-widely. The most-found device that uses wireless communication technology in our daily life is mobile phones and wireless computer parts (Rappaport *et al.*, 2013, p. 335-349). The technology develops rapidly and now they have current wireless phones equipped with 2.4 and 5G networks, Bluetooth and Wi-Fi technologies.

People use wireless communication technology to transmit data with less time taken. The speed of wireless communication can be affected by a few factors (Wang *et al.* , 2010, p. 1-3) The deep study of wireless communication was held to find ways to increase the speed of data transmission so less time needed to transmit data.

Communication technology can be defined as a method to communicate data and information from one person to another, from one place to another. Some of the earliest and primitive manifestations of communication technology were the hieroglyphs used by the ancient Egyptians, the use of pigeons to send messages by the Chinese, and the use of smoke signals by the native Americans.

وَلَقَدْ آتَيْنَا دَاوُدَ مِنَّا فَضْلًا يَا جِبَالُ أَوِيبِي مَعَهُ وَالطَّيْرَ وَالنَّارَ لَهُ الْحَدِيدَ (١٠)

Indeed, We granted David a 'great' privilege from Us, 'commanding: ' "O mountains! Echo his hymns! And the birds as well." We made iron mouldable for him.
(Surah Saba':10)

In Islamic perspective, Dani Fitriani (n.d) said the word "أَوِيبِي" in this verse is translated as "sound return or repetition," recalls the echo based on radar technology. In a radar system, electromagnetic energy signals are used in many of the same ways. Signals emitted to the object then return after being reflected by it.

In an administration of an organisation especially schools and colleges, efficient network coverage and strength is need to transmit data. In this study, the loss in transmitted data due to multi-path fading which slowing the transmission of data is measured. Ferrer-Coll (2014) wrote the duration of the symbol period of a radio system and the dispersive properties of the environment determine the reduction rate of communication performances. Our main objective is to evaluate free space path loss by conducting measurement campaign using 2.4GHz at administration building of Kolej GENIUS Insan.

METHODOLOGY

Measurement campaign

Our measurements campaign took place in one indoor environments: Administration block of Kolej GENIUS Insan. These two settings provide the fundamental scenarios for a WLAN operating at 2.4 GHz, where a fixed router (Access Point – AP) transmits electromagnetic radiation in an indoor environment (MacCartney *et al.*, 2014) [1]. The router, marked with Tx, for the first point and with Rx for another point. Measurement were taken between the router and receiver with uniform distances. Due to lack of equipment, we just can measure the received signal strength.

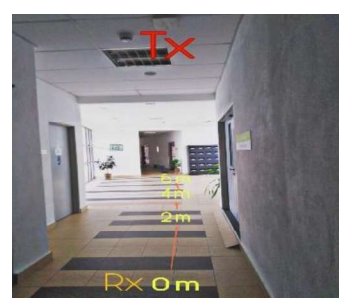


Figure 1. The setup of the signal receiver (Rx) and the router (Tx)

In Kolej GENIUS Insan scenario, a fixed router (Access Point of the WLAN) was the transmitter, with an antenna and a transmitting power level of 3 dBm for the college environment. In this case, a properly equipped laptop functioned as the receiver, and the Acrylic Wi-Fi Home software was installed and used for measuring the received signal strength (Lele *et al.*, n.d). The Acrylic Wi-Fi Home software allows the operator of the laptop to know the exact received power coming from the specific router of the WLAN, excluding all other signals even if they belong to the same frequency of 2.4 GHz (Chryssikos *et al.*, 2009)[7]. Thus, the actual power received

from the signal is measured and processed for transmitted from the router is analysis further. A variety of measurements have been carried out in for a particular time period, a given location of a few minutes, and it eventually considered the best value as the average signal intensity for a particular area.

The power of electromagnetic waves in a wireless channel decreases according to the power law function of the distance between the transmitter and receiver. This function determines the energy dissipation while the signal travels through the path towards the receiver in a direct line of sight, or through multi-path (Miranda *et al.*, 2013, p. 54-58)[4]. The way to get the data loss or which is known as Free space path loss is by using the data collection calculated in the following equation (A. Holt *et al.*, 2010)[5].

$$FSPL = 10\log_{10}(d) + 20\log_{10}(f) + 20\log_{10}\left(\frac{4\pi}{c}\right) \quad (1)$$

where d (m) is the free space reference distance, $c = 3 \times 10^8$ m/s, f (Hz) is the RF carrier frequency.

RESULTS AND DISCUSSION

Received Signal Strength at Uniform Distance

Table 1 shows the results of the received signal strength between the two routers with uniform distances. The results show that there is different signal strength along the distance between the router and the receiver.

Table 1. Measurements of received signal strength of a router in administration building of Kolej GENIUS Insan

Distance (m)	Received Signal Strength (dbm)
2	-46
4	-49
6	-53
8	-51
10	-53
12	-58
14	-61

Table 1 show that the data of measurements of received signal strength between the router and receiver. Based on the table, as the distance from the one router is increase, thus the received signal strength will decrease. This data was collected to construct the free-space path loss model of transmitted data between the router and the receiver. The model is construct by using equation (1) on Maple software.

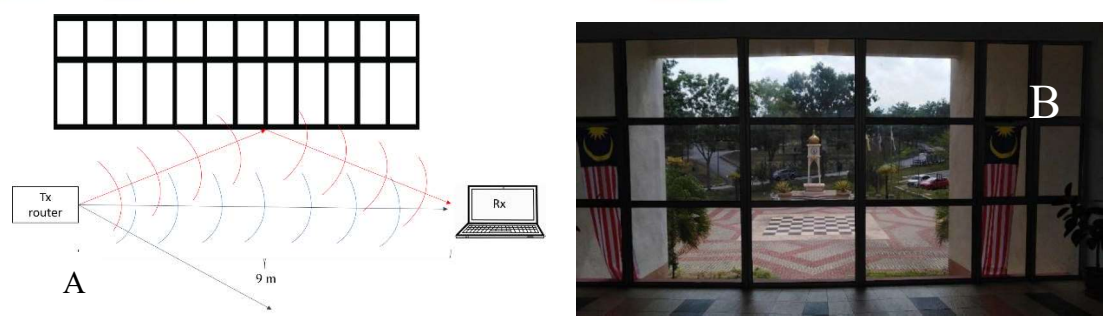


Figure 2. The model of reflected wave in between 9 meter from the router (Tx) A. diagram B. photo

Based on Table 1, we can see that at $d = 8$ and 10 , the value of received signal strength is slightly higher than it should be, the value supposed to decrease but it increase at 8 meter from the router. This happens because there is reflection of waves occur caused by the environment condition, which is surrounded by glass windows. The receiver receives signal both from the router directly and the reflected signals from the windows (Tang *et al.*, n.d, p.1-32).

Free-space path loss

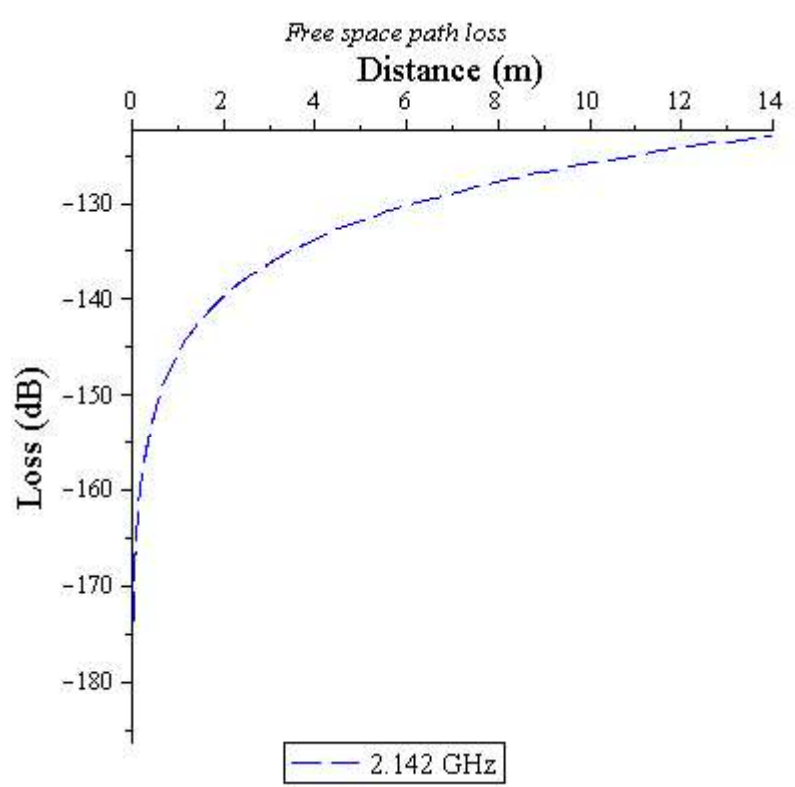


Figure 3. The model of free space path loss (dB) against distance (m)

Figure 3. shows the model of free-space path loss along the distance between the router and receiver. The distances are varying at , $0 \leq d \leq 14$. At distance $d = 0m$, the data loss is about $-170 < dB < -175$. After $d > 0$, the data loss starts to move up until the last calculation of the distance that have be measured. The data loss increase against the distance because according to the power law of the distance between the transmitter and receiver. This function determines the energy dissipation or data loss while the

signal travels through the path towards the receiver in a direct line of sight, or through multi-path (Miranda *et al.*, 2013)[6].

CONCLUSION

Being a good administration must have a great network and data transmission to ensure effective administration. In this research, the received signal of 2.4 GHz Wi-Fi of administration building Kolej GENIUS Insan is collected to measure the data loss. The free-space path loss of a signal or wave depends on its received signal strength (RSS). To obtain the result of free-space path loss, the RSS have been taken from a measurement campaign which involves a router in administration building and a receiver (in this research, a Wi-Fi analyzer software in a laptop) with uniform distance between them, from 2 meter up to 14 meter. Our aim for this research is to calculate and measure the free-space path loss of the Wi-Fi signal in administration building of Kolej GENIUS Insan. The free-space path loss will be solved based on equation (1) to achieve our objectives. The results are obtained and produced using Maple software. Based on the graph of free-space path loss against time obtained from the Maple software, it shows that the signal loss will increase along with the increasing distance.

REFERENCES

- G. R. MacCartney, Jr., M. K. Samimi and T. S. Rappaport (2014) "Omnidirectional Path Loss Models in New York City at 28 GHz and 73 GHz," in 2014 IEEE 25th International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC)
- T. S. Rappaport et al. (2013) "Millimeter wave mobile communications for 5G cellular: It will work!" IEEE Access, vol. 1, pp. 335–349
- S. Sun et al. (2016) "Propagation Path Loss Models for 5G Urban Micro- and Macro-Cellular Scenarios," in 2016 IEEE 83rd Vehicular Technology Conference (VTC2016-Spring).
- Jorge Miranda, Reza Abrishambaf, Tiago Gomes, Paulo Gonçalves, Jorge Cabral, Adriano Tavares, and J Monteiro (2013) Path loss exponent analysis in wireless sensor networks: Experimental evaluation. In 2013 11th IEEE International Conference on Industrial Informatics (INDIN), pages 54–58. IEEE.
- A. Holt and C. Huang (2010) 802.11 Wireless Networks: Security and Analysis. Springer Science & Business Media.
- Miranda, J., Abrishambaf, R., Gomes, T., Gonçalves, P., Cabral, J., Tavares, A., & Monteiro, J. (2013). Path loss exponent analysis in wireless sensor networks: Experimental evaluation. Proceedings of the 2013 11th IEEE International Conference on Industrial Informatics (INDIN).
- T. Chrysikos, G. Georgopoulos, K. Birkos and S. Kotsopoulos (2009) "Wireless Channel Characterization: On the validation issues of indoor RF models at 2.4 GHz", First Panhellenic Conference on Electronics and Telecommunications (PACET), Patras, Greece.
- Wang, K., Nirmalathas, A., Lim, C., & Skafidas, E. (2010). Gigabit optical wireless communication system for indoor applications. *Optics InfoBase Conference Papers*, (c), 1–3. <https://doi.org/10.1117/12.887955>
- A. Kong, 1975 "Theory of electromagnetic waves," wi.
- Lele, C., Shen, S., & Chalasani, S. R. (n.d.). Measuring the Performance of Home Wireless. Acrylic WiFi Home. n.d. <https://www.acrylicwifi.com/en/wlan-software/wlan-scanner-acrylic-wifi-free/> (accessed December 2016)
- Dani Fitriani n.d. *Al Quran Berikan Ilham Penggunaan Teknologi Radar* <https://www.eramuslim.com/peradaban/quran-sunnah/radar-teknologi-terkini.htm#.X6qyL2gzblV>
- B. -. Klepser, M., Punzenberger, T., Ruhlicke, and M. Zannoth, (2003) "5-GHz and 2.4-GHz dual-band RF-transceiver for WLAN 802.11a/b/g applications," *IEEE Radio Frequency Integrated Circuits (RFIC) Symposium, 2003*, Philadelphia, PA, USA, pp. 37-40.

- Sengaliappan, M., & Kumaravel, K. (2017). Analysis Study of Wireless Technology and its Communication Standards Using IEEE 802 . 11. *International Journal of Advanced Research in Science, Engineering and Technology*, 4(6), 4061–4066.
- Ferrer-Coll, J. (2014). *Channel Characterization and Wireless Communication Performance in Industrial Environments*.
- Topor-Kaminski, T., Zurkowski, R., & Grygiel, M. (2011). Selected methods of measuring the delay in data transmission systems with wireless network interfaces. *Acta Physica Polonica A*, 120(4), 748–754. <https://doi.org/10.12693/APhysPolA.120.748>
- Tang, W., Chen, M. Z., Chen, X., Dai, J. Y., & Han, Y. (n.d.). *Wireless Communications with Reconfigurable Intelligent Surface : Path Loss Modeling and Experimental Measurement*. 1–32.