Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>
Title	Multi-hop System Evaluation Methodology (Channel Model and Performance Metric)
Date Submitted	2006-05-11

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Re:	Response to a call for contributions for the Relay TG, see C80216j-06/001.pdf
Abstract	This document captures scope of the Multi-hop System Evaluation Methodology including the Channel Model, Traffic Model and Performance Metrics.
Purpose	System Evaluation Methodology including the Channel Model, Traffic Model and Performance Metrics documented in this contribution is used as a reference for the performance evaluation for the IEEE802.16j Task Group.
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Multi-hop System Evaluation Methodology

1 Introduction

[Editor's notes: This document provides the proposed scope and captures the definitions and methodology for performance modeling and evaluation metric]

1.1 Simulation overview

The objective of the system level simulation methodology, the definitions for channel models, traffic models and performance metric are presented in this document. The simulator architecture is shown in Figure 1.

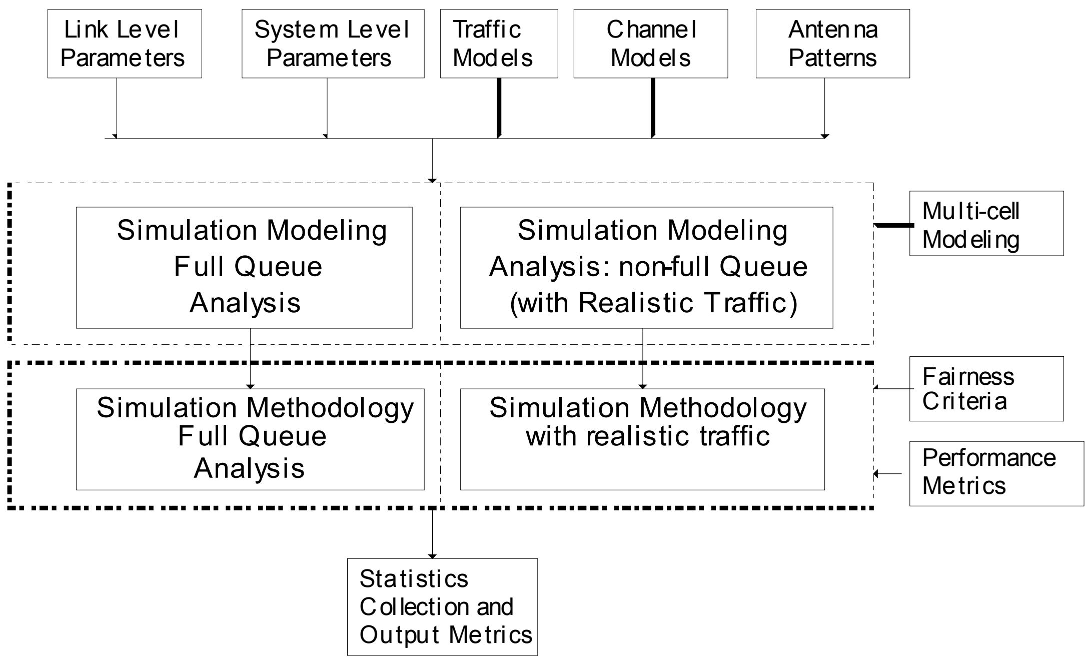


Figure 1 Simulation Components and Overall Methodology

2 Channel Models

[Editor's note: adopt the modified IEEE802.16d SUI channel model as baseline [?], and open for further comparison with other models such as the path-loss models in [6]]

2.1 Path-Loss Model

[Editor's note:]

2.1.1 BS ↔ RS, LOS pathloss model

2.1.2 BS ↔ RS, NLOS pathloss model

2.1.3 BS ↔ MS, LOS pathloss model

2.1.4 BS ↔ MS, NLOS pathloss model

2.1.5 RS ↔ RS, LOS pathloss model

2.1.6 RS ↔ RS, NLOS pathloss model

2.1.7 RS ↔ MS, LOS pathloss model

2.1.8 RS ↔ MS, NLOS pathloss model

2.1.9 BS↔RS and BS↔ MS propagation modeling

[Editor's note: adopt the model in [9]]

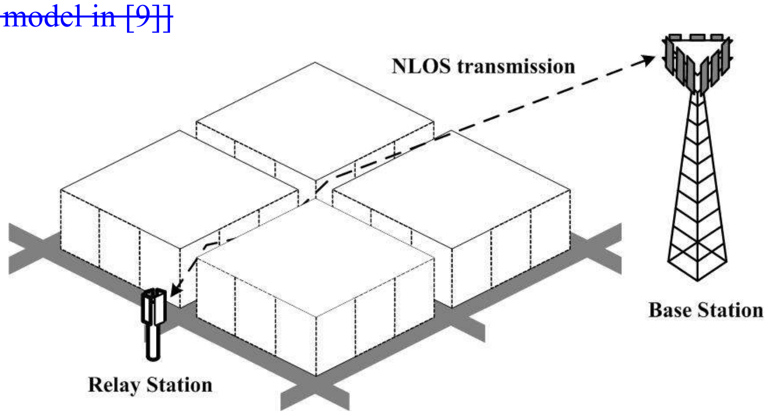


Figure 2 NLOS transmission between BS ↔ RS

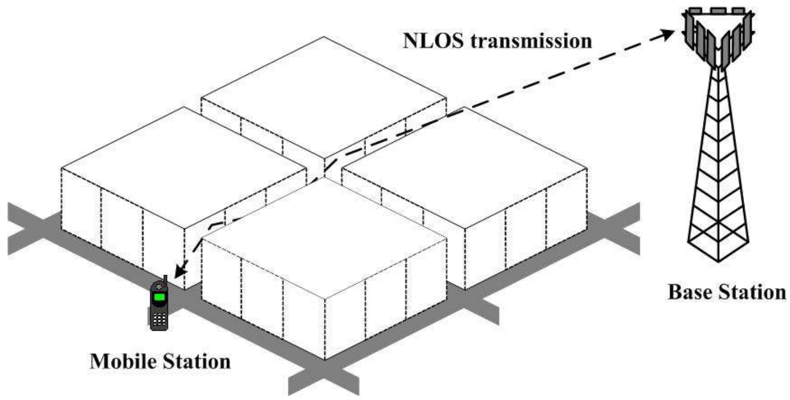


Figure 3 NLOS transmission between BS ↔ MS

2.1.10 RS↔ MS and RS↔ RS propagation modeling

[Editor's note: Editor's note: adopt the model in [8]]

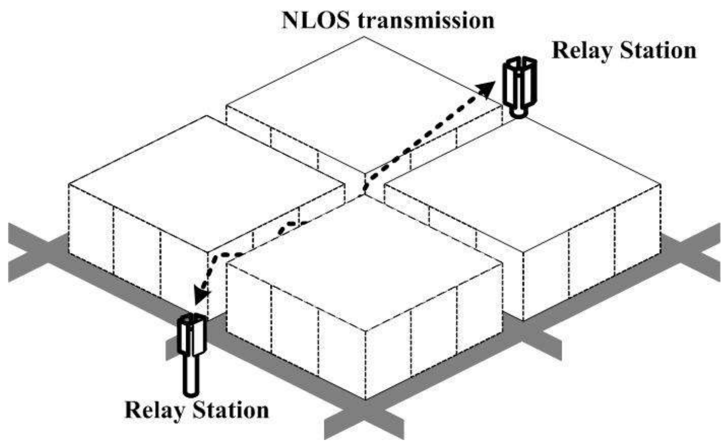
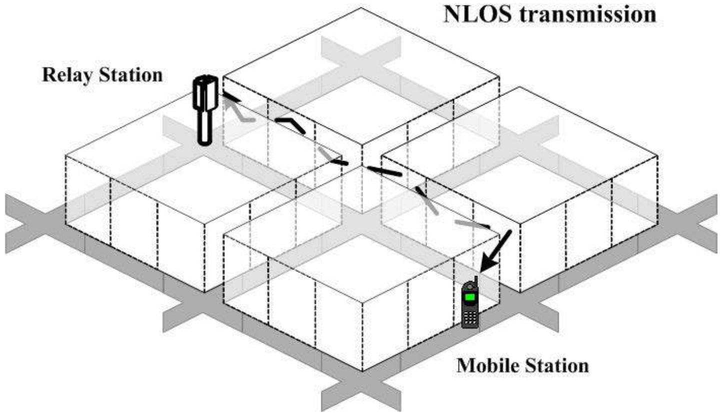


Figure 4 NLOS transmission between RS↔ RS



~~Figure 5 NLOS transmission between RS↔MS~~

2.1.11 Shadowing modeling

[Editor's note: adopt the model in [7]]

2.1.12 Tap-Delayed-Line channel modeling

[Editor's note: Further inputs are required FFS]

2.1.13 Antenna pattern

2.1.13.1 BS antenna

[Editor's note: adopt the antenna pattern in [6]]

For omni-directional antenna, the antenna gain should be $0\ dBi$ for each direction. For 3-sector or 6-sector antenna, the antenna pattern specified by [4] should be applied:

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right] \quad dBi$$

where

$-180^\circ < \theta \le 180^\circ$;

θ is the angle between the direction of interest and the steering direction of the antenna;

$_{3db} = 70^{o}$ is the 3 dB beam width for 3 sector antenna, 35^{o} for 6 sector antenna.
A_m = 20dB maximum attenuation (front-to-back ratio) for 3 sector antenna, 23dB for 6 sector antenna.

2.1.13.2RS antenna

[Editor's note: need further study]

2.1.13.3MS antenna

[Editor's note: no change]
Omni antenna pattern is assume for MS

3 Traffic models

[Editor's note: Full buffer is baseline model, need to choose on real-time traffic model, adopt [4] and use references]

Table 1 Traffic Model

#	Application	Traffic Category	Priority
1	Full buffer		x
2	FTP	Best-effort	
3	Web Browsing	Interactive	
4	VoIP	Real-time	TBD
5	Video Streaming	Streaming	TBD
6	Live Video	Interactive Real-time	

3.1 Non Real-Time Traffic

3.1.1 Full buffer model

[Editor's note: adopt the model in [4]]

3.1.2 FTP

[Editor's note: adopt the model in [4]]

3.1.3 Web browsing

[Editor's note: adopt the model in [4]]

3.2 Real-Time Traffic

3.2.1 VoIP

[Editor's note: adopt the model in [4]]

3.2.2 Video streaming

[Editor's note: adopt the model in [4]]

3.2.3 Live video

[Editor's note: adopt the model in [4]]

4 Performance Metrics

4.1 Definitions of Performance Metric

[Editor's note: the following 6 metrics are considered as initial input]

4.1.1 System data throughput

The data throughput of a MMR-BS is defined as the number of information bits per second that a site can successfully deliver or receive using the scheduling algorithms.

4.1.2 Packet call throughput:

Packet call throughput which is the total bits per packet call divided by total packet call duration.

4.1.3 Effective system spectral efficiency

Effective system spectral efficiency normalized by the downlink/uplink ratio of TDD system, for the DL case:

$$\text{DL Site Spectral Efficiency} \quad \frac{\text{DL System Data Throughput}}{\text{Total Site BW allocated to DL}}$$

4.1.4 CDF of data throughput per user

The throughput of a user is defined as the ratio of the number of information bits that the user successfully receives during a simulation run and the simulation time.

4.1.5 The CDF of packet delay per user

5 Link Budget

5.1 Link Budget

[Editor's note: adopt the model in [4]]

5.1.1 BS→ RS and BS→MS Link Budget

[Editor's note: FFS]

5.1.2 BS←RS and BS←MS Link Budget

[Editor's note: FFS]

5.1.3 RS→ MS and RS→RS Link Budget

[Editor's note: FFS]

5.1.4 RS←MS and RS←RS Link Budget

[Editor's note: FFS]

6 References

[1] 3GPP2/TSG-C.R1002, “1xEV-DV Evaluation Methodology (V14)”, June 2003.
[2] 3GPP TR 25.996 V6.1.0, “Spatial channel model for Multiple Input Multiple Output (MIMO) simulations,” September 2003.
[3] IEEE C802.16j-6/023, “Multi-hop System Evaluation Methodology” May, 2006
[4] IEEE C802.16j-6/024, “Multi-hop System Evaluation Methodology: Traffic Models”, May, 2006
[5] IEEE C802.16j-6/025, “Multi-hop System Evaluation Methodology–Performance Metrics” May, 2006
[6] IEEE C802.16j-6/020r1,“Channel Models & Performance Metrics for IEEE 802.16j Relay Task Group” May, 2006
[7] IEEE C802.16j-6/009, “Correlated Lognormal Shadowing Model”, May, 2006
[8] IEEE C802.16j-6/010, “Below Rooftop Path Loss Model”, May, 2006
[9] IEEE C802.16j-6/011, “Multi-hop Path Loss Model (Base-to-Relay and Base-to-Mobile)”, May, 2006
[10] IEEE C802.16j-6/012, “Multi-hop Network Simulation with Street Layout “May, 2006
[11] IEEE C802.16j-6/014, “Metrics for Multi-hop Systems” May, 2006
[12] IEEE C802.16j-6/015, “RF compatibility of RS with other MSS” May, 2006
[13] IEEE C802.16j-6/003, “Seaport Path Loss Model for Fixed Wireless Applications”, May, 2006

Appendices

A.1 Multi-Cell Layout

In Figure 6, a network of cells is formed with 7 clusters and each cluster consists of 19 cells. Depending on the configuration being simulated and required output, the impact of the outer 7 clusters may be neglected. In those cases, only 19 cells and associated relays may be modeled. These cases are identified in the sections below.
For the cases where modeling outer-cells are necessary for accuracy of the results, the 7 cluster network can be used. However, the six of the seven clusters are just virtual clusters repeating the middle cluster in its surroundings as shown in the figure. Each cell with generic hexagonal grid is separated to 3 sectors, each is formed by a panel directional antennas.

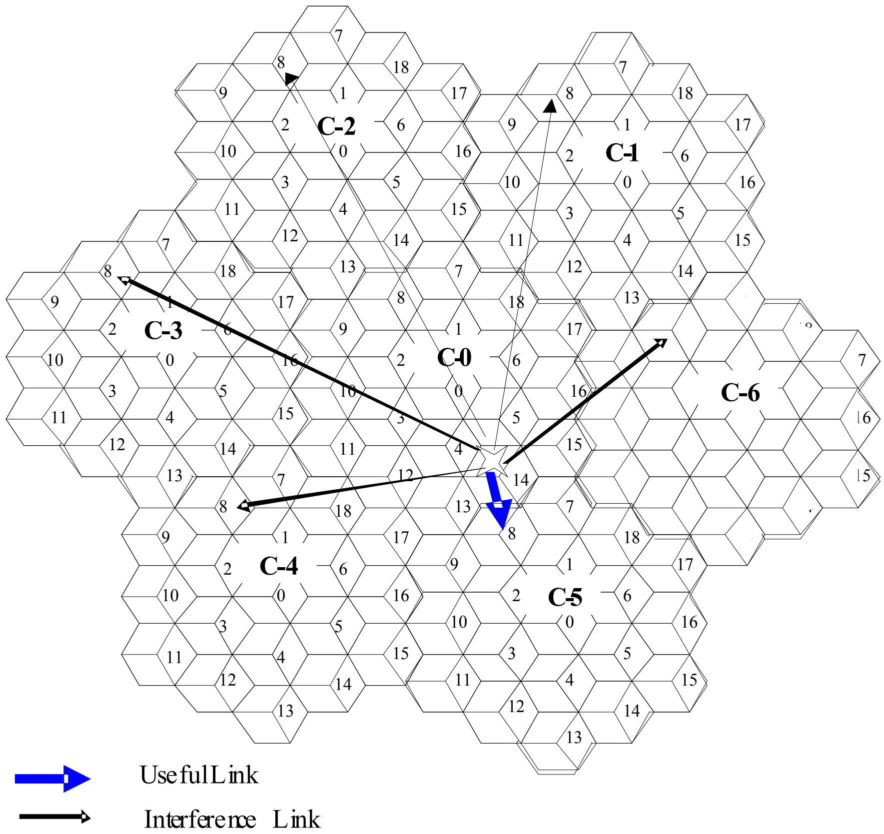


Figure 6 Multi-cell Layout and Wrap-around Example

A1.1 Obtaining virtual MS locations

The number of MSs is predetermined for each sector, where each MS location is uniformly distributed. The MS assignment is only done in the cluster-0 from where the decided MSs are replicated in the other six clusters. The purpose to employ this wrap-around technique, as will be discussed in later section, is to easily model the interferences from other cells.

A1.2 Determination of severing cell for each MS in a wrap-around multi-cell network

The determination of serving cell for each MS is carried out by two steps due to the wrap-around cell layout;

one is to determine the shortest distance cell for each MS from all seven logical cells, and the other is to determine the severing cell for each MS based on the strongest link among 19 cells related to the path-loss and shadowing.

To determine the shortest distance cell for each MS, the distances between the target MS and all logical cells should be evaluated and select the cell with a shortest distance in 7 clusters. Figure 2 illustrates an example for determination of the shortest distance cell for the link between MS and cell-8. It can be seen that the cell-8 located in cluster-5 generates the shortest distance link between MS and cell-8.

To determine the severing cell for each MS, we need to determine 19 links, whereby we may additionally determine the corresponding path-loss, shadowing and transmit/receive antenna gain in consideration of antenna pattern. The serving cell for each MS should offer a strongest link with a strongest received long-term power. It should be noted that the shadowing experienced on the link between MS and cells located in different clusters is the same.