The purpose of this slide set is to introduce our contribution C802.16j-06_020r1. This contribution proposes the channel models and performance metrics to be used in IEEE 802.16j Relay Task Group for performance evaluation in urban environment.
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• Classification of Propagation Scenarios

• Channel Model for Each Propagation Scenario

• Performance Metrics and Presentation

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Introduction

- This contribution proposes the channel models and performance metrics to be used in IEEE 802.16j Relay Task Group for performance evaluation.

- The channel models for urban environment is proposed in this version and will be updated to include other environments in the future.
  - The models in this contribution are mostly referenced from [1], which specifies the channel models for various relay transmission scenarios.
Classification of Propagation Scenarios

- The propagation scenarios are classified by the type of each hop and LOS/NLOS (Non-Line-Of-Sight) condition. Following scenarios are considered:

  - Scenario 2.1 BS↔RS, LOS

  - Scenario 2.2 BS↔RS, NLOS
Classification of Propagation Scenarios

- Scenario 2.3 BS↔MS, LOS
  
  - The probability to have LOS condition between BS and MS is considered as zero in urban environment [1], therefore, there is no specific channel model for this scenario.
  
  - Our interpretation is that the occasional gain from LOS condition between BS↔MS is included in log-normal shadow fading effect in NLOS environment with corresponding low probability.

- Scenario 2.4 BS↔MS, NLOS
Classification of Propagation Scenarios

- Scenario 2.5 RS↔RS, LOS

- Scenario 2.6 RS↔RS, NLOS
Classification of Propagation Scenarios

- Scenario 2.7 RS↔MS, LOS

- Scenario 2.8 RS↔MS, NLOS
The channel model for each scenario is characterized by four parts: pathloss, shadow fading, multi-path fading and antenna pattern.

Pathloss model [1]

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Pathloss Model</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 BS→RS, LOS</td>
<td>( \text{Pathloss}(d) [\text{dB}] = 42.5 + 23.5 \cdot \log_{10}(d) + 20 \cdot \log_{10}(\frac{f_c}{5}) )</td>
<td>( d ) is the distance in meter between transmitter and receiver, ( f_c ) is the carrier frequency in GHz.</td>
</tr>
<tr>
<td>2.2 BS→RS, NLOS</td>
<td>( \text{Pathloss}(d) [\text{dB}] = 38.4 + 35 \cdot \log_{10}(d) + 20 \cdot \log_{10}(\frac{f_c}{5}) - 0.7 \cdot h_m )</td>
<td>( h_m ) is the height (meter) of the RS below rooftop for scenario 2.2 and 2.6.</td>
</tr>
<tr>
<td>2.4 BS→MS, NLOS</td>
<td>( \text{Pathloss}(d) [\text{dB}] = 41 + 22.7 \cdot \log_{10}(d) + 20 \cdot \log_{10}(\frac{f_c}{5}) )</td>
<td>( h_m = 1.5 ) for scenario 2.4.</td>
</tr>
<tr>
<td>2.6 RS→RS, NLOS</td>
<td>( \text{Pathloss}(d_1, d_2) [\text{dB}] = 65 + 0.096 \cdot d_1 ) ( + (28 - 0.024 \cdot d_1) \cdot \log_{10}(d_2) + 20 \cdot \log_{10}(\frac{f_c}{5}) )</td>
<td>( d_1 ) and ( d_2 ) are the distances along main street and perpendicular street respectively. (see Figure 3).</td>
</tr>
</tbody>
</table>
Channel Model for Each Propagation Scenarios

- **Log-normal shadow fading** model with correlation [2] is considered in this contribution, which has different parameter for each scenario.
  
  - Consider the de-correlation distance as 20m [3]
  
  - Different standard deviation is considered for each propagation scenario [1]:

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2.1 BS↔RS LOS</th>
<th>2.2 BS↔RS NLOS</th>
<th>2.4 BS↔MS NLOS</th>
<th>2.5 RS↔RS LOS</th>
<th>2.6 RS↔RS NLOS</th>
<th>2.7 RS↔MS LOS</th>
<th>2.8 RS↔MS NLOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard deviation of log-normal shadow fading ($\sigma$)</td>
<td>3.4dB</td>
<td>8dB</td>
<td>8dB</td>
<td>3.4dB</td>
<td>8dB</td>
<td>2.3dB</td>
<td>3.1dB</td>
</tr>
</tbody>
</table>

Note: The shadow fading for LOS scenario represents the different level of first Fresnel zone clearance [7]
Channel Model for Each Propagation Scenarios

- **Multipath fading model**
  - The tapped delay line model for each propagation scenario and Doppler spectrum are listed in section 3.3

- **Antenna pattern**
  - For omni-directional antenna, the antenna gain is considered as 0 $dBi$ for each direction.
  - For 3 or 6-sector antenna, following antenna pattern are considered [4]:

- $-180^\circ < \theta \leq 180^\circ$
- $\theta$ is the angle between the direction of interest and the steering direction of the antenna;
- $\theta_{3\text{db}} = 70^\circ$ is the 3 dB beam width for 3 sector antenna, $\theta_{3\text{db}} = 35^\circ$ for 6 sector antenna.
- $A_m = 20\text{dB}$ maximum attenuation (front-to-back ratio) for 3 sector antenna, 23dB for 6 sector antenna.
Performance Metrics and Presentation

- The following performance metrics are proposed to be considered in IEEE 802.16j Relay TG for performance comparison:
  - Over the air (OTA) throughput
  - Packet delay
  - Throughput for various QoS classes
  - Throughput outage
  - Packet call throughput
  - Sector throughput
  - BS Duty Factor (Utilization)
  - RS Duty Factor (Utilization)
  - Delay per packet, per connection, per application.
  - Jitter per application
  - Overhead ratio
  - Effective spectral efficiency
  - Fairness
  - Route discovery/recovery time
  - Dropped calls due to unsuccessful handover, sleep and idle modes
  - Packet loss rate
Performance Metrics and Presentation

- The following metric presentations are proposed for performance comparison in 802.16j Relay TG:
  - CDF of user packet delay for delay sensitive traffics
  - Plot of system throughput vs. average user throughput
  - CDF of normalized user packet call throughput with fairness criterion
  - CDF of user packet call throughput
  - User throughput vs. distance
  - System load vs outage probability
  - CDF of received signal quality
  - Effective spectral efficiency
Reference


