IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)	
Title	**Interference model for 802.16**	
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Re:	[]	
Abstract	[This document contains a proposal for the inteference model of 802.16 PHYs for the 802.15.3c criteria document.]	
Purpose	[To summarize the characteristics of the 802.16 PHYs that could potentially interfere with proposed 802.15.3c PHYs and provide a suggested model for interference.]	
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1. Summary of the 802.16 PHYs

1.1 802.16-2004

IEEE Std 802.16-2004 defines a variety of PHYs for different applications and frequency bands. 802.16 can be viewed more as a "cafeteria" model for a standard; there are a variety of options that may be selected from, many which are incompatible with each other. A summary of the PHYs defined in IEEE Std 802.16-2004 is listed in Table 1.

Table 1—802.16 PHYs

Title	Frequency range	Modulation type	Comments
WirelessMAN-SC	10-66 GHz	Single carrier	
WirelessMAN-SCa	< 11 GHz	Single carrier	
WirelessMAN-OFDM	< 11 GHz	Multi-carrier	Designed for NLOS
WirelessMAN-OFDMA	< 11 GHz	Multi-carrier	Designed for NLOS
WirelessHUMAN	5-6 GHz	Multi-carrier	

Only the WirelessMAN-SC overlaps with TG3c, so this analysis focuses on that PHY. A summary of the PHY characteristics are as follows:

- Single carrier
- QPSK, 16-QAM (optional for uplink) and 64-QAM (optional for downlink and uplink)
- Symbols are filtered by a root-raised cosine filter with excess bandwidth, $\alpha = 0.25$.
- Both half-duplex and full-dupex implementations are allowed
- FDD (separate uplink and downlink frequencies) and TDD (same uplink and downlink frequencies) modes are defined.
- Two preambles are used, a 16 symbol QPSK CAZAC and an 8 symbol QPSK CAZAC, both repeated to form 32 and 16 symbol preambles, respectively.
- Four FEC schemes (two optional)
- No frequency bands or channels are specified as the rules vary widely in geographic regions and this standard is aimed at both licensed and unlicensed applications.
- Power control is required for the uplink channel, supporting at least 40 dB range and 20dB/s

The channel sizes and data rates are shown in Table 2.

The minimum performance is only specified for the 24-32 GHz band

- Center frequency $\pm 8 \times 10^{-6}$ from 10 to 66 GHz
- Adjustable transmit power (40 dB range, monotonic with 0.5 dB steps), at least +15 dBm at highest power level.
- Maximum emissions when transmitter is off: -80 dBm/MHz
- The transmit EIRP from the base station is less than +28.5 dBmi/MHz
- The transmit EIRP from the subscriber station is less than +39.5 dBmi/MHz

The receiver parameters are listed in Table 3.

Table 2—Channel bandwidth and data rates for WirelessMAN-SC

Channel size (MHz)	Symbol rate (Mbd)	Bit rate (Mb/s) QPSK	Bit rate (Mb/s) 16-QAM	Bit rate (Mb/s) 64-QAM	Recommended Frame duration (ms)	Number of physical slots per frame
20	16	32	64	96	1	4000
25	20	40	80	120	1	5000
28	22.4	44.8	89.6	134.4	1	5600

Table 3—Receiver sensitivity for various WirelessMAN-SC modulations

Parameter[a]	QPSK	16-QAM	64-QAM
Sensitivty	-90 dBm + 10 $\log_{10}$(R)[b]	-83 dBm + 10 $\log_{10}$(R)	-74 dBm + 10 $\log_{10}$(R)
SIR[c] for 1st adjacent channel interference[d]	-5 dB	+2 dB	+9 dB
SIR for 2nd adjacent channel interference	-30	-23	-16

[a]All parameters are for a BER < 1×10^{-6}. The standard also specifies parameters for a BER < 1×10^{-3}, but this represents a link that is failing, not one that is successful.
[b]R is the symbol rate in Mbd.
[c]SIR is the signal to interference ratio with an interferer that is the same modulation as the desired signal with random data. Negative numbers indicate that the signal power is less than the power of the interferer.
[d]For a 3 dB degradation. The standard also specifies the parameters for a 1 dB degredation, but that is not reflected in the table

The transmit spectral mask for the downlink and uplinks are shown in Table 4 and Table 5.

Table 4—802.16 WirelessMAN-SC downlink transmitter mask with 28 MHz channel

Frequency offset (MHz)	13	14	14.4	14.8	22.4	28	56	70
Relative attenuation (dB)	0	-15	-20	-28	-34	-42	-52	-52

Table 5—802.16 WirelessMAN-SC uplink transmitter mask with 28 MHz channel

Frequency offset (MHz)	11.2	13.5	14.5	22.4	28	56	70
Relative attenuation (dB)	0	-7	-17	-32	-37	-52	-52

1.2 802.16.2-2004

Coexistence recommended practice.

1.3 802.16-2004/Cor1/D4

A corigendum draft, it doesn't make any changes that would affect the coexistence modeling.

1.4 802.16eD11

Adds mobility and ranging capabilities but also the following PHY changes

- WirelessMAN-OFDMA: 2048, 1024, 512 and 128 FFTs are mandatory to allow varying channel widths.
- WirelessMAN-OFDMA: MIMO and space-time coding are added, but this shouldn't change any interference potential.

2. Summary and suggestion

Only one of the 802.16 PHYs, WirelessMAN-SC, lists a mm-wave band as part of its specification. Even with the designation of 10-66 GHz, it is unlikely that WirelessMAN-SC is or will be deployed in the 60 GHz unlicensed band. However, for completeness sake, we should include a model of WirelessMAN-SC as a potential inteference source. However, because of the relative bandwidths of WirelessMAN-SC (< 28 MHz) and 802.15.3c (> 500 MHz, likely > 1 GHz), WirelessMAN-SC can be treated as a tone jammer in simulations.

The author would like to propose the following model:

- 28 MHz bandwidth of AWGN noise (no need to model the actual transmit wave form)
- EIRP of 40 dBmi/MHz with an antenna gain of 25 dBi (for any directional considerations)
- Minimum separateion between 802.15.3c device and WirelessMAN-SC device of 10 m with 1 wall. The rationale is that WirelessMAN-SC is a point-to-point, last-mile application that will likely be mounted on the outside of a building.
- The antenna for the 802.16 device will be pointed away from the structure, so that the only power entering the structure would be dominated by the side-lobes of the antenna.
- Assume antenna side lobes that are -20 dB (conservative, the actual antennas would probably have better directivity).

For the interference of 802.15.3c into an 802.16 SS

- Assume the reciever is operating in QPSK mode, 28 MHz bandwidth and the desired signal from the BS is 10 dB above the reference sensitivity.
- Use the SIR for the 24-32 GHz band to determine the receiver susceptibility mask.