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Re:	Interim Channel Models for G2 MMDS Fixed Wireless Applications
Abstract	This document raises issues with previously proposed channel models
Purpose	Consideration and Addressing of the issues presented herein
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Issues with the Interim Broadband Fixed Wireless Channel Model

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Introduction

We believe the current Broadband Fixed Wireless channel model has some internal inconsistencies as well as inconsistencies with past experience in channel modeling. In addition, we believe the channel model should consider the frequency correlation function. We detail these inconsistencies below and present a potential frequency correlation function.

Doppler shifts on multipaths

The Doppler shifts on the multipaths that are proposed for SUI channel models 1-6 are small and uniform. Physically plausible arguments suggest Doppler shifts should be larger and not uniform across multipaths. In particular, moving vehicles in the area of the BTS and CPE would introduce much larger Doppler shifts than that accounted for in the SUI models. Traffic in the vicinity of the BTS and CPE will be moving on the order of 60mph or approximately 30 m/s. This translates into a Doppler frequency of approximately

$$f_d = f_c \frac{v}{c} = (2.5x10^9\,Hz)\,\frac{30m/s}{3x10^8\,m/s} = 250\,Hz$$

But all the multipaths in the SUI models have Doppler shift of 0-2Hz. Thus, the SUI models do not seem to account for reflections off vehicles moving at normal speeds. Furthermore, one would expect that not all multipaths would have the same Doppler shift. One would expect some multipaths to bounce off moving reflectors and others off stationary reflectors so that the Doppler shift would vary with multipath. However, all the multipaths within any particular SUI model have the same Doppler shift. Note that neither the BTS nor the CPE are moving, so if the reflectors all have the same multipath Doppler shift, they must all be moving the same speed relative to the CPE and BTS. This seems physically unlikely.

Power-Delay Profile

Measurements taken in suburban environments seem to suggest that multipath powers are much lower and multipath delays much longer than that suggested by the SUI models.

If a narrow beamwidth is used, the model developed in [1] suggests that the first multipath (at approx. 0.1 microseconds) is approximately 10dB down from the spike (or direct) path, not the –3dB to –5dB suggested by SUI models 1-5. More specifically, Fig. 1 in [1] shows the first multipath is approximately 19dB down from the direct path. By 1 microsecond, the multipath powers are approximately 30dB down from the main path. Furthermore, the multipath measurements made in [1] suggest that 8-10 multipaths can be detected within 1 microsecond after the arrival of the direct path. The SUI models show only 3 taps within 0.6 to 20 microseconds. We suggest that further data analysis is required to better determine rms delay spread

Inconsistency of the Beamwidth and Power-Delay Profiles

The beamwidth is assumed to be large for the BTS antenna and moderate for the CPE antenna, but the multipath delay profile model is applicable only to antennas with narrow beamwidths. The beamwidths for the BTS and CPE antennas are 120 and 50 degrees respectively. However, the multipath delay profile as described and referenced in [1] were taken with beamwidths of 32 degrees. The Power-Delay profile proposed for the SUI models is therefore inconsistent with the beamwidths proposed for the models. The authors of [1] point out that their 'spike + exponential' model does not hold for omnidirectional antennas.

Ricean K Factor

The Ricean K Factor values proposed in SUI models 3-6 do not seem consistent with data presented in the literature. The data presented in [1] and other literature suggest that the median value for K_0 is in the range 5-20, but the SUI models 3-6 use $K_0=0$. This discrepancy should be resolved.

This may be explained partly by the fact that the SUI models assume larger beamwidths than those used in [1]. If this is true, then it would seem beneficial to use as narrow a beam as possible to have as high a value of K_0 as possible. A larger value of K_0 implies a larger LOS component and therefore, a higher detection probability. Thus, higher detection probability can be achieved by using narrow beamwidths to isolate the direct path, lowering multipath powers (to limit fading), and having higher K_0. Therefore, it is to the system designer's benefit to take advantage of that direct path power.

Deployment Scenario limitations and the Gain Reduction Factor

The SUI channel models use restrictive CPE/BTS geometries which limit the potential performance of any future fixed wireless system. The SUI channel models specify the BTS antenna height to be 50 ft, the CPE antenna height to be 10 ft, and the cell size to be 6.4 kilometers [3]. Restricting the channel models in this way could limit the performance of future systems that do not use these parameter values.

We propose instead to allow the BTS/CPE antenna geometries to vary over a range of parameter values. Regarding the antenna heights, we propose to allow the BTS and CPE antenna heights to vary over a reasonable range. In particular, the CPE should be allowed to vary within 8-20 ft +, and BTS should be allowed to vary within 50-150 ft. We also propose that Line-of-sight (LOS), near LOS, and non-line-of-sight (NLOS) channels be considered in the channel model. Allowing this variation in geometries will more accurately measure the relative performance of competing systems and therefore, produce a more robust final system for the customer.

These restrictive geometries introduce a Gain Reduction Factor which we found inconsistent with past experience. We have done studies of antenna gain variation using the Antenna Substitution Method. These studies indicated little variation in antenna gain using antennas with different array gain patterns. We would therefore like clarification on the data reduction method used in [4] to reconcile our experience with the results presented in [4]. This may lead to further analysis in the future.

Frequency correlation function

The fading of two signals at different frequencies at the same spatial location is an important parameter in determining the performance of any proposed system. In particular, the fading correlation function would determine the utility of frequency diversity. Fuhl, Molisch, and Bonek addressed the question of correlation of fading as a function of frequency in [2]. The scattering model proposed in [2] considered scatterers Gaussian distributed over a disk surrounding the antenna of interest. The signal at the antenna position has a fading correlation over frequency of the following form:

$$\rho_{\Delta w} = \exp\left[-\left(\frac{R\Delta w}{\sqrt{2}c_0}\right)^4\right]$$

where R is the radius of the scattering disk, Δw is the frequency variation, and c_0 is the speed of light. The plot of this function is shown in Fig. 5 in reference [2]. We propose consideration of this as the model for fading correlation across frequency.

Conclusion

In summary, we believe the current Broadband Fixed Wireless channel model has some internal inconsistencies as well as inconsistencies with past experience in channel modeling. In addition, we believe the channel model should also consider the frequency correlation function. The Doppler shifts on the multipaths are too small and uniform across multipaths. The power-delay profile is not supported by the literature. The beamwidths assumed for the power-delay model are not consistent with the beamwidths assumed for the SUI models. The Ricean K factor is too small in several of the SUI models. The range of model parameters is too limited and introduces a

Gain Reduction Factor that we believe is not applicable to most of the models of interest to this community. We also propose introduction of a frequency correlation function into the model as described in [2].

Reference:

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