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Link Budget Design for RF Line-of-Sight via Theoretical Propagation Prediction

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Abstract

Line-of-sight (LOS) link planning condition has been observed to have effects on the atmospheric factor which cause crucial signal loss. The main objective of the planning was to improve a set of a link using point to point condition to assist the performance in emerging its strategy for handling the fixed WLAN service. The purpose of this paper is to provide a quick description of various propagation loss mechanisms on Link Budget Tool (LBT). LBT is customized to create point to point link for local area network (LAN) through radio frequency range operating between 2.400 GHz and 5.800 GHz. This software is able to define the effect of signal loss and expected performances according to the distances between link propagation conditions based on a number of system parameters.

Keywords

Path Loss (PL), Line of Sight (LOS), Microwave Link Budget (MLB), Link Planning (LP)

1. Introduction

Daily have the great interests in utilizing a novel platform to provide best link prediction between point to point (PTP) due to the technology requirements [1] [2]. Radiofrequency link system used high-performance data, video transmission and management engine for advanced microwave through the wireless network [3]. This communication could allow the provision of personalized services in wireless connectivity as well as for sharing service engineering. Most of the industrial created a number of new possibilities for highly flexible link performance and efficient wireless communications for automation solutions [4].

Among wireless communication architecture, wireless link propagation is the most concerning process to have a success sharing purposes [5] [6]. The environment of radio applications is changing according to environmental factors [7]. Possible resources to the link consideration are based on a better understanding of the environmental factors affecting the link performance of the reliable transmission medium of the radio channel and it is important [8].

The best way of Radio Transmission which takes place under situations whereby a clear line of sight should exist between receiver and transmitter [9] [10]. This condition confirms the strongest conceivable signal with marginal attenuation according to environmental factors with no obstacles between the two sites.

To design an acceptable operational link with high quality at the lowest possible cost we must specify the requirements of the system performance, and then it is necessary to compute the power and bandwidth.

2. Lınk Budget Plannıng Objectıves

This planning presents the findings of a link budget and applied into the prospective future request for the range in frequency bands, which was presented for fixed links via point to point connection. This potential method carried out the fixed links in LAN applications, such as short range link among devices or satellite links. This planning elaborates the progress of a number of situations for local area network (LAN) service development and evaluating the situation of environmental impairment for spectrum allocation under each condition. The objectives of this planning are to attempt the link capacity quantify of certain frequency bands for fixed links where the future demand is heading to and other services were considered to be particularly high demand with fewer losses.

3. Maintaining the Integrity of the Specifications

There are three most important issues to be taken into consideration as far as propagation losses attention. Free space loss (FSL) in the line of sight condition is the principal factor in the loss of the signal strength and power spectral density (PSD). These losses referred to spreading signal through space. In addition, a key factor must be reserved and all the required calculations must be designed in a proper way as shown in the link power budget for any wireless communication.

Equation (1) expressed the Free Space Path Loss in decibels using a generic frequency (f), versus distance (D) [11]:

$$\text{FSPL} = 32.45 + 20 * \log(D) + 20 * \log(F) \quad (1)$$

where Free Space Path Loss (FSPL) is considered and calculated in dB in distance per kilometers for the given frequency in GHz. and scenario

4. Measuring Transmission Losses

The purposes of the Link Budget Tools used excel software to determine the propagation impairments and it is a prediction for signal strength and surface roughness based on factor values found in the selected condition. The first step in this software was measured the ideal case to obtain the stream of the signal between point A and point B as shown in Figure 1. After adjusting the link performance, the gage of the signal starts to transmit from points A and end at point B of the link, with different values of propagation impairments were calculated in the chart as shown in Figure 1.

The link budget software developed in this work is designed under the Excel platform; it is organized based in Figure 1 and Figure 2 to calculate the path loss. Furthermore, it has a list of options that comprehends all the different calculations that adequate the target performance of the link budget as system settings with a set of parameters that characterize [12], based on the distance between point A and Point B.

Table 1 shows the major losses in point to point communication, however, the losses in the received signal perhaps have their basis of the signal in its propagation from the transmitter to the receiver. Table 1 intended to provide a clear understanding of the major propagation impairments, as well as their origin and cat gory. A part of these losses clarified to determine and validate the values attained for the calculations for link budget calculation.

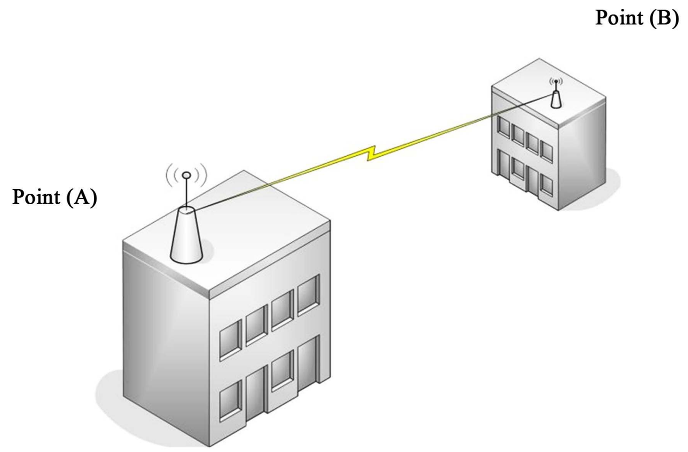

Figure 1. Point to point link condition.

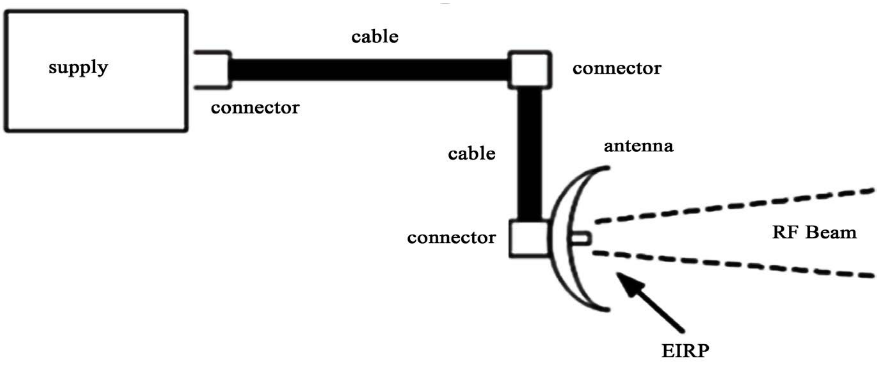

Figure 2. Equivalent isotropically radiated power.

Table 1. Major losses in point to point communication.

External Losses			Internal Losses
Free Space Losses	Impairment Path Losses		Equipment Losses
Signal Attenuation	Climate	Terrain Profile	Choosing Best Equipment
Antenna Pointing, Height of the Pool, Fade Margin, Depolarization, Receive Signal Strength	Temperature, Humidity, Channel Noise	Mountains, Trees, Buildings, Antenna Height	Connector Loss, Antenna Gain, Feeder Loss, Receiver Threshold, Power of the antenna, Atmospheric Absorption

5. Link Budget Calculation Performance Prediction

In any wireless transmission, there are continuously losses occurring from various sources during the transmission. Several losses may exist constant according to the device specifications; others are dependent on the nature of data and the environmental conditions, especially with rain.

When planning a communication for long distance to a remote two points, one of the most concerns is the successful link requirement. One considers is the information capacity and rate of error to calculate the signal strength required to not only reach the receiver, but to also reach with some level of high power or margin of loss, considering for the unexpected propagation impairments. Once the transmitter activates with the power capacity consists of the system gains and internal losses to determine the level of actual predicted power at the receiver. In order to ensure a consistent link between the transmitter and the receiver, the level of power delivered to the receiver should be obtained a minimum level of performance that required.

For the selected scenario, the basic transmission loss considered to be constant as shown in Tables 2-4 of a radio link between the free-space condition for the transmitter, receiver and general reference respectively. Table 5 shows the reference values for the channel specification in ideal cases. The related losses in the first step in the design for FSL are to define the losses in clear LOS conditions and these losses are remaining constant in all cases.

Based on a set of parameters that characterize the link, for this case was configured to work on 5.800 GHz and 2.400 GHz frequency. Among these constraints, there are already presets parameters such as synchronizes of the points and the location of the points [8] to estimate the exact signal strength in the given distance between them.

The losses in Tables 2-5 were considered as the input of the link in the ideal case. Link budget calculation is also introduced accurately the entire sources of each factor and allow the exact conception of all the presented analysis as shown in Figure 3.

6. Conclusion

This paper presented a feasibility study of purely theoretical prediction of the

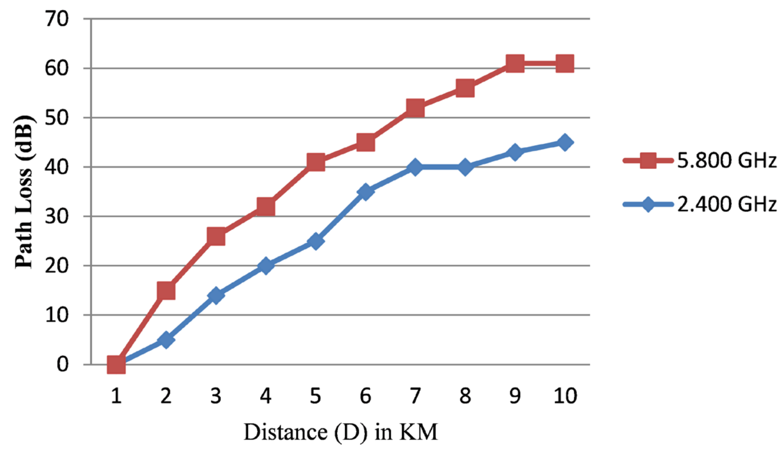

Figure 3. Free space path loss.

Table 2. Performance prediction.

Availability	100%
Outage Time	0.00
Availability	100%
Outage Time	0.00
Availability	100%
Outage Time	0.00

Table 3. Constant values for the transmitter specification.

Transmitter	Point A
Transmitter Power (Power out)	23.00 dBm
Transmission Line (Tx)	1.5 m
Transmit Feeder Loss (TFL)	1.00 dB
Tx Antenna Gain (TAG)	32.00 dB
Connector Loss (CL)	3.00 dB

Table 4. Constant values for the transmitter specification.

Receiver	Point B
Connector Loss (CL)	3.00 dB
Rx Antenna Gain (RAG)	32.00 dB
Receive Feeder Loss (RFL)	1.00 dB
Transmission Line (Rx)	1.00 m
Receiver Threshold	91.00 dBm (BER 10^{-3})
RSL	−34.00 dB (BER 10^{-6})
Fade Margin	55.00 dB (BER 10^{-6})

Table 5. Reference values for the channel specification.

Reference	Terrain
Average	0.98
Mountainous	0.115
Dry	0.96
Humid	0.498

received signal strengths in limited condition with selected losses, while this work is considered as an initial stage for a further proceeding to advance system. For well-developed a theoretical prediction, it could evaluate the actual break-point counters and predicted signal strength efficiency. Therefore, the importance of this link budget software used the theoretical method to enhance the system. A systematic link budget design is adopted for propagation prediction. The software is used to investigate the link configuration based on the received signal strength in a given distance. The purpose of this paper is to predict the signal strength and losses between two points based on theoretical approaches utilizing the various aspects and parameters. The main objective of this software is to predict the effect of different frequencies in various factors to obtain a lower loss, and the desired power to transfer certain information designed to carry data via the link budget. The theoretical method has shown that the overall path loss was mixed with propagation impairments at the optimum frequency range between 5.800 GHz and 2.400 GHz.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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