Path Loss Assignment Probabilities

Document Number:
IEEE C802.16j-06/066

Date Submitted:
2006-07-03

Source:
Dean Kitchener, Mark Naden
Nortel
London Road
Harlow, Essex, CM17 9NA

Wen Tong, Peiying Zhu,
Gamini Senarnath, Hang Zhang, David Steer, Derek Yu
Nortel, 3500 Carling Avenue

Venue:
IEEE 802.16 Session #44, San Diego, USA

Base Document: C80216j-06_040:” Multi-hop System Evaluation Methodology (Channel Model and Performance Metric)”

Purpose:
To discuss the probability assignment for RS above and below rooftop and the standard deviation of lognormal shadowing distribution

Notice:
This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:
The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:
The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.
Introduction

• In this contribution, some assignment probabilities are proposed for the different multihop path loss models, and some recommendations are made for the lognormal shadowing standard deviation for different links
Recommended path loss models

- **BS-RS/RS-RS rooftop-to-rooftop**
  - Modified IEEE 802.16d Category C [1]
- **BS-RS/BS-MS/RS-MS rooftop-to-below-rooftop**
  - Modified IEEE 802.16d [1]
- **RS-MS/RS-RS below-rooftop-to-below-rooftop on same street**
  - Advanced LOS model [2]
- **RS-MS/RS-RS below-rooftop-to-below-rooftop on different streets**
  - Modified Berg/ETSI over-the-rooftop model [2]
Assignment Probabilities (1)

<table>
<thead>
<tr>
<th></th>
<th>First Hop</th>
<th>K\textsuperscript{th} - Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>30%</strong></td>
<td><img src="image1.png" alt="Diagram" /></td>
<td><img src="image2.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Probability of RS above rooftop = 0.3</td>
<td>Modified IEEE 802.16d Category C</td>
<td>Modified IEEE 802.16d Category C</td>
</tr>
<tr>
<td>Probability of RS below rooftop = 0.7</td>
<td>Modified IEEE 802.16d</td>
<td>Modified IEEE 802.16d</td>
</tr>
<tr>
<td><strong>70%</strong></td>
<td><img src="image3.png" alt="Diagram" /></td>
<td><img src="image4.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

For the BS-RS link \(\rightarrow\) for user self deployed scenarios

Probability of RS above rooftop = 0.3
Probability of RS below rooftop = 0.7
Assignment Probabilities (2)

For the below rooftop case (RS-RS/RS-MS) the assignment probabilities indicated below can be used. The advanced LOS model is used if the RS and MS are located on the same street, and the Berg/ETSI model are used if they are located on different streets.

<table>
<thead>
<tr>
<th>Last Hop</th>
<th>Advanced LOS model</th>
<th>Modified Berg/ETSI model</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>LOS transmission</td>
<td>Given $d$, uniform generate $d_1 (0,d)$</td>
</tr>
<tr>
<td></td>
<td>Relay Station</td>
<td>Relay Station</td>
</tr>
<tr>
<td></td>
<td>Mobile Station</td>
<td>Mobile Station</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>$d_1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$d_2$</td>
</tr>
</tbody>
</table>

Given $d$, uniform generate $d_1 (0,d)$
Shadowing standard deviation

Propose a shadowing standard deviation dependant on excess path loss over free space. This ensures that shadowing is reduced when the path loss model is close to free space loss.

\[
\begin{align*}
r & = \frac{|P_{r} - P_{fs}|}{4r_{e}} \\
 & \approx 1.5
\end{align*}
\]

where,

- \( u \) Maximum standard deviation
- \( P_{r} \) Mean path loss (dB)
- \( P_{fs} \) Free Space path loss (dB)

- For BS-RS with RS above rooftop:-
  - For wanted BS, assume RS is deployed with LOS back to BS. \( u = 1.9 \text{dB} \)
  - For neighbouring BS’s, no guarantee of LOS so shadowing will be greater. \( u = 4.5 \text{dB} \)
- For BS-MS/BS-RS with MS/RS below rooftop:-
  - Use (Okumura equation [1] – 1.5) for \( u \)
- For RS-MS with MS on same or different street:-
  - \( u = 6.5 \text{dB} \)
Summary

• Regarding location of user deployed RS
  – 1st hop
    • Probability of RS above rooftop = 0.3,
    • Probability of RS below rooftop = 0.7
  – Kth hop
    • Probability of RS above rooftop = 0.6,
    • Probability of RS below rooftop = 0.4

• Regarding the RS and MS location in the urban
  – Probability of RS-MS at same street = 0.3,
  – Probability of RS-MS at different street = 0.7

• Recommend shadowing standard deviation which is dependant on excess path loss
  – Ensures shadowing is reduced when path loss is close to free space loss
References

[1] ‘Multihop Path Loss Model (Base to Relay and Base to Mobile)’, Dean Kitchener et al., IEEE C802.16j-06/011, 1/5/2006


[3] ‘Multihop Network Simulation with Street Layout’, Dean Kitchener et al., IEEE C802.16j-06/012, 2/5/06