Development of a Simple Near-Ground Path Loss Model Verified by Measurements

Kemal Kapetanovic, Mads Gotthardsen, Thomas Jørgensen
(kkapet08, mgotth13, tkjj13)@student.aau.dk WCS7 2016

Problem

In the future there will be used more wireless sensor networks to different task and many nodes in these networks, can be placed at low heights, where communication between nodes get worse, as the path loss (PL) increases as the multipath waves can no longer be ignored. This will effect the link budget, when designing the antennas.

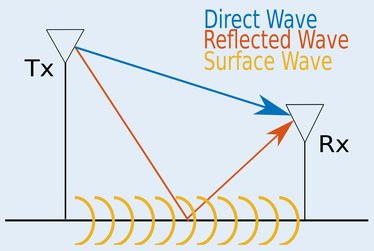


Figure 1: The different waves effecting the PL

Test setup

A measurement campaign were designed with given different parameters. By knowing system gains and losses, the PL can be calculated. For the test setup there where these different parameters;

- 2 Antenna sets at 858MHz (monopole and rectangular patch)
- 2 Polarization (horizontal and vertical)
- 2 Location (parking lot and school gym)
- 4 different height for the antennas (0.04, 0.14, 0.36 and 2.02 m)
- 6 distances between antennas (1, 2, 4, 8, 15 and 30 m)

In each point, 10 measurements were performed and the mean hereof were found, to lessen the effect of small scale fading.

PL Models

Friss free space PL (FSPL):

This model only uses the direct wave and do not take any reflections into account. It is not reliable at low heights.

Approximated two-ray ground-reflection PL (ATRPL):

This model takes the direct wave and a single reflection into account. This aproximated version of the model works best in the heights between FSPL and NSPL.

Norton surface wave PL (NSPL):

This model only takes into account the surface wave and is not reliable at higher heights, than where the surface wave effects.

Ground wave PL (GWPL):

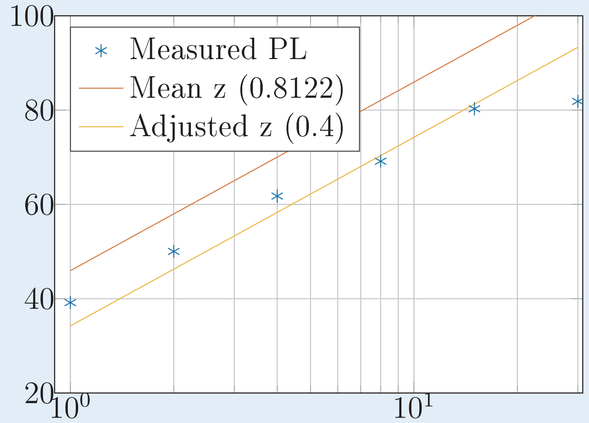
This model takes into account all the waves, seen on figure 1 and also the reflection and absorbing coefficient of the surface.

New proposed PL model

Forklarende tekst

$$L_p = \frac{d^4}{h_t^2 h_r^2 + h_0^4}$$

Her snakker vi omkring z og fuck up irrenterende den er



Models	MSE	Applicability
FSPL	15.95	35 %
ATRPL	141.58	65 %
GWPL	35.49	100 %
NSPL	230.05	30 %
Our	60.18	65 %

Comparison

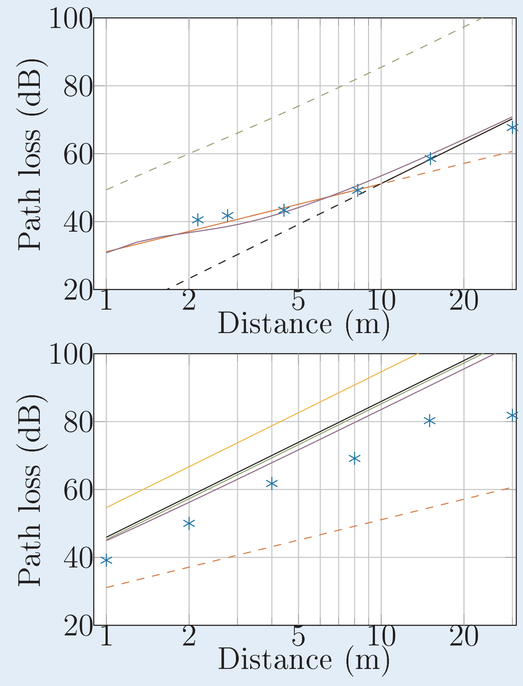


Figure 2: Comparison between the different PL model. At the top, the Tx and Rx height are 0.14 and 2.02 m and at the bottom, both are 0.04 m
The points are the measured PL, The red is FSPL, the blue is ATRPL, the yellow is NSPL, the purple is GWPL and the black is the NPPL.

Acknowledgements

The authors would like to thank Vendelbo hallen for providing access to their facilities during the measurement campaign.

Reference

[1] K. Bullington, "Radio Propagation at Frequencies Above 30 Megacycles,"
[2] P. K. Chong and D. Kim, "Surface-Level Path Loss Modelling for Sensor Networks in Flat and Irregular Terrain,"