Document Number:

IEEE 802.16.1pp-00/07

Title:

Classification of Statistical Channel Models for Local Multipoint Distribution Service Using Antenna Height and Directivity

Date Submitted:

2000-01-05

Source:

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Venue:

802.16 Session #5 PHY Presentation Tuesday

Base Document:

IEEE 802.16.1pc-00/07 (http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_07.pdf)

Purpose:

To provide an input to the specific area “Channel model”

Classification of Statistical Channel Models for Local Multipoint Distribution Service Using Antenna Height and Directivity

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Outline

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Summary

Introduction

How to use/develop available statistical channel models for evaluating the performance of broadband wireless systems such as local multipoint distribution service (LMDS)?

Classify them using the height and directivity of antennas, which can be determined for LMDS systems.

The mechanisms and characteristics of radio propagation strongly depend on the antennas' heights and directivities.

High antennas: providing line-of-sight (LOS) propagation paths. Directivity/Gain: limiting the number of multi-path and its effects.

Antenna Height and Directivity Dependence of Channel Models

- Low, omni-directional, antennas, no LOS propagation path, but a large number of non-LOS paths.

  Amplitude of received signal: Rayleigh distributed.

  Phase: uniformly distributed from 0 to 2π.

- High, at least omni-directional at one end, antennas, LOS path along with a large number of non-LOS paths.

  Received signal: Rician distribution.

- High, at least directional at one end, antennas, LOS path along with a limited number of non-LOS paths.

  Received signal: lognormal distribution.

- High or low , directional or omni-directional, antennas, a number of non-LOS paths with or without LOS path.

  Received signal: Nakagami-m distribution taking Rayleigh distribution as a special case.

Complementary Cumulative Distribution of Relative Power Level

Formulations and plots for lognormal, Rayleigh, and Nakagami-m distributions.

Rician distribution may fail when using directional high-gain antennas which limit the number of non-LOS propagation paths.

A hybrid of lognormal and Rayleigh distributions may apply to a propagation environment including both LOS and non-LOS propagation paths.

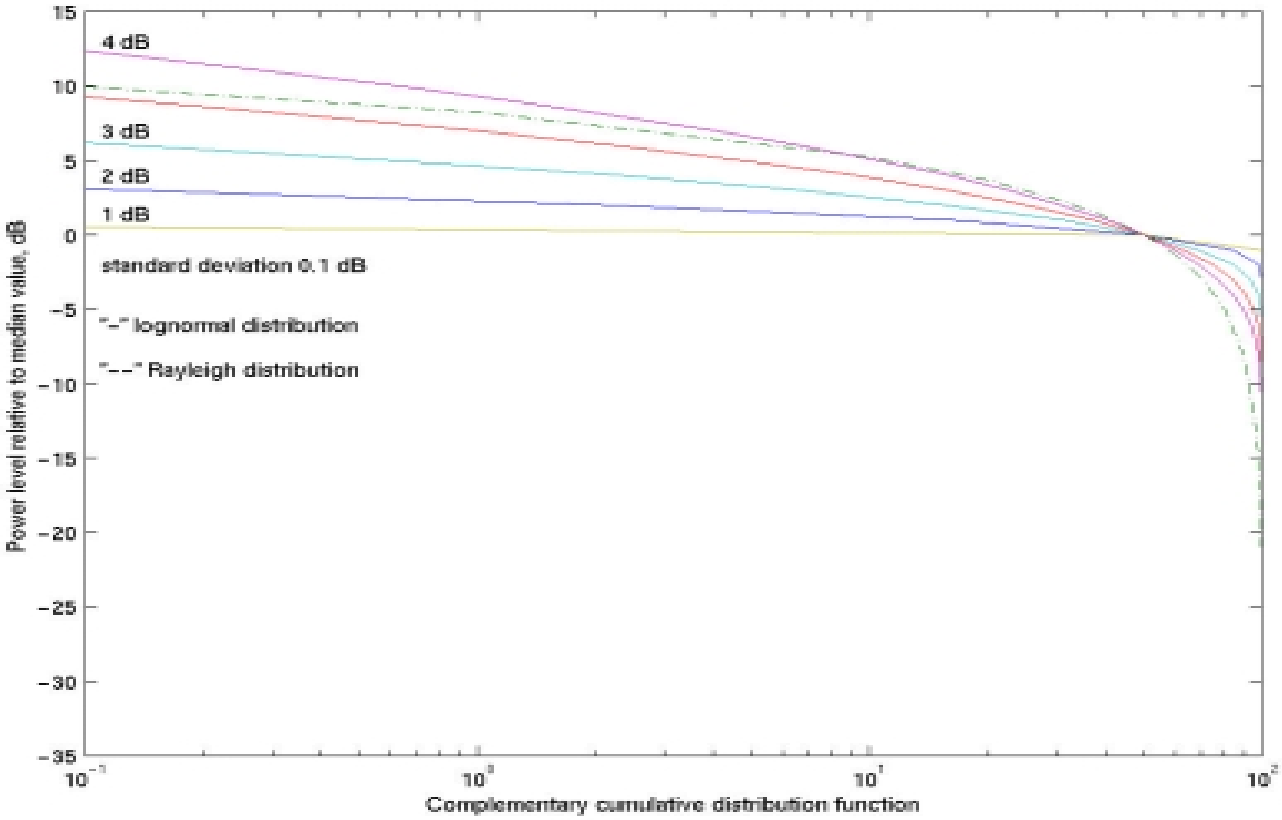

Fig. 1. Complementary cumulative distribution function of relative power level for lognormal distribution. Similar result for Rayleigh distribution is included.

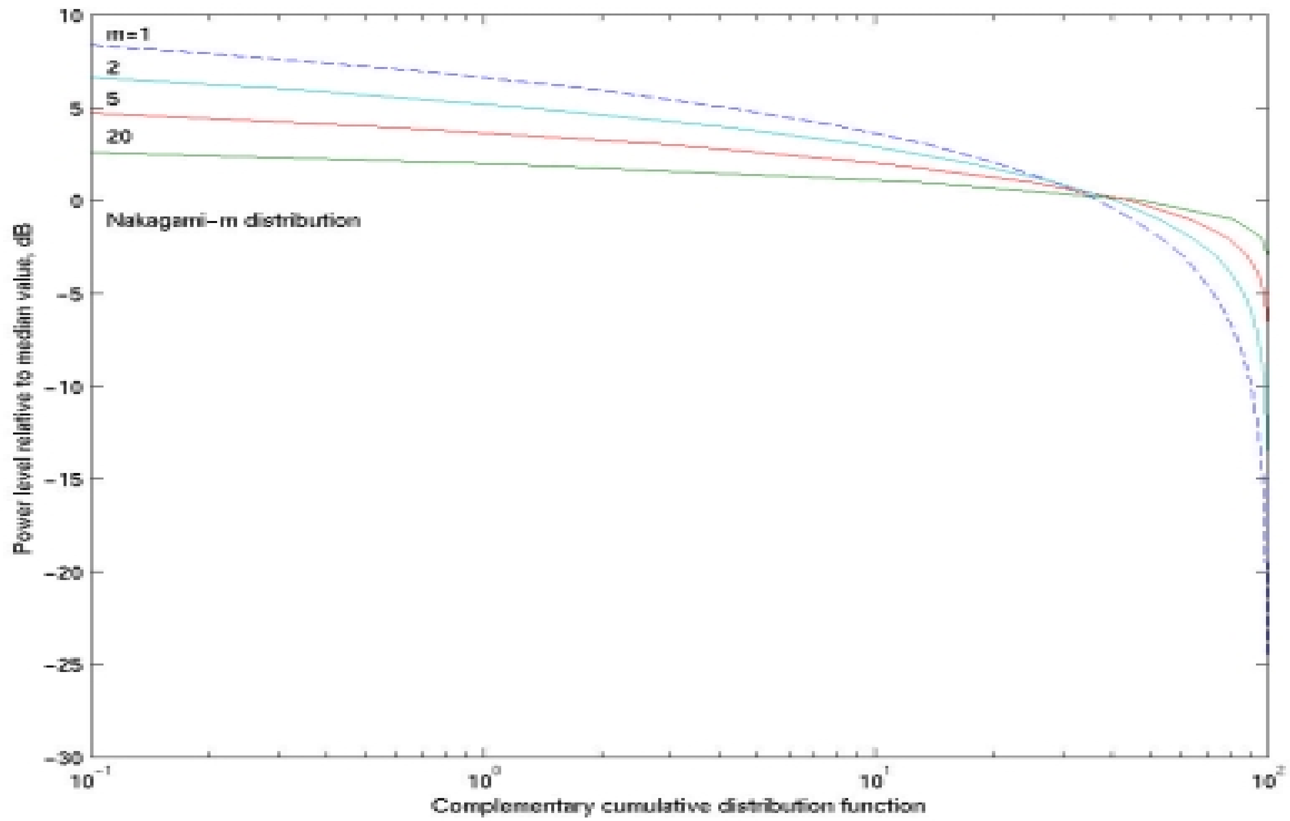

Fig. 2. Complementary cumulative distribution function of relative power level for Nakagami m-distribution.

Error Rate Performance for Uncoded Transmission

Formulations and some plots for lognormal, Rayleigh, and Nakagami-m distributions.

Modulations: binary phase-shift keying (BPSK) and differential quature phase-shift keying (DQPSK).

For $m < 1$, Nakagami-m channel is worse than Rayleigh channel!

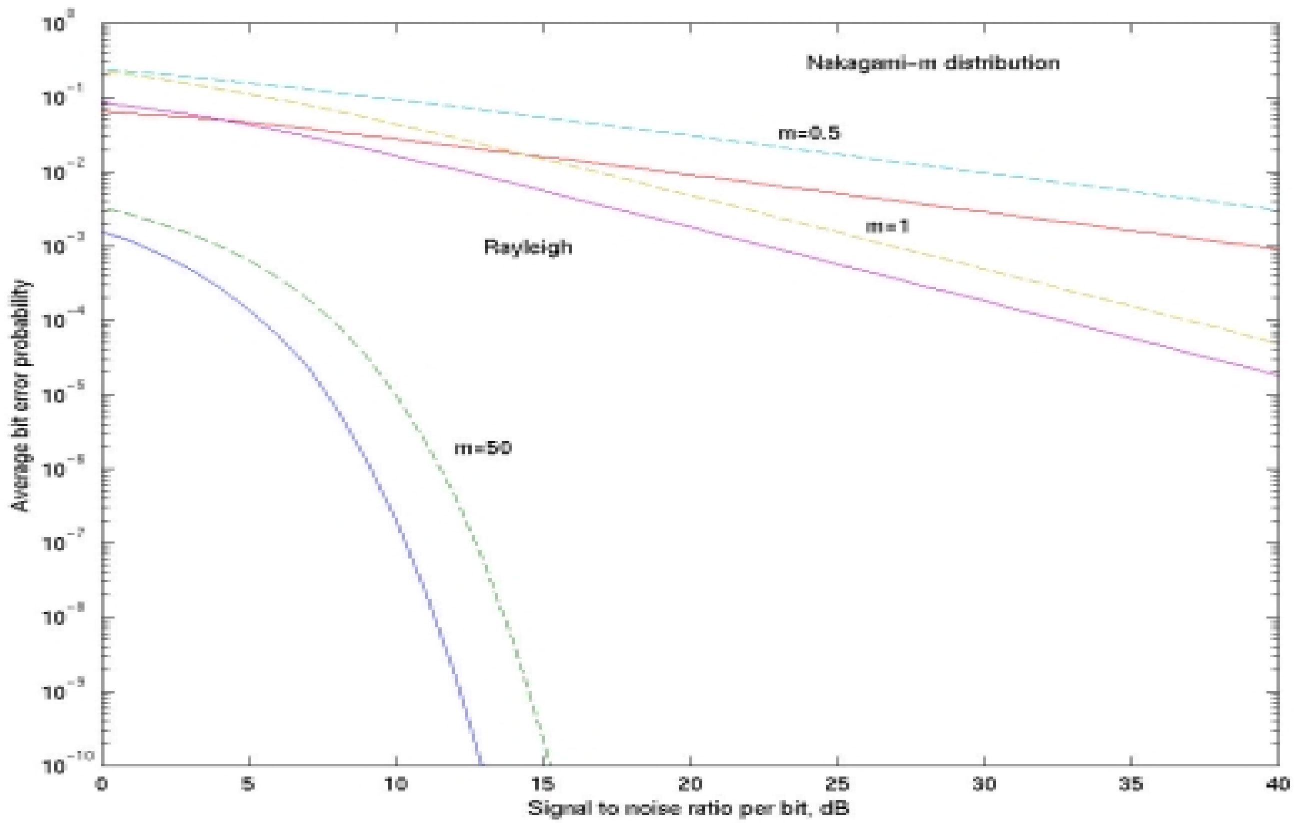

Fig. 3. Average bit error probability of Nakagami m-distribution channel for uncoded transmission as a function of the mean signal to noise ratio per bit; solid lines used for BPSK modulation and dashed lines for DQPSK modulation.

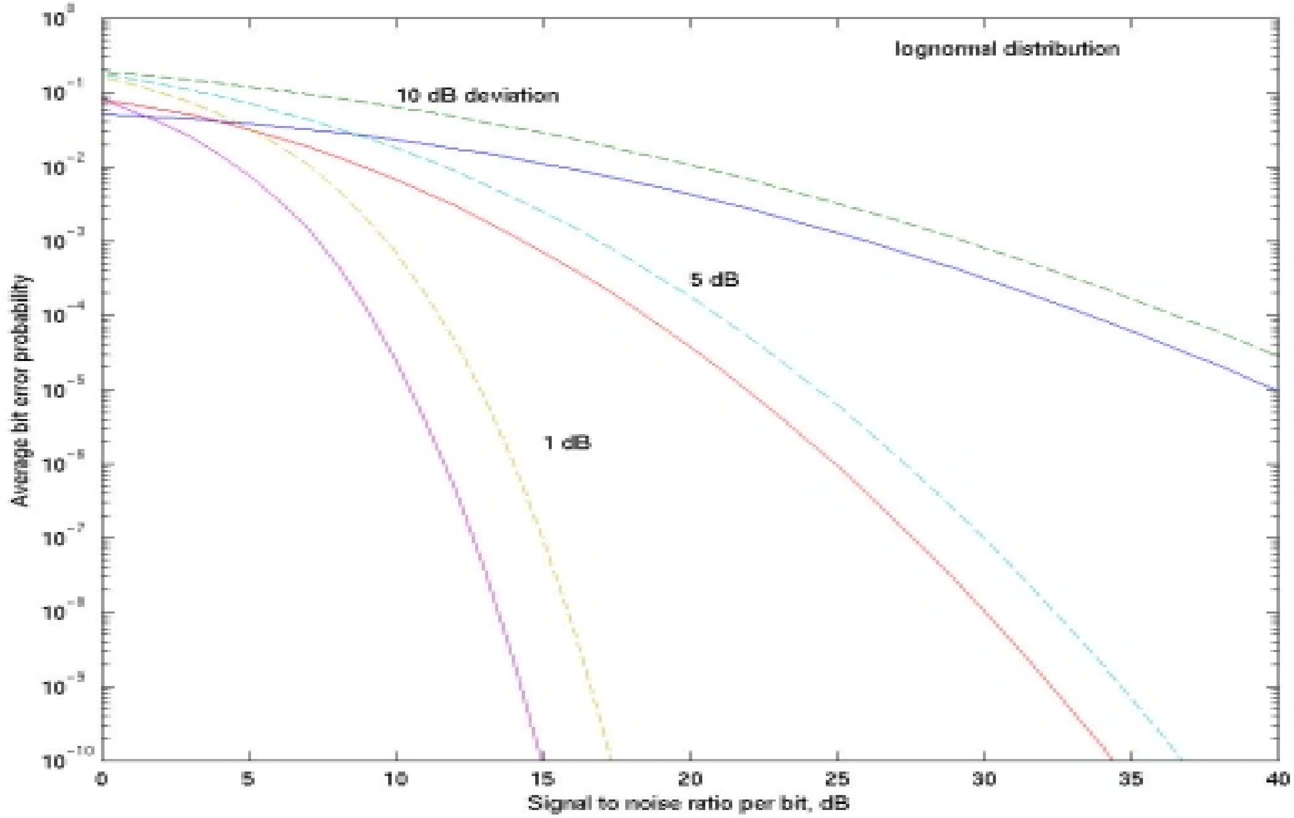

Fig. 4. Average bit error probability of lognormal distribution channel for uncoded transmission as a function of the mean signal to noise ratio per bit; solid lines used for BPSK modulation and dashed lines for DQPSK modulation.

Relationship Between Data Rate and SNR

Data Rate (describing the link capacity) decreases as Propagation Loss increases for a required Signal to Noise Ratio (SNR).

SNR (describing the quality of service) decreases as Propagation Loss increases for a given Data Rate.

Data Rate decreases as SNR increases for given Propagation Loss.

Propagation Loss can be minimized by installing high, directional high-gain, antennas.

Summary

Classification of channel models for use in LMDS evaluation:

- High, directional gain, antennas providing LOS path and limiting non-LOS paths: lognormal, or Nakagami-m, channel.
- High antennas providing LOS path and a large number of non-LOS paths: Rician channel.
- Low antennas providing no LOS paths: Rayleigh, or Nakagami.

High antennas with directional high-gain should be utilized, which minimize propagation impairments such as multi-path effects.