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Simulations Results for Subchannelization Mode

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Introduction

This document presents simulations results for the subchannelization mode.

Simulation Setup

The systems under test were those defined in 80216a-D6. Two systems were compared

a. 256 FFT OFDM mode, referred to as ‘OFDM system’.
b. Subchannelization mode using the subchannel #1. In the following this system is referred to as ‘OFDMS system’.

Both systems were designed for the 3.5MHz bandwidth, and the sampling rate was 4MHz.

The performance of the system was evaluated under and AWGN and multipath conditions.
The multipath model was the SUI model defined in document IEEE802.16.3c-01/29r4. The channel was assumed to be static. A transmit frequency error of 100Hz was assumed.

For each simulation experiment at least 1000 packets were generated. The packets contained either 200 or 1000 bytes. For each packet, a different channel impulse response was generated.
The simulation results include the effects of channel estimation and tracking, unless otherwise noted.

In the following, the SNR is defined as the ratio of the power spectral density (PSD) of the transmitted signal to the PSD of the noise. For SUI channels, the impulse response was normalized to unit power.

Performance in AWGN

Figures 1-3 show the performance of the systems, under AWGN conditions. For QPSK and QAM16 the OFDMS system outperformed the OFDM system for PER$<10^{-3}$. This is related to the use of convulotional codes (CC) only in OFDMS relative to concatenated CC and Reed-Solomon (RS) codes in OFDM. The RS codes used a block length which is equivalent to one OFDM symbol. For low modulation orders this block is short and the coding gain of the resulting scheme is impaired.
For QAM64 system the OFDMS is better for PER$<10^{-2}$. For lower error probabilities the OFDM is better. This is also related to the differences in coding schemes.

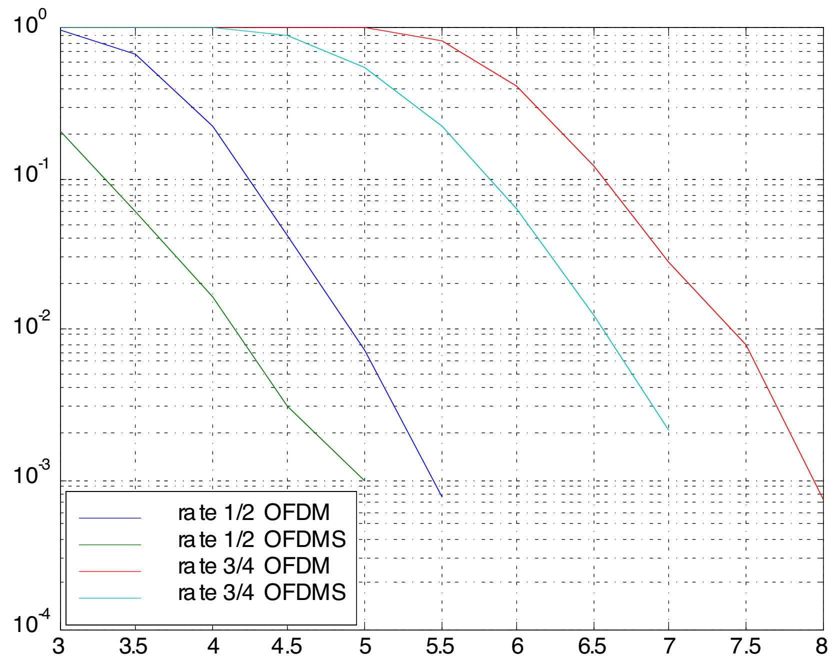

Figure 1 QPSK in AWGN channels

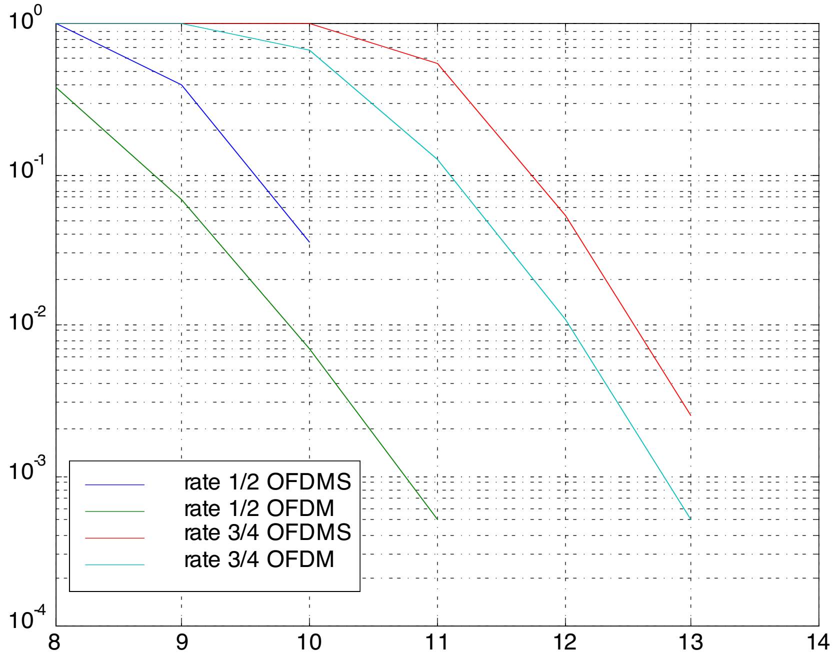

Figure 2 QAM16 in AWGN channels

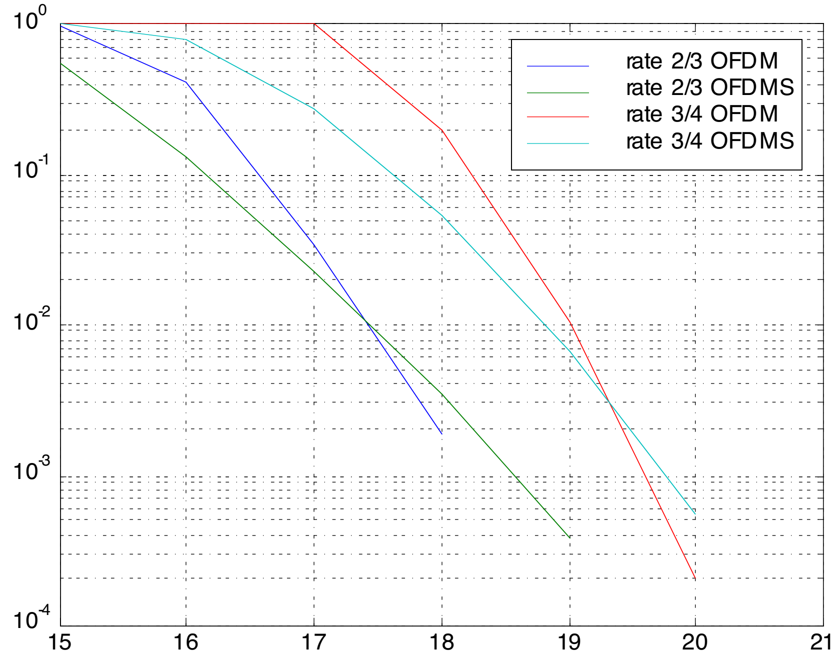

Figure 3 QAM64 in AWGN channels

Performance in Multipath

Figures 3-6 show the performance on SUI channels. For QPSK and QAM16 cases, the OFDM system is better. For the QAM64 on SUI3 channel the OFDM system is better by about 2dB. This is related to the differences in FEC error correction schemes.

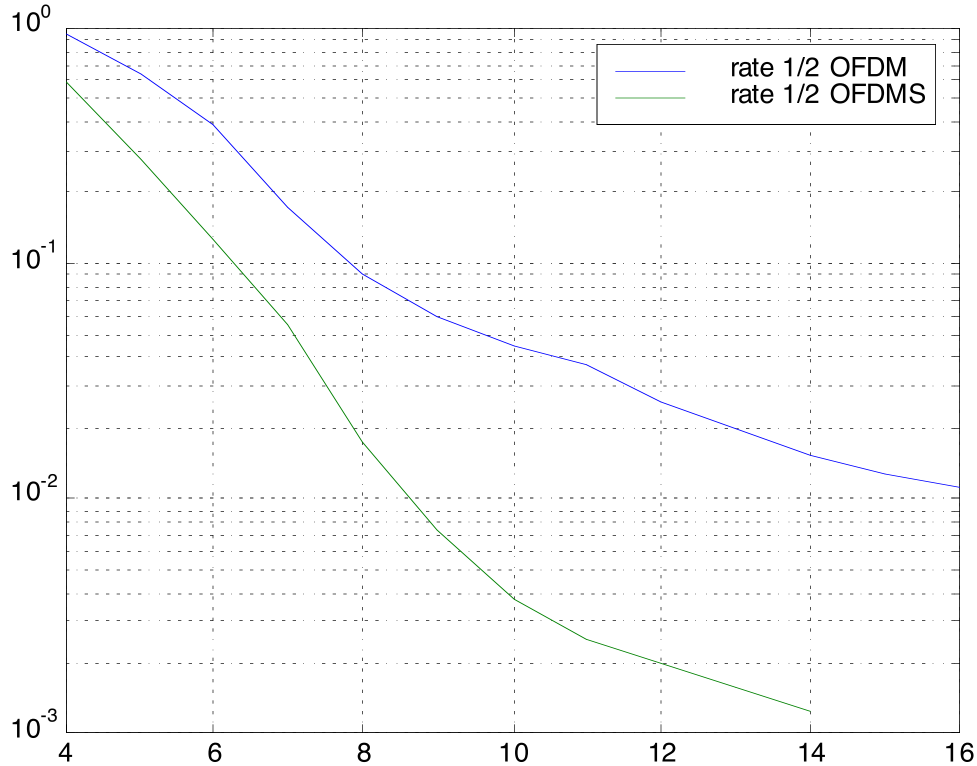

Figure 4 QPSK rate 1/2 on SUI5 channel

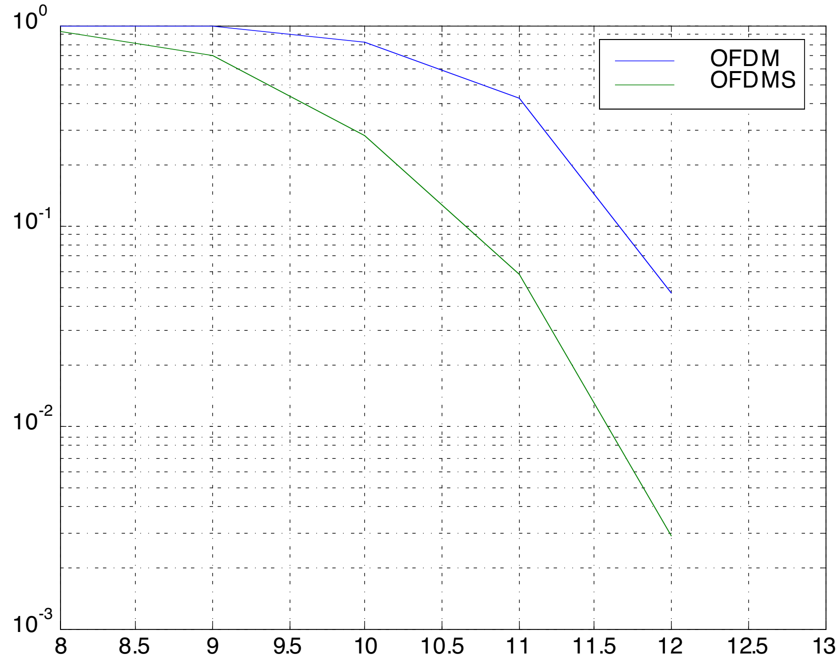

Figure 5 QMA16 rate _ on SUI 4 channel

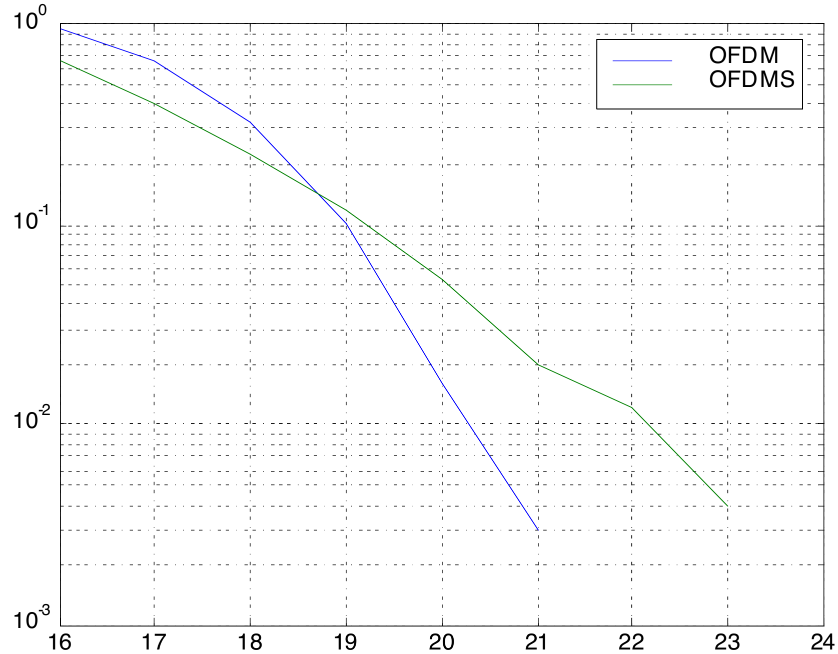

Figure 6 QAM64 rate 2/3 on SUI3 channel

Effects of Channel Estimation and tracking

In this section, effects of channel estimation and tracking are considered. Figure 7 shows the performance of the OFDMS system for QAM64 rate 2/3 under AWGN channel when:

a. Both phase/ tracking and channel estimation are employed
b. Only channel estimation is employed. The frequency error is assumed to be known.
c. The Channel State Information (CSI) is provided externally.]

The phase tracking was performed using decision aided techniques. This proved o be rather tricky and it is recommended to increase the number of pilots in the OFDM/OFDMS modes in order to allow robust pilot aided tracking,

It can be seen that channel estimation caused a degradation of about 0.8dB. This is also the case of the OFDM system (Not shown). The phase tracking incurred an additional degradation of 0.4dB.

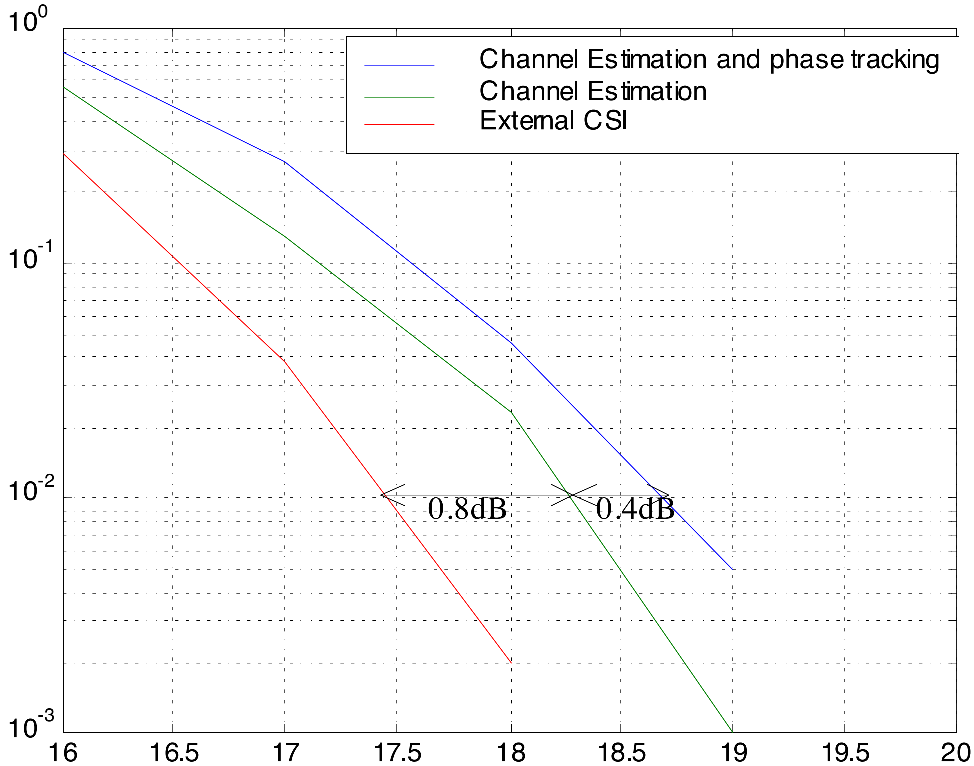

Figure 7 Effects of estimation and tracking for QAM64

Conclusions

The OFDMS system proved to be as robust or better than the OFDM system. The exceptions are:

a. QAM64 under AWGN conditions for PER $<10^{-2}$. In this case the degradation of OFDMS relative to OFDM is smaller than 0.5 db for PER $<10^{-2}$.
b. QAM64 under SUI3 conditions. The degradation here is about 2dB for PER $=10^{-2}$.

The differences are related to differences in the FEC scheme.

As defined in 802.16aD6, the OFDMS system necessities the use decision–aided tracking techniques. This is needed to overcome the fact that t only two pilots assigned to a sub-channel. The techniques employed in this simulation trial caused a degradation of 0.4dB for QAM64.

It is strongly recommended to increase the number of pilots per sub-channel.