Project	**IEEE 802.20 Working Group on Mobile Broadband Wireless Access** <**http://grouper.ieee.org/groups/802/20/**>	
Title	**Simulation Data for Letter Ballot Comments on Quasi-Guard Subcarriers and Reverse Link Waveform**	
Date Submitted	**2007-1-17 (Jan 17, 2007)**	
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Re:	802.20 Letter Ballot Comments	
Abstract	This contribution provides some simulation data for letter ballot comments for 802.20, regarding the issues of quasi-guard subcarriers and reverse link waveform.	
Purpose	To show the benefits for the changes proposed in the original ballot comments.	
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Simulation Data for Letter Ballot Comments on Quasi-guard Subcarriers and Reverse Link Waveform

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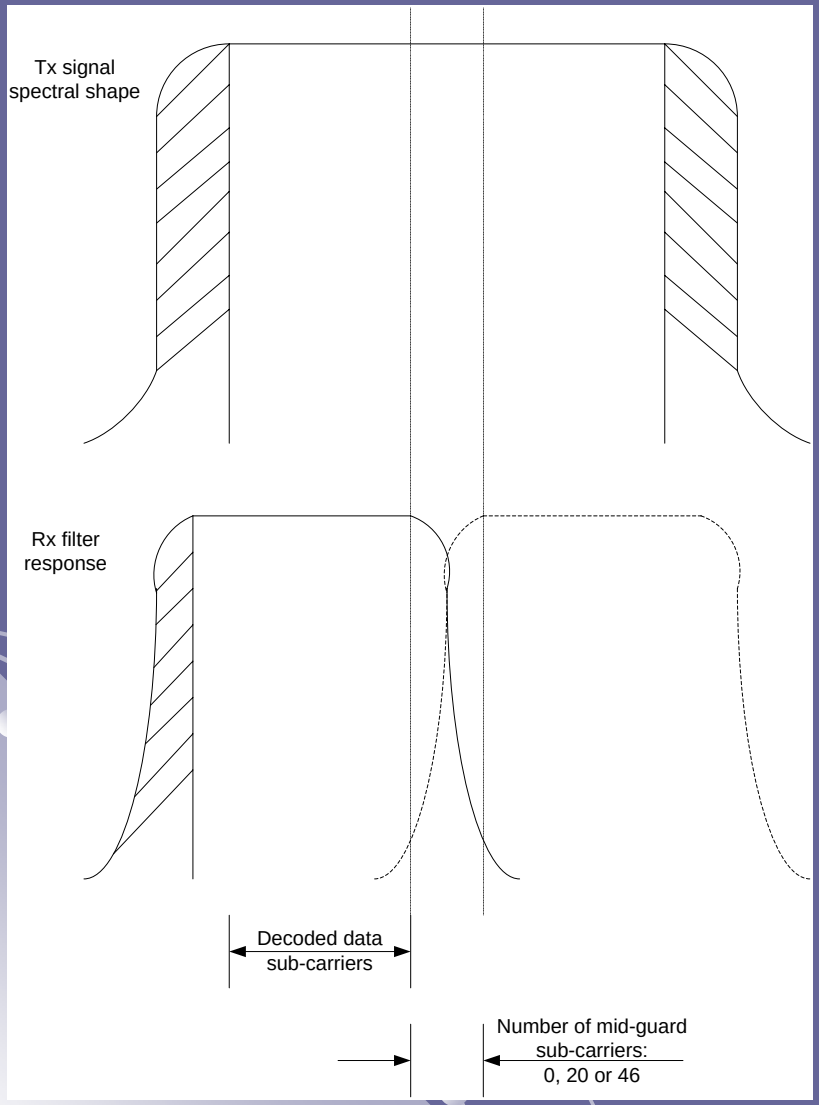
January 15, 2007

Letter Ballot Comment on Quasi-guard Subcarriers

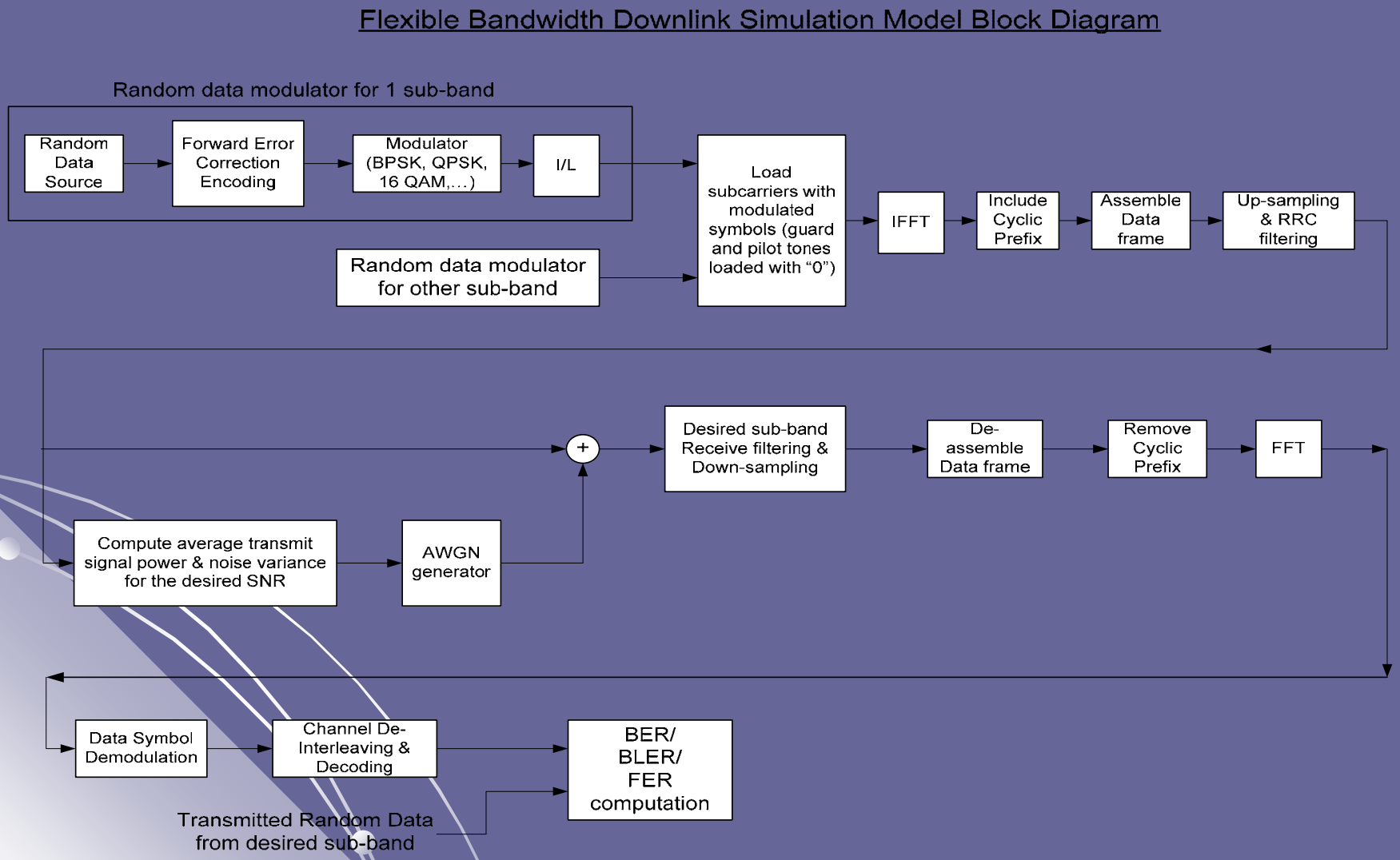
- Comments on the number of quasi-guard subcarriers were submitted to Letter Ballot (LB) 1 (#428) and LB 2 (#78)
- System can be further optimized by allowing the number of quasi- guard subcarriers to be different from that of guard subcarriers
- Current draft document requires the number of guard subarriers to be the same as that of quasi-guard subcarriers

Simulation Scenario

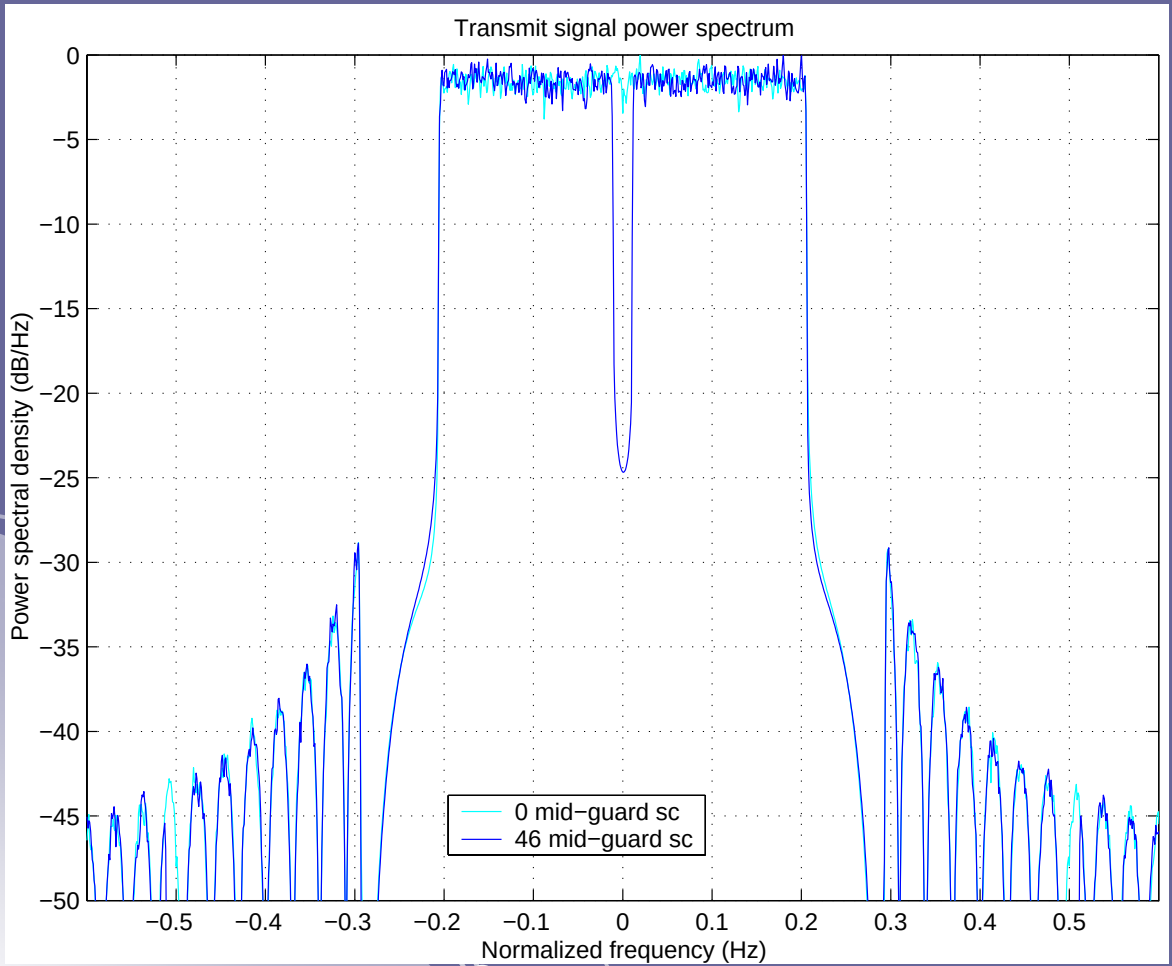


- Wideband filtered transmit signal with left-, right- guard sub-carriers: 91, 92
- Assume the scenario that two equal sub-bands, each with half of the transmitter bandwidth are served
- Simulation parameters:
  - Tx FFT: 1024
  - Rx FFT: 512
- Number of quasi-guard sub-carriers:
  - 0, 20 or 46

Simulation Block Diagram

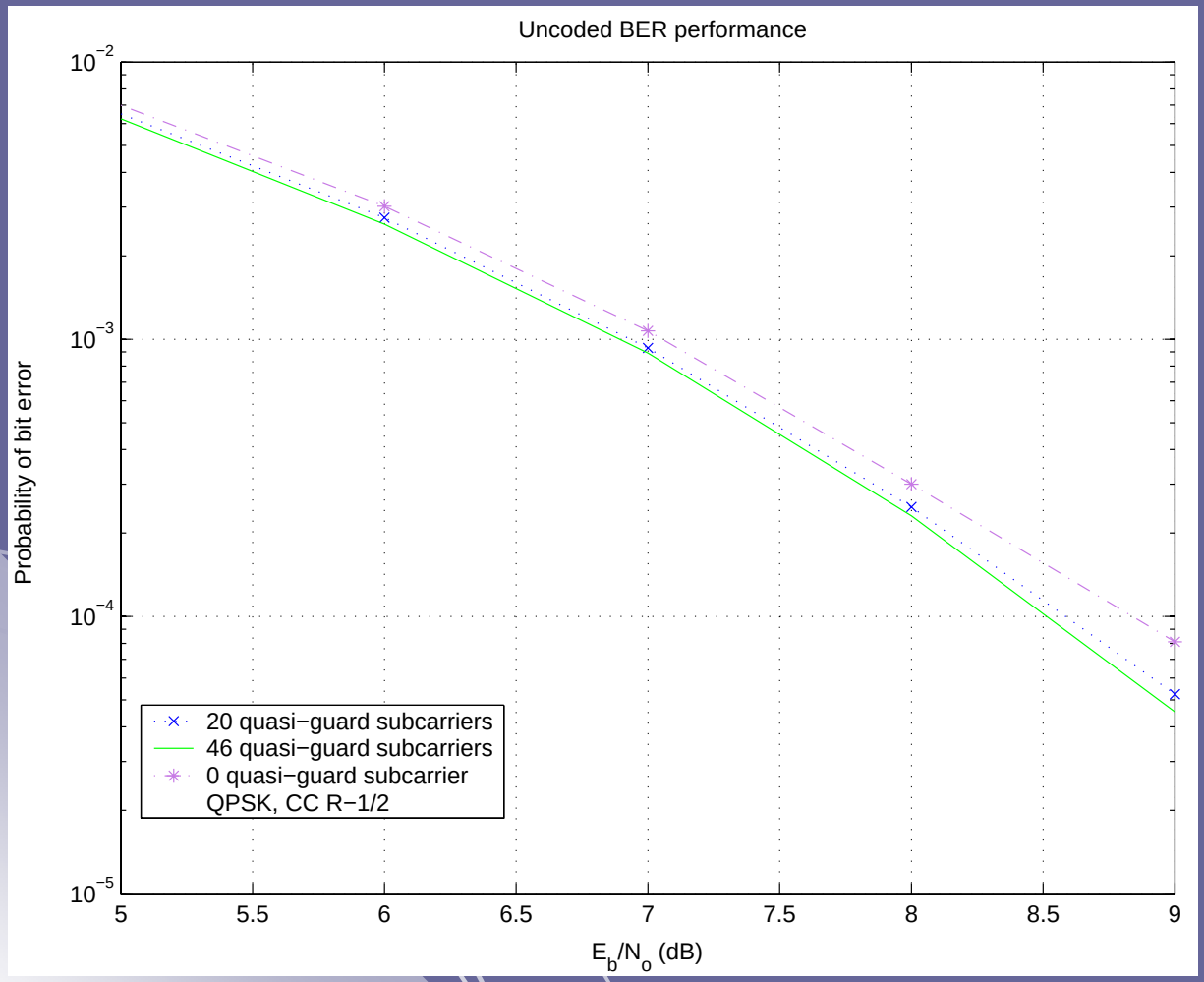


Power spectral density of transmit signal - 2 sub-bands



- Simulated transmit signal
- Parameters:
  - Tx FFT: 1024
  - 91, 92 guard sub-carriers
- Number of quasi-guard sub-carriers:
  - 0 or 46

Uncoded Bit Error Rate Performance
- for different numbers of Quasi-Guard subcarriers



- QPSK, uncoded
- No PA nonlinearity
- Comparison between:
  - 0, 20 and 46 guard sub-carriers between 2 sub-bands
- Decrease in data throughput as number of guard sub-carriers increases
- Un-coded BER performance improves as number of quasi-guard sub-carriers increases:
  - ~0.3 dB at 10^{-3} BER, in case of 46 quasi-guard sub-carriers

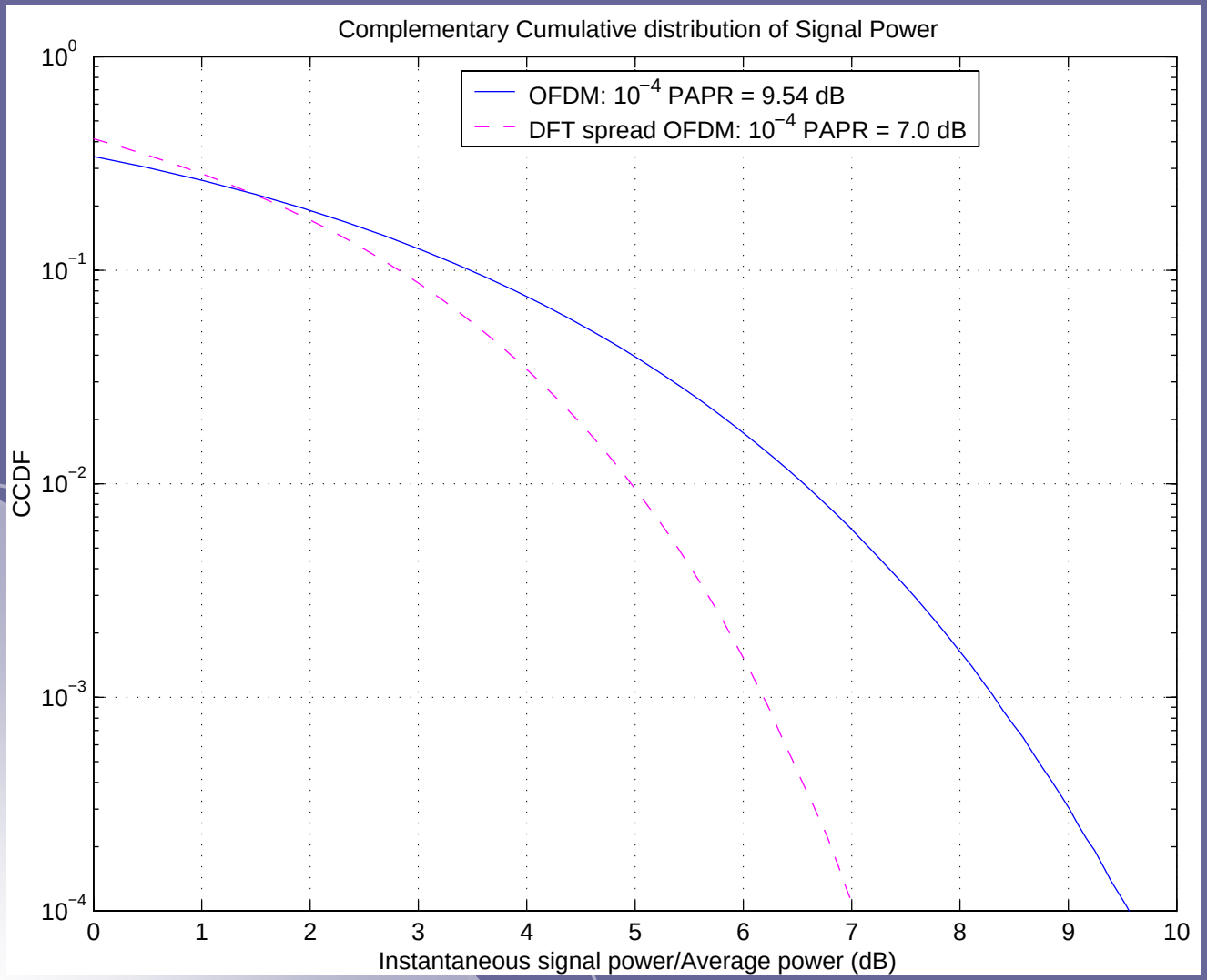
Summary

- Tradeoff between throughput and degradation
- Insignificant difference between 20 and 46 quasi-guard subcarriers
  - 20 quasi-guard subcarriers is an optimal number in this case
- Shows that the optimal number of quasi-guard subcarriers can be very different from that for the normal guard subcarriers at the band edge
- Simulation results also show the implication on tradeoff between channel spacing and performance degradation due to Adjacent Channel Interference
  - An important system aspect when multiple carriers are deployed in a given channel block
  - Information should be provided for evaluation in accordance with Section 15 of the Evaluation Criteria Document

Reverse-link Transmit Waveform

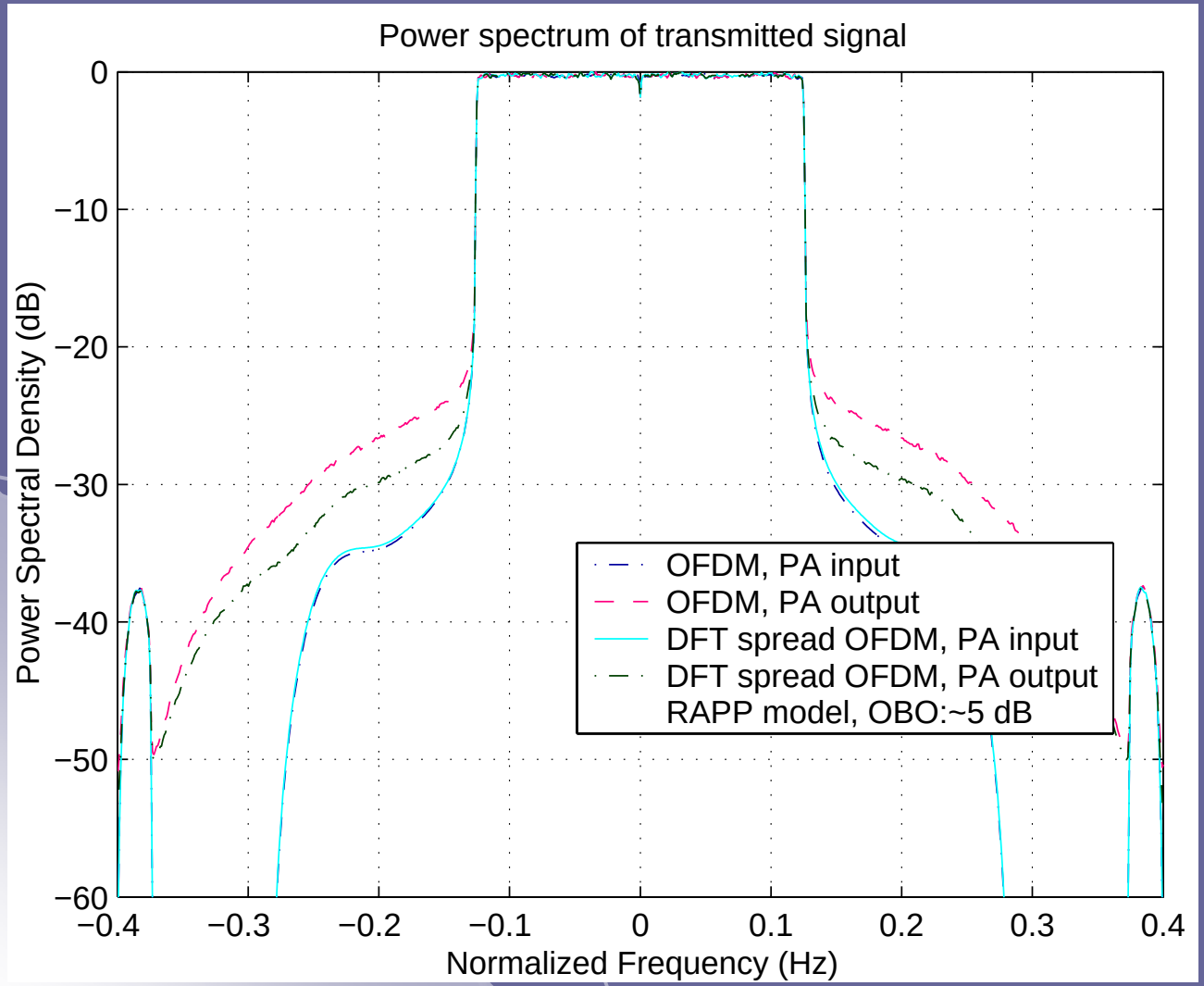
- Letter Ballot 1 Comment #22
- Letter Ballot 2 Comment #17, #18
- OFDM waveform has a high Peak-to-Average power ratio, with the following disadvantages:
  - Reduced power efficiency
  - Undesirable for mobile transmitters in the reverse link
  - Requires higher backoff at the power amplifier for:
    - Compliance with out-of-band spectral emission requirements
    - Reduction of in-band distortion
    - Reduction of adjacent channel interference
- Alternate waveform should be considered, e.g., DFT spread OFDM

PAPR Comparison: OFDM vs DFT spread OFDM waveform



- DFT spread OFDM outperforms OFDM waveform by 2.54 dB at 10^{-4} CCDF PAPR

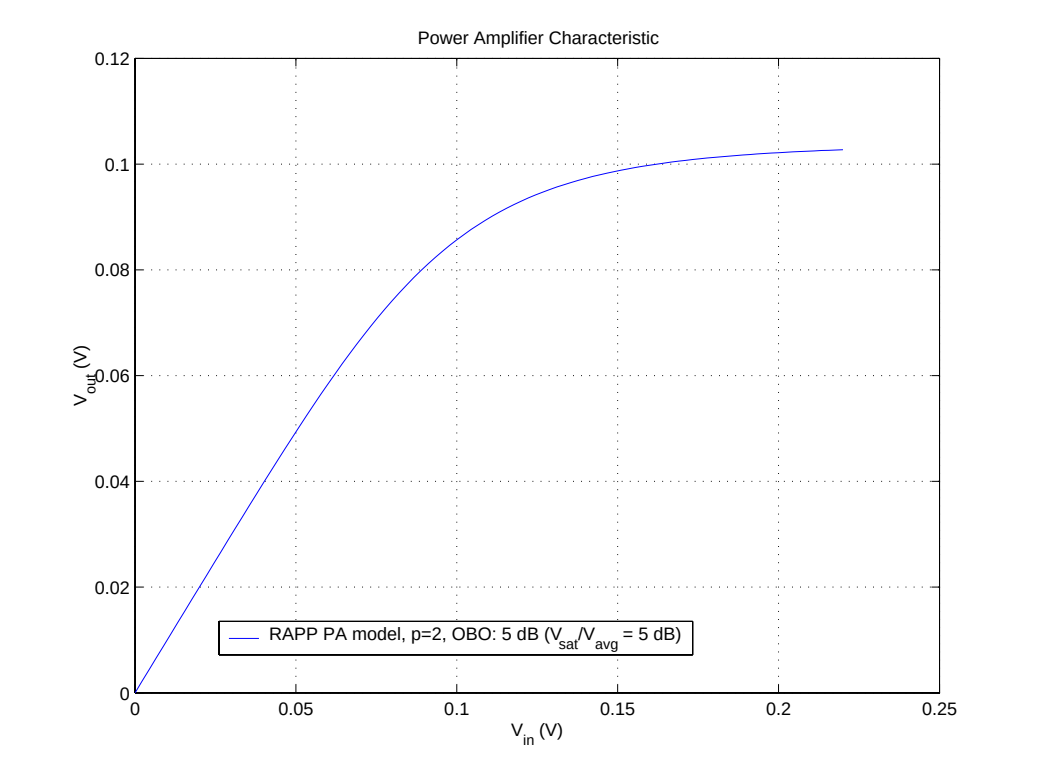
Power Spectrum: OFDM vs DFT spread OFDM waveform



- DFT spread OFDM has significantly lower out-of-band spectral emission than OFDM waveform

Power Amplifier model

- The PA model used in this simulation is RAPP's model for the AM/AM characteristic:
- Model parameter p = 2
- Operating point of PA selected such that the Output Backoff is about 5 dB



$$V_{out} = \frac{V_{in}}{\left(1+\left(\frac{|V_{in}|}{V_{sat}}\right)^{2p}\right)^{\frac{1}{2p}}}, \quad p = 2$$

Conclusion

- PAPR performance of DFT spread OFDM waveform outperforms that of OFDM waveform significantly
- Clipping of OFDM signal to reduce the PAPR will result in out-of-band spectral re-growth
  - More severe than that shown on Slide 10, which is caused by the PA model on Slide 11
- Filtering of the signal at the PA output leads to additional problems, e.g., increase in insertion loss
  - Further reduce the range and coverage of the reverse link
- Alternative waveform with lower PAPR should be considered for a reverse link coverage that is comparable with existing deployed technology, e.g., 3G systems

References

- IEEE 802.20 Letter Ballot 1 comments
- IEEE 802.20 Letter Ballot 2 comments
- ‘Suggestions on improvements for LB1 comment resolution results’, C802.20-06/24, May 5, 2005.
- IEEE 802.20 Evaluation Criteria Document, IEEE 802.20 PD-09, Sept., 2005
- ‘Performance degradation caused by adjacent channel interference’, IEEE 802.20-05/21, March 14, 2005