Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Amendments for Coexistence of High Density Fixed Systems (HDFS) Point-to-Multipoint (PMP), Point-to-Point (PTP) and Mesh Systems**
Date Submitted	**2001-03-06**
Source(s)	Peter A. Soltesz / Fred Ricci / Brandon Hinton Winstar Communications, Inc. 2545 Horse Pen Road, Herndon, VA Tel: 703-889-6430 / 703-889-6477 /703-889-6404 E-mail: p.soltesz@ieee.org, fricci@winstar.com, bhinton@winstar.com
Re:	IEEE PAR 802.16.2
Notice:	This document was approved by the ***Wireless Communications Association (WCA)*** **Engineering Committee** for submission to the IEEE 802.16.2
Abstract	Whereas there are, and will continue to be, High Density Fixed Service (HDFS) system deployments consisting of a significant mix of Point-to-Multipoint (PMP), Multipoint-to-Multipoint and Point-to-Point systems, a recommended practice for coexistence should be inclusive of these types of deployments. In fact recommendation 6 of the current practice refers to this need. The scope of such a practice should investigate and amend the susceptibility of Point-to-Point (PTP) stations that exist, either co-channel or adjacent channel, with Multipoint systems. Investigations should be done on the coexistence of these systems and specific Power Flux Densities (*Pfd*) of PTP victims and corresponding coordination distances should be determined with inputs from Radio vendors. All of the current practice should be reviewed and amended to reflect the coexistence of PTP systems.
Purpose	The authors would like to have the attached information included as an amendment to the 802.16.2 working document. A study group should be formulated to write a PAR.
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributors grants a free, irrevocable license to the IEEE to incorporate text contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Co-existence of High Density Fixed Systems (HDFS) Point-to-Multipoint (PMP), Point-to-Point (PTP) and Mesh Systems*

Overview

Many existing and future High Density Fixed Systems (HDFS) consists of both Point-to-Point (PTP) and Point-to-Multipoint (PMP) systems that must coexist with other licensed systems in the 24, 26 and 28 and 37.0-42.5 GHz bands. The National Spectrum Management Association (NSMA), the Federal Communications (FCC) and the International Telecommunication Union (ITU) have done studies and taken positions with regard to the coexistence of HDFS and satellite systems within these bands. It is the Wireless Communications Association s (WCA) position that HDFS wireless links should not suffer unacceptable interference from other licensees on co- or adjacent channels.

Typically HDFS systems operate at 99.999% availability in order to compete with equivalent fiber optic systems for access services. Therefore, any unacceptable interference to PTP or PMP systems will severely degrade Network performance, and impact overall network efficiency, throughput, and service quality. In order for HDFS to perform properly coordination with other potentially interfering systems must be performed and any standards body must take into account the complexity of these mixed PTP/PMP networks and the operators criteria for coexistence.

This document will provide guidelines for including PTP/PMP link characteristics in any coexistence criteria developed by standards bodies and provide recommendations for amending the IEEE 802.16.2 Practice. It is extremely important that the proper coordination take place with any potential interfering *HDFS , Geostationary (GSO) and Non-Geostationary (Non-GSO) satellites as specified by the ITU-R. The ITU-R is presently working on a number of standards concerned with the effects of Satellites on HDFS systems. WCA is particularly

concerned about the accumulative effect of these systems on HDFS . Furthermore, WCA is concerned about the deployment of new high capacity Radios. These radios must meet the criteria of **99.999%** availability under the most stressed conditions.

Co-Existence of PTP and PMP Systems

Many HDFS networks consist of a high percentage of PTP radios overlaid with PMP radios. Prior to deployment a careful line of sight (L-O-S) and interference analysis are performed to mitigate intra-system interference and assure link availability of 99.999%**.** It is incumbent on other HDFS networks to assure that proper coordination is done before implementing potentially interfering links. The NSMA, FCC, ITU-R and IEEE have done studies to consider the proper co-existence of systems in this frequency band. However, the IEEE 802.16.2 committee which is recommending a Practice for Coexistence of Fixed Broadband Wireless Access Systems (FBWA) has not considered nor set guidelines for the coexistence of PTP systems. Considerable analyses and guidelines for PMP systems have been established in the 802.16.2 document. Moreover, ITU-R, WRC-2000 and Resolution 84 et al, also addressed interference for protecting PTP/PMP HDFS links from GSO and non-GSO satellite systems.

PMP and PTP systems must coexist in any particular market layout. The characteristics of PMP and PTP systems are very different. PMP systems utilize Hubs that are sectored in 90-degree (or less) increments, providing up to 360 degrees of coverage with antenna gains of 16 dBi to 23 dBi or higher. PTP systems on the other hand have narrow beam antennas with typical gains up to 44 dBi. Figure 1 shows a HDFS cellular configuration consisting of PMP/PTP systems and an interfering cell that may be typical of an HDFS deployment. Both the Central/Hub and Remote/Subscribers can cause interference in an HDFS

system. The Interfering cell has an impact on the operation of HDFS cells. Thus, the proper coordination procedures must be in place. As can be seen in Figure 1, the Hub, PMP or PTP systems can receive interference from the interfering cell. One critical issue that needs to be addressed is that the interfering cell can cause significantly more interference on the PTP systems than on the PMP systems because of the higher antenna gains of the PTP radios. Included below is a calculation of the interference caused in both the PMP and PTP configurations as considered by the ITU. The fundamental equation for the Power Flux Density (***Pfd***) is:

Pfd = Prl +10 log (4 *3.14 **) -** 20 log (c/f **) -** Gr

Where : Prl = power in interference objective = No+NF+I/N (dBW/MHz)
Gr = receive antenna gain
f= 38 GHz
c = 300,000,000 m/s
No = -144 dBW/MHz
NF= 3 to 6 dB
I/N= -6 to —10 dB

For a PMP system, Gr = 16 to 23 dBi (Hub/Central Antenna)

Therefore: for Gr= 16 dBi

Pfd = -144 + 11 + 42 — 16

Pfd = - 107 dBW/m*2 ; in any 1 MHz

for Gr= 23dBi

Pfd = -144 +11 + 42 —23

Pfd= -114 dBW/m*2 ; in any 1 MHz

For a PTP system Gr = 44 dBi (Remote/Subscriber Antenna)

Therefore:

Pfd = -144 +11 + 42 — 44

Pfd = -135 dBW/m*2 ; in any 1 MHz

It can be seen that for a PTP system, a much lower ***Pfd*** is needed for the given distance between cells. For the PTP case, the threshold has a 29 dBW/m*2/MHz lower power flux density that can be tolerated versus that of a PMP system. If the accumulated effect of many interferers (HDFS and Satellites) is considered, a lower ***Pfd*** is needed.

Another factor that should be considered is the acceptable distance D between an interfering cell causing co-channel interference and a cell with radius R that is being interfered with. To properly address this situation two (2) cases should be considered. In case 1; The distance D can be appropriately found by comparing the tolerable received interference ***Pfd*** with the possible transmitted interferer s ***Pfd*** and relating the difference to the distance between the two. In case 2, the distance D could be found from the equation:

Q = D/R = Square Root (3* N)

which has been derived from considering the minimum C/I for high quality voice, video and data communication.

The following are ratios for specified cluster sizes (N) for an acceptable C/I as examples.

N	**Q**
3	3
7	4.58
12	6
13	6.24

If higher order modulations are used, such as 64 QAM, the C/I ratio could be as high as 25 dB. These calculations will have to be investigated when the analysis is performed. In coordinating distances between cells to prevent co-channel interference, the distance D should be considered the minimum acceptable allowable distance to assure acceptable receive levels at subscriber sites and Hubs within a Cell. For a particular subscriber, the minimum distance could be D+2R. As specified by the FCC, and the coordination distance is 16 km (not 60 km)

To reduce the excess burden to both parties it is recommended that a distance of 10 km be used and only if I the RF Receive level exceeds —87 dBm at the border.

To summarize some of the criteria to assure co-existence for PTP and PMP systems, refer to table 1.

Radio Entity	Interference Objective (dBW/m*2/MHz)	Minimum Distance (kM)
HUB (PMP)	-107	
Subscriber (PMP)	-127	
PTP (Subscriber/HUB)	- 135	

Table 1

Interference Objectives for Various Radio Entities

It can be seen that a PMP HUB with a 90 degree antenna and a gain of 16 dBi might have an acceptable ***Pfd*** of -**107dBW/m*2/MHz**, whereas a radio associated with a PMP system might have an acceptable Pfd of **-127dBW/m*2/MHz**. For a PTP radio in the same cell an acceptable ***Pfd*** may be **-135dBW/m*2/MHz.**

The key aspect of WCA s position is that HDFS Networks will likely consist of both PMP and PTP systems and that any interference from another licensed user must consider interference to both the PMP and PTP Network.

Figure 1 indicates the co-existence of PTP/PMP and other potentially interfering Networks in a typical HDFS configuration that would exist in Los Angeles, New York City, etc. Interference from the HUB or PTP/PMP radios from a coexisting Network must comply with the ***Pfd*** s as indicated above. Further interference from GSO/non-GSO Satellites must also be taken into account in considering ***Pfd*** s for co-existence as specified in ITU documents referred to before. For example, in New York City where the cells are close together (short links), there may be considerable interference from coexisting Networks and GSO/Non-GSOs. Figure 1 should be utilized as a basis for considering the accumulated effects from interferers. Maximum trigger distances can be calculated from this configuration. Various antenna configurations could be utilized to adequately consider the effects of interference, since receive antenna gain and configuration is a factor in determining ***Pfd*** trigger limits.

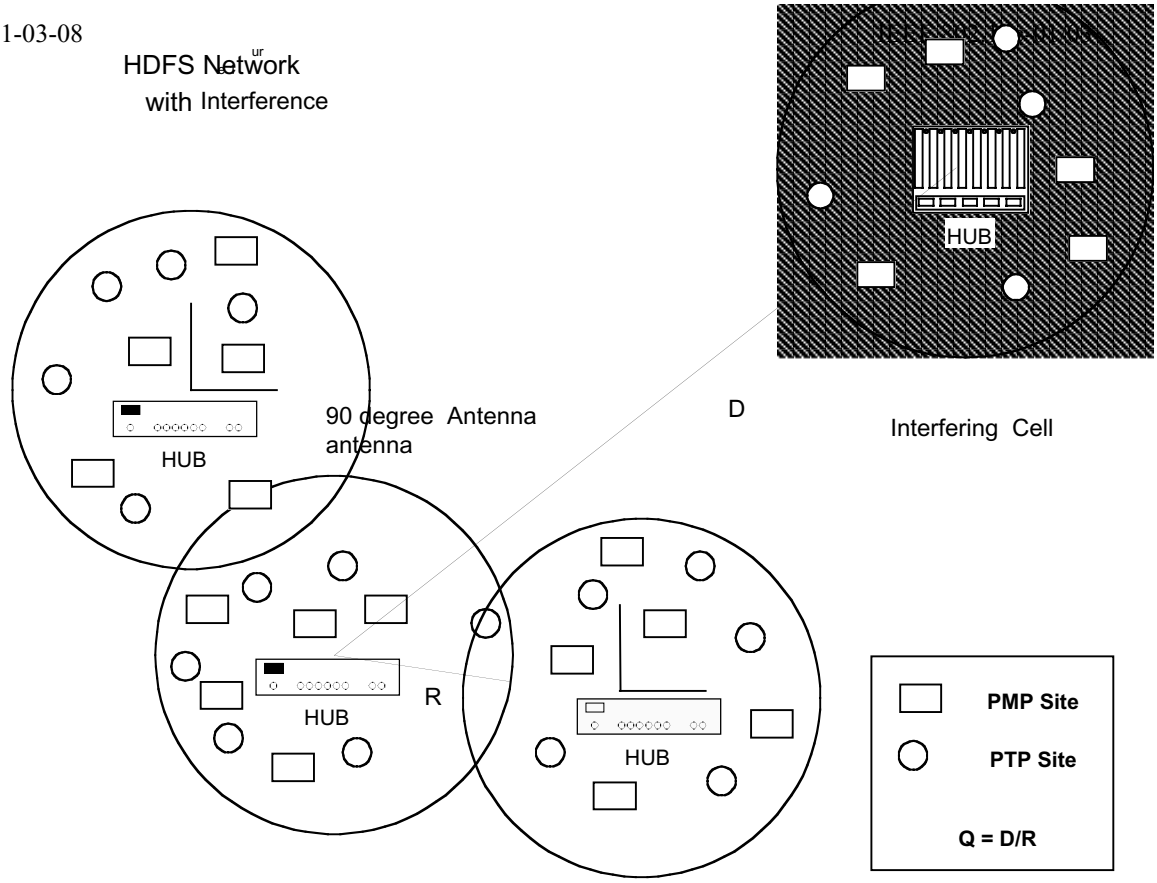

Figure 1

Additions and Modifications to 802.16.2 Document

WCA is recommending additions, deletions and modifications to the IEEE 802.16.2 document to include the criteria for interference to PTP systems. Although considerable analysis and simulations have been done to determine the effects on PMP systems, additional studies on the effects on PTP systems must be included. In fact Recommendation 6 of the current Co-existence Practice refers to the need to investigate protection of PTP systems where they are deployed with PMP systems. There will be instances where operators may employ a given frequency band for PMP access and employ the same or lower frequency bands for PTP, inter-cell links. These longer haul PTP links will need to coexist with other PMP systems in those bands.

The IEEE document should include the input from vendors of PTP systems including high-capacity radios.
The document should consider input from operators on the overall deployment architectures. Furthermore,
the impact of different licensing procedures in various international markets where PTP may be licensed individually must be considered. WCA has made specific recommendations to the IEEE working groups for inclusion into 802.16.2. These recommendations should be adhered to in the Practice.

CONCLUSIONS

HDFS deployment of Point-to-Multipoint (PMP) and Point-to-Point (PTP) radios requires that they coexist with other licensed systems in the 24, 26 28 and 37 — 42.5 GHz frequency bands . It is essential for many of WCA operators to maintain radio links that provide for a 99.999% availability under all conditions. Therefore, in order for the proper coordination to take place, accurate Power Flux Densities (***Pfd***) must be determined to assure the correct trigger limit is specified. Where there is significant deployment of PTP systems as well as PMP systems, protection of the PTP systems is mandated; tighter ***Pfd*** trigger levels will be appropriate.

This document has provided the analytical rationale for choosing PTP systems trigger ***Pfd*** values and minimum distances necessary for the proper operator coordination to take place. It has also included specific recommended changes to the 802.16.2 document. The **–135dBW/m*2/MHz** value calculated is a much tighter level than specified in the IEEE 802.16.2 document . The analysis and recommendations for additions and corrections in the IEEE 802.16.2 document have been done in order to prepare for an amendment to the existing 802.16.2 document in the form of a project authorization request (PAR). The recommendations made in this document are essential to assure the proper

operation of the HDFS networks. The IEEE 802.16.2 document should be modified to reflect the recommendations made above. Alternatively, to make it easier for the generic FS/HDFS community it may be useful to define the ***Pfd*** values in dBm.