Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**An Interference Requirement on the proposed TG4 Standard-based BFWA System**
Date Submitted	**2001-03-04**
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Re:	This contributions is based on request made by the TG4 PHY Layer Interim 11.5 Session
Abstract	This contribution has endeavored to make a case for the need for BFWA antenna directivity specification in the proposed TG4 BFWA Standard. It is recognized and proposed that the value of BFWA system antenna directivity that should be specified by TG4 requires further study, and liaison with the ITU-R Study Groups working on this issue.
Purpose	The purpose of this contribution is to identify the need for TG4 to specify U-NII BFWA systems antenna directivity, as a means for the reduction of BFWA interference to space-borne sensors that have been assigned as primaries by WRC '97 in the Mid-U-NII band, and that TG4 should establish liaison with ITU-R Groups currently considering such interference issue.
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1.0 Introduction

At the closing minutes of the PHY Layer group's meeting at the TG4 Interim meeting in San Jose Ca., the requirement on Wireless HUMAN Standard-based Broadband Fixed Wireless Access (BFWA) equipment (operating in the U-NII 5250 to 5350 MHz band) not to interfere with the Earth Exploration Satellite Services (EESS)(active) and Space Research Services (SRS)(active) was considered but not resolved. I was among a number of other participants that volunteered to contribute to the next TG4 Session on the interference benefits of BFWA antenna directivity to space-borne sensors.

It should also be noted that the Contribution 802.16.4c-01/13(presented at the 802.16.4 Session #11) listed a number of key coexistence considerations (including one on BFWA antenna directivity) that Wireless HUMAN Standard-based Broadband Fixed Wireless Access (BFWA) equipment (operating in the U-NII 5.25 to 5.35 GHz band) need to consider.(See Appendix 1). Review of these considerations may facilitate a reader's understanding of the BFWA systems' interference to space-borne sensors and other relevant issues.

2.0 Interference from Middle U-NII BFWA Systems into SAR-4

The interference requirement stems from the 1997 the World Radiocommunications Conference (WRC '97) that allocated the 5250-5350MHz and 5350-5460 MHz bands on a world wide-primary basis to the radiolocation services. These bands are currently also allocated on a world wide-primary basis to active space-borne sensors, including Synthetic Aperture Radars (i.e., SAR 1-4). See Appendix 2 on the Characteristics of these SARs from ITU-R WP7C/126, "Analysis of Potential interference Between Spaceborne SARs and Wireless High speed Local Area Networks Around 5.3.GHz.".

What follows is an attempt to give an indication to TG4 participants of the interference minimization capability of BFWA antenna directivity to SAR-4, based on some published results of ITU-R studies(e.g., USA ITU-R WP7C/24 Contribution). SAR-4 is used because the SAR-4 system is the most interference sensitive and its center frequency is 5.3GHz.

The approach used in the above noted ITU-R study in analyzing the interference potential from a Middle band U-NII BFWA systems into space-borne SAR 4 receiver was to determine the worst case signal power from a single BFWA transmitter at the space-borne SAR. Then, the single interferer margin can be calculated by comparing the BFWA system interference level with the SAR interference threshold. Knowing the SAR footprint, the allowable density of active BFWA transmitters can then be calculated, if a positive margin results from a single BFWA interferer.

3.0 Interference from Fixed Wireless Access Systems into SAR-4

Table 1 Summarizes the assumed for demonstration purposes characteristics of two Mid-U-NII band BFWA systems. BFWA1 uses an omni-directional antenna, while BFWA2 antenna has some directivity that results in an antenna high elevation gain of -4.0dBi .

Table 2 summarizes the analysis result that indicates that while both BFWA (under worst conditions) fail to meet the SAR-4 interference threshold requirement, the antenna directivity of BFWA2 results in less interference to SAR-4 than BFWA1.

It is noted that while this contribution has tried to make a case for the need and benefits that can result from BFWA antenna directivity specification in the proposed TG4 Standard, it is recognized and proposed that the value of antenna directivity that should be specified by TG4 requires further BFWA system studies, and liaison with the ITU-R Study Groups working on this issue.

Table 1. Technical Characteristics of Two Mid-U-NII BFWA Systems at 5.3 GHz

Parameters	BFWA1	BFWA2
Frequency Band	5.25-5.35 GHz	5.25-5.35 GHz
Operation Mode	Point to multipoint	Point to multipoint
Cell radius	1 to 2 km	1 to 2 km
EIRP (dBW)	-6 dBW	0 dBW
Transmitter Peak Power (W)	.250 W	.250 W
Antenna Peak Gain (dBi)	0 dBi	6 dBi
Antenna High Elevation Gain (dBi)	0	-4.0 dBi
Transmitter Bandwidth (MHz)	20 MHz	20 MHz
Receiver Noise Figure (dB)	8 dB	8 dB
Polarization	Vertical or horizontal	Vertical or horizontal
Active ratio	100 % within cell	100 % within cell

Table 2.Interference from a Single U-NII BFWA Transmitter to

Parameter	SAR-4	
	Value	DB
Transmitted Power, Watts		
BFWA1	0.25	-6.02
BFWA2	0.25	-6.02

Building Loss, dB	0.00	0.00
Antenna High Elevation Gain, Xmit dB		
BFWA1	0.00	0.00
BFWA2	-4.00	-4.00
Antenna Gain, Rcv dB	44.52	44.52
Polarization Loss, dB	3.00	-3.00
Wavelength, m	5.65E-02	-24.96
(4*pi)-**2	6.33E-03	-21.98
Distance, km	425.67	-112.58
Power received, dBW		
BFWA1		-124.03
BFWA2		-128.03
Noise Figure, dB	4.62	4.62
k*T	4.00E-21	-203.98
Rcvr Bandwidth, MHz	46.00	76.63
Noise power, dBW		-122.73
SAR-4 Interference threshold (I/N=-6dB)		-128.73
Margin, dB		
BFWA1		-4.71
BFWA2		-0.71

APPENDIX 1
KEY COEXISTENCE CONSIDERATIONS FOR THE TG4 BFWA SYSTEM

A. That the frequency band 5250-5350MHz is allocated to the Earth Exploration Satellite Services (EESS)(active) and Space Research Services(SRS)(active) on a primary basis;

B. That the allocation in the frequency band 5250-5350MHz will be reviewed by WRC 2003 under agenda Item 1.5 with a view to allocate this band to mobile service, and for Region 3 to fixed wireless access(FWA);

C. That currently in USA the 5250-5350MHz band is part of the Unlicensed National Information Infrastructure(U-NII) that permits operation of FWA devices and that large number of proprietary PMP FWA systems are currently in service;

D. That some administrations have proposed using the 5250-5350MHz band for broadband radio local area networks (RLANs) in the mobile services;

E. That the broadband RLANs in the mobile services are proposed to be deployable in the 5250-5350MHz band world wide as unlicensed devices, making regulatory control of their deployment density non-feasible;

F. That ITU-R studies indicate that to meet the interference requirements of the EESS (active) and SRS (active) systems, there is a need for RLANs that use this band to be constrained (e.g., RLANs used indoors only, limit their density and their E.I.R.P, and restrict operationally), and that other wireless access transmitters (e.g., FWA) in this band also need to limit their EIRP so that the total interference does not exceed the EESS or SRS systems' threshold of allowable interference; Worst case consideration indicate that interference from a single RLAN operating indoor at 200 mw peak radiated power will exceed the SAR4 interference threshold.

G. That as the repeat period for the sensitive Synthetic Aperture Radar (SAR 4) is 8-10 days, and as the SAR is not necessarily active for every repeat pass, a given area of the earth would be illuminated by the SAR beam(footprint of 57.6Kmsq and Bandwidth 46 MHz) no more often than .5-1.0 second every 8-10 days

H. That wireless LANs (WLANs) standard groups are currently seeking ways for WLANs detecting the arrival of a SAR illumination and stop transmitting at the bird's frequency.

I. That FWA devices can minimize their interference to EESS (active) and SRS(active) through the permanent positioning of high directivity antennas, and their back-off on the peak transmitted power and the peak power spectral density reduction by the amount of dB that the directional gain of the antenna exceeds 6dBi, and using modulation techniques with low peak to average ratio;

J. That RLANs using omni-directional antennas are likely to be deployable in the 5250-5350MHz band world wide as unlicensed devices, the regulatory control of their indoor/outdoor deployment is not-feasible;

K. That the excess path loss (provided by building structures has been estimated based on preliminary studies to be on the average 15 dB) is beneficial to the sharing of the 5250-5350MHz frequency band among EESS (active), SRS (active), FWA, and RLANs;

APPENDIX 2

Technical characteristics of space-borne active sensors in the 5 250-5 570 MHz band Table 1

5.3 GHz typical space-borne imaging radar characteristics

Parameter	Value			
	SAR1	SAR2	SAR3	SAR4
Orbital altitude	426 km (circular)	600 km (circular)	400 km (circular)	400 km (circular)
Orbital inclination	57 deg	57 deg	57 deg	57 deg
RF centre frequency	5 305 MHz	5 405 MHz	5 405 MHz	5 300 MHz
Peak radiated power	4.8 Watts	4 800 Watts	1 700 Watts	1 700 Watts

Polarization	Horizontal (HH)	Horizontal and vertical (HH, HV, VH, VV)	Horizontal and vertical (HH, HV, VH, VV)	Horizontal and vertical (HH, HV, VH, VV)
Pulse modulation	Linear FM chirp	Linear FM chirp	Linear FM chirp	Linear FM chirp
Pulse bandwidth	8.5 MHz	310 MHz	310 MHz	40 MHz
Pulse duration	100 microsec	31 microsec	33 microsec	33 microsec
Pulse repetition rate	650 pps	4 492 pps	1 395 pps	1 395 pps
Duty cycle	6.5%	13.9%	5.9%	5.9%
Range compression ratio	850	9 610	10 230	1 320
Antenna type	Planar phased array 0.5 m x 16.0 m	Planar phased array 1.8 m x 3.8 m	Planar phased array 0.7 m x 12.0 m	Planar phased array 0.7 m x 12.0 m
Antenna peak gain	42.2 dBi	42.9 dBi	42.7/38 dBi (full focus/beamspoiling)	42.7/38 dBi (full focus/beamspoiling)
Antenna median sidelobe gain	-5 dBi	-5 dBi	-5 dBi	-5 dBi
Antenna orientation	30 deg from nadir	20-38 deg from nadir	20-55 deg from nadir	20-55 deg from nadir
Antenna beamwidth	8.5 deg (El), 0.25 deg (Az)	1.7 deg (El), 0.78 deg (Az)	4.9/18.0 deg (El), 0.25 deg (Az)	4.9/18.0 deg (El), 0.25 deg (Az)
Antenna polarization	Linear horizontal/vertical	Linear horizontal/vertical	Linear horizontal/vertical	Linear horizontal/vertical

TABLE 1 (*CONTINUED*)

5.3 GHz typical spaceborne imaging radar characteristics

Parameter	**Value**			
	SAR1	**SAR2**	**SAR3**	**SAR4**
System noise temperature	550 K	550 K	550 K	550 K
Receiver front end 1 dB compression point ref to rcvr input	-62 dBW input	-62 dBW input	-62 dBW input	-62 dBW input
ADC saturation ref to rcvr input	-114/-54 dBW input @71/11 dB rcvr gain	-114/-54 dBW input @71/11 dB rcvr gain	-114/-54 dBW input @71/11 dB rcvr gain	-114/-54 dBW input @71/11 dB rcvr gain
Rcvr input max. pwr handling	+7 dBW	+7 dBW	+7 dBW	+7 dBW
Operating time	30% the orbit	30% the orbit	30% the orbit	30% the orbit
Minimum time for imaging	9 sec	15 sec	15 sec	15 sec
Service area	Land masses and coastal areas	Land masses and coastal areas	Land masses and coastal areas	Land masses and coastal areas
Image swath width	50 km	20 km	16 km/320 km	16 km/320 km