Project	IEEE P802.16 Broadband Wireless Access Working Group
Title	TDD Boundary Interference Coordination
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Re:	Call for contributions on coexistence, posted on the IEEE 802-16-web site, August 1999. Specifically, this contribution addresses BTA and cross-border boundary interference coordination for TDD.
Abstract	This contribution quantitatively examines TDD-TDD boundary coordination parameters when it is assumed that sector assignments across boundaries are randomly aligned. It is demonstrated that for 30 degree TDD sectors, the probability of interference alignment is quite low, of the order of a few percent. It is further demonstrated that by selection of frequency re-use plans that provide reserve sector assignments, TDD coordination requirements become minimal.
Purpose	To demonstrate to the 802.16 standards committee that TDD systems can be deployed with minimal concern with respect to boundary coordination.
Notice	
Release	

TDD Boundary Interference Coordination

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1.0 Introduction

In a previous contribution (802.16cc-99/10), boundary interference trigger thresholds were proposed referenced to a power flux density (pfd) level. Based on an assumed set of Broadband Wireless Access (BWA) equipment parameters, two trigger thresholds were proposed, these being < –114 dBW/m^2/MHz (Category 1-no coordination requirement) and < -94 dBW/m^2/MHz (Category 2-operator-operator coordination).

Referenced to these thresholds, this contribution will quantitative examine the probability of interference intercept for TDD systems that employ 30 degree sector antennas. The analysis will be restricted to examination of hub-to-hub interference, this being stated in contribution 802.16cc-99/05 to be of most concern.

The analysis will demonstrate that the probability of trigger level intercept for 30 degree sectored TDD systems is quite low; of the order of a few percent. The analysis will further demonstrate that the re-use flexibility which is unique to TDD can be exploited to reduce coordination requirements to minimal values.

2.0 System Parameters

The system parameters employed for the analysis are:

RF Frequency:	28.15 GHz
TX Power:	+16 dBm
HUB Antenna Gain:	+20 dBi
Remote Antenna Gain:	+36 dBi
Carrier Bandwidth:	10 MHz
Inbound Power Control:	10 dB (cell edge)
Antenna Patterns:	ETSI – EN 301 215-2 Class CS2
Transmission Loss:	LOS for both victim and interference paths
Cell Radius R:	3 km (CCIR rain region K)

3.0 Computation Methodology and Results

Across a BTA boundary, one can always connect a straight line between the centers of an interference cell and a victim cell as illustrated on Figure 1. Co-polarized sectors are assumed to be randomly positioned relative to each other since, internal to each BTA, service applications and cellular re-use orientation would be expected to be independent.

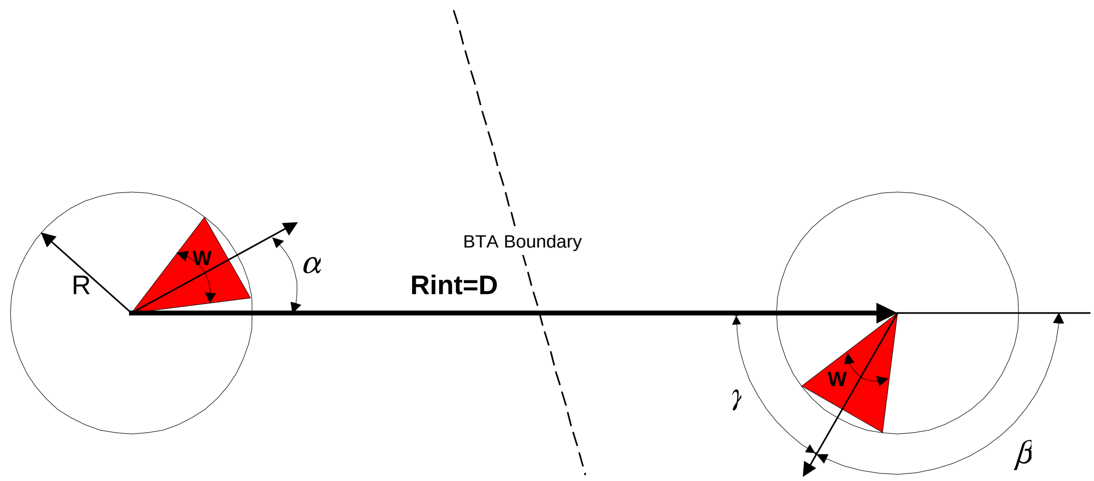


Figure 1. Hub to Hub Boundary Interference Geometry

The probability of the victim hub experiencing a given pfd level is then simply determined by the link calculations, assuming uniformly random and independent sector alignments. To develop this estimate, both sectors were spun in 5 degree increments, thus resulting in a set of $72\times72=5184$ pfd estimates for a computation. The results are then sorted and displayed as a CDF for the probability of pfd exceedance vs pfd level.

Contribution 802.16cc-99/10 did not consider antenna gain differential in terms of development of the pfd trigger thresholds. For the assumed system parameters, this is 16 dB. If cell edge inbound power control is set at 10 dB, then the victim hub benefits from a 6 dB transmission gain advantage. This is included in the link calculations and the pfd estimate is therefore labeled as *Effective* pfd.

Figure 2 illustrates the computation results for an interference distance D ranging from 6 to 60 km. At 6 km, the interference and victim cells are just touching at the BTA boundary.

For the range of interference distances examined, there are no pfd levels that exceed the Category 2 trigger threshold and beyond 30 km, there are no pfd levels that exceed the Category 1 trigger threshold. At the cell touching distance of 6 km, only a modest 2% of exposures exceed the –114 dBW/m^2/MHz Category 1 threshold.

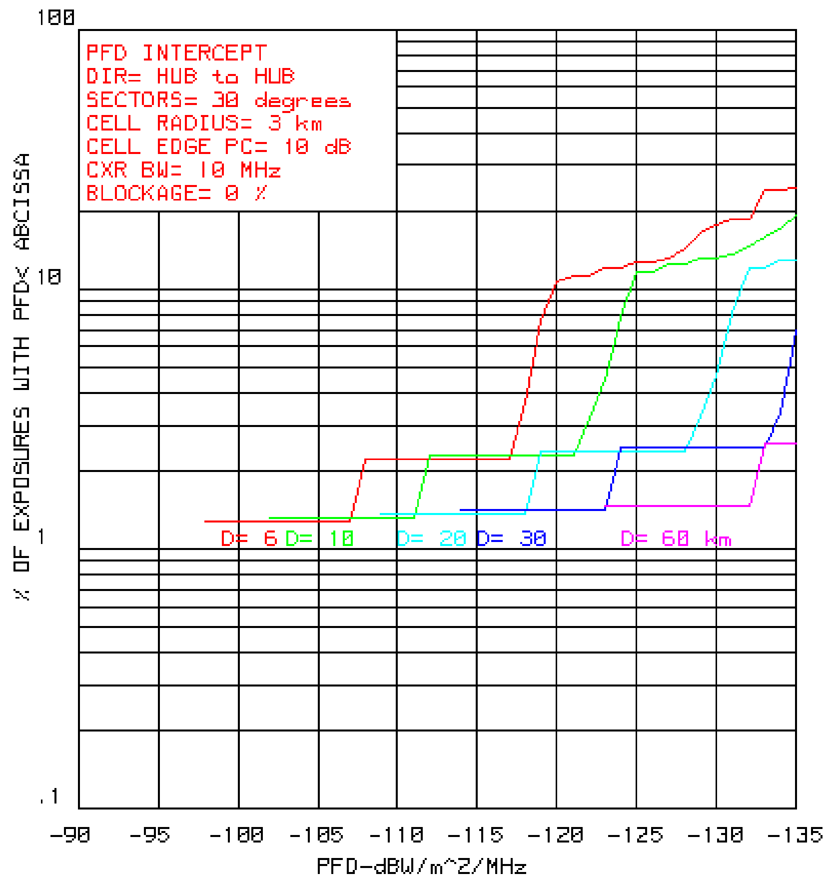
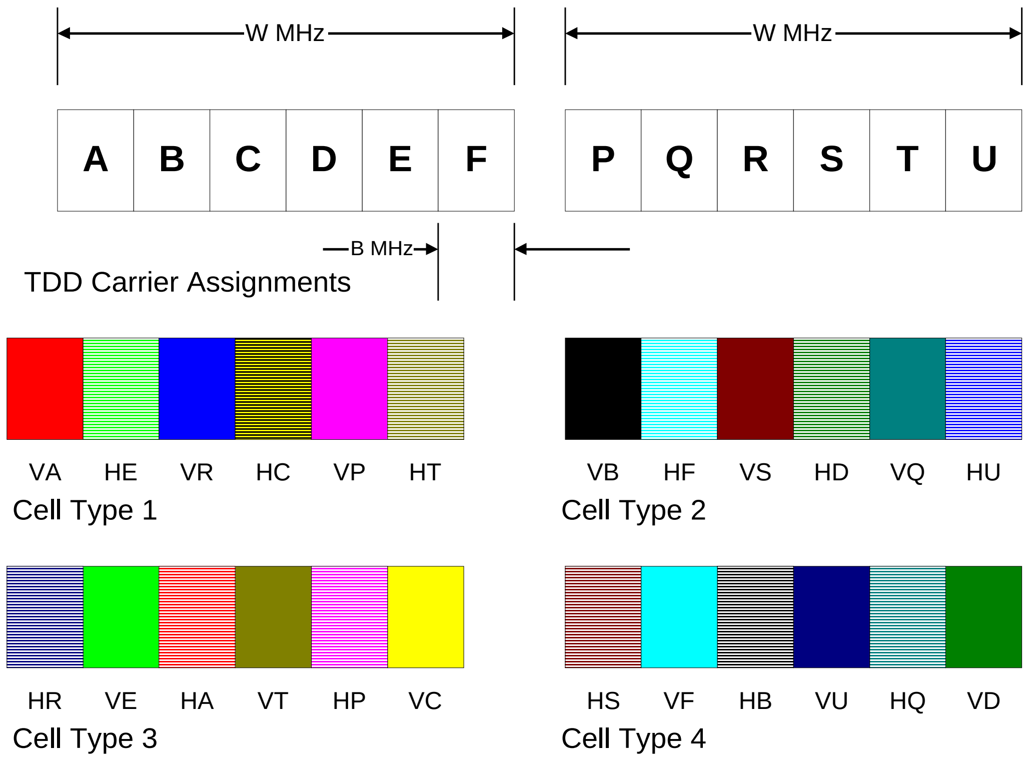


Figure 2. Hub to Hub Interference Probability for 30 Degree TDD Sectors

5.0 Interference Coordination Mitigation

In contribution 802.16cc-99/08 it was conclusively demonstrated that efficient TDD frequency re-use plans could be developed that, under worst case interference scenarios, would meet the stringent performance objectives required for BWA. For the example re-use design 2 blocks of 6 carriers were employed in conjunction with 2 polarization’s H and V. As TDD benefits from the ability to employ all carrier assignments, 24 distinct degrees of freedom were available for sector assignments.

With 30 degree sectors, and frequency/polarization repeat at 180 degrees, 4 distinct cell types were available that were employed within an N=12 cluster architecture. Each cell type was employed 3 times within the cluster and sector rotations were employed to minimize direct interference exposures. Figure 3 illustrates the frequency and polarization assignments selected for the example design.



However, other satisfactory cluster dimensions can be considered. An example is N=9. With each cell type employed 3 times within the cluster, only Cell Types 1-3 are required to develop the cluster as illustrated on Figure 4. As there is now 1 spare cell type available within the cluster, the reserve cell or sector assignments can be employed to selectively increase sector capacity, for route diversity or for deployment of higher modulation index carriers. If required for BTA boundary coordination, they can also be employed for this purpose. As the reserve assignments represent 25% of the total available, there are ample carriers available to minimize coordination requirements.

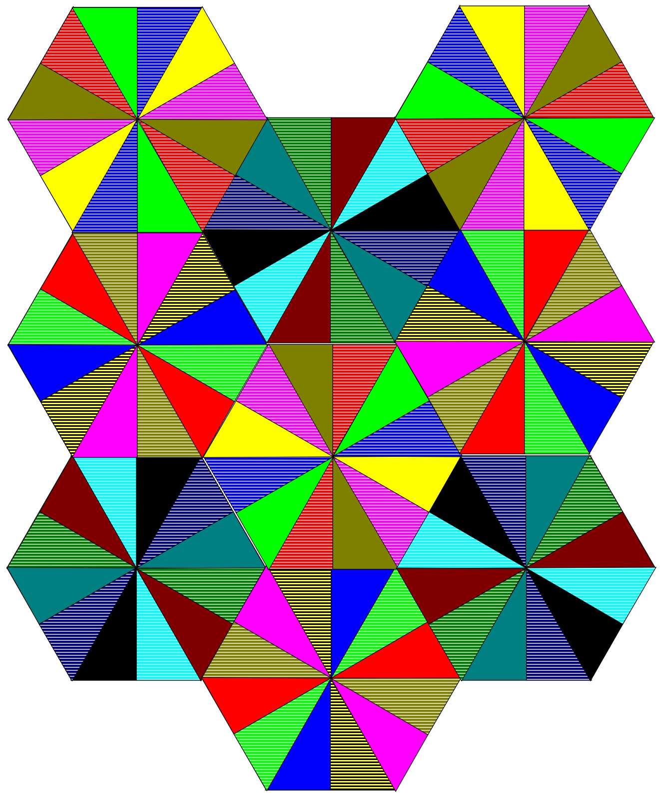


Figure 4 N=9 Frequency Re-Use Cluster for 30 Degree Sectors

6. Summary

This contribution has examined boundary interference coordination issues for TDD systems. A computational example demonstrates that TDD will experience only a modest coordination requirement when deployed with 30 degree sector assignments, even for worst case hub to hub exposures.

The ability of TDD to utilize all available carrier assignments for the development of efficient frequency re-use can provide reserve carrier assignments. These reserve assignments can be employed to minimize or eliminate coordination requirements as demonstrated by the example N=9/30 degree sector design. Comparable strategies can be developed for other sector beamwidths.