Channel Measurement for IEEE 802.11aj (45 GHz)

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</table>
Outline

1. Transmission Scenario
2. Measurement Setup
3. Channel Measurement Results
Transmission Scenarios

- Conference room
- Cubicle room
- Living room
Conference Room
Outline

1. Transmission Scenario
2. Measurement Setup
3. Channel Measurement Results
A PC is used to not only control the rotary table with an RS-232 port but also control the signal generator and network analyzer with LAN ports.

The signal generator transmits CW signal at each frequency, then Rx power and channel frequency response are obtained by the network analyzer. The positions of Tx and Rx antennas and measured data are simultaneously recorded.
Parameters of Q-band Channel Measurement

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Frequency band</td>
<td>45 GHz (45.115~45.385 GHz)</td>
</tr>
<tr>
<td>Method</td>
<td>Signal Generator and VNA Sweep Frequency</td>
</tr>
<tr>
<td>Subcarrier Spacing</td>
<td>4.21875 MHz (adjustable)</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>270 MHz (adjustable, 540, 1080 MHz)</td>
</tr>
<tr>
<td>Sweep Frequency Points</td>
<td>64 (128, 256)</td>
</tr>
<tr>
<td>Sweep Frequency Duration</td>
<td>80 ms (adjustable)</td>
</tr>
<tr>
<td>Tx Power</td>
<td>0 dBm (adjustable, max 10 dBm)</td>
</tr>
<tr>
<td>Cable Length</td>
<td>2 m at both ends</td>
</tr>
<tr>
<td>Antenna</td>
<td>Horn antenna / Open ended waveguide antenna</td>
</tr>
<tr>
<td>Measurement Scenario</td>
<td>Conference room (Cubicle room, Living room)</td>
</tr>
</tbody>
</table>
Antennas for Channel Measurement

- **Type I: Horn antenna with 23.7-dBi gain**

- **Type II: Open-ended waveguide (OEW) antenna with 6-dBi gain**
Power Delay Profile (PDP) of STA-STA

Fig. 1 STA-STA Transmission

\[ d_{TR} = 3.47 \text{ m}, \ h_T = h_R = 1.04 \text{ m}, \ \varphi_T = \varphi_R = 0^0, \ P_T = 0 \text{ dBm} \]

BW: 270 MHz, \( f_c \): 45 GHz
Tx Ant: Type I, Rx Ant: Type I

16.3 ns \( \leq \bar{\tau} \leq 117.4 \text{ ns}, 14.7 \text{ ns} \leq \sigma_{\tau} \leq 75.2 \text{ ns} \)

Fig. 2 STA-STA Transmission

\[ d_{TR} = 3.47 \text{ m}, \ h_T = h_R = 1.04 \text{ m}, \ \varphi_T = \varphi_R = 0^0 \]

\[ P_T = 0 \text{ dBm}, \ \text{BW: 270 MHz, } f_c : 45 \text{ GHz} \]
 Tx Ant: Type II; Rx Ant: Type I

15.8 ns \( \leq \bar{\tau} \leq 79.8 \text{ ns}, 16.4 \text{ ns} \leq \sigma_{\tau} \leq 52.5 \text{ ns} \)
Power Delay Profile (PDP) of AP-STA

Fig. 1 AP-STA Transmission
\[ d_{TR} = 5.59 \text{ m}, h_T = 2.72\text{ m}, h_R = 1.04 \text{ m}, \varphi_T = -15^0, \varphi_R = 0^0 \]
BW: 270 MHz, \( f_c \): 45 GHz
Tx Ant: Type I, Rx Ant: Type I

\[ 30.3 \text{ ns} \leq \tau \leq 132.1 \text{ ns}, 16.2 \text{ ns} \leq \sigma_\tau \leq 61.7 \text{ ns} \]

Fig. 2 AP-STA Transmission
\[ d_{TR} = 5.59 \text{ m}, h_T = 2.72\text{ m}, h_R = 1.04 \text{ m}, \varphi_T = -15^0, \varphi_R = 0^0 \]
P_T = 0 dBm, BW: 270 MHz, \( f_c \): 45 GHz
Tx Ant: Type II; Rx Ant: Type I

\[ 25.2 \text{ ns} \leq \tau \leq 113.9 \text{ ns}, 20.7 \text{ ns} \leq \sigma_\tau \leq 58.2 \text{ ns} \]
Power Angle Profile (PAP) of STA-STA

Fig. 1 PAP of STA-STA Transmission

\[ d_{TR} = 3.47 \text{ m}, \ h_T = h_R = 1.04 \text{ m}, \]
\[ \phi_T = \phi_R = 0^\circ, \ P_T = 0 \text{ dBm} \]

BW: 270 MHz, \( f_c \): 45 GHz

Tx Ant: Horn antenna or OEW antenna
Rx Ant: Horn antenna

- For horn antenna,
  \[ \Lambda = 0.23, \ \gamma = 0.58, \ \theta_{\text{max}} = -5.0^\circ \]
- For OEW antenna,
  \[ \Lambda = 0.32, \ \gamma = 0.40, \ \theta_{\text{max}} = -21.3^\circ \]
Power Angle Profile (PAP) of AP-STA

Fig. 1 PAP of STA-STA Transmission

$h_T = 2.7\, m$, $h_R = 1.3\, m$, $d_{TR} = 5.83\, m$

$\varphi_T = -15^0$, $\varphi_R = 0^0$

$P_T = 0\, \text{dBm}$

BW: 270 MHz, $f_c: 45\, \text{GHz}$

Tx Ant: Horn antenna or OEW antenna

Rx Ant: Horn antenna

- For horn antenna,

  $\Lambda = 0.74$, $\gamma = 0.71$, $\theta_{max} = -68.1^\circ$

- For OEW antenna,

  $\Lambda = 0.62$, $\gamma = 0.43$, $\theta_{max} = 33.1^\circ$
Future Works

• The 45 GHz band channel will be measured in conference room, cubicle room and living room;
• Transmission scenarios will include LoS and NLoS;
• Channel measurement for 3 bandwidth configurations (270, 540 and 1080 MHz) will be compared;
• More measurement data will be obtained, which will be used for statistical channel modeling;
• Penetration losses for different kinds of walls and blockage objects will also be measured;
• Some parameters, for example penetration losses, PAP and PDP of multipath will be compared between 45 GHz and 60 GHz bands.
Thank you very much for your attention!