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Budalal, A.A.[a] , Islam, M.R.[b]

The Probabilistic Component of Outdoor Millimeter Wave Propagation Path Loss Model Considering Rain Fade
(2023) *Proceedings of the 9th International Conference on Computer and Communication Engineering, ICCCE 2023*, pp. 30-34.

DOI: 10.1109/ICCCE58854.2023.10246068

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Abstract
The close-in free space reference distance model CI can be extended to account for the channel shadow fading SF and rain attenuation factors as a different time probability function. Robustness and performance motivated the adoption of combining rain fade and shadowing using the CI model at exceedance probability (0.001% ≤ P% ≤ 1.0%) and weighing the path losses using a probabilistic distribution of rain fade shadowing as a function of link distance. A probabilistic CI model is proposed considering rain attenuation and shadowing at different probabilities. The mean estimated path loss in this new 'hybrid' path loss model is probabilistic. The model can give a close prediction compared to path loss analytically estimated from measured data at 38 GHz at 300m (χ σ =5.22 dB). The difference between path loss predicted from the proposed probabilistic model and path loss analytically estimated from measured path loss at 38 GHz over 300 m at (0.001% ≤ p % ≤1.0%) has been calculated at the tropical region. The findings show a 20 dB per decade loss in signal strength in the equatorial region more than in the temperate areas by considering rain fade for 300 m at 38 GHz. The proposed hybrid probabilistic path loss model can be used as an alternative to conventional propagation path loss models to calculate the directional path loss by increasing the prediction accuracy. The effect of lognormal shadowing, which essentially accounts for the randomness in the shadowing factor around the cell because of the large obstacles, has also been analysed. Additional transmit power is proposed to maintain the fade margin during the rains. Probabilistic path loss models are commonly used in the design and evaluation of millimeter wave wireless systems, which operate at high frequencies and are highly sensitive to the propagation environment. By accounting for the probabilistic nature of the path loss, these models can help to improve the accuracy of predictions and reduce the risk of unexpected performance degradation in real-world deployments. © 2023 IEEE.

Author Keywords
NYUSIM; Probabilistic, Outdoor millimeter wave Path Loss Model; rain fade; shadow fading

Index Keywords
Electromagnetic wave attenuation, Millimeter waves, Probability distributions, Rain, Wave propagation; Millimeter wave propagation, NYUSIM, Path loss, Path loss models, Probabilistic, outdoor millimeter wave path loss model, Probabilistics, Propagation paths, Rain attenuation, Rain fades, Shadow fading; Forecasting

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Publisher: Institute of Electrical and Electronics Engineers Inc.

Conference name: 9th International Conference on Computer and Communication Engineering, ICCCE 2023
Conference date: 15 August 2023 through 16 August 2023
Conference code: 192690

ISBN: 9798350325218
Language of Original Document: English
Abbreviated Source Title: Proc. Int. Conf. Comput. Commun. Eng., ICCCE
2-s2.0-85173651382
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus