Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Coexistence Same Area Simulations at 10.5 GHz (Inbound)**
Date Submitted	**2002-06-03**
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Re:	Coexistence C/I Simulation Estimates in Support of 802.16a System Design
Abstract	This document examines inbound C/I estimates at 10.5 GHz. Coordination distance separation between operators is investigated for both clear sky and rain faded conditions.
Purpose	This document is provided to TG2a for consideration and inclusion in the amended Coexistence Practice for PMP systems operating below 11 GHz.
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Patent Policy and Procedures	

Coexistence Same Area C/I Simulations at 10.5 GHz (Inbound)

1.0 Introduction

A companion contribution [1] examined inbound C/I simulation estimates at 3.5 GHz. The simulation model remains as in [1] with the addition of the consideration of rain attenuation differentials as described in [2], [3]. Rain attenuation in ITU-R regions K and P are considered.

System and equipment parameters for 10.5 GHz remain as described in prior contributions. Using these parameters, link budget estimates indicate that the inbound link is likely restricted to 4-QAM for an R = 7 km path. This places threshold C/N at 12 dB and a 1 dB threshold impairment set at 18 dB.

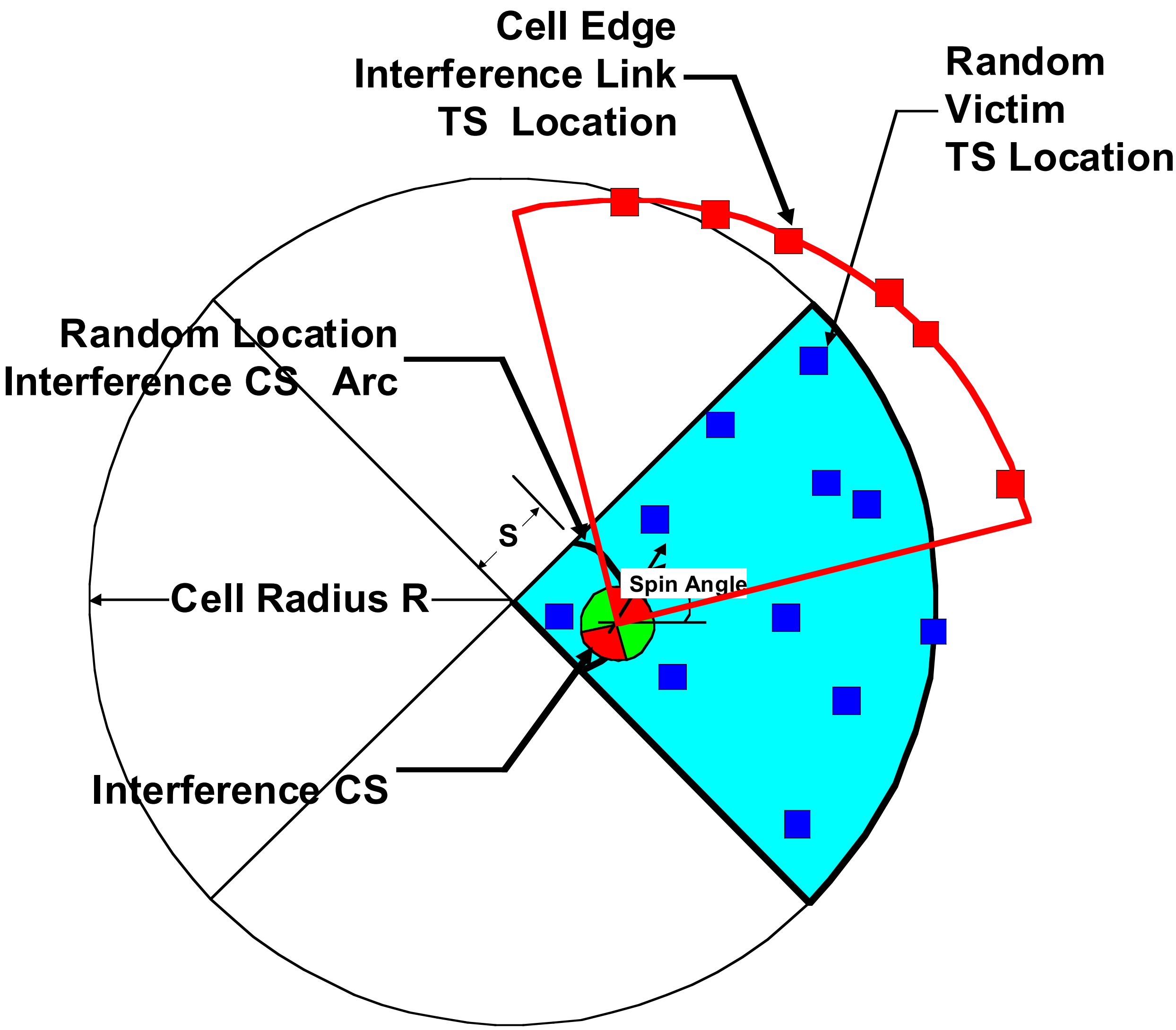
2.0 Simulation Model

The simulation methodology for developing Monte Carlo C/I estimates has been repeatedly described in prior contributions and will not be repeated herein. The simulation model follows closely that of prior models and is illustrated on Figure 1. Here, the interference CS is located at some parameterized distance S from the CS of the victim sector. Its angular position is random for each spin angle increment.

For each spin increment, a randomly positioned cell edge interference TS is selected as active. Twenty randomly positioned victim TS locations are assigned and the C/I of each is computed. These are entered into a database and the procedure is repeated for each spin increment of 5 degrees.

Under rain fading conditions, a rain cell of diameter D_c = 2.4 km is overlaid on the victim sector. It's distance D_{rc} and angle φ from the victim CS are random. Allowing for adjustments to distance proportional ATPC due to rain attenuation, the relative signal levels of the victim and interference vectors are then computed. These are constrained to meet the inclusion/exclusion distance and angle limits described in [2], [3].

Figure 1. Simulation Model



2.0 Simulation Results

Previous studies have indicated that the C/I estimates are the most severe for small S. Hence, S is constrained to be less than 0.5 km in the following. NFD without a guard band is set to 27 dB.

2.1 Clear Sky

Figure 2 illustrates the clear sky simulation estimates. Clearly, there are no C/I estimates that approach the 4-QAM threshold impairment limit of 1 dB. The C/I results are comparable to those for 3.5 GHz (Figure 5 of [1]). As well, they are roughly comparable to the outbound results for 10.5 GHz [4].

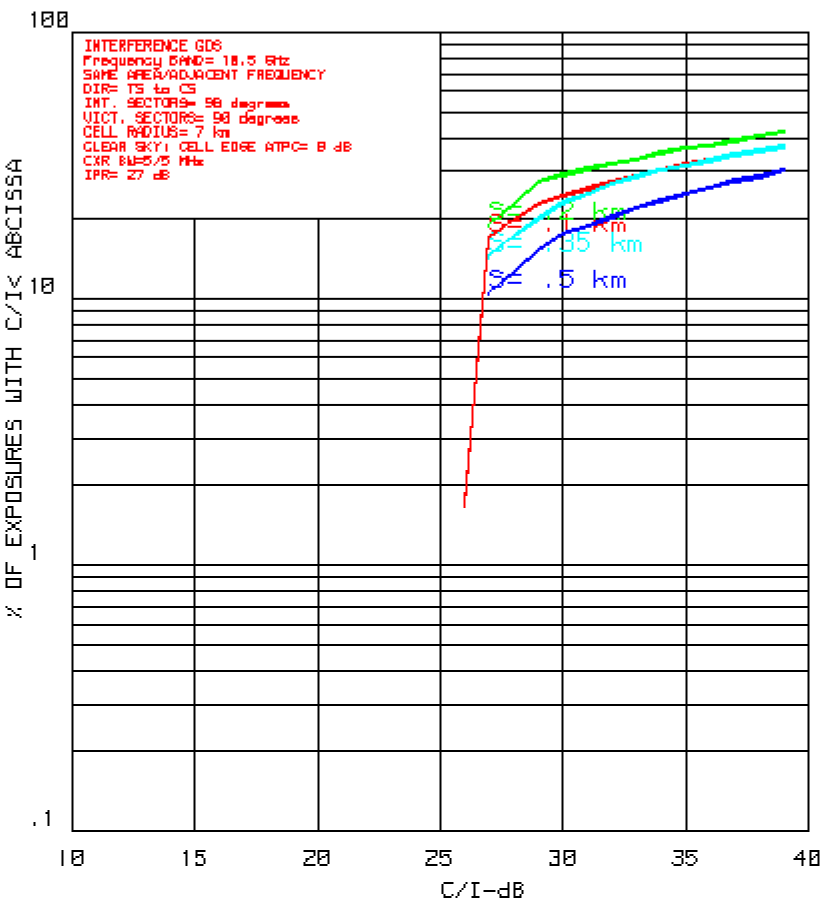


Figure 2. Clear Sky CDF for Zero Guard Band and Same Polarization (S < 0.5 km)

2.2 Rain Faded

Figure 3 illustrates the rain faded C/I estimates for ITU-R rain region K. For 99.99% availability, reference [2] indicated that a fade margin of 7 dB would be required. Hence, this loss is set for the maximum rain attenuation experienced from the rain cell. While the rain attenuation between the victim and interference links has degraded the C/I estimates, the performance is still more than adequate to support 4-QAM on the inbound link, even up to CS separation distances of 0.1 km.

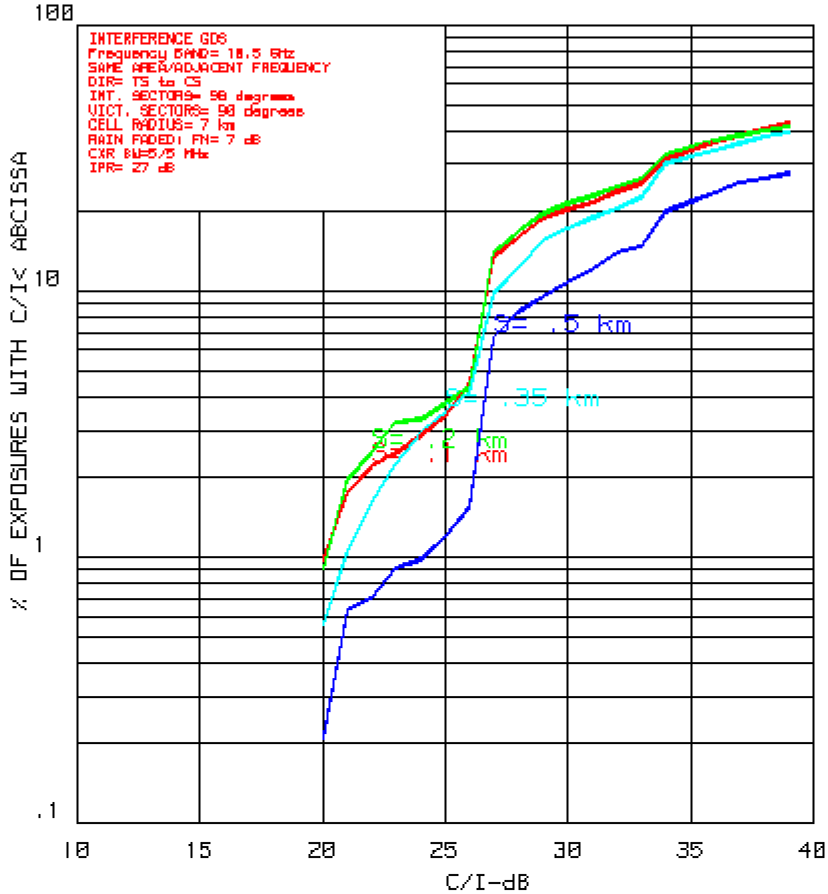


Figure 3. Rain Region K CDF for Zero Guard Band and Same Polarization (S < 0.5 km)

Figure 4 illustrates the rain faded C/I estimates for ITU-R rain region P. For 99.99% availability, reference [2] indicated that a fade margin of 16 dB would be required. Thus, this is the loss set for the maximum rain attenuation experienced by the rain cell.

Without a guard band, the assumed NFD is 27 dB. For this NFD value, it would be concluded that even 4-QAM operation would be questionable. However, even a modest 8 dB improvement in NFD to 35 dB would resolve the performance issues as the graphs simply move to the right by 8 dB. Such an NFD improvement is likely representative of current product NFD's.

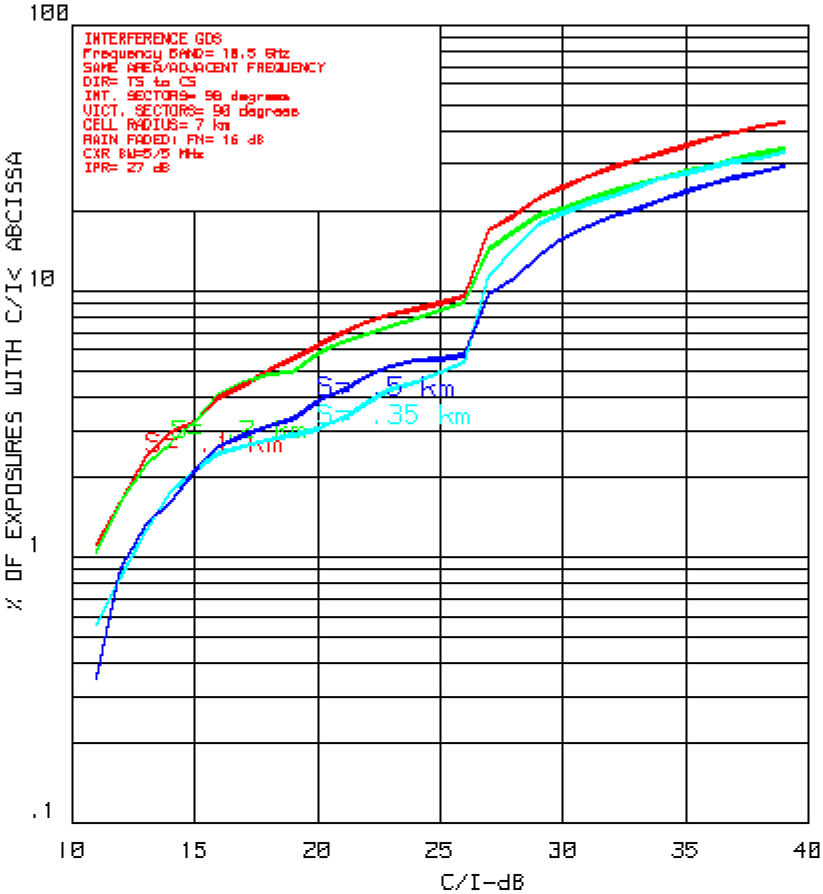


Figure 4. Rain Region P CDF for Zero Guard Band and Same Polarization (S < 0.5 km)

3.0 Summary

The preceding simulations have indicated that, at 10.5 GHz, the inbound link is capable of supporting 4-QAM performance objectives up to ITU-R rain region K. This would apply for a zero guard band and a modest NFD of 27 dB. However, when we examine the outbound link [4], the transmission modulation index was assumed to be 16-QAM. Here, it was noted that an NFD of 27 dB would be quite marginal, but that an NFD improvement to 35 dB would satisfy performance objectives. This NFD improvement would seem to be achievable, referenced to current product parameters. Hence, one might conclude that successful operation of FDD links are likely up to a rain rate environment of ITU-R rain region K. This would apply to even modest CS to CS separation distances of 0.1 km.

However, when we extend the rain rate environment to ITU-R rain region P, we find that the inbound link likely requires an NFD improvement to 35 dB to be successfully operational. But, we note that the outbound link, as described in [4], would require also CS separation distance constraints of 500 m unless NFD can be improved even further.

Hence, it is concluded that that the controlling limit on the C/I performance is the outbound link. There are further limits on the outbound link when the C/I impairments associated with CS to CS TDD operation are considered. These issues are likely resolvable if improved NFD from ultra-linear CS transmitters is employed.

4.0 References

[1] Coexistence Same Area Simulations at 3.5 GHz (Inbound), C802.16.2a-02/08.

[2] A Simplified Method for the Estimation of Rain Attenuation at 10.5 GHz, C802.16.2-02/15.

[3] An Addendum to: "A Simplified Method for the Estimation of Rain Attenuation at 10.5 GHz", C802.16.2-02/17.

[4] Coexistence Same Area Simulations at 10.5 GHz (Outbound), C802.16.2a-02/16.