**Wireless LANs**

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| IEEE 802.11be Channel Model Document  |
| The purpose of this document is to record progresses and consensus related to channel model.  |
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Abstract

This document provides the channel model document to be used for IEEE802.11be task group.

**Revision History**

|  |  |  |
| --- | --- | --- |
| **Date** | **Version** | **Description of changes** |
| 02/26/19 | 0.1 | Initial Draft |
| 02/28/19 | 0.2 | Correct some typos. |

# Introduction

TGn, TGac and TGax task group have developed a comprehensive MIMO broadband channel model, with support for up to 160 MHz channelization and up to 8 antennas [1-3]. In TGax channel model document [3], UMa and UMi channel models have been adopted as the outdoor channel models with modified Doppler Effect.

IEEE 802.11be task group targets to enable at least one mode of operation capable of supporting a maximum throughput of at least 30 Gbps, as measured at the MAC data service access point (SAP), with carrier frequency operation between 1 and 7.250 GHz while ensuring backward compatibility and coexistence with legacy IEEE802.11 devices in the 2.4 and 5 GHz unlicensed bands, and with IEEE802.11ax devices in the 6 GHz band.

IEEE 802.11be task group identifies some potential features such as wider bandwidth support, more spatial streams, multi-AP coordination and multi-band/channel operations. To assist the link level simulations and performance evaluation, TGbe channel model document is required.

This document describes the additional channel models for link level performance evaluations for IEEE 802.1be.

# Channel Models for 6GHz Band

Since 6GHz band is close to 5GHz band, wireless signals of 6GHz band have similar propagation property as wireless signals of 5GHz band.

## Indoor spatial channel models

TGn and TGac spatial channel models for 5GHz band [1-2] are adopted as IEEE 802.11be indoor channel models for 5GHz band and 6GHz band.

The delay spreads and cluster parameters of indoor TGn and TGac spatial channel models are listed in the Table I.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **rms Delay Spread****(ns)**  | **Number Of Clusters**  | **Taps/Cluster**  | **Propagation Scenario**  | **Usage Model**  |
| A  | 0  | 1  | 1  | Flat fading  | Gaussian Channel-like |
| B  | 15  | 2  | 5,7  | Indoor Residential  | Intra Room, Room to Room  |
| C  | 30  | 2  | 10,8  | Indoor Residential/Small Office  | Enclosed Offices Meeting, Conference or Class rooms  |
| D  | 50  | 3  | 16,7,4  | Indoor Typical Office  | Offices – cubes farms, open areas and large classrooms  |
| E  | 100  | 4  | 15,12,7,4  | Indoor Large Office/Warehouse  | Indoor Hotspots with large rooms  |
| F  | 150  | 6  | 15,12,7,3,2,2  | Large Space Indoor (pseudo-outdoor).  | Large Indoor Hotspot – Airport  |

Table I. Delay spreads and cluster parameters of indoor TGn and TGac channel models

## Outdoor spatial channel models

TGax outdoor channel models for 5GHz band [3] are adopted as IEEE 802.11be outdoor channel models for 5GHz band and 6GHz band.

The brief summary of delay spread of UMi and UMa channels models is listed in Table II.

|  |  |  |
| --- | --- | --- |
| Channel Model |  Scenario | DS (ns) |
| UMi | LOS | 65 |
| NLOS | 129 |
| O-to-I | 240 |
| UMa | LOS | 93 |
| NLOS | 363 |

 Table II. Brief Summary of delay spreads for UMi and UMa channel models

# Channel Models for 320MHz Bandwidth

Generation of channels of bandwidth greater than 160MHz, such as 320MHz, uses the same interpolation scheme for channel bandwidth expansion as described in [1].

The tap spacing reduction factors are listed in Table III.

|  |  |  |
| --- | --- | --- |
|  **System Bandwidth W** | **Channel Sampling Rate Expansion Factor** | **PDP Tap Spacing** |
| **W ≤ 40 MHz** | 1 | 10 ns |
| **40 MHz < W ≤ 80 MHz** | 2 | 5 ns |
| **80 MHz < W ≤ 160 MHz** | 4 | 2.5 ns |
| **160 MHz < W ≤ 320 MHz** | 8 | 1.25 ns |
| **320 MHz < W ≤ 640 MHz** | 16 | 0.625ns |

Table III. Channel sampling rate expansion (tap spacing reduction) factors

# Channel Model for MIMO Systems With More Than 8 Antennas

In TGn, TGac and TGax, we model the correlations at AP with a correlation matrix $R\_{AP}$ with antenna distance $λ$ and we model the correlations at the non-AP STA with a correlation matrix $R\_{non-AP}$ with antenna distance $\frac{λ}{2}.$ In TGbe, more antennas can be equipped at the AP. Given the limited foot-size of the AP, new correlation parameters need to be considered.

Another factor affects the correlation parameters is the configuration of multiple antennas. To assist the performance evaluation, typical antenna configurations are considered.

## Typical Antenna Array Configurations

\*Note: We propose to have one or two typical antenna array configurations, such as a 2D square configuration, 2D square configuration with Polarization.

## Correlation Parameters for More Than 8 Antennas

\*Note: The correlation parameters can be generated for each typical antenna array configuration using the linear approximation method.

# Channel Models for Multiple AP Systems

To help evaluate the performance of multi-AP system, channel modelling for multi-AP system is required.

**STA**

**1**

**STA**

**2**

**AP**

**1**

**AP**

**2**

*H*

*(*

*1*

*,*

*1*

*)*

*H*

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*2*

*,*

*1*

*)*

*H*

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*1*

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*2*

*)*

*H*

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*2*

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*2*

*)*

Figure 1. Channels for a Multi-AP System

Since the antenna distances between different APs and different non-AP STAs are generally large, we can assume that there is no correlations among the antennas from different APs or non-AP STAs.

We also assume that the antenna configurations of an AP or Non- AP STA does not change during transmissions, therefore the correlation parameters are local to the AP or the Non-AP STA itself.

For example, for the multi-AP system as shown in Figure 1, we can model the downlink channels as follows

$$H(1,1)=R\_{STA1}H\_{1,1}T\_{AP1}$$

$$H(2,1)=R\_{STA1}H\_{2,1}T\_{AP2}$$

$$H(1,2)=R\_{STA2}H\_{1,2}T\_{AP1}$$

$$H(2,2)=R\_{STA2}H\_{2,2}T\_{AP2}$$

where $H\_{m,n}$ is the channel between AP m and non-AP STA n without correlation (assuming infinite antenna distance at AP m and non-AP STA n), $T\_{APm}$ is the Cholesky decomposition of the transmit correlation matrix at AP m, and $R\_{STAn}$is the Cholesky decomposition of the receive correlation matrix at non-AP STA n.

Similarly, we can model the uplink channels for the multi-AP system as

$$H(m,n)=R\_{APm}H\_{m,n}^{\*}T\_{STAn}$$

where $H\_{m,n}^{\*}$ is the transpose of $H\_{m,n}$, $R\_{APm}$ is the Cholesky decomposition of the receive correlation matrix at AP m, and $T\_{STAn}$is the Cholesky decomposition of the transmit correlation matrix at non-AP STA n.

# System Level Evaluation Methodology

TGax Evaluation Methodology in [4] is adopted as the evaluation methodology for system level performance evaluations.

**References**

1. “TGn Channel Models”, IEEE 802.11-03/940r4, Vinko Erceg, etc.
2. “TGac Channel Model Addendum”, IEEE 802.11-09/0308r12, Greg Breit, etc.
3. “TGax Channel Model Document”, IEEE 802.11-14/0882r4, Jianhan Liu, etc.
4. “11ax Evaluation Methodology”, IEEE 802.11-14/0571r12, Ron Porat, etc.