Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: OFDM Proposal Considerations for TV White Space

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Re: OFDM Proposal Consideration for TG4m

Abstract: This contribution is prepared to identify recommendations to TG4m.

Purpose:

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Introduction

- There has been a desire to leverage PHY modes introduced in TG4g for the purpose of TG4m.

- This work analyzes the spectral properties of TG4g OFDM signals from the point of view of TVWS regulatory requirements known at this time.

- This presentation makes recommendations to TG4m on leveraging TG4g OFDM modes with some modifications.

Out-of-band emission limit in TVWS

(Source: IEEE 802.15-11-0820-00-004m)

- **FCC** (unlicensed)
  - See the right figure.
- **Canada** (licensed)
  - Out of band emission: more than 27dB reduction
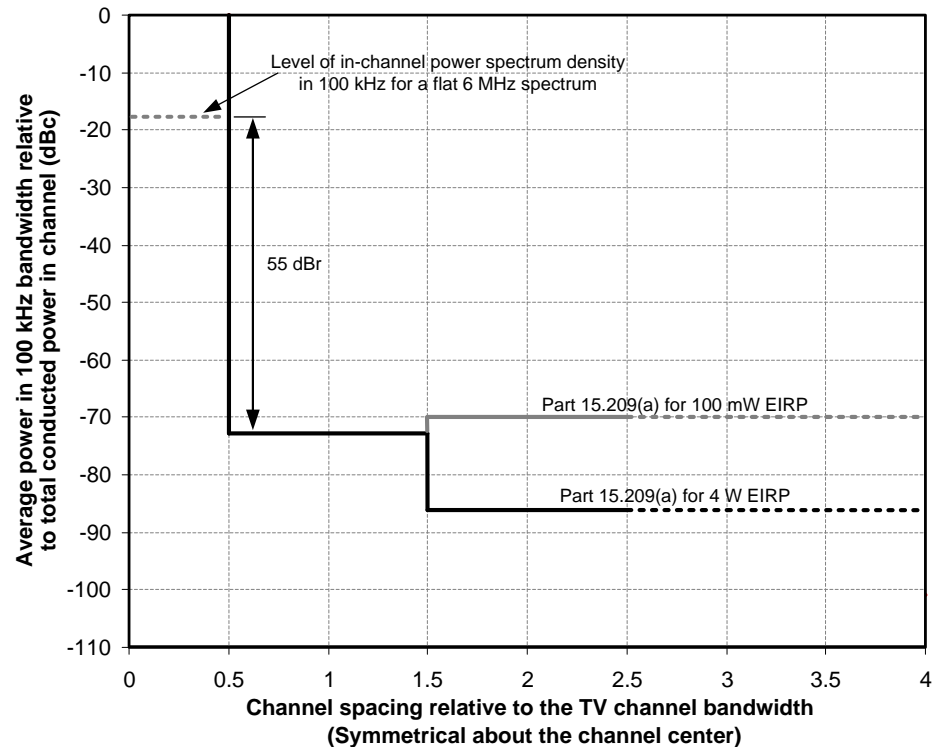- **UK Ofcom** (unlicensed)
  - Not specified yet

Chart (right side):
- Y-axis: Average power in 100 kHz bandwidth relative to total conducted power in channel (dBc), from 0 to -110
- X-axis: Channel spacing relative to the TV channel bandwidth (Symmetrical about the channel center), from 0 to 4
- Level of in-channel power spectrum density in 100 kHz for a flat 6 MHz spectrum
- 55 dBr
- Part 15.209(a) for 100 mW EIRP
- Part 15.209(a) for 4 W EIRP

Fig. 1 RF spectrum mask in USA
(Source: IEEE Std 802.22™-2011, Annex A)

TG4g OFDM Modes

	Channel Spacing (kHz)	"Nominal" b/w (kHz)	b/w -6dB (kHz)	b/w -20dB (kHz)	Channel Edge intersect (dB)
TG4g OFDM Opt 4	200	156	156	207	-18
TG4g OFDM Opt 3	400	281	281	346	-23
TG4g OFDM Opt 2	800	552	553	627	-25
TG4g OFDM Opt 1	1200	1094	1093	1166	-21

- Only ~20 dB of attenuation at the channel edge.

- Thus, a TG4g OFDM channel cannot be allocated right next to the edge of the TVWS channel.
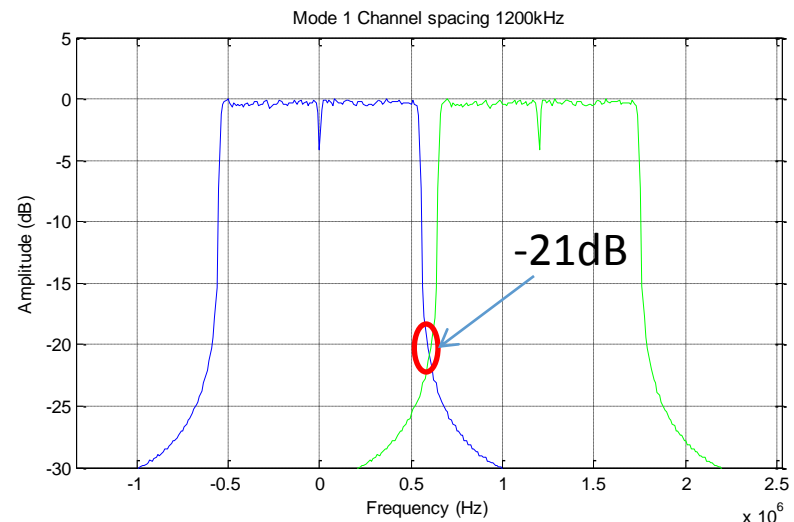

(Source: S. Shearer)

TX Filtering and Guard Bands

Welch Power Spectral Density, Option 2
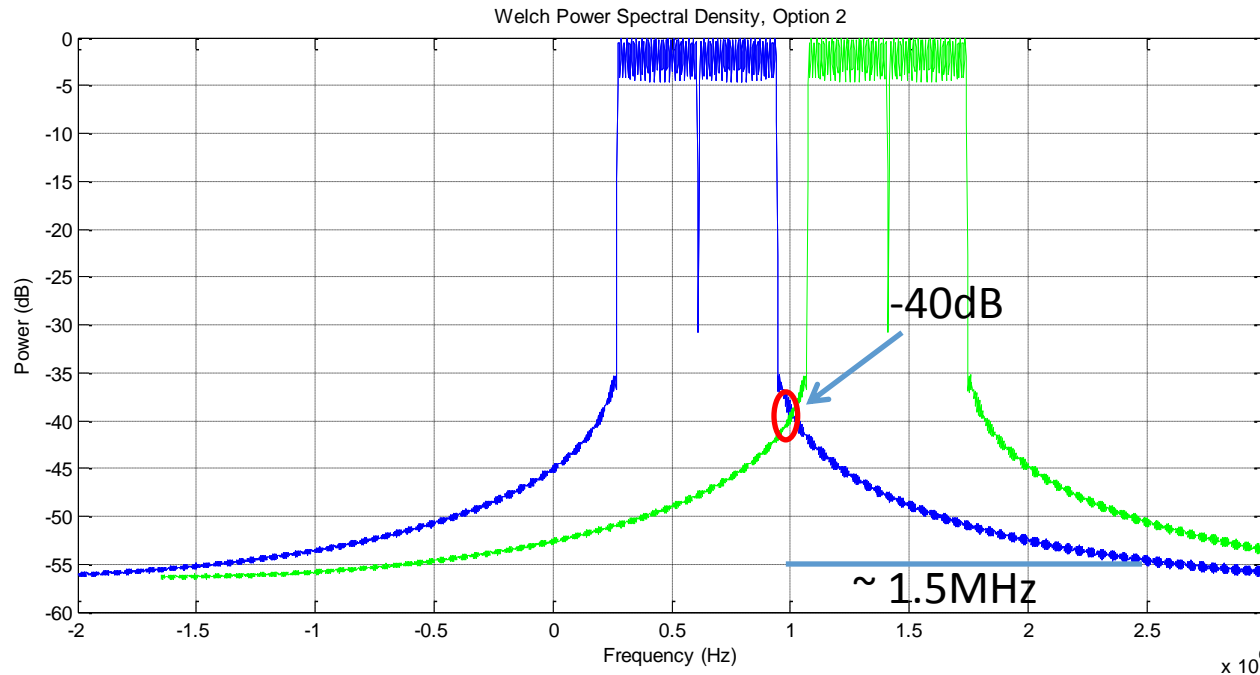
- Spectrum shaping at the TX can further attenuate sidelobes.
- However, still ~1.5MHz for side-lobe tapering to -55 dBm in this example
- That leaves about 3 MHz of "useful b/w" in a 6 MHz TV channel and 5 MHz in a 8 MHz TV channel

Use 600 kHz for Option 2

- Recommend allocating 600 kHz instead of 800 kHz channels for Option 2.

- This allows for optimal packing of TG4m OFDM channels in the "useful b/w" of a TVWS channel.

- The attenuation at the channel edge becomes ~ -18 dB, on par with that for Option 4

Option 2, 800 kHz

-20dB b/w ~ 619.7917kHz

Option 2, 600 kHz

-20dB b/w ~ 627.6042kHz
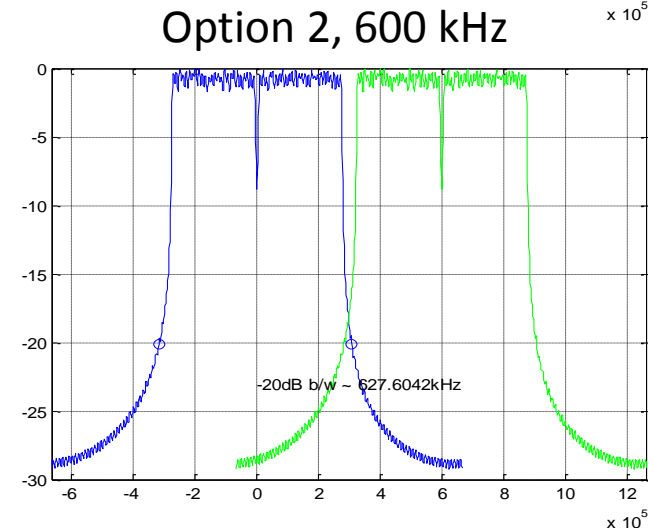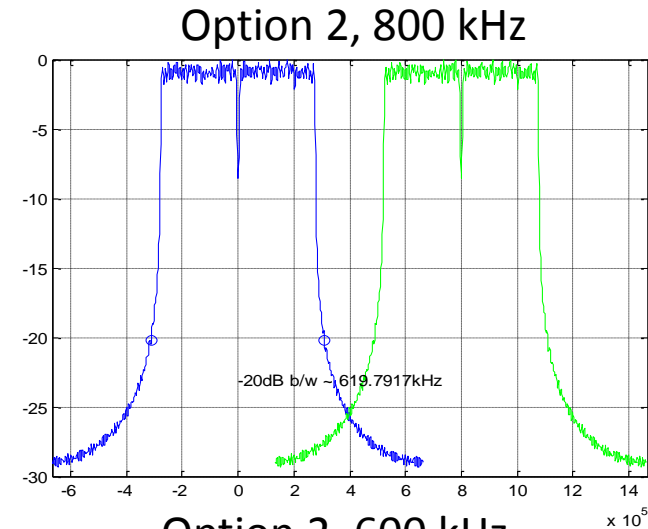
TG4m OFDM Proposal

	Channel Spacing (kHz)	Num. chan in 6MHz/8Mhz TVWS Chan, 1.5 MHz guard band	FFT Size, Tone spacing of ~ 10.4 kHz	Nominal b/w (kHz)	b/w -6dB (kHz)	b/w -20dB (kHz)	Channel Edge intersect (dB)
OFDM Opt 4	200	15/25	16	156	156	207	-18
OFDM Opt 3	400	7/12	32	281	281	346	-23
OFDM Opt 2	600	5/8	64	552	553	627	-18
OFDM Opt 1	1200	2/4	128	1094	1093	1166	-21

Generally leverage TG4g with some changes

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CONCLUSIONS

- One can generally leverage the TG4g OFDM modes for TG4m.

- However, channel spacing for Option 2 should be 600 kHz.

- Some form of TX filtering and guard band allocation required to meet TVWS regulatory requirements.