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| TGah Channel Model – Indooor Channel Model  |
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# 3.0 Channel models

# 3.1 Indoor Channel models

The proposed indoor channel model for TGah is based on the 802.11n channel models, which have been widely used in the 802.11 Standard development. 802.11n model is described in [1] and the associated Matlab implementation is described in [2]. This section summarizes the general modelling approaches used by 802.11n and the assumptions made to extend it for the usage of 802.11ah.

802.11n models are indoor MIMO models based on the cluster and correlation modelling approach. In the cluster modelling approach, the tap-dependent and cluster-dependent angular and power properties are characterized. The correlation of the MIMO channel is modelled based on the Kronecker product between transmit and receive correlation matrices. Based on these parameters, an accurate time-domain MIMO channel matrix can be obtained with proper transmit and receive antenna correlation properties.

Despite 802.11n channel models are used for both 2 GHz and 5 GHz frequency bands, we assume that the small scale characterization of the 802.11n model can also be applied to sub-1GHz band since [3] showed that only marginal difference in terms of small scall parameters of the channel can be observed between sub-1GHz and 2/5 GHz bands. With this assumption, the generation of the MIMO channel matrix for each tap at one instance follows exactly the procedures as in [1]. However, the large scale parameters are expected to be significantly different between these bands.

The path loss model for the same floor measurement conducted in the office environment (as represented by the black cureve in Figure 1) can be approximated by simply scaling the frequency from 2/5GHz to sub-1 GHz band. This leads to the up to 5.5dB difference between these two path loss models. 11ah is expected to operate at longer distance with multiple floors between the access points and stations. However, such scenario is not modelled in 11n channel model. As show in Figure 1, the path loss in the case of office office building 1 (red line) and office building 2 (magenta line), where the transmitter and receiver are separated by one floor can be predicted accurately by a multi-floor model (blue line) but poorly by the 11n model.



Figure 1: Path loss for scaled 802.11n Model A/B (green), office buiding in the same floor (black), and one floor scenario for office building 1 (red), building 2 (magenta) and multi-floor model (blue).

We suggest the generic average indoor path loss model for 11ah can be expressed as



Where

PL(*d*0) is the path loss at reference distance *d*0

*Xq* accounts for the additional attenuation due to specific obstruction by object q. This can be treated as floor attenuation factor (FAF) in case of multi-floor scenario.

Xσ is the shadowing fading that is modeled as log-normally distributed i.e. *X*σ[dB]=*N*(0, *σS*), where *X*σ denotes zero mean, Gaussian random variable in unit dB with standard deviation *σS*

**Open Issues**

1. Value of *n* for different environment
2. Xq term for different environment. A generic FAF model for multi-floor may be needed to simplify the model.

**References**

[1] V. Erceg and et. al., TGn Channel Models, IEEE P802.11 Wireless LANs Std. IEEE 802.11-03/940r4, May 2004.

[2] L. Schumacher “WLAN MIMO Channel Matlab program,” download information: <http://www.info.fundp.ac.be/~lsc/Research/IEEE_80211_HTSG_CMSC/distribution_terms.html>

[4] SK Yong, R. Banerjae and H. Zhang, Indoor Channel Model for TGah, IEEE 11-11-0361-00-00ah, March 2011.